GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY

Guru Gobind Singh Indraprastha University
Sector – 16C Dwarka, New Delhi – 110078

(Coordination Branch)
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F.No.: GGSIPU/Co-ord./46th AC/2019/17 Dated: 13 August 2019

CIRCULAR

The 46th meeting of the Academic Council of the University was held on 22.07.2019. Please find enclose herewith the minutes of the 46th meeting of the Academic Council for kind information.

(Brig. P.K. Upmanyu)
Registrar

F.No.: GGSIPU/Co-ord./46th AC/2019/17 Dated: 13 August 2019

To

1. Dean- USBAS/ USBT/ USCT/ USEM/ USICT/ USHSS/ USMC/ USLLS/ USM&PMHS/ USMS/ USAP/ USE, GGSIP University
2. Director- Academic Affairs/ Coordination/ Students' Welfare/ CDMS/ Development/ International Affairs/ CEPS/ Research and Consultancy/ Legal Aid / IUIIC, GGSIP University
3. Librarian, GGSIP University
4. Prof. P.K. Jhulka, (Retired), Max Institute of Cancer Care, 26-A Ring Road, Nirmal Puri, Nirmal Colony, Block-2, Lajpat Nagar-IV, New Delhi-110024
5. Prof. M.C. Sharma, 109, Nav Shakti Sadan, Sector 13, Rohini, New Delhi-110085
6. Prof. Karmeshu, (Retired), 150, Deepali, Road No. 42, Pitampura, Delhi-110034
7. Sh Arvind Misra, 5/101, Mathura Road, Agra-282002
8. Shri. Sandeep Gupta, 100 UB Jawahar Nagar, Delhi-110007
9. Prof. Rajiv Bhat, School of Biotechnology, Jawaharlal Nehru University, New Delhi
10. Prof. (Dr.) Pradeep Kulshrestha, Dean, School of Law, Sharda University, Plot No. 32 & 34, Knowledge Part-III, Greater Noida-201306 (UP)
11. Dr. Rupal S. Randhawa, 204-A, Pocket B, Mayur Vihar, Phase-2, New Delhi-110091
12. Prof. P.N. Varshney, E-30, Greater Kailash-III, New Delhi-110048
13. Dr. Jagdish Lal Gupta, CP-18, Maurya Enclave, Pitam Pura, Delhi-110034
14. Prof. M.N. Hooda, Director, Bharti Vidyapeeth's Institute of Computer Application & Management, A-4, Paschim Vihar, Rohtak Road, New Delhi-110063
15. Dr. Surendra Kumar, Principal, Delhi Institute of Rural Development, Holambi Khurd, Delhi-110082
16. Dr. Maharaj Krishen Bhat, Director, Maharaja Agrasen Institute of Management Studies, Maharaja Agrasen Camp, Plot No.1, Sec-22, Rohini, Delhi-110086

Contd.....2/-

17. Dr. Dhirendra Srivastava, Principal, ESIC Dental College & Hospital, Sector-15, Rohini, New Delhi -110085
18. Prof. Sanjiv Mittal, University School of Management Studies, GGSIP University
19. Prof. U.K. Mandal, University School of Chemical Technology, GGSIP University
20. Prof. Udyan Ghosh, University School of Information Communication & Technology, GGSIP University
21. Dr. Nimisha Sharma, Associate Professor University School of Biotechnology, GGSIP University
22. Dr. Gulshan Dhamija, Asst. Professor, University School of Basic and Applied Science, GGSIP University

Copy for information of the Competent Authority:
(i) AR to the Vice Chancellor, GGSIP University
(ii) AR to the Registrar, GGSIP University

Shikha

(Shikha Agarwal)
Dy.Registrar (Co-ordination)

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
SECTOR – 16 C, DWARKA, NEW DELHI - 110078

GURU GOBIND SINGH
INDRAPRASTHA
UNIVERSITY

FORTY SIXTH MEETING OF THE ACADEMIC COUNCIL

DATE : 22ND JULY, 2019 (Monday)

TIME : 03:00 P.M.

VENUE : VC SECTT., (Conference Hall)

MINUTES FOR 46TH ACADEMIC COUNCIL MEETING

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Agenda Item No. AC 46.16: **To consider and approve the Scheme of Examinations (up to 4 semesters) and syllabus of the 1st semester for M.Voc. (Interior Design) programme proposed to be introduced from Academic Session 2019-20.**

The Academic Council considered and approved the Scheme of Examinations (up to 4 semesters) and syllabus of the 1st semester for M.Voc. (Interior Design) programme proposed to be introduced from Academic Session 2019-20.

Agenda Item No. AC 46.17: **To consider and approve the syllabus of Ph.D. Program offered by CEPS**

The Academic Council considered and approved the syllabus/course content of Ph.D. Course Work for Ph.D. programme offered by CEPS.

Agenda Item No. AC 46.18: **To consider and approve the syllabus of M. Pharm. (Pharmaceutical Chemistry) offered by CEPS.**

The Academic Council considered and approved the syllabus/course content of M. Pharm. (Pharmaceutical Chemistry) programme offered by CEPS.

Agenda Item No. AC 46.19: **To consider and approve the syllabus of M.Sc (Medicinal Chemistry & Drug Design) offered by CEPS.**

The Academic Council considered and approved the syllabus/course content of M.Sc. (Medicinal Chemistry & Drug Design) programme offered by CEPS.

Agenda Item No. AC 46.20: **Finalization of Admission Brochure from the Academic Session 2020-2021 and onwards.**

The Academic Council appreciated the efforts of the University for timely planning of the activities of the next academic session. All the members approved the proposal for constitution of the committee as posed in agenda regarding finalization of Admission Brochure for the Academic Session 2020-2021 by 30th November, 2019 and also approved that thereafter the Admission Brochure should be finalized by 30th November of every year for the next academic session.

Guru Gobind Singh Indraprastha University
Sector-16C, Dwarka, New Delhi-110078

STRUCTURE, SCHEME & SYLLABUS

For

Master of Science
(Medicinal Chemistry and Drug Design)

Under

Centre of Excellence in Pharmaceutical Sciences

Entrepren urship | EmployabilitySkill Development

Semester-I	Semester-II	Semester-III	Semester-IV
PC-601: Foundation Course in Inorganic Chemistry ④	PC-602: Conformational Analysis and Asymmetric Synthesis ④	PC-701: Advanced Organic Chemistry ④	PC-702: Drug Synthesis and Mechanism of Action ④
PC-603: Foundation Course in Organic Chemistry ④	PC-604: Synthetic Methods in Medicinal Chemistry ④	PC-703: Bioenergetics and Metabolism ④	PC-704: Molecular Pharmacology ④
PC-605: Foundation Course in Physical Chemistry ④	PC-606: Spectroscopic Studies ④	PC-705(A1): Separation Science ②	PC-706: Medicinal Chemistry ④
		PC-705 (A2): Molecular Spectroscopy ②	
PC-607 Introduction to Biomolecules and Computational Chemistry ④	PC-608: Enzymes and Green Chemistry ④	PC-707: Introduction to Microbiology ③	PC-708 (A1): Formulation Chemistry ②
			PC-708 (A2): Heat and Mass Transfer ②
PC-651: Foundation Course Practical-I (Organic Chemistry) ⑧	PC-650: Medicinal Chemistry Practical⑧	PC-709: Developing Entrepreneurial Mindset ②	PC-710 (A1): Bio-Statistics ②
		PC-711: Concepts in Drug Design ③	PC-710 (A2): Bio-Ethics ②
			PC-710 (A3): Intellectual Property Rights ②
PC-653: Foundation Course Practical-II (Physico-Inorganic Chemistry) ⑧	PC-652: Enzymology ⑧	PC-751: Computational Drug Design Practical ④	PC-800: Project/Dissertation (16)
		PC-753: Microbiology Practical ④	
		PC-799: Project/Dissertation ⑧	

CC: Core Course
DCE: Discipline Centric Elective
SEC: Skill Enhancement Course ②②②②
CFC/AECC: Compulsory Foundation Course/Ability Enhancement Compulsory Course
GE: Generic Elective Course
NUES: Non University Examinational Subject

***Note: Student would have to opt one course each from 705A1/705A2, 708A1/708A2 and 710A1/ & 10A2/710A3**

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SECTOR-16C, DWARKA, NEW DELHI-110078

FOUNDATION COURSE IN INORGANIC CHEMISTRY

Course Code: **Maximum Marka: 50 + 50 (CE)**
PC-601(4 0 0) **Foundation Course in Inorganic Chemistry** **Credit: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units**.

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.

Course Objective:

1. On successful completion of this course, a student should be able to understand and appreciate basic concepts of structure and bonding in organometallic chemistry in general and also should be able predict stability of organometallic compounds,
2. It would equip students to understand the various mechanisms operative in inorganic complexes during substitution and in electron transfer reactions. Further,the utility towards synthesis of newer compounds will be studied. Concept of Metal ligand equilibrium in solutionis introduced.

Course/Learning Outcomes:

- Fundamental understanding for organometallic structure and bonding and inorganic synthetic chemistry through substitution reactions is learnt.
- Mechanistic aspect of transition metal chemistry including substitution reaction, electron transfer reaction and lig nd reactions and theory of Spectroscopic Transitions in Inorganic Complexes is incorporat d along with concept of nano materials.
- Basic concepts involved in the use of these compounds as catalysts is learnt

Unit-I

Organotransition Metal Chemistry

General introduction, Structure and bonding, Survey oforganometallic complexes according to ligands. Π bonded organometallic compounds including carbonyls, nitrosyls, tertiary phosphines, hydrides, alkene, alkyne, cyclobutadiene, cyclopentadiene, arene compounds and their M.O. diagrams. Metal-carbon multiple bonds.Fluxional organometallic compounds including π-allyl complexes and their characterization.Metallocycles, unsaturated nitrogen ligands including dinitrogen complexes, metal-met l bonds, cluster compounds of *d*-block elements.

Unit-II

Metal-Ligand Bonding

Limitation of crystal field theory, crystal field effects, John Teller distortion, nephelauxetic series, spin-orbital coupling molecular orbital theory of octahedral, tetrahedral and square planar complexes (with and without Π – bonding). Structure and bonding in complexes containing π-acceptor ligands.

Theory of Spectroscopic Transitions in Inorganic Complexes

Term symbols, Russel-Saunders states, Crystal field theory and splitting in O*h*, T*d*, D-4*h* and C4*v* systems, Orgel and Tanabe-Sugano diagrams, determination of D*q* and Racah parameters, oxidation states and electronic absorption spectra of complex ions. Spectrochemical series and effects of covalency, nephelauxetic series, magnetic properties of transition metal complexes and lanthanides.

Unit-III

Metal-Ligand Equilibria in Solution

Stepwise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.

Inorganic Reaction Mechanisms

Inert and labile complexes, mechanisms of substitution reactions of tetrahedral, square planar (theories of trans effect w.r.t. Pt (II) complexes), trigonal bipyramidal, square pyramidal and octahedral complexes. Potential energy diagrams, transition states and intermediates, isotope effects, Berry's pseudo rotation mechanism, factors affecting the reactivity of square planar complexes, Swain-Scott equation, Trans effect and its application to synthesis of complexes.

Unit-IV

Molecular Rearrangement Processes

Electron transfer reactions (outer and inner sphere), HOMO and LUMO of oxidant and reluctant, chemical activation. Precursor complex formation and rearrangement, nature of bridge ligands, fission of successor complexes, Two-electron transfers, Synthesis of coordination compounds using electron transfer reactions, mixes valence complexes and internal electron transfer.

Nanomaterials

Preparation of nanomaterials and their characteristic differences over bulk materials.Principles of Electron Microscopy, Dynamic Light Scattering, Atomic Force Microscopy and Characterization of Nanomaterials.

Suggested Reading:

1. Shriver D.F., Atkins P.W. & Langford C.H., *Inorganic Chemistry*, 5th Ed., Oxford Univ. Press (2010).
2. Gupta, B.D, Elias, A J; *Basic Organometallic Chemistry, Concepts, syntheses and applications,* 2nd edn, Universities Press (2013).
3. Mabbs F.E. & Machin D.J., *Magnetism and Transition Metal Complexes*, Chapman and Hall, U.K. (2008) Digitized (2011).

4. Rossotti F.J.C. &Rossotti H., *The Determination of Stability Constants,* MacGraw Hill, London (1961).
5. Tobe M. &Wadington F.C. (Ed.), *Inorganic Reaction Mechanism,* Thomas Nelson, London (1973).
6. Huhey J.E., Keiter R.L., Medhi O.K., *Inorganic Chemistry, Principles of Structure and Reactivity,* 4th Ed., Pearson Education (2008).
7. Cotton F.A. and Wilkinson G., *Advanced Inorganic Chemistry,* 11th Ed., Wiley & Sons, New York (1998).
8. Gilber Thomas, Kriss R.V. N. Foster& Davies G. Chemistry., 4th Ed., W.W. Norton & Co. Inc.(2014).
9. Housecraft C.E. & Sharpe A.G. Inorganic Chemistry, 1st Ed., Pearson Prentice Hall, (2005).

References:

1. Hartwig, J.F, Organo-transition metal chemistry: From bonding to catalysis, 1st edn, University science books (2010).
2. Crabtree R. H., The organometallic chemistry of the transition metals, 6thedn, Wiley (2014).
3. Eldik Rudi Van(Ed), Advances in Inorganic Chemistry, Volume62-65 and other related Volumes Elsevier Pub. (2012-2015).
4. KarlinK.ennethD,(Ed.) Progress in Inorganic Chemistry Series, Wiley Interscience (2014).
5. Wilkinson G., Gillars R.D. & A. Mcclevertry J.A.; *Comprehensive Coordination Chemistry*, Pergamon (1987, 2003).

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FOUNDATION COURSE IN ORGANIC CHEMISTRY

Course Code: **MaximumMarks: 50 + 50 (CE)**
PC-603 (4 0 0) **Foundation Course in Organic ChemistryCre it: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks:**
50Question Paper shall contain **five Units**.

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit**I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.

Course Objective:

1. On successful completion of this module, the learner will be able to identify and explain the reaction mechanisms in organic chemistryAn examination of methods use to probe the mechanism of organic reactions and chemistry of some important reactive intermediates.
2. Topics includes Nucleophillic, elecrophillic and elimination reactions; formation, reactivity and stability of free radicals, and the structure, bonding and rearrangement reactions.

Course/Learning Outcomes:

Students will gain an understanding of:

- Reaction intermediates, nucleophiles, electrophiles, electronegativity, and thermodynamic controlled reactions
- The prediction of reaction mechanisms for organic reactions and chemistry of some important reaction intermediate
- How to use their understanding of organic mechanisms to predict the outcome of reactions
- Topic include rearrangements, carbocations carbanions, carbenes, radicals and acyclic strained and strained molecule.

Unit-I

Reaction Mechanism: Structure and Reactivity

Reaction intermediates**:** Generation, structure, stability and reactivity of carbocations (classical and non-classical), ion-pairs, reactivity of bridgehead carbocations, carba ions, ambient ions, free radicals, cage effects, carbenes, and nitrenes.

Reaction Mechanism

Type of reaction and mechanism, Thermodynamic and Kinetic controlled reactions, Baldwin rule for ring closer, Potential energy diagrams and transition states, The Hammett equation, Taft equation, Hammond's postulate and Curtin-Hammett principle.

Unit-II

Mechanism of Nucleophilic Substitution Reaction

The S_N2, S_N1, S_Ni, S_N2', S_N1' and S_Ni' types of reaction mechanism with stereochemical aspects. Nucleophilicity and solvent effects, competition between nucleophilicity and basicity, ambident nucleophiles, hard and soft nucleophiles and electrophiles, leaving group effects, steric and other substituent effects on substitution and ionization rates. Mechanism of Nucleophilic substitution in aromatic systems via diazonium ions, by addition-elimination and elimination-addition mechanism (involving arynes); S_{RN}, mechanism; von Richter rearrangement and Stevens rearrangements.

Unit-III

Aromatic Electrophilic Substitution

Theoretical treatment of aromatic substitution reactions, structure-reactivity relationship in mono substituted benzene ring, orientation in other ring system , energy profile diagram, Vilsmeir-Haak reaction , Reimer-Tiemann reaction, BischlerNapieralski reaction, Pechamann reaction, Houben-Hoesch reaction, Fries rearrangement.

Aliphatic Electrophilic Substitution:

The S_E1, S_E2 and S_Ei mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and medium on the reactivity.

Mechanism of Elimination Reactions:

The El, ElcB and E2 mechanism with stereochemical aspects. Saytzeff and Hoffman rules.Effect of Base, leaving group and medium on the mechanism. Mechanisms and orientation in pyrolytic eliminations, Dehydration of Alcohols.

Unit-IV

Rearrangements

Anchimeric assistance, neighbouring group participation by non-bonding electrons, sigma and n-bonds, classical and non-classical carbocation, carbocations rearrangements, migratory aptitudes, Wagner Meerwein rearrangement, pincol pinacolone rearrangement, Demjanove rearrangement, Tiffeneau-Demjanove ring expansion, aldehyde-ketonerearrangement,dienone-phenol rearrangement and transannular rearrangements.

Suggested Reading:

1. Carey. F.A. & Sundberg, R.J. *Advanced Organic Chemistry,* 7th Ed., Parts A & B, Plenum: U.S. (2004).
2. March, J. *Advanced Organic Chemistry,* 6th Ed., John Wiley & Sons (2006).
3. Ingold C.K., *Structure and Mechanism in Organic Chemistry,* Cornell University Press (2000)
4. Peter Sykes, *A Guidebook to Mechanism in Organic Chemistry,* 6th Ed., Pearson Education(1986).
5. Clayden Jonathan, Greeves Nick and Warren Stuart, *Organic Chemistry,* 2nd Ed., Oxford Press (2012).

References:

1. Volhardt P. and Schora N., *Organic Chemistry Structure and Function,* 5th Ed., (2007).
2. Solomons T.W.G. and Fryhle C.B., *Organic Chemistry,* 10th Ed., (2009).

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FOUNDATION COURSE IN PHYSICAL CHEMISTR

Course Code: **MaximumMarks: 50 + 50**
(CE) PC-605 (4 0 0) **Foundation Course in Physical Chemistry** **Cr dit: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks:**

50Question Paper shall contain **five Units**.

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.

Course Objective:

1. To impart fundamental knowledge about the basic concepts of both classical and quantum statistical mechanicsThis course covers statistical mechanics for chemical systems.
2. To understand the link between macroscopic thermodynamics and microscopic quantum mechanics through different statistical methods.
3. To highlight applications of Boltzmann distribution in the fundamental concepts of electrochemistry and kinetics. Also covered are ensembles, partition functions, thermodynamic functions, applications to various systems,

Course/Learning Outcomes:

- On successful completion of this course, a student should be able to appreciate microscopic connection between classical mechanics and thermodynamics. and have a background in basic thermodynamics, statistical mechanics at the level of a standard physical chemist.
- The student will learn the basic principles of statistical mechanics, which correlates the microscopic properties of systems with the macroscopic observables.
- The students would also learn the applications of the Boltzmann distribution and partition functions in electrochemistry, theories of chemical kinetics surface chemistry and catalysis

Unit-I

Chemical Kinetics

Collision theory of reaction rates, the steric requirement, Arrhenius equation and activated complex theory (ACT), comparison of collision and activation complex theory, Potential energy surfaces (Only basic idea), thermodynamic formulation of activated complex theory, chain reactions (hydrogen-halogen reaction), unimolecular reactions, steady state approximation, Lindemann-Hinshelwood mechanism of unimolecular reactions, kinetics of solutions.

Electrochemistry

Debye-Huckel theory of ion-ion interaction and activity coefficient, applicability and limitations of Debye-Huckel limiting law, its modification for finite-sized ions, effect of ion-solvent interaction on activity coefficient. Physical significance of activity coefficients, mean activity coefficient of an electrolyte.

Debye-Huckel-Onsager (D-H-O) theory of electrolytic conductance, Debye-Falkenhagen effect, Wein effect. D-H-O equation – its applicability and limitations, Pair-wise association of ions (Bjerrum treatment), Modification of D-H-O theory to account for ion-pair formation.

Unit-II

Surface Chemistry and Catalysis

Gibbs adsorption equation, Langmuir Adsorption isotherm and its kinetic derivation for non-dissociative and dissociative adsorption, BET adsorption isotherm, its kinetic derivation and applications.

Heterogeneous catalysis, homogenous catalysis, kinetic of enzyme catalysis, evaluation of Michealis Menten constant and study the effect of substrate concentration on it. Study of surfaces by STM, SEM. Surface heterogeneity, surface catalyzed unimolecular and bimolecular reactions, temporary and permanent catalytic poisons, activation energy for surface reactions. Comparison of homogeneous and heterogeneous reaction rates.

Unit-III

Quantum Mechanics

The postulates of quantum mechanics, Linear and Hermitian operators. Commutation of operators and Uncertainty Principle. Schrodinger equation, eigen function and eigen values, free particle, schrödingerequation for a particle in a box, the degeneracy, particle in a box with a finite barrier, Schrodinger equation for simple harmonic oscillator and its solution, zero point energy, Tunneling Problem: Tunneling through a rectangular barrier.

Energy levels and wave-function of Rigid rotator. Hydrogen atom: complete solution (separation of variables in spherical polar coordinates and its solution). Radial distributions functions, Angular momentum and its directional quantization, Angular momentum operators, commutation relation, shape of atomic orbitals upto d-level and their discussion.

Unit-IV

Statistical Mechanics and Thermodynamics

Fundamentals: Concept of distribution. Thermodynamic probability and most probable distribution. Canonical and other ensembles. Statistical mechanics for systems of independent particles and its importance in chemistry.

Types of statistics: Maxwell, Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Idea of microstates and macrostates. Thermodynamic probability (W) for the three types of statistics. Derivation of distribution laws (most probable distribution) for the three types of statistics. Lagrange's undetermined multipliers. Stirling's approximation, Molecular partition function and its importance. Assembly partition function.

Applications to Ideal Gases

The molecular partition function and its factorization. Evaluation of translational, rotational andvibrational partition functions for monatomic, diatomic and polyatomic gases. The

electronic and nuclear partition functions. Calculation of thermodynamic properties of ideal gases in terms of partition function. Statistical definition of entropy. Ortho-and para-hydrogen, statistical weights of ortho and para states, symmetry number. Calculation of equilibrium constants of gaseous solutions in terms of partition function, perfect gas mixtures.
Einstein theory and Debye theory of heat capacities of monatomic solids.
Third law of thermodynamics, Residual entropy.

Suggested Reading:

1. McQuarrie, D.A. *Statistical Mechanics* Viva Books Pvt. Ltd.: New Delhi (2003).
2. Atkins, P.W. & Paula, J. De *Atkin's Physical Chemistry,* 10th Ed., Oxford University Press (2013).
3. Nash, L.K. *Elements of Statistical Thermodynamics* 2nd Ed., Addison Wesley (2006) Reprint.
4. Laidler, K.J. *Chemical Kinetics* 3rd Ed., Bengamin Cummings (1987).
5. Hill, T.L., *Statistical Mechanics: Principle & Selected Applications,* Dower Publication, New York (1987).
6. Ball D.W., *Physical Chemistry,* Thomson Press, India (2011).
7. Castellan G.W., *Physical Chemistry,* 4th Ed. Narosa (2004).
8. Mortimer R.G., *Physical Chemistry,* 3rd Ed., Elsevier, Noida (2008).
9. Pilar, F.L. *Elementary Quantum Chemistry,* 2nd Ed., Dover Publication Inc.: N.Y. (2001).
10. Chandra A.K. *Introduction to Quantum Chemistry,* 3rd Ed., Tata McGraw Hill, (1989).
11. Glasstone Samuel, *An Introduction to Electrochemistry,* Reprint (2007).

References:

1. Glasstone Samuel S., *Physical Chemistry,* Affiliated East-West.
2. Levine I.N., *Physical Chemistry,* 6th Ed.
3. Glasstone S., *Thermodynamics for Chemists,* Affiliated East-West Press, (2007).
4. Bockris S. and Reddy A.K.N., *Modern Electrochemistry,* Vol. 1 and 2, Butterworth London, (2006).

CENTRE OF EXCELLENCE IN PHARMACEUTICAL CHEMISTRY
GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
SECTOR-16C, DWARKA, NEW DELHI-110079

INTRODUCTION TO BIO-MOLECULES AND COMPUTATIONALCHEMISTRY

Course Code: **MaximumMarks: 50 + 50**
(CE)PC-607 (4 0 0)Introduction to Bio-Molecules and ComputationalChemistry **Credit: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks:**
50Question Paper shall contain **five Units**.

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Units **II to V** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.

Course Objective:

1. Students will be able to understand the central dogma of molecular biology
2. This course provides basic knowledge of metabolic process in all living organism.
3. The students will understand various pathways like ATP, role of various enzymes, role of amino acids, and proteins and also explain DNA structure, transfer of genetic information from one generation to another generation, disorders etc.
4. Emphasis would be placed on using small office software or programmes to obtained statistical analysis for common statistical methods and interpreting outputs.

Course/Learning Outcomes:

The students will acquire knowledge of:

- Metabolic process in all living organism.
- Various pathways like ATP, role of various enzymes, role of amino acids, and proteins
- DNA structure, transfer of genetic information from one generation to another generation.
- Understanding the complexity of biological reactions in a living organism.
- Role of vitamins, advant ge and disadvantages in a living organism
- Use of software and introduction of computational chemistry as tool and scope

Unit-I

Carbohydrates

Introduction to Metabolic Processes**:** Catabolism and anabolism, ATP- currency of biological energy, energy rich and energy poor phosphates.

Classification of carbohydrates, basic chemical structure, general reactions and properties, biological significance, sugar derivatives, deoxy sugars, amino sugars and sugar acids. Furanose and Pyranose forms of glucose and fructose, Haworth projection ormula for glucose;

chair and boat forms of glucose, formation of Disaccharides, concept of reducing and non-reducing sugars, occurrence and Haworth projection of maltose, lactose and sucrose. Polysaccharides-homo and hetero-polysaccharides, storage polysaccharides (starch and glycogen) and structural polysaccharides (cellulose, peptidoglycan and chitin).

Unit-II

Lipids

Classification, structure and function of lipids. Building blocks of lipids – fatty acids, glycerol, ceramide. Storage lipids – triacyl glycerol and waxes. Structural lipids in membranes – glycerophospholipids, galactolipids and sulpholipids, sphingolipids and sterols, structure, distribution and role of membrane lipids. Introduction of lipid micelles, monolayer and bilayer, liposomes.

Vitamins

Structure and active forms of water soluble and fatsoluble vitamins, deficiency diseases and symptoms, hypervitaminosis.

Unit-III

Amino Acids

Structure and classification, physical, chemical and optical properties of amino acids.

Protein:

Organisation of protein structure into primary, secondary, tertiary and quaternary structures. N-terminal and C-terminal amino acid analysis. Sequencing techniques –Edman degradation. Disulfide bonds and their location. Solid phase peptide synthesis. Nature of stabilizing bonds – covalent and non covalent. Importance of primary structure in folding. The peptide bond – bond lengths and configuration. Dihedral angles psi and phi. Helices, sheets and turns. Ramachandran map. Structures of myoglobin and hemoglobin.

Nucleic Acids*:* Chemical and enzymatic hydrolysis, structure and functions of DNA, RNA (m-RNA, t-RNA, r-RNA), an overview of gene expression (replication, transcription and translation).

Unit IV

Computation

Application package for report generation and presentation, application of MS-office, document and manipulations, saving and printing, incorporation of graphs, tables, pictures and chemical structures into the document. Use of spreadsheet and mathematical package in data analysis and solving problems in chemistry, report generation, data base management, and graphical representation of tabulated data. Power Point: application of power point for representation reports.

Introduction of ChemOffice, Chemdraw, ChemSketch and other chemical drawing software, common structure format and extension. Experimental data visualizing and interpretation by different software e.g. ACD 1D NMR Processer, Jeol Delta etc., molecule library generation.

Introductionto computational chemistry as a tool and its scope, Potential energy surface: stationary point, transition state or saddle point, local and global minima; introduction of Hartree-Fock and DFT calculation with selection of basic set, single point energy calculation, geometry optimization, constrained optimization and frequency calculation, calculation of

ionization energies, Koopmans' theorem, electron affinities and atomic charges, interpretation and prediction of UV/Vis, IR and Raman spectra, identifying HOMO and LUMO-visualization of molecular orbitals and normal modes of vibrations using suitable graphics and computational packages.

Introduction to protein structure databases

Protein sequence and structure databases (PDB). Use of sequence and domain information. Viewing protein structures using in *silica tools*.

Suggested Reading:

1. Lehniger C., David L. Nelson and Michael M. Cox, *Principles of Biochemistry,* 6th Ed., (2013).
2. Stryer L., Freeman W.H., *Biochemistry,* 5th Ed., San Francisco, (2014).
3. Wood W.B. and Wilson J. H., Benbow R.M., and Hood L.E., *Problem Approaches in Biochemistry,* 1st Ed., Wiley, (1974).

References:

1. Stryer, L. *Biochemistry* 4th Ed., W. H. Freeman & Co. (1995).
2. Zubay, S. *Biochemistry* Addison-Wesley (1983).
3. Litwak, G. Vitamins and Hormones, Academic Press, (2005)

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SECTOR-16C, DWARKA, NEW DELHI-110078

FOUNDATION COURSE PRACTICAL-I (ORGANIC CHEMISTRY)

Course Code: **MaximumMarks: 50 + 50**
(CE)PC-651 (0 0 8). **F undation Course Practical-I(OrganicChemistry)** **Credit: 4**

Course Objective:

1 Aimed at learning the techniques of separating organic mixtures as well as systematic identification of organic compounds based on their physical and chemical spectral properties.
2 To acquire knowledge of laboratory techniques for organic synthesis and characterization.

Course/Learning Outcome:

The students will acquire knowledge of:

- Safe laboratory practic s by handling laboratory glassware, equip ent, and chemical reagents
- Starting materials, functional groups, mechanism, and typical reaction conditions.
- Purification, Crystallization, and different Distillation processes.
- Synthetic procedures: queous workup, distillation, reflux, separation, isolation, and crystallization and Characterization

Purification of organic compounds involving fractional crystallization, fractional distillation, steam distillation, sublimation and extraction.

Systematic identification of pure organic compounds

Separation and identification of simple binary mixtures having acidic, basic and neutral components.

Synthesis of Organic Molecules using following reactions (any five*)

1. Fischer Indole Synthesis
2. Baker-Venkatraman Reaction
3. Fries Reaction
4. Sandmeyer Reaction
5. Benzillic Acid Rearrangement
6. Photochemical Reaction
7. Pechman Synthesis
8. Friedel-Crafts Reaction
9. Beckmann Rearrangement
10. $NaBH_4$ Reduction

11. Bromination and Bromine addition
12. Diazotisation Reactions

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.
***Any new preparation may also be included.**

Experiment **Marks: 30**
Lab record & Viva-voce **Marks: 5+15**

Suggested Reading:

1. Saunders & Mann, *Practical Organic Chemistry.*
2. Shriner Ralph L, Hermann Christine K.F., Morrill Terence C. and Curtin David Y., *The Systematic Identification of Organic Compounds.*
3. Furhen B.S. et. Al., *Vogel's Text Book of Practical Organic Chemistry,* Longman-Group Ltd.
4. Vogel Arthur I., *Elementary Practical Organic Chemistry* EX CBS Publishers and Distributors.
5. Louis, *Experiments in Organic Chemistry,* D.C. Heath and Company Boston (1955).

References:

1. Furniss B.S., Hannaford A.J., Smith P.W.J. and Tatchell A.R., *Vogel's Text Book of Practical Organic Chemistry,* 5th Ed., Addison Wesley Longman (1997).
2. Harwood Laurence M., Moody Christopher J., Percy Jonathan M., *Experimental Organic Chemistry: Standard and Microscale,* 2nd Ed., Wiley-Blackwell Sevenlife, (1998).

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FOUNDATION COURSE PRACTICAL-II (PHYSICO INORGANIC CHEMISTRY)

Course Code: **Maximum Marka: 50 + 50 (CE)**

PC-653 (0 0 8) Foundation Course Practical-II (Physico-Inorganic Che istry) Credit: 4

Course Objective:

1The course aims to make familiar with equipment and standard laboratory techniques for carrying out reaction and purification of products along with concept of green chemistry.

2. The study tracks practical skills in refractometry, chemical kinetics, polarimetry and potentiometryThe course aims to make aware of risk and hazards.

Course/Learning Outcome:

The students:

- Will acquire hands on experience on synthesizing various inorganic compounds by employing a variety of synthetic strategies and their characterization will be aimed.
- will equip on the analytical applications and various ways of analyzing data derived from different experiments.
- would make the to know the process of selecting and adopting the synthetic route to a known compound using searching electronic database and primarily literature

Chemical Kinetics

1. Determine the specific rate constant for the acid catalyzed hydrolysis of methyl acetate by the *Initial Rate Method.* Study the reaction at two different temperatures and calculate the thermodynamic parameters.

Refractometry

1. Determine the refractive index of simple organic liquids like methyl acetate, ethyl acetate, methanol, ethanol, n-hexane, chloroform.
2. Determine the refractivity and molar refractivity of some organic liquids like methyl acetate, ethyl acetate, methanol, ethanol, n-hexane, chloroform.

Polarimetry

1. Study the variation of angle of optical rotation with the concentration of any optically active substance (sucrose or glucose) and thereafter determine the unknown oncentration of the same substance in given solution.
2. Determine the specific and molecular rotation of sucrose or glucose at number of concentrations.

Potentiometry: (Any Two)

1. Titrate hydrochloric acid and sodium hydroxide potentiometrically.
2. Determine the dissociation constant of acetic acid poteniometrically.
3. Titrate a mixture of:
   (a) strong and weak acids (Hydrochloric acid and acetic acids)
   (b) weak acid (acetic acid) and dibasic acid (oxalic acid)
   (c) strong acid (hydrochloric acid) and dibasic acid (oxalic acid) versus sodium hydroxide.
   (d) Titrate a solution of Mohr's salt against potassium permanganate potentiometrically.

Cyclic Voltammetry

1. Reset the CV of aqueous solution of sulphuric acid (0.5 M) at Pt electrode as working electrode and counter electrode.
   (a) Interpret and explain various peaks and regions of the CV and their significance.
   (b) Determine the area and roughness factor of the electrode by H-adsorption and H-desorption.
   (c) Determine the area and roughness factor of the electrode by Pt oxide region.
2. Determine the extent of catalytic activity of the Pt electrode by H_2evolution reaction (HER) and O_2 evolution reaction (OER).

Impedance

1. Verify Warburg equation using electrochemical impedance spectroscopy. Perform experiment with various bias potentials around CV peak potential.
2. Determine the exchange current density, α (symmetry factor) and double layer capacity of a redox reaction using platinum electrode (aqueous solution of 10 mM $(Fe(NH_4)_2(SO_4)_2$ + $Fe(NH_4)_2(SO_4)_2)$) in 1 M $HClO_4$.

Nanoscience (Any Two)

1 Determine the rate constant of the redox reaction between hexacyanoferrate and thiosulphate ions in the presence and absence of gold nanoparticles.
2 Determine the temperature coefficient, activation energy and other thermodynamic parameters of the reaction.
3. Prepare gold nanostructures by reducing auric chloride with tea extract in presence of CTABas capping agent, and characterize spectrophotometrically.
4. Prepare CdSnanonparticles and record their UV/Vis spectra.
5. Prepare CdSe quantum dots and record their absorption and emission spectra.

Preparations

Preparation of selected inorganic compounds and their spectroscopic studies (any three):

1. $Hg[Co(SCN)_4]$
2. Prussian Blue and Turnbull's Blue
3. $Mn(acac)_3$
4. $[Ni(NH_3)_6]Cl_2$
5. Cis and trans $[Co(en)_2Cl_2]$
6. Bromination of Cr (III) acetylacetonato $Cr(acac)_3$. [J. Chem. Edu. 1986, 63].
7. Separation of optical isomers of cis $[Co(en)_2Cl_2]Cl$: J. Chem. Soc. 1960, 4369.
8. Preparation of copper glycine complex-cis and trans bis (glycinatoCu(II)

9. Tris (acetylacetonato) cobaltate (III)
10. Tris (Thiourea) Copper (I) Sulphate. (Estimation of Cu-Iodomedtrically). Any other compound prepared in the lab.

Complexometric Titrations (any two)

1. Determine the strength of Zn^{2+} and Mg^{2+} in the given solution mixture by titrating it against EDTA using Erichrome black T as the indicator.
2. Determine the strength if Ca^{2+} & Mg^{2+} (as CO_3^{2-}) in the given solution mixture by titrating it against EDTA using Erichrome black T &Calcol as the indicators.
3. Estimation of Sn^{2+} as (ZnO) by titrating it against EDTA using Xylol-orange as the indicator.
4. Estimation of Zn^{2+} and Ba^{2+} mixture by back titration.
5. Determine the strength of $CuSo_4$, $5H_2O$ solution by titrating it against $Na_2S_2O_3$iodometrically.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

Experiment **Marks: 30**
Lab record & Viva-voce **Marks: 5+15**

Suggested Reading:

1. James A.M. and Prichard F.E., *Practical Physical Chemistry,* Longman.
2. Levitt B.P. *Frindeleys Practical Physical Chemistry,* Longman.
3. Palit S.R. and De S.K., *Practical Physical Chemistry,* Science.
4. Shomaker D.P., *Experiments in Practical Physical Chemistry,* 8th Ed., (1967) Rep. (2012).
5. Jolly W.B., *Synthesis and Characterization of Inorganic Compounds,* Prentice Hall, Englewood, (1970).
6. Bell C.F., *Synthesis and Physical Studies of Inorganic Compounds,* 1st Ed., Pergamon Press, (1972).
7. Palmer W.G., *Inorganic Preparations,* Cambridge, (1970).

References:

1. Mendham J., Denney R.C., Barnes J.D. and Thomas M.J.K., *Vogel's Text Book of Quantitative Chemical Analysis,* 6th Ed., Third Indian Reprint, Pearson Education Pvt. Ltd., New Delhi (2003).

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SECTOR-16C, DWARKA, NEW DELHI-110078

CONFORMATIONAL ANALYSIS AND ASYMMETRIC SYNTHESIS

Course Code: **MaximumMarks: 50 + 50 (CE)**
PC-602 (4 0 0) Conformational Analysis and Asymmetric Synthesis. Credit: 4

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units.**

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.

Course Objective:

1. The course aims to understand the biological significance of chirality and need for asymmetric synthesis general strategy of asymmetric synthesis mechanism of illustrated examples.
2. It also aims to translate the asymmetric reactions covered for use in the retro synthesis approach.
3. To know about conformational analysis and stereochemistry of ring systems. To learn about stereochemistry of fused and bridged rings, O.R.D. and C.D.

Learning Course/Learning Outcomes:

The students will acquire knowledge of:

- Conformational analysis of cycloalkanes, reactivity, chirality, interconversion, resolution andasymmetric synthesis.
- Develop a fundamental understanding of the concepts of stereoisome im, optical activity and chirality.
- Learn the principal methods that are used to prepare enantiomerically pure products from achiral starting materials.

Unit-I

Conformational Analysis (Cyclic Systems)

Study of conformations of cyclohexane, mono, di and polysubstitutedcyclohexanes, cyclohexene, cyclohexanone (2-alkyl and 3-alkyl ketone effect), 2-halocyclohexanones, cyclopentane, cyclobutane, cycloheptane and cyclooctane. Stereochemistry of decalins. Conformational effects on the stability and reactivity of diastereomers in cyclic molecules – steric and stereo electronic factors – examples factors governing the reactivity of axial and

equatorial substituents in cyclohexanes. Stereochemistry of addition to the carbonyl group of a rigid cyclohexanone ring.

Unit-II

Topicity, Prostereoisomersism

Introduction and terminology. Topicity in molecules Homotopic, stereoheterotopic (enantiotopic and diastereotopic) groups and faces – symmetry, substitution and addition criteria. Prochirality nomenclature: Pro-R, Pro-S, Re and Si faces.

Unit-III

Asymmetric Induction

Stereoselective reactions: Substrate stereoselectivity, product stereoselectivity, enantioselectivity and diastereoselectivity. Symmetry and transition state criteria, kinetic and thermodynamic control. Methods for inducing enantio and diastereoselectivity. % Enantiomeric excess, enantiomeric ratio, optical purity, % diastereomeric excess and diastereomeric ratio. Chiral derivatizing agents, Chiral solvent, Chiral shift reagents and Chiral HPLC.

Cram's and Prelog's; Dynamic stereochemistry (acyclic and cyclic), Qualitative correlation between conformation and reactivity, Curun-Hammett Principle.

Unit-IV

Organic Stereochemistry

Methodologies in Asymmetric Synthesis, Strategies in Asymmetric Synthesis: 1. Chiral substrate controlled, 2. Chiral auxiliary controlled, 3. Chiral reagent controlled 4. Chiral catalyst controlled.

1. **Chiral Substrate Controlled Asymmetric Synthesis**
   Nucleophilic additions to chiral carbonyl compounds. 1, 2-Asymmetric induction, Cram's rule and Felkin-Anh model.
2. **Chiral Auxiliary Controlled Asymmetric Synthesis**
   α-Alkylation of chiral enolates, azaenolates, imines and hydrazones. 1, 4-Asymmetric induction and Prelog's rule. Use of chiral auxiliaries in Diels-Alder reaction.
3. **Chiral Reagent Controlled Asymmetric Synthesis**
   Asymmetric reductions using BINAL-H. Asymmetric hydroboration using IPC_2BH and $IPCBH_2$.
4. **Chiral Catalyst Controlled Asymmetric Synthesis**
   Sharpless and Jacobsen asymmetric epoxidations. Sharpless asymmetric dihydroxylation. Asymmetric hydrogenations using chiral Wilkinson biphosphine and Noyoricatalys. Enzyme mediated enantioselective synthesis.
5. **Asymmetric Aldol Reaction**
   Diastereoselective aldol reaction (chiral enolate & achiral aldehydes and achiral enolate & chiral aldehydes) its explanation by Zimmerman-Traxel model.

Molecular dissymmetry and chiroptical properties:

Linear and circularly polarized lights, circular birefringence and circular dichroissm, ORD and CD of ORD and CD curves, cotton effect. The axial haloketone rule, octant diagrams, heto structural and stereochemical problems.

Suggested Reading:

1. Lehniger C., David L. Nelson and Michael M. Cox, *Principles of Biochemistry,* 6th Ed., (2013).
2. Stryer L., Freeman W.H., *Biochemistry,* 5th Ed., San Francisco, (2014).
3. Wood W.B. and Wilson J. H., Benbow R.M., and Hood L.E., *Problem Approaches in Biochemistry,* 1st Ed., Wiley, (1974).
4. Nasipuri D., *Stereochemistry of Organic Compounds – Principles & Applications,* 2nd Ed., New Age Publication, (2005).
5. Eliel Ernest L. & Wilen Samuel H., *Stereochemistry of Organic Compounds,* 1st Ed., Wiley, (1994).
6. Kalsi P.S., *Stereochemistry: Conformation & Mechanism,* 6th Ed., New Age Pub., (2009).
7. Bassendale Alan, *The Third Dimension in Organic Chemistry,* 3rd Ed., John Wiley & Sons, (1984).
8. Stephenson G.R., Nogradi, *Asymmetric Synthesis,* 3rd Ed., John Wiley and Sons, (1984).
9. Izumi Y. & Akira Tai, *Stereo Differentiating Reactions,* 3rd Ed., Academic Press, (1977).
10. Smith M. B., *Organic Synthesis,* 3rd Ed., (1978).

References:

1. Morrison J.D. and Moscher H.S., *Asymmetric Organic Reactions,* Vol. 3, Academic Press, (1984).
2. Hawley Robert E. & Aube Jeffrey, *Principles in Asymmetric Synthesis,* 2nd Ed., Elsevier, (2012).

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SECTOR-16C, DWARKA, NEW DELHI-110078

SYNTHETIC METHODS IN MEDICINAL CHEMISTRY (ORGANIC SYNTHESIS)

Course Code: **Maximum Marks: 50 + 50 (CE)**
PC-604 (4 0 0) Synthetic Methods in Medicinal Chemistry (Organic Synthesis) Credit: 4

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units.**

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unit and the student needs to attempt only one question from each unit.

Course Objective:

1. After a successful completion of this course one would demonstrate understanding of the key elements of developing practical methods for the synthesis of pure organic compounds with a special emphasis on the design of economically feasible chiral processes.

Course/Learning Outcomes:

The students will acquire knowledge of:

- Mechanistic pathway of organic reactions.
- Retrosynthetic approach to planning organic synthesis.
- Conversion of different functional group via rearrangement reaction.
- And become adept at identifying strengths and weaknesses of particular methods and determine which will be optimal for a particular synthetic operation

Unit-I

Retrosynthetic Analysis

Basic principles and terminology of retrosynthesis (Disconnection, synthons, functional group interconversions (FGI) , synthetic equivalents), synthesis of aromatic compounds, one group C-X and two group C-X, one group C-C and two group C-C disconnections, amine and alkene synthesis, functional group transposition, important strategies of retrosynthesis, important functional group interconversions, regioselectivity and regiospecificity. Use of chiral auxiliaries in synthesis.

Unit-II

Oxidations & Reductions

a) Application of DDQ, SeO_2, PCC, PDC, Swern oxidation, Periodic acid.
b) Application of Homogenous (Wilkinsons's catalytic hydrogenation) and heterogeneous catalytic reduction, boron reagents, Birch reduction, $LiA1H_4$, $NaBH_4$ and their modifications, BH_3, DIBAL.

Unit-III

Organometallic Reagents

a) Preparation and application of the following in organic synthesis:
   (i) Grignard
   (ii) Organo lithium
   (iii)Organo copper reagents
b) Organo boranes in C-C bond formation
c) Organo silicon reagents: reactions involving β-carbocations and α-carbanions, utility of trimethyl silyl halides, cyanides and triflates.
d) Organophosphorus: witting reaction, Mitsunobu reaction + Tebbe + Sulphur elites

Carbonyl methylenation

a) Phosphorous ylide mediated olefination:
   (i) Witting reaction
   (ii) Horner-Wordsworth-Emmons reaction
b) Titanium-Carbene mediated olefination:
   (i) Tebbe reagent
   (ii) Petasis reagent
   (iii)Olefination by Nysted reagent

Unit-IV

New Synthetic Reactions

1. **Metal mediated C-C and C-X coupling reactions**
   Suzuki, Heck, Stile, Sonogishira cross coupling, Buchwald-Hartwig and Negishi-Kumada coupling reactions.
2. **C=C formation reactions**
   Shapiro, Bomford-Stevens, McMurrey reactions, Julia-Lythgoe olefination and Peterson's stereoselective olefination.
3. **Multicomponent reactions**
   Ugi, Passerini, Biginelli, Hantzsch and Mannich reactions.
4. **Ring formation reactions**
   Pausan-Khand reaction, Bergman cyclisation, Nazerov cyclisation.
5. **Click Chemistry**
   Criteria for Click reaction, Sharpless azides cycloadditions.
6. **Metathesis**
   Grubb's 1st and 2nd generation catalyst, Olefin cross coupling metathesis (OCM), ring closing metathesis (RCM), ring opening metathesis (ROM), applications.

Suggested Reading:

1. Carruthers W., *Some Modern Methods of Organic Synthesis,* 1st Ed., Reprint, Cambridge University Press, (1986).
2. Smith B. Micheal, *Organic Synthesis,* 3rd Ed., Elsevier, (2011).

References:

1. MeckieR.K., Smith D.M. &Atken R.A., *Guidebook to Organic Synthesis,* 3rd Ed., Longman Publishing Co., (1990).
2. Fieser&Fieser, *Reagents for Organic Synthesis,* Vol. 1-26, Wiley, (2011).
3. Reich and Rigby, *Handbooks of Reagents for Organic Synthesis,* Set of Volume, (2007).
4. Warren S., *Designing Organic Synthesis,* Wiley, (1978)
5. Carruthers W., *Some Modern Methods of Organic Synthesis,* 4th Ed., Cambridge University Press, (2004).
6. House H.O. & Benjamin W.A., *Modern Synthetic Reactions*2nd Ed., (1965).

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SPECTROSCOPIC STUDIES

Course Code: **MaximumMarks: 50 + 50 (CE)**
PC-606 (4 0 0) **Spectroscopic Studies** **Credit: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units.**

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.

Course Objective:

1. The course covers structural elucidation by joint applications of spectroscopic techniques.
2. Emphasis would be on the qualitative analysis of molecules, biological active compounds using NMR, MS, UV, and IR.
3. The students will solve structural problems based on UV-Vis, IR, ^{1}HNMR, ^{13}CNMR and Mass Spectral data. Some emphasis will be given on quantitative aspects of these techniques.

Course/Learning Outcomes:

The students will be able to:

- Describe the basic instrumental principles involved in the operation of mass spectrometers, infrared spectrometers, and nuclear magnetic resonance spectrometers. This includes methods of sample handling and preparation, signal generation and detection, and data analysis for each method.
- Describe the physical and chemical principles that occur at the molecular level during a MS, IR, or NMR experiment.
- Evaluate the utility of U /Vis spectroscopy as a qualitative and quantitative method.
- Identification of functional group based on IR spectra
- Analyze MS, IR, and/or NMR spectral data (either alone or in combination) to elucidate the structure of an organic olecule. This includes being able to make correlations of spectral features to specific portions of a molecule's structure. Students should b in a position to use spectroscopic methods for qualitative and quantitative analysis.

Unit-I

Symmetry and Group Theory in Chemistry

Definitions of group, subgroup, relation between orders of a finite group and its subgroup.Conjugacy relation and classes.Symmetry elements and symmetry operation, symmetry point group. Schönflies symbols, representation of groups by matrices (representation for the C_n, C_{nv}, C_{nh}, D_{nh} etc. groups to be worked out explicitly). Character of a representation, reducible and irreducible representations, the great orthogonality theorem (without proof).Molecular asymmetry, dissymmetry and optical activity.

Unit-II

Ultraviolet and Visible Spectroscopy

Various electronic transitions (185-800nm), Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

Infrared Spectroscopy

Instrumentation and sample handling.Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines.Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds).Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. FTIR, IR of gaseous, solids and polymeric materials.

Unit-III

Nuclear Magnetic Resonance Spectroscopy

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, measurement of chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides &mercapto), complex spin-spin interaction between two, three, four and five nuclei (first order spectra), spin system-Pople notation, virtual coupling, Stereochemistry, concept of topicity, effect of enantiomeric and diastereomeric protons, hindered rotation, Karplus curve – variation of coupling constant with dihedral angle. Fourier transform technique, Hetro nuclei NMR-F, P.

Carbon-13 NMR Spectroscopy

Resolution and multiplicity of ^{13}C NMR, ^{1}H-decoupling, noise decoupling, broad band decoupling; Deuterium, fluorine and phosphorus coupling; NOE signal enhancement, off-resonance, Structural applications of CMR. DEPT and INEPT experiments; Introduction to 2D-NMR; COSY, HMQC and HETEROR spectra.

Unit-IV

Mass Spectrometry

Theory, instrumentation, and modifications; Unit mass and molecular ions; Important terms – singly, doubly/multiple charged ions, metastable peak, base peak, isotopic mass peaks, relative intensity, FTMS, etc.; Recognition of M ion peak; Ionization methods (EI, CI and FAB), General fragmentation rules: Fragmentation of various classes of organic molecules, including

compounds containing oxygen, sulphur, nitrogen and halogens; α-, β-, allylic and benzylic cleavage; McLafferty rearrangement; ESI, APCI and MALDI, etc.

Combined problems on UV, IR, NMR and MASS.

Suggested Reading:

1. Kemp. W. *Organic Spectroscopy* 3rd Ed., W.H. Freeman & Co. (1991).
2. Silverstein, R.M., Webster Francis X., Kiennle David J., Bryce David L., *Spectroscopic Identification of Organic Compounds*, 8th Ed., John Wiley & Sons (2014).
3. Pavia Donald L., Lampman Gary M. and Kriz George S., *Introduction to Spectroscopy,* 5th Ed., Saunders Golden Sunburst Series. Harcourt Brace College Publishers, New York, (2015).
4. Dyer J.R., *Application of Absorption Spectroscopy of Organic Compounds,* Prentice Hall, (1965).
5. Williams D.H. and Fleming I., *Spectroscopic Methods in Organic Chemistry,* 6th Ed., Tata McGraw-Hill (2007).
6. Das K.G. & James E.P., *Organic Mass Spectrometry,* Oxford &IBH Publishing Co, (1976).
7. Kemp William, *NMR in Chemistry – A Multinuclear Introduction,* Macmillon, (1988).
8. Atta-ur-Rahman, *Nuclear Magnetic Resonance Basic Principles,* 1st Ed., Springer, (1986).

References:

1. Derome Andrew B., *Modern NMR Techniques for Chemistry Research,* Elsevier.
2. Levy G.C. and Nelson O.L., *Carbon-13 NMR for Organic Chemists,* 2nd Ed., Plenum Press.
3. Bovey F. and Jelinski L., *Nuclear Magnetic Resonance Spectroscopy,* Academic Press.
4. Gross, *Mass Spectrometry: A Textbook.*

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SECTOR-16C, DWARKA, NEW DELHI-110078

EN YMES AND GREEN CHEMISTRY

Course Code: **Maximum Marka: 50 + 50**
(CE)PC-608 (4 0 0) **Enzymes and Green Chemistry** **C edit: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units.**

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and sh ould cover the entire syllabus.
- Unit **IIto V** shall have 2 questions in each unitand the studentneedsto attempt only one question from each unit.

Course Objective:

1. This course provides theory and knowledge relevant to enzymology principles including fundamental properties of enzymes, enzyme catalytic mechanisms and enzyme kinetics.
2. Green Chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances..

Course/Learning Outcomes:

The students will be able to:

- Describe the structure and the function of an enzyme.
- Identify and explain the factors that affect the enzyme activity.
- Derive a rate law for general enzyme catalysed reaction.
- A functional understanding of the field of green chemistry.
- A working understandin of the 12 principles of green chemistry.
- An understanding of several real world examples where organizations used green chemistry to improve the sustainability performance of their products.

Unit-I

Introduction to enzymes

Nature of enzymes – protein and non-protein (ribozyme), Cofactor and prosthetic group, apoenzyme, holoenzyme. Factors affecting the rate of chemical reactions, collision theory, activation energy and transition state theory, catalysis, reaction rates and thermodynamics of reaction. Catalytic power and specificity of enzymes (concept of active site), Fischer's lock and key hypothesis, Koshland's induced fit hypothesis.

Enzyme Kinetics

Relationship between initial velocity and substrate concentration, steady state kinetics, equilibrium constant – monosubstrate reactions. Michaelis-Menten equation, Lineweaver-Burk plot,Eadie-Hofstee and Hanes plot, K_m and V_{max}, K_{cat} and turnover number. Effect of pH, temperature and metal ions on the activity of enzymes.

Enzyme inhibition

Reversible inhibition (competitive, uncompetitive, non-competitive, mixed and substrate). Mechanism based inhibitors – antibiotics as inhibitors.

Unit-II

Mechanism of Action of Enzymes

General features – proximity and orientation, strain and distortion, acid base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes, transition state analogues.

Regulation of enzyme Activity

Control of activities of single enzymes (end product inhibition) and metabolic pathways, feedback inhibition (aspartate transcarbomoylase), reversible covalent modification phosphorylation (glycogen phosphorylase). Protcolytoc cleavage –zymogen. Multienzymes complex as regulatory enzymes. Occurrence and isolation, phylogenetic distribution and properties (pyruvate dehydrogenase, fatty acyl synthase) Isoenzymes – properties and physiological significance (lactate dehydrogenase).

Enzyme Immobilization

Methods of immobilization, advantage and applications of immobilization.

Unit-III

Biosynthesis of secondary metabolites

Introduction, Difference between laboratory synthesis and biosynthesis. Methods for determination of biosynthetic mechanism. Isolation and identification of Biosynthetic precursors, Feeding experiments – use of radioisotopes measurement of incorporation – absolute incorporation, specific incorporation. Identification of the position of labels in labelled natural products by chemical degradation and spectral methods.

Total Stereoselective Synthesis of Natural Products

Woodward's synthesis of reserpine and cholesterol, Corey's synthesis of prostaglandins (E2, F2α) and paeoriflorin, Sharpless synthesis of L-hexoses, Nicolaous synthesis of taxol, Danishefsky synthesis of indolizomycin, Takasago synthesis of menthol, Hoffmann-LaRoche synthesis of Biotin.

Unit-IV

Green Chemistry

History of emergence of Green Chemistry through some industrial disasters, environmental movements for public awareness and some important environmental laws, Definition of Green Chemistry, Need for Green Chemistry, goals of Green Chemistry, Green Chemistry advances towards a sustainable future, Green Chemistry v/s Environmental Chemistry, Green Chemistry and its interdisciplinary nature, Twelve Principles of Green Chemistry and their illustrations with examples. Green starting materials, Green reagents, Green solvents and reaction conditions, Green catalysis (Introduction to Industrial Enzymes).

Green synthesis: Microwave assisted Synthesis, Ultrasound assisted reactions. Synthesis of adipic acid and BHC, synthesis of Ibuprofen involving principle of green chemistry.
Green energy and sustainability. Wealth from waste, Industrial case studies.
Pharmaceutical industries: The largest waste producer problems and solutions through Green Chemistry, benefits of greening industries, Emerging Green Technologies.

Suggested Reading:

1. Balasubramananian D., *Concepts in Biotechnology,* University Press, (1996).
2. Moran Laurence A., Horton Robert A. Gray Strimgeom and Marc Perry, *Principals of Biochemistry,* Prentice Hall, (2011).
3. Dugas Herman and Penney Christopher, *Bioorganic Chemistry – A Chemical Approach to Enzyme Action,* 3rd Ed., Springer, (1986).
4. Anastas, P.T. and Warner, J.K. Oxford Green Chemistry -Theory and Practical, University Press, (1998)

References:

1. Drauz, Karlheinz,*Enzyme Catalysis in Organic Synthesis*, a comprehensive handbook. Vol. I and II, John Wiley & Sons, (2012).
2. D-Fessner W., *Biocatalysis from Discovery to Application,* 1st Ed., Springer (1999).

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SECTOR-16C, DWARKA, NEW DELHI-11 078

MEDICINAL CHEMISTRY PRACTICAL

Course Code: **MaximumMarks: 50 + 50 (CE)**
PC-652 (0 0 8) **Medicinal Chemistry Practical** **Credit: 4**

Course Objective:

1. To study special techniques of importance in phytochemical research such as extraction procedures, open column chromatography, thin layer chromatography, preparative HPLC, GC, GCMS and LCMS.

Course/Learning Outcomes:

The students will be able to:

- Isolation and identificati n of natural products.
- Estimation of bio-molec les by chemical methods.
- Synthetic procedures: aqueous workup, distillation, reflux, separation, isolation, and crystallization.
- Characterization of compounds by using modern analytical techniques

Qualitative Analysis:

1. Isolation of natural products, by chemicals and chromatographic methods (TLC/Column/GC/HPLC) and characterization using spectroscopic tech iques (any five):
   (i) Isolation of caffeine from tea leaves
   (ii) Isolation of piperine from black pepper
   (iii) Isolation of β-carotene from carrots
   (iv) Isolation of lycopene from tomatoes
   (v) Isolation of cholesterol from bile stones
   (vi) Isolation of limonene from lemon peel
   (vii) Isolation of euginol from cloves

Estimation of Natural Biomolecules (any nine):

1. Separation of amino acid mixture by Paper chromatography.
2. Estimation of amino acid by Ninhydrin method.
3. Estimation of protein by Biuret method.
4. Estimation of protein by Lowry et.al method.
5. Estimation of protein by Bradford method.
6. Specific reactions of Carbohydrate.
7. Estimation of sugar by Folin-wu method.
8. Estimation of sugar by Ferricyanide method.
9. Estimation of sugar by DNSA method.
10. Identification of carbohydrate mixture with suitable tests.

11. Isolation of amino acid cysteine from hair hydrolysate.
12. Estimation of Vitamin C from lemon fruits.
13. Determination on alpha amino nitrogen of amino acid.
14. Estimation of inorganic phosphorus by Fiske-Subbarow method.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

Experiment **Marks: 30**

Lab record & Viva-voce **Marks: 5+15**

Suggested Reading:

1. Vogel's*, Practical Organic Chemistry,* Longman Group, B.S. Furness et al., Ltd.
2. Fieser Louis F., *Experiments in Organic Chemistry,* O.C. Health and Company Boston (1955).
3. *Organic Synthesis*, Collective Vol. I
4. Pavy, *A Guide to Spectroscopy in Organic Chemistry*
5. Bansal R.K., *Laboratory Manual in Organic Chemistry,* Wiley Eastern Ltd., New Delhi (1980)
6. Sounder and Mann, *Practical Organic Chemistry*

References:

1. Plummr David T., *An Introduction to Practical Biochemistry,* Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Raphel I., *Natural Products: A Laboratory Guide,* 2nd Ed. New Delhi, Elsevier.

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ENZYMOLOGY

Course Code: **MaximumMarks: 50 + 50 (CE)PC-654 (0 0 8)** **Enzymology** **Credit: 4**

Course Objective:

1. The course aims to develop the key scientific skill required in scientific works. These includes practical research skill on experimental basis and to enable to acquire specialized knowledge.

Course/Learning Outcomes:

The students will be able to learn:

- A broad experimental approach, along with a theoretical introduction together with practical protocols,considering all aspects of enzymology.
- The fundamental experi ents in enzymology and work on easily realiza le protocols.

Experiments:

1. Detection of some common enzymes.
2. Extraction and Isolation of enzyme invertase/amylase/peroxidase/catalase.
3. Study of specific activity and progress curve.
4. To Asses effect of substrate conc. (V_{max} and K_m) on enzyme activity.
5. To Asses effect of pH on enzyme activity.
6. To Asses effect of enzyme conc.
7. To Asses temperature stability of the enzyme.
8. To Asses effect of activator on enzyme activity.
9. To Asses effect of inhibitor on enzyme activity.
10. Effect of enzyme immobilization on its activity.
11. Statistical analysis of data.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

Experiment **Marks: 30**
Lab record & Viva-voce **Marks: 5+15**

Suggested Reading:

1. Robyt J.R. and White B.J., *Biochemical Techniques Theory and Practice*
2. Wilson K. and Walker J., *Practical Biochemistry: Principles and Techniques*
3. Plummer David, *Practical Biochemistry*
4. Sawhney S.K. and Singh R., *Introductory Practical Biochemistry*

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ADVANCED ORGANIC CHEMISTRY

Course Code: **MaximumMarks: 50 + 50 (CE)**
PC-701 (4 0 0) **Advanced Organic Chemistry** **Credit: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units.**

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.

Course Objective:

1. To provide knowledge of photochemistry, pericyclic reactions and heterocyclic chemistry.
2. To make understand the orbital interactions (Woodward Hoffmann rules) in concerted reactions.
3. A survey of chemical nature of heterocyclic moieties of medical substances with emphasis on methods of synthesis of medicinally important compounds containin heterocyclic ring.

Course/Learning Outcomes:

At the end of the course, the learners should be able to:

- Comprehend the structure-reactivity pattern of reactive intermediates involved in organic reactions.
- Comprehend the orbital interactions and orbital symmetry correlations of various pericyclic reactions.
- Write the mechanism of organic reactions involving reactive intermediates and concerted processes.
- Apply these reactions in organic synthesis.
- Predict the course of an organic photochemical reaction and identify the product with the type of functional group present on the molecule.
- Comprehend Nomenclature and reactivity and synthesis of different heterocyclic compoundsand learn the synthesis different heterocyclic compounds

Unit-I

Concerted reactions:

Pericyclic Reaction: Classification, electrocyclic, sigmatropic, cycloaddition, chelotropic and ene reactions, Woodward Hoffmann rules, Frontier Molecular Orbital and Orbital symmetry correlation approaches, examples highlighting pericyclic reactions in organic synthesis such as

Claisen, Cope, Diels-Alder, Sommelet-Hauser and Ene reactions (with stereochemical aspects), introductory dipolar cycloaddition.

Unimolecular Pyrolytic Elimination Reactions:

Cheletropic elimination, Decomposition of cyclic azo compounds, β-eliminations involving cyclic transition states such as sulfoxides, selenoxides, N-oxides, acetates, xanthates eliminations.

Unit-II

Photochemistry

Principles and concepts:An overview of Laws of photochemistry, Beer-Lambert law, electronic energy levels, singlet-triplet state, intensity and strength of electronic transition, selection rules for electronic transition, Jablonski diagram and photophysical processes, Franck-Condon principle. Excited state lifetime, steady state and time resolved emission, factors affecting excited state energy: solvent effect, TICT.

Reactions: Photochemistry of alkene, cis-trans isomerization, photocycloaddition reactions of alkene, photochemical electrocyclic and sigmatropic reactions, di-pi-methane rearrangement, electron transfer mediated reactions of alkene. Photochemistry of carbonyl compounds, Norrish type I and type II reactions, enone and dienone cycloadditions. Photochemistry of aromatic systems, electron transfer and nucleophilic substitution reactions.Photochemistry of nitro, azo and diazo compounds.Photochemistry involving molecular oxygen, generation and reactions of singlet oxygen. Photo-fragmentation reactions (Barton, Hofmann-Loffler-Freytag).

Photosynthesis, Phototherapy.

Unit-III

Heterocyclic Chemistry

Introduction to Heterocycles*:* Nomenclature, spectral characteristics, reactivity and aromaticity.Synthesis and reactions of three and four membered heterocyles, e.g., aziridine, azirine, azetidine, oxiranes, thiarines, oxetenes and thietanes.

Five membered rings with two heteratoms: pyrazole, esoxazoles, imidazoles, oxazoles, thiazoles, isothiazole.

Unit-IV

Chemistry of Fused Heterocyclic Compounds

Benzofused five membered heterocylcles with one heteroatom, e.g. indoles benzofuran, benzothiophenes.

Chemistry of bicyclic compounds containing one or more heteroatoms.

Benzofused six membered rings with one, two and three heteroatoms: benzopyrans, quinolines, isoquinolines, quinoxazalines, acridines, phenoxozines, phenothiazines, benzotriazines, pteridines.

Seven and large membered heterocylces: azepines, oxepines, thiepines

Chemistry of porphyrins and spiro heterocycles.

Suggested Reading:

1. March, J. *Advanced Organic Chemistry* John Wiley & Sons (2006).
2. Carey, F.A. & Sundberg, R.J. *Advanced Organic Chemistry,* Parts A & B, Plenum: U.S. (2004).

3. Acheson Van R.M., *Introduction to the Chemistry of Heterocyclic Compounds,* 1st Ed., John Wiley & Sons (1977).
4. Mukherjee S.M., *Pericyclic Reactions,* 1st Ed., Macmillon, (1980).
5. HarspoolW.M., *Aspects of Organic Photochemistry,* 1st Ed., Academic Press (1976)
6. Marchand A.P., & Lehr R.E., *Pericyclic Reactions,* 1st Ed., Academic Press (1977)
7. Turro N.J., Ramamurthy V., Scanian J.C., *Modern MolecularPhotochemistry of OrganicMolecules,* Angew Chemistry, Int. Ed., (2010).
8. Coyle D., *Introduction of Organic Photochemistry,* Wiley (1986).
9. Joule J.A. & Mills K., *Heterocyclic Chemistry,* 5th Ed., Wiley, (2010).
10. Paquett A., *Principles of Modern Heterocyclic Chemistry,* 1st Ed., Wiley, (1976), Digitized (2010).

Reference:

1. Katritzky A.R., *Handbook of Heterocyclic Chemistry,* 3rd Ed., Elsevier, (2010).
2. Gilchrist T.L., *Heterocyclic Chemistry,* 3rd Ed., Longman Scientific Technical, (1997).
3. Katritzky A.R. and Rees C.W., *Comprehensive Heterocyclic Chemistry,* Vol. 1 to 15, Elsevier.

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SECTOR-16C, DWARKA, NEW DELHI-110078

BIOENERGETICS AND METABOLISM

Course Code: **Maximum Marka: 50 + 50 (CE)**
PC-703 (4 0 0) **Bio nergetics and Metabolism** **C edit: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **M ximum Marks: 50**

Question Paper shall contain **five Units.**

- Student has to atten pt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.

Course Objective:

1. The objectives of this Course is to study and consolidate concepts in the areas of Metabolism and Bioenergetics, focusing on the main metabolic pathways in living cells, their regulation and energy requirement.
2. The focus will be on bringing the students up to date on new advances in these areas while stressing the fundamental principles and molecules involved.

Course/Learning Outcomes:

By the end of this course a learner would:

- Understands the concepts of metabolism and how metabolism is regulat d at the level of the cell and the whole organism.
- Understands which organic compounds are used as 'fuel' or metabolic substrates and understand how cells and organisms use these fuels.
- Knows which metabolic pathways and reactions contribute to cellular m tabolism.
- Understands the concepts of bioenergetics including determining and evaluating free energy and redox potential in relation to metabolism.
- Understands the central importance of ATP in energy currency.
- Knows the mechanisms involved in the generation of ATP. Understands how enzymes and cofactors function in bio nergetic reactions.
- Be familiar with the m lecular complexes and pathways involved in photosynthesis and carbon fixation (PSI, PSII and Calvin cycle).
- Be familiar with the key steps in the main pathways of carbohydrate, fat, lipid and nitrogen metabolism (synthesis and breakdown), how they are regulated and their importance.
- Understands the switches in metabolic pathways during fasting and feeding.

- Be able to apply your knowledge of metabolism to your understanding of health and disease

Unit-1

Basic Design of Metabolism

Autotrophs, heterotrophs, metabolic pathways, catabolism, anabolism, ATP as energy currency, reducing power of the cell.

Glycolysis

Glycolysis – a universal pathway, reactions of glycolysis, fermentation, fates of pyruvate, feeder pathways for glycolysis, galactosemia.

Gluconeogenesis and Pentose Phosphate Pathway

Synthesis of glucose from non-carbohydrate sources, reciprocal regulation of glycolysis and gluconeogenesis, pentose phosphate pathway and its importance.

Glycogen Metabolism

Glycongenesis and glycogenolysis, regulation of glycogen metabolism, glycogen storage diseases.

Citric Acid Cycle

Production of acetyl CoA, reactions of citric acid cycle, anaplerotic reactions, amphibolic role, regulation of citric acid cycle, glyoxalate pathway, coordinated regulation of glyoxalate and citric acid pathways.

Synthesis of Carbohydrates

Calvin cycle, regulation of calvin cycle, regulated synthesis of starch and sucrose, photorespiration, C_4 and CAM pathways.

Unit-II

Fatty Acid Oxidation

Digestion, mobilization and transport of cholesterol and triacyl glycerols, fatty acid transport to mitochondira, β oxidation of saturated, unsaturated, odd and even numbered and branched chain fatty acid, regulation of fatty acid oxidation, peroxisomal oxidation, ω oxidation, ketone bodies metabolism, ketoacidosis.

Fatty Acid Synthesis

Fatty acid synthase complex. Synthesis of saturated, unsaturated, odd and even chain fatty acids and regulation. Lipid storage diseases.

Starve-feed Cycle

Well-fed state, early fasting state, fasting state, early re-fed state, energy requirements, reserves and caloric homeostasis, five phases of glucose homeostasis.

Unit-III

Proteins and Nucleic Acids

1. **Oxidative Degradation of Amino Acids:** Proteolysis, transamination, oxidative deamination, acetyle CoA, alpha ketoglutarate, acetoacetyle CoA, succinate, fumarate and oxaloacetate pathway. Decarbodylation, urea cycle, ammonia excretion.
2. **Biosynthesis of Amino Acids:** Amino acid biosynthesis, precursor functions of amino acid (Biosynthesis of glycine, serine, cysteine, methionine, threonine).
3. Inborn errors of amino acid metabolism.
4. Peptides, polyamines, porphyrins, gamma glutamyl cycle, glutathione biosynthesis, nonribosomal protein biosynthesis.

5. Disorders of amino acids metabolism, phenylketonuria, alkaptonuria, maple syrup urine disease, methylmalonic academia (MMA), homocystinuria and Hartnup's disease.

Unit-IV

Biosynthesis of Purine and Pyrimidine Nucleotides

De novo synthesis of purine and pyrimidine nucleotides, regulation and salvage pathways.

Deoxyribonucleotides and Synthesiss of Nucleotide Triphosphate

Biosynthesis of deoxyribonucleotides and its regulation, conversion to triphosphates, biosynthesis of coenzyme nucleotides.

Degradation of Purine and Pyrimidine Nucleotides

Digestion of nucleic acids, degradation of purine and pyrimidine nucleotides. Inhibitors of nucleotide metabolism. Disorders of purine and pyrimidine metabolism – Lesch-Nyhan syndrome, Gout, SCID, adenosine deaminase deficiency.

Suggested Reading:

1. Berg Jeremy M., Tymoczko John L. and StryerLubo, *Biochemistry,* 7th Ed., W.H. Freeman (2011).
2. Conn E.E. and Stumpf P.K., *Outlines of Biochemistry,* John Wiley, (1987).
3. Finar, I.L. &Finar, A.L. *Organic Chemistry* Vol. 2, Pearson (2002).
4. Finar, I.L. *Organic Chemistry* Vol. I Longman (1998).
5. Sinden, R.P. *DNA Structure and Function,* 1st Ed., Academic Press (1994).
6. Zubay G., *Biochemistry,* 4th Ed., Addison Wesley Publ. (1999).
7. Horton & others, *Principals of Biochemistry,* 5th Ed., Prentice Hall, (2011).

References:

1. Murray Robert K., Graner Daryl K., Rodwell Victor W., *Harper's Biochemistry,* 29th Ed., Lange McGraw Hall (2012).
2. Lehniger A.L., David L. Nelson, Michael M. Cox, *Principles of Biochemistry,* 5th Ed., W.H. Freeman, (2008).

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SECTOR-16C, DWARKA, NEW DELHI-110078

SEPARATION SCIENCE

Course Code: **MaximumMarks: 25 + 25(CE)**
PC-705(A1) (2 0 0)* **Separation Science** **Credit: 2**

Instruction to Paper Setters: **Time: 2 hours**
Attempt three questions **Maximum Marks: 25**

Question Paper shall contain **three Units.**

- Student has to attempt **three questions** from threeunits..
- Unit **I** is compulsory and it is of 9 marks and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II &III** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.
- Unit **II &III** are of 8 marks each question.

Course Objective:

1. The main objective of this course is to familiarize students with the fundamental principles of separation processes used in analytical chemistry such as various extraction techniques, gas and liquid chromatography, size and ion chromatography and electr phoresis.
2. By completion of the course, students are also expected to gain independent laboratory skills in certain separation techniques
3. The learner will have the ability to interpret data from analytical separation methods.

Course/Learning Outcomes:

On completion of the course, the student should be able to:

- Have understanding of different purification criteria at separation.
- Account for fundamental separation processes and their connection to molecular properties.
- Have awareness about the most common separation and detection methods.
- Account for application of different chromatographic methods regarding examination type, component analysis and concentration range.
- Be able to choose and a ply appropriate separation and detection methods on the basis of a simpler problem.

Unit-I:

Separation Techniques:

Need for learning separation techniques, separation techniques in natural product research and drug discovery, extraction techniques.

Chromatography:

General principles, classification of chromatographic techniques, normal and reverse phase, bonded phase chromatography, stationary phases, activity of stationary phases, elutropic series and separation mechanisms.

Column Chromatography and Short Column Chromatography:
Column packing, sample loading, column development, detection.

Flash Chromatography and Vacuum Liquid Chromatography:
Objectives, optimization studies, selecting column and stationary phases, selecting suitable mobile phases, automated flash chromatography and reverse phase flash chromatography.

High Performance Liquid Chromatography:
Principles, instrumentation, peak shapes, capacity factor, selectivity, plate number, plate height, resolution, band broadening, pumps, injector, detectors, columns, column problems, gradient HPLC, HPLC solvents, trouble shooting, sample preparation, method development.

Planar Chromatography-TLC/HPTLC/OPLC
Basic principles sample application, development of plates, visualization of plates, 2D, TLC, densitometry, over pressure layer chromatography.

Counter Current Chromatography
Basic principles, droplet countercurrent chromatography, centrifugal partition chromatography, choice of solvents for SP and MP.

Gas Chromatography
Principles, instrumentation, split-splitless injector, head space sampling, columns for GC, detectors, quantification.
Gel Permeation Chromatography

Biochromatography
Size exclusion chromatography, ion exchange chromatography, ion pair chromatography, affinity chromatography general principles, stationary phases and mobile phases.

Hyphenated Techniques
Introduction to GC-MS and LC-MS techniques and their applications in natural products.

Unit-II:

Separation and Characterization of Proteins
Ammonium sulphate fractionation, solvent fractionation, dialysis and lyophilization. Ion-exchange chromatography, molecular sieve chromatography, hydrophobic interaction/reverse phase chromatography, affinity chromatography.

Determination of purity, molecular weight, extinction coefficient and sedimentation coefficient, IEF, SDS-PAGE and 2-D electrophoresis.

Suggested Reading:

1. Mermet J.M., Otto M., R. Kellner, *Analytical Chemistry,* Wiley-VCH (2004).
2. Dick J.G., *Analytical Chemistry,* 3rd Ed., R.E. Krieger Pub., (1978).
3. Willard H.H., Merritt L.L., Dean J.A., *Instrumental Methods of Analysis,* 7th Ed., Van Nostrand, (2004).
4. Christian G.D., O'Reilly J.E., *Instrumental Analysis,* 2nd Ed., Allyn & Bacon, (1986).
5. Wendlandt W.W., *Thermal Methods of Analysis,* 2nd Ed., Interscience, (1964).
6. Hatakeyama T., Zenhai, *Thermal Analysis,* John Wiley & Sons, (1998).
7. Wiesendanger R., *Scanning Probe Microscopy and Spectroscopy,* Cambridge University Press, (1998) Reprint.

References:

1. Kennedy John H., *Analytical Chemistry Principles,* 2nd Ed., Sounders College Publishing, California (1990).
2. Harvey, *Modern Analytical Chemistry,* McGraw Hill. (2000).
3. Skoog, *Principles of Instrumental Analysis,* 6th Ed., (2014).
4. Settle F.A., *Handbook of Instrumental Techniques for Analytical Chemistry,* Prentice Hall PTR, (1997).

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- One course to be selected among 705A1/705A2
- The course would be offered with a minimum of 7 students

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MOLECULAR SPECTROSCOPY

Course Code: **MaximumMarks: 25 + 25(CE)**
PC-705(A2) (2 0 0)* **Molecular Spectroscopy** **Credit: 2**

Instruction to Paper Setters: **Time: 2 hours**
Attempt three questions **Maximum Marks: 25**

Question Paper shall contain **three Units.**

- Student has to attempt **three questions** from three units.
- Unit **I** is compulsory and it is of 9 marks and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II &III** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.
- Unit **II &III** are of 8 marks each question.

Course Objective:

1. The course aims to teach the students the theoretical background and to make conversant with the quantum mechanical nature of atoms and molecules, building on basic materials.

Course/Learning Outcomes:

Upon successful completion of this course, the student will be able to:

- Explain the change in behavior of atoms in external applied electric and magnetic field.
- Explain rotational, vibrational, electronic and Raman spectra of molecul s.
- Apply these concepts to understand the structure of molecules
- Able to apply knowledge to detailed understanding of electronic states f atoms, molecules, Franck-Condon Factors

Unit-I

Unifying Principles

Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorption, emission, transmission, reflection, refraction, dispersion, polarization and scattering. Uncertainty relation and natural line width and line broadening, transition probabilities, results of the time dependent perturbation theory, transition moment, selection rule, intensity of spectral lines, Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels.

Microwave Spectroscopy

The rotation of molecules, rotational spectra of rigid diatomic molecules, intensities of rotational spectral lines, isotopic effect, non-rigid rotator, spectra of polyatomic linear, molecules and symmetric top molecules.

Infrared Spectroscopy

The vibrating diatomic molecule, force constant, zero point energy, simple harmonic vibrator, anharmonicity, Morse potential, overtones, hot bands, diatomic vibrating rotators, P, Q, R branches, vibration of polyatomic molecules, normal mode of vibrations. Fourier transform spectroscopy.

Raman Spectroscopy

Classical and quantum theories, pure rotational raman spectra of linear molecules, vibrational raman spectra, mutual exclusion principle, polarization of the light and raman effect, depolarization of raman lines, technique.

Unit-II

Electron Spin Resonance Spectroscopy

Basic principle of ESR, experimental technique, the g-value hyperfine structure, applications of ESR spectroscopy to the study of free radicals and fast reactions, spin densities and Mc Connell relationship.

X-Ray

Production of X-rays, X-ray spectra, absorption edges, X-ray filters, reciprocal lattice concept and its importance, Definition of Reciprocal lattice vector (derivation excluded). Interplanar spacing using reciprocal lattice concept for cubic, tetragonal, orthorhombic and hexagonal crystal systems.Equivalence of Bragg's and Laue condition. Structure factor calculations for primitive, base-centered, body-centered and face centered unit cells. Relation of structure factor to electron density and intensities (derivation excluded). Data collection and data reduction, Phase problem-Patterson method and Heavy-atom method, refinement of structure by successive and difference fourier synthesis. Correctness of a structure (Discrepancy index).

Electron Diffraction

Basics, measurement technique, Comparison with X-ray diffraction technique. Applications in structure determination.

Neutron Diffraction

Basics, measurement technique, applications and comparison with X-ray diffraction technique.

Suggested Reading:

1. BanwellC.N. *Fundamentals of Molecular Spectroscopy,* 4th Ed., Tata McGraw Hill. (2008).
2. Barrow, G.M. *Introduction to Molecular Spectroscopy* McGraw-Hill (1962).
3. Chang, R. *Basic Principles of Spectroscopy,* 2nd Ed., McGraw-Hill, New York, N.Y. (1973).
4. Warren, B.E. *X-Ray Diffraction* Dover Publications (1991).

References:

1. Gullavy W.A., *Introduction to Molecular Structure and Spectroscopy,* 1st Ed., Allyl and Bacon (1977).

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- One course to be selected among 705A1/705A2
- The course would be offered with a minimum of 7 students

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INTRODUCTION TO MICROBIOLOGY

Course Code: **Maximum Marks: 50 + 50**
(CE)PC-707 (3 0 0) **Introduction to Microbiology** **Credit: 3**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units**.

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unit and the student needs to attempt only one question from each unit

Course Objective:

1. The primary objective of the course is to build a strong foundation in the area of bacterial cell structure, division, survival and propagation and to develop clear understanding of various aspects of microbial physiologyand interactions along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation.
2. The course will facilitate in understanding of molecular virology by examining common processes and principles in viruses to illustrate viral complexity, to understand viral reproduction.
3. Demonstrate scientific literacy in major concepts and processes relative to the major groups of fungi and fungal-like organisms.

Course/Learning Outcomes:

Upon successful completion of the course, the student:

- Will be able to describe the morphological features, cell arrangement an structural components of bacterial cell in detail;
- Will be able to differentiate between Gram-positive and Gram-negative acteria.
- Will have gained knowledge about cell wall structure and extracellular appendages in different bacteria.
- Will have gathered detailed information regarding bacterial cell division and endospore formation.
- Can enlist the characteristics of archaea that differentiate it from eubacteria, and will have learnt key features of so e model archaeal organisms.

- Can enlist the salient features of the genome organization.
- Understands different secretion systems existing in bacteria for toxins and biomolecules secretion, and their role in bacterial survival and pathogenesis.
- Develop an understanding of microbes, fungi and lichens and appreciate their adaptive strategies

Unit-I

History of Development of Microbiology

Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Loch, Joseph Lister, Alexander Fleming. Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

Bacterial Cell Organization

Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili. Cell-wall: Composition and detailed structure of Gram-positive and Gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolyssaccharide (LPS).

Bacteriological Techniques

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

Unit-II

Growth and nutrition

Definitions of growth, Batch culture, Continuous culture, generation time and specific growth rate, Effect of temperature and pH on microbial growth, Effect of solute and water activity on growth, Effect of oxygen concentration on growth, Nutritional categories of microorganisms.

Nutritional requirements in bacteria and nutritional catergories, Culture media: components of media, natural and sunthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media.

Logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

Unit-III

Virus

Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin. Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses. Isolation, purification and cultivation of viruses. Viral taxonomy: Classification and nomenclature of different groups of viruses. Bacteriophages: Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage).

Fungi

Fungi General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra-structure, thallusorganization and aggregation, fungal wall structure and synthesis, asexual production, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism.

Unit-IV

Microbial Interactions

Microbial genetics-transformation, conjugation, transduction, protoplast fusion, genetic recombination.

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation.

Microbe-animal interaction: termite gut microflora, nematophagus fungi and symbiotic luminescent bacteria.

Normal microflora of the human body; Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract.

Host pathogen interaction: Definitions – Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection.

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence).

Suggested Reading:

1. Ananthanarayan&Paniker's, *Textbook of Microbiology,* 9th Ed., University Press, (2012).
2. Dawes G.W., *Microbial Physiology,* 2nd Ed., Oxford, (1992).
3. Gardner J.F. and Peel M.M., *Introduction to Sterilization and Disinfection,* 2nd Ed, (1986).
4. Murray P. R., *Manual of Clinical Microbiology,* 7th Ed., Amer Society for Microbiology, (1999).
5. Collier L and Oxford J. *Human Virology,* 4th Ed., London Oxford University Press, (2011).
6. Stanimr R.V., Ingraham J.L., WheelisM.L., Painter P.R., *The Microbial World,* 5th Edition, Prentice-Hall, (1990).
7. Wileman A., *Principles of Biotechnology,* 2nd Edition, Surrey University Press.

References:

1. Schwartz R.S., *Diversity of the Immune Response,* New Eng J Med 348:1017 (2003).
2. TalaroK.P., Chess B., *Foundation in Microbiology: Basic Principle,* 8th Ed., McGraw Hill Science, (2014).
3. Law Chamber, *Medical Microbiology-The Big Picture,* 1st Ed., McGraw Hill, (2008).

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Developing Entrepreneurial Mindset

Course Code: **NUES***
PC-709 (2 0 0) **Developing Entrepreneurial Mindset** **Credit: 2**

Course Objective:

1. The course aims at developing entrepreneur attitude in the student by helping them to understand the steps involved in becoming entrepreneur and developing a mindset of entrepreneurship.

Unit 1

Introduction to entrepreneurship:

Who is an Entrepreneur? Advantage of becoming entrepreneur, Characteristics of entrepreneur, Competencies and skills possessed by entrepreneur, Myths about entrepreneur etc. Difference between entrepreneur and manager, between entrepreneur and entrepreneurship. Case studies on Indian entrepreneur.

Unit 2

Steps involving in starting enterprise:

Deciding the type of organization to start business, deciding the name of the enterprise, registration formalities, identification of opportunities, sources of finance, arranging finance and managing the enterprise.

Unit 3

Definition of MSME& Institutional support:

Definition as per MSMED Act 2016, revised guideline 2020, incentives available to MSME by Govt. of India, Institutional setups available at the center and state level supporting MSME. Case study on MSME enterprises in India.

Unit 4

Developing entrepreneurship attitude:

Practical training on developing creativity and Innovation in the students, entrepreneur attitude using behavioral scales, entrepreneurship scorecard for the students. Improving public speaking and negotiation skills, doing a live project.

Suggested Reading:

1. Nath Suryakant,*Entrepreneurship Development and Small Scale Industries*, Neha Publishers & Distributors, Delhi(2012),
2. Holt D.H., *Entrepreneurship New Venture Creation*, Pearson Education (2016).

3. Nath Suryakant *Entrepreneurship Development and Small Scale Industries,* Neha Publishers & Distributors, Delhi (2012).
4. Charantimath,*Entrepreneurship Development and Small Business Enterprise Pearson Education* (2013).
5. Scarborough N.M. and Cornwall H.R., *Essentials of Entrepreneurship and small Business Management, 8/e, Pearson Education*(2016).
6. Taing Kalpana, *Entrepreneurship Theory and Practice, Anmol Publication Pvt. Ltd.,* Delhi (2014).

*NUES: Non University Examination System

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CONCEPTS IN DRUG DESIGN*

Course Code: **Maximum Marks: 50 + 50 (CE)**
PC-711 (3 0 0). **Concepts in Drug Design*** **Credit: 3**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units.**

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unit and the student needs to attempt only one question from each unit.

Course Objective:

1. Course aims to provide students with an understanding of the process of drug discovery and development from the identification of novel drug targets to the introduction of new drugs.
2. It covers the basic principles of how new drugs are discovered with emphasis on lead identification, lead optimization, classification and kinetics of molecules targeting enzymes and receptors, prodrug design and applications, as well as structure-based drug design methods.
3. Recent advances in the use of computational and combinatorial chemistry in drug design will also be presented.

Course/Learning Outcomes:

Upon successful completion of the course, the student:

- Would understand the various stages of drug discovery and target identification to final drug registration.
- Learn the concept of bioisosterism and drug resistance
- Describe physicochemical Properties and the techniques involved in QSAR
- Explain various structure based drug design methods (Molecular docking)
- Learn the concept of pharmacophore and modelling techniques ta get selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughput screening

Unit-I

Computational Molecular Modeling

Molecular Mechanics (MM), Force Field, Energy minimization, Geometry optimization methods: Linear and non-linear methods of minimization, Confirmation search different methods: (Systematic Search, Random Search, Monte Carlo Methods, Tabu Search, Simulated Annealing, Matrix Method, Genetic Algorithmsetc) Advantages and limitations of different method.

Structure Based Drug Design

Introduction, Molecular interactions; Protein structure selection-preparation; Binding Site Analysis; Docking; Search algorithms; Scoring methods: Molecular Mechanics, Empirical functions, Knowledge based, consensus scoring; Grid based docking, validation of the results; Comparison of different docking software; Rigid docking Vs Flexible docking methods; Induced fit docking; Covalent docking; Binding affinity calculations; Hydration thermodynamics in lead optimization; Structure based Virtual screening workflow; De-novo Drug Design methods: Fragment based drug design, Combinatorial library generation, Scaffold hopping.

Unit-II

Protein Structure Prediction and Biologics

Introduction: Homology modeling, Threading method; Template identification; Sequence alignment methods: Sequence based alignment, Fold based alignment; Model building; Protein-loop refinement; Protein model validation; Protein-protein Docking; Antibody modeling, Protein Engineering tools: Cysteine Scanning, Residue Scanning, protein aggregation analysis.

Ligand Based Drug Design

Introduction; 3D-Pharmacophore; Hypothesis development; Validation of the pharmacophore; energy based pharmacophore; Shape based search methods for virtual screening.

Unit-III

Quantitative Structure Activity Relationship (QSAR)

Introduction; Physicochemical properties; Electronic effects: Hammett equation; lipophilicity effects: Hansch equation; steric effects: Taft equation; Discriptors for QSAR: Physico chemical descriptors, Steric descriptors: 1D, 2D, 3D-QSAR; atom based QSAR, Field based QSAR; ADME Screening.

Quantum Mechanics (QM)

Introduction; Difference between QM and MM; Introduction of Hartee-Fock and DFT calculation with selection of basic set, single point energy calculation, geometry optimization, Prediction of pKa, interpretation and prediction of UV/Vis, IR and Raman Spectra, identifying HOMO and LUMO-visualization of molecular orbitals and normal modes of vibrations.

Unit-IV

Molecular Dynamics

Introduction and theory; Ensembles: Canonical and micro-canonical ensemble, Free Energy perturbation method; Total free energy calculation.

Chemo-informatics Methods in Drug Design

Introduction to chemo-informatics, Structure fingerprint methods; Structure similarity search/Clustering methods; R-group analysis.

***To be taken along with practical.**

Suggested Reading:

1. Young David C., *Computational Drug Design: A Guide for Computational and Medicinal Chemist,* Wiley (2009).
2. Silverman R.B., *Organic Chemistry of Drug Design and Drug Action,* 3rd Edition, Academic Press, (2014).
3. Charifson P.S., *Practical Applications of Computer Aided Drug Design,* Marcel Deckker, (1997).
4. Cohen N.C., *Molecular Modeling in Drug Design,* Online.
5. Goodman J., *Chemical Applications of Molecular Modeling,* RSC, (2004).
6. GunerO.F., *Pharmacophore Perceptio, Development and use in Drug Design,* International University, (2000).
7. Lemke Thomas L. and William David A., *Berger'sMedicinal Chemistry and Drug Design,* 6th Edition, Lippincott, (2008).
8. Purcell William P., *Strategies of Drug Design,* RSC, (2011).
9. Abraham Donald J. and Rotella D.P., *Foye's Medicinal Chemistry,* Vol. 1-8, 7th Edition, Wiley, (2010).
10. Korolkovas A. and Burckhalter J.H., *Essentials of Medicinal Chemistry,* John Wiley, (1976).
11. VeerapandionPandi, *Structure Based Drug Design,* Monograph, Vol. II and III, Academic Press.

References:

1. Leach A.R., *Molecular Modeling.*

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COMPUTATIONAL DRUG DESIGN PRACTICAL

Course Code: **MaximumMarks: 50 + 50 (CE)**
PC-751 (0 0 4) **Con putational Drug Design Practical** **Credit: 2**

Course Objective:

1. This practical introduces modern protein engineering techniques available to researchers to understand protein structure and function.
2. This is field that lies on the interface of chemistry, biology and engineering and involve use of computational, biochemical and self-based screening technologies to identify natural and synthetic compounds with pharmacological activity.
3. Study of structural activity relationship to understand mechanism of drug action.

Course/Learning Outcomes:

Upon successful completion of the course, the student would know:

- Computational molecular modeling tools which are used to aid in drug discovery and design and to incorporate these tools into drug discovery.
- To apply Molecular Modeling to Drug Discovery
- To Create Computational Molecules
- To View Protein-Ligand Interactions
- Ligand-Based Virtual Screening in Preparation for SAR
- Combining Modeling and Experimental Data for SAR Development and would carry Drug Discovery Case Study

Topics

1. Visualization of small / Macro-molecule structure, drawing of small molecules and optimization of small molecule (ligand Preparation).
2. Sequence Database: Swiss-Prot/Uniprot; Protein Database (PDB); Selection and optimization of the protein structure (Protein Preparation).
3. Docking: Protein grid generation, small molecule docking and analysis of docking results.
4. Flexible protein docking: Induced fit docking.
5. Covalent docking.
6. Homology modeling generation; Model refinement and validation of generated model.
7. De-novo structure based drug design: Combinatorial library design and identification of potential molecule by virtual screening workflow.
8. Pharmacophore generation and virtual screening of database.
9. 2D-QSAR, 3D-QSAR development for series of molecules by atom based QSAR and Field based QSAR techniques and ADME Toxicity predictions.
10. Energy based Pharmacophore (E-Pharmacophore) generation and Shape based virtual screening.

11. Antibody modeling, model validation, Antigen-Antibody docking or Protein-Protein Docking.
12. Residue-scanning and associated property predictions, Cysteine scanning, Reactive hot spots prediction and Affinity Maturation.
13. QM: Small molecule Geometry optimization, Single point energy calculation, spectral (UV/Visible, VCD, IR, NMR, Raman) and molecular property calculation(HOMO and LUMO, molecular orbitals, density, potential).
14. Molecular Dynamics Simulations and trajectory analysis.
15. Chemo informatics analysis of chemical database (Binary finger print analysis, Similarity search, Clustering, Scaffold decomposition)

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

Experiment **Marks: 30**
Lab record & Viva-voce **Marks: 5+15**

References:

1. Internet, Documentation of Software.

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MICROBIOLOGY PRACTICAL

Course Code: **Maximum Marka: 50 + 50 (CE)**
PC-753 (0 0 4) **Microbiology Practical** **Credit: 2**

Course Objective:

1. The major objective of the course is to impart hands-on training in basic microbiological, biochemical and immunological techniques.
2. Students will be trained in basic bacterial culturing and identification methods, as well as working in biosafety cabinet.
3. Student will become familiar in basic enzyme and immunological assays and be taught to present the results both, qualitatively and quantitatively.

Course /Learning Outcomes:

Upon successful completion of the course, the student:

- Is able to use different sterilization procedures and learn handling of micropipette.
- Is able to work in Biosafety Cabinet for culturing cells,
- Can use Fluorescence Microscopy for live cell imaging
- Is versed with identification and classification of given bacterial isolate by performing variety of cultural, biochemical and molecular tests.
- Can determine pI of ami o acids by titration method
- Is able to determine concentration of sugar and protein in a given sample after drawing a standard curve. Is able to study glucose uptake by E.coli.
- Is able to perform TLC for separating a mixture of amino acids, lipids, and sugars.
- Is able to study ammonium uptake by E.coli.
- Is able to determine specific growth rate of E.coli in different media.
- Understands the techniques of enzyme assay to determine its specific activity, pH optima, pH stability, temperature optima and temperature stability and calculate inactivation constant(K_d) and $t_{1/2}$of t e enzyme reaction based on the temperature stability curve.
- Can determine K_m,$V_{max}$and $K_{cat}$of a purified enzyme and determine its activation energy by plotting Arrhenius curve.

Microbial Techniques

1. Permanent Slides (Bacteria, Fungi)
2. Media preparation, pour plate and streak plate techniques.
3. Microscopic examination (motility, monochrome staining and gram staining).
4. **Sterilization:** Steam, Dry heat and filter.
5. Detection of amylase, caseinase, catalase activity.
6. Preservations of bacterial cultures.

7. Growth curve of *E. coli*.
8. Total viable count determination (pour plate and spread plate).
9. Ultraviolet irradiation and survival curve.
10. Isolation of auxotrophic mutants.
11. Plaque assay for phage.
12. Immobilization of yeast cells.
13. Microbial assay of vitamin and antibiotic.
14. Transformation
15. Lac operon by studying β-galactosidase.

Note: Any experiment may be introduced/deleted in the practical class based on the availability/non-availability of the instruments/chemicals.

Experiment **Marks: 30**
Lab record & Viva-voce **Marks:5+15**

Suggested Reading:

1. Collins J., *Microbial Methods.*
2. Cruickschank, *Medical Microbiology,* Vol-II.

References:

1. Singer, *Laboratory Auditing for Quality and Regulatory Compliance,* T &

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PROJECT/DISSERTATION

Course Code: **MaximumMarks: 200**
PC-755 (0 0 8). **Project/Dissertation** **Credit: 4 +8#**

Dissertation work would comprise of research work carried out by each student during semester IV under the supervision of a particular faculty member. The student would carry out the review of literature on the topic of research and formulate the plan of work in consultation and in the supervision of the mentor.The student would then conduct the research experiments for the proposed work. Towards the end of semester IV, the student will compile the research work including review of literature, aims and objectives, methodology and results and discussion in the form of a dissertation in the supervision of the mentor. At the end of semester 4, students would make presentations in the prese ce of all faculty members and would be collectively judged by the faculty members. Marks will be assigned to each student collectively by the fac lty based on his/her performance, work and continuous assessment throughout the year by the mentor.

 # 8 Credit in fourth semester and to be evaluated after IV semester

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DRUG SYNTHESIS AND MECHANISM OF ACTION

Course Code: **MaximumMarks: 50 + 50**
(CE)PC-702 (4 0 0) **Drug Synthesis and Mechanism of Action** **Credit: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units.**

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unit and the student needs to attempt only one question from each unit.

Course Objective:

1. The course aims to provide an advanced understanding of the core principles and topics of biochemistry and their experimental basis, to enable acquire a specialized knowledge on mode of action of drugs and their chemical synthesis.

Course /Learning Outcomes:

Upon successful completion of the course, the student would know:

- The principles governing drug actions in humans and acquire the specifi knowledge related to the different classes of drugs, and important distinctions among members of each class, in relation to the organ systems they affect, and the diseases for which they are used therapeutically.
- The basis for continued development in drug discovery
- How to build a rational approach to the use of drugs in practice.
- To develop a foundation to effectively use the medical literature to evaluate new drugs in the context of evidence-based drug discovery

Unit-I

Drug Acting on Metabolic Process, Cell Wall and Specific Enzymes

Basic concepts of mechanism of drug action**:** Introduction to macromolecular targets, carbohydrates, proteins, lipids and nucleic acids as possible drug targets. Classification of drugs. Enzyme inhibition and its types.

a) **Drug acting on metabolic process:** Antifolates – Discovery and mechanism of action of sulphonamides, Syntheis of sulfomethoxazole, sulfodoxine, sulfaguanidine and dapsone. Diaminopyrimidines – trimethoprim, bacterial resistance of sulfonamides and drug synergism.

b) **Drugs acting on cell wall:** Structure of bacterial cell wall, β-Lactam antibiotics – mechanism of action of penicillins and cephalosporins. Synthesis of pencillin-G and cephalosporin-C, cephalexin and cycloserine. Resistance to pencillins, broad spectrum penicillins – cloxacillin, methicillin, ampicillin, amoxicillin and carbenicillin. β-Lactamase inhibitors –Structural formulae and mode of action of clavulanic acid and sulbactum.

c) Drugs acting on specific enzymes: H^+/K^+-ATPase inhibitors – synthesis of Omeprazole and Carbonic anhydrase inhibitors – synthesis of Acetazolamide.

Unit-II

Drugs Acting on Genetic Material and Immune System

Drugs acting on genetic material: Introduction, classification and mechanism of action.

a) DNA-intercalating agents – Anticancer and antimalarial agents. Structural formulae of Daunomycin, Adriamycin and Amsacrine. Synthesis of Amscarine, Nitracrine, Quinacrine and Chloroquine.
b) DNA – Binding and nicking agents: Antiprotozoal drugs. Synthesis of Metronidazole, Dimetridazole and Tinidazole.
c) DNA – Alkylators: Synthesis of Cyclophosphamide and Bisulphan.
d) DNA – Polymerase inhibitors: Antiviral agents – Synthesis of Acyclovier and AZT.
e) DNA – Topoisomerase inhibotors: Anti bacterial agents. Synthesis of Ciprofloxacin and Norfloxacin. Structural formulae of loxacin and Lomefloxacin.
f) Inhibitors of transcribing enzymes: Anti-TB and antileprosy agents-strcutural formulae of Rifamycins and partial synthesis of Rifampicin.
g) Drugs interfering with translation process: Antibacterial drugs – Structural formulae of Erythromycin, 5-Oxytetracycline and Streptomycin. Synthesis of Chloromycetin.

Drugs acting on immune system: Introduction to immune system. Immunosupressing agent – structural formula of Cyclosporin. Immunoenhancers – use of vaccines and structural formula of levamisol.

Unit-III

Drugs Acting on Receptors and Ion Channels

Introduction to nervous system: structure of neuron, nerve transmission. Definition and examples of agonist, antagonist, neurotransmitters and receptors.

Drugs acting on receptors:

a) Adrenergic receptors – Introduction and classification. A-Adrenergic-receptor agonists and antagonists – Synthesis and biological activity of Nor-adrenaline, Methyl L dopa and Tetrazosin.
   B-Adrenergic-receptor – agonists and antagonists – Synthesis and pharmacological activity of Salbutamol, Tetrabutalin, Propranolol and Atenolol.
b) Cholinergic-receptors: Introduction and classification. Cholinergic-receptor agonists and antagonists – Structural formulae of Nicotine, Atropine and Tubocurarine. Synthesis of Acetyl choline and Succinyl choline.
c) Dopamine receptors: Introduction and classification. Dopamine – receptor agonists and antagonists – Biosynthesis of Dopamine. Synthesis of L-Dopa and Chlorpromazine.
d) Serotonin receptors: Introduction and classification. Serotonin receptor agonists and antagonists –synthesis and pharmacological activity of Serotonin and Metoclopramide.

e) Histamine receptors: Introduction and classification. Histamine receptor agonists and antagonists-synthesis and biological action of Histamine, Chloropheneramine and Ranitidine.

Hormones and their receptors: Introduction to estrogen receptors, Structural formulae of Tamoxifen.

Drugs acting on ion channels: Introduction to ion channels, drugs acting on Ca^{2+}, Na^{+} and Cl^{-} channels and their mode of action. Structural formulae of Tetracaine and synthesis and of Nifedipine, Diltiazen, Tetracine and 4-aminopyridine.

Unit-IV

Chiral Drugs

Introduction to chiral drugs. Three point contact model, Eutomer, Distomer and eudesmic ratio. Pfeiffer's rule. Role of chirality on biological activity: Distomers

a) with no side effects
b) with undesirable side effects
c) both isomers having independent therapeutic value
d) combination products having therapeutic advantages
e) metabolic chirality inversion

Pharmacological activity of some important drugs (e.g. S-Ibuprofen, Levocetrazine).

Suggested Reading:

1. Patrick Graham, *Introduction to Medicinal Chemistry,* 5th Ed., Oxford (1995).
2. Silverman R.B., *The Organic Chemistry of Drug Design and Drug Action,* 3rd Ed., Academic Press, (2011).
3. Foye Hollday, Thomas L. Lemke, William D.A., Vitoria F. Roche, Zito S. William, *Principles of Medicinal Chemistry,* 7th Ed., Wolter KluwerdLippment, (2013).
4. Nogrady T., Weaver D.F., *Medicinal Chemistry: A Molecular and Bio-Chemical Approach,* 3rd Ed., Oxford, (2005).
5. Roth Herman J., Kelemon Axel, Wenger T. Beiss, Horwood Ellis, *Pharmaceutical Chemistry and Drug Synthesis,* (1988), Digitized (2008).
6. Thomas Gareth, *Medicinal Chemistry An Introduction,* 2nd Ed., Wiley (2007).
7. Ashutoshkar, *Medicinal Chemistry,* New Age International, Revised (2005).
8. Sheldon Roger A., *Chirotechnology Industrial Synthesis of Optically Active Compound,* Marcel Decker (1993).

Reference:

1. Wolf Manfred B., *Burger's Medicinal Chemistry and Drug Discovery,* Wiley, (2014) Digitized.
2. Hantzsch, *Comprehensive Medicinal Chemistry,* Vol 1-5.

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GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
SECTOR-16C, DWARKA, NEW DELHI-110078

MOLECULAR PHARMACOLOGY

Course Code: **Maximum Marka: 50 + 50 (CE)**
PC-704 (4 0 0) **Molecular Pharmacology** **Credit: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units**.

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unit and the student needs to attempt only one question from each unit

Course Objective:

1. The course intends to provide basic knowledge of the modes of action of drugs at the molecular level and pharmacological methodology.
2. It aims at detailed analysis of the mechanisms of drug action at the molecular level through the application of biochemical and molecular biological techniques.
3. Receptor binding, is studied.

Course /Learning Outcomes:

Upon successful completion of the course, the student would:

- Define pharmacological terms and concepts - explain the modes of action of drug at the cellular level by describing their interactions with target proteins.
- Describe and explain the principles of absorption, distribution, metabolism and elimination of drugs.
- Describe the properties of different classes of neurotransmitter transport proteins.
- Understand the molecular and structural aspects of different classes of neurotransmitter transport proteins.

Unit-I

General

Introduction to Pharmaceutical sciences, history and development of chemotherapeutic agents, its branches, standards for drugs, naming of drugs, therapeutic index, LD50 and ED50, Pharmaceutical literature, official books, routs of drugs administration.

Cell Structure & Cellular Physiology

Sub Cellular organization, membrane processes, cell metabolism, cell division, structure and function of epithelial connective, muscular and nervous tissues, muscle contraction and properties, nerve impulse generation and transmission. Skull & skeleton.

Respiratory System

Structure respiratory volumes and capacities, ventilation, compliance and resistance, gaseous exchange and transport in blood, nervous and chemical regulations of respiration. Acid-base balance.

Renal System

Structure of kidney and urinary tract; nephorn transport processes concentration and dilution of urine, renal control of body fluids, plasma clearances, maturation.

Endocrinology

Functions of hormones and their regulation. Chemical signaling – endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms. Chemical classification of hormones, transport of hormones in the circulation and their half-lives. Hormone therapy. General introduction to Endocrine methodology.

Major categories of formulations, physical properties and chemical characteristics of drugs influencing their formulations.

Unit-II

Metrology:

Introduction, units of weight and volume in both imperial and metric system, simple calculations involved in preparing solutions of solids in liquids and liquids based on imperial and metric systems, method of allegation.

Pre Formulation Considerations: Analytical methods for characterization of drugs, determination of *p*Ka value, *p*H, solubility profile and effect of temperature, solution and solid state stability.

Emulsions

Types, identification and selection of emulgents, preparation and stability. Emphasis may be given on official products.

Suspensions and Mixtures

Practical considerations, preparation of products of different categories evaluation, stability and official suspensions.

Semi-Solid Dosage Forms

A brief description, preparation of ointments, creams jellies and suppositories.

Aerosol Dosage Forms

Advantages, formulation and standardization.

Principle of Toxicology and Treatment of Poisoning

Introduction, Toxic agents, Toxicity-acute, subacture and chronic, descriptive toxicity tests in animals, general principles of management of poisoning, antidotes, treatment of heavy metal poisoning and drugs (barbiturates, benzodiazepines, salicylates, morphine & morphine derivatives, alcohol).

Unit-III

Pharmacokinetics

ADME (Absorption, Distribution, Metabolism-Phase I and Phase II Reactions, Excretion) of drugs, important pharmacokinetic parameters-apparent volume of distribution, bioavailability,

clearance.

Pharmacodynamics

Elementary idea about drug action, drug targets, neurotransmitters, the receptor role, drug receptor interactions, types of receptors-ion channel receptors, G-protein coupled receptors, kinase-linked receptors, ion channels and their control, membrane bound enzymes-activation/deactivation, design of agonists and antagonists.

Unit-IV

Systemic Pharmacology

A detailed study of the mechanism of action, pharmacology and toxicology of drugs used in:

a) ANS-Parasympathomimetics and lytics, sympathomimetics and lytics, agents acting at neuromuscular junction and ganglia.
b) Local and general anesthetics.
c) CNS-General anesthetics, sedatives, hypnotics. Drugs used to treat anxiety, depression, psychosis, mania, epilepsy, neurodegenerative diseases, drug dependence and addiction.
d) CVS – Diuretics, anti ischemics antihypertensives, antiarrythmics, drugs for heart failure and dyslipidiemia.
e) Effect of drug on blood constituents.
f) Autocoid Pharmacology – A study of the mechanisms involved in the formation, release, pharmacological actions and possible physiological role of histamine, serotonin, kinins, prostaglandins, opioidautocoids and cyclic 3' – 5' AMP. Systemic pharmacology of drugs acting as agonists and antagonist to the autocoids.
g) Immunopharmacology – Cell and biochemical mediators involved in allergy, immunomodulation and inflammation. Classification of hypersentitivity reactions and diseases involved. Therapeutic agents for allergy, asthma, COPD and other immunological diseases with emphasis on immunomodulators.
h) GIT pharmacology – Antiulcer, prokinetics, antiemetics, antidiarrhoeal and drugs for constipation and irritable bowel syndrome.
i) Analgesics and anti-inflammatory agents.
j) Harmone and hormone antagonists.
k) Antibiotics & Chemotherapeutic agents.

Suggested Reading:

1. Goodman and Gilman's *Pharmacological Basis of Therapeutics*, 12th Ed., McGraw-Hill.
2. Dandya P.C. and Kulkarni S.K., *Introduction to Pharmacology,* Vallabh Publication.

References:

1. B.G. Katzung, Trever A.J., *Basic and Clinical Pharmacology*, 3rd Ed., McGraw Hill Large Medical Publication, (2015).

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SECTOR-16C, DWARKA, NEW DELHI-110078

MEDICINAL CHEMISTRY

Course Code:		**MaximumMarks: 50 + 50 (CE)**
PC-706 (4 0 0)	**Medicinal Chemistry**	**C edit: 4**

Instruction to Paper Setters: **Time: 3 hours**
Attempt five questions **Maximum Marks: 50**

Question Paper shall contain **five Units.**

- Student has to attempt **five questions** from five units.
- All units are of 10 marks each.
- Unit **I** is compulsory. and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II to V** shall have 2 questions in each unit and the student needs to attempt only one question from each unit

Course Objective:

1. Medicinal Chemistry course aims to gain a comprehensive understanding of the fundamental concepts related use of major classes of drugs from their chemical structures
2. It aims to interpret relationships between molecule concentration and enzyme or receptor activity.
3. Compute a molecule's pharmacokinetic parameters from C_p-time data points Correlate a molecule's structure to its metabolic behaviour. Prioritize the viability of weakly active molecules for potential drug development

Course /Learning Outcomes:

Upon successful completion of the course, the student would:

- Understand and apply th principle involved in drug action
- Correlate the pK/PD asp cts of biologically active molecules
- Gain theoretical expertis in various tools employed in drug discovery
- Be able to relate the physico-chemical properties, pharmacological activities, mechanisms of action, ADME (adsorption, distribution, metabolism, and excretion), and pharmacokinetic properties of drugs to their chemical structures.
- Integrate knowledge fro foundational sciences to explain how specific drugs or drug classes work and evaluate their potential value.

Unit-I

Principles of Medicinal Chemistry

Drug development, how to plan a drug, amino acids what affects bind of drug to its target. Gibbs free energy, the molecular forces: strong, weak, electrostatics, hydrogen bridges, the forces of Van der Waals. Water, entropy, degrees of freedom. Aqueous solubility; Flick's Law

of diffusion; The cell membrane and lipophilicity; Partition and distribution coefficients. Isosterism and bioisosterism.Functional group modifications. Quantitative relation between structure and activity: Hammett equation and SAR.

Hansch equation, log p Lipinski rule of five.Hits, leads and validated leads; specific and non-specific drug action. Lead optimization. Pharmacophores and auxophores; Minimalisation; Homologation;Branching; Ring-chain transformations.

Protease Inhibitors

Proteases - serine, wiring (cysteine), aspartic metalloproteinase (Zinc): proposed mechanisms of action, specificity and selectivity, contact various diseases.

Inhibitors of proteases - a situation beyond imitation, imitation intermediate product.Examples of inhibitors of zinc proteases and development antihypertensive medications - blood (ACE inhibitors).Metalloenzymes proteases as flame retardants cancer.

Cholinergic System Drugs

Introduction, acetylcholine, conformation and the relationship between them and the activity.Agonists and antagonists of the Nicotinic and Muscarinic systems. acetylcholine esterase: Structure and mechanism of operation, and other relevant enzymes. Activation of the cholinergic system. Esterase blockers: Carbamates: structure, mechanism of action. Inhibitors structure. Aging process, Activation by Oximes: SAR, mechanism of action.

Antibiotic

Beta lactams and penicillins, bond angles, structure and mechanism of action, the relationship between the structure, stability and activity. Sulfonamides, structure and activity.

Peptide Drugs

Structure of proteins, protein-drug limitations of therapeutic proteins and protein modifications, synthesize peptides and prodrugs.

Inhibitors of HIV

Viruses, HIV and drug development: Reverse transcriptase inhibitors, non-nucleosides inhibitors, and nucleosides-like inhibitors, HIV protease inhibitors and drug development based on crystallography.

Unit-II

Oncology

Overview and introduction of cancer, tumorigenesis, molecular basis of cancer phenotypes, cancer-related genes, interventions in reference of targets and prevention strategies.

Antimetabolites and hormones inhibitors with chemistry and pharmacology; estrogen, progesterone and androgen receptors.

DNA targeted anti-cancer drugs: DNA alkylating agents, alkylating and non-alkylating compounds interacting with the DNAminor groove, drugs targeting DNA and DNA-associated enzymes.

Anticancer drugs targeting tubulin and microtubules, signalling pathways inhibitors: kinase inhibitors, natural products in cancer prevention and therapy.

Biological and non-biological therapies of cancer; drug resistance in cancer chemotherapy, cancer chemoprevention, and anticancer drugs acting via radical species: radiotherapy and photodynamic therapy of cancer.

Unit-III

Tuberculosis

Signs and symptoms; Pulmonary, Extrapulmonary.Mycobacterium tuberculosis, cell structure, Transmission and Pathogenesis. A Global Epidemic, The Medical History of Current TB Chemotherapy, The Emergence of Drug-Resistant TB, Special Challenges in TB Drug Development.

The Development of Commonly Used First-Line and Second-Line Agents for TB Therapy, Rifamycins, Isoniazid, Thioisonicotinamides and Thiosemicarbazones, Pyrazinamide, Para-Aminosalicylic Acid, Capreomycin, Aminoglycosides.

Classes of Compounds in Clinical Development, Nitroimidazoles, Diarylquinolines, Oxazolidinones, Fluoroquinolones, Ethylenediamines.

Series in Preclinical Development, Benzothiazinones, Nucleosides, Macrolides, b-Lactams, Rhiminophenazines, Pyrroles, Deazapteridines.

Targets based; TP Synthase Inhibitor, Translocase I Inhibitor, InhA Inhibitors, Isocitrate Lyase Inhibitors.

Drug Resistance in TB and is diagnosis.

Critical Issues in TB Drug Development e.g.Cell Penetration, Animal Models for Evaluation, Pharmacological Models for Antitubercular Drugs.

Clinical Development Methodologies.

Unit-IV

Malaria

The Malaria Parasite and its Life-cycle; Clinical Features of Malaria, The Sporozoite, the Merozoite, and the Infected Red Cell: Parasite Ligands and Host Receptors. Antimalarial Medicines; Amino-alcohols, 4-aminoquinolines, Endoperoxides of the artemisinin family, Aniline-sulphonamides/sulphones,Diaminopyrimidines/diamino-dihydrotriazines, Hydroxynaphthoquinones, Lincosamides, Tetracyclines.

Novel and Advanced Chemotypes; Spiroindolone, Aminoindole, Oxaborole, Liver Stage Acting Antimalarials; Primaquine, Tafenoquine, Bulaquine.

Target-Based Optimisation; Pyrimidine Biosynthesis, Folate Biosynthesis, Deoxyuridine 50-Triphosphate Nucleotidohydrolase, Purine Biosynthesis, Degradation/Catabolic Pathways; Haemoglobin Processing, Heat Shock Proteins 70/90. Anabolism/Synthesis Pathways; Non-Mevalonate Pathway, Choline Pathway, Fatty Acids.Signalling/Proliferation Pathways; Kinases, Histone Deacetylase, DNA-Binding Bisamidines.Protein Synthesis Pathways.

Drug Resistance in Malaria

Clinical Development Methodologies.

Suggested Reading:

1. Rosenthal Philip J.,*Antimalarial Chemotherapy; Mechanisms of Action, Resistance, and New Directions in Drug Discovery*, Humana Press, New Jersey, (2001).
2. Elliott Richard L.,*Third World Diseases*, Springer-Verlag Berlin Heidelberg Series Volume-7, (2011).
3. Mats Wahlgren, and Peter Perlmann. *Malaria: molecular and clinical aspects*. CRC Press, (2003).
4. Elliott Richard L.,*Third World Diseases*, 1st Ed., Springer-Verlag Berlin Heidelberg (2011).
5. Donald Peter R., Paul D. Van Helden, *Antituberculosis Chemotherapy*, Karger Medical and Scientific Publishers (2011).

6. Yew W. W.; *Development of New Antituberculosis Drugs*; 1st Ed., Nova Science Publisher, New York, (2006).
7. CarmenAvendaño and Menéndez J. Carlos, *Medicinal Chemistry of Anticancer Drugs*, 2ndEdition, Elsevier, (2008).
8. Chemotherapeutic Agents, *Burger's Medicinal Chemistry and Drug Discovery*, 6th Edition, Volume 5, John Wiley and Sons, (2003).
9. Bradbury Robert H. *Cancer-Topics in Medicinal Chemistry,*1st Ed., Springer-Verlag Berlin, (2007).
10. Michelle Prudhomme,*Advances in Anticancer Agents in Medicinal Chemistry*, Vol. I & II, Bentham Science Publishers, (2013).
11. Patrick, *Introduction to Medicinal Chemistry,* 5th Ed., Oxford (2013).
12. Hantzsch, *Comprehensive Medicinal Chemistry,* Elsevier, (1995).
13. Foye William, *Principle of Medicinal Chemistry,* 7th Ed., (2012).
14. Thomas Garith, *Medicinal Chemistry: An Introduction,* 2nd Ed., Wiley (2008).
15. Thomas Nogrady, *Biochemical Approach to Medicinal Chemistry,* Oxford (2005).

References:

1. *Harrison's Principles of Internal Medicine*, 19th Ed., New York McGraw Hill, (2014).
2. Chan E.A. and Isman M.D., *Current Medical Treatment for Tuberculosis,* BMJ 325:1282
3. Wolf Manfred E., *Burger's Medicinal Chemistry and Drug Discovery,* 5th Ed.

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SECTOR-16C, DWARKA, NEW DELHI-110078

Course Code:		**MaximumMarks: 25 +**
25(CE)PC-708(A1) (2 0 0)**	**Formulation Chemistry**	**Credit: 2**

Instruction to Paper Setters: **Time: 2 hours**
Attempt three questions **Maximum Marks: 25**

Question Paper shall contain **three Units.**

- Student has to attempt **three questions** from three units..
- Unit **I** is compulsory and it is of 9 marks and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II & III** shall have 2 questions in each unit and the student needs to attempt only one question from each unit.
- Unit **II & III** are of 8 marks each question.

Course Objective:

1. The course aims to identified the effective functioning of drug regulations for the new products.
2. The pharma regulatory affairs are important for knowledge of law and to equip with the educational foundation of regulatory affairs and quality education.

Course/Learning Outcomes:

On completion of the course the students should:

- Be able to describe basic physico-chemical properties for solid phases, liquids and solutions.
- Be able to account for the preformulation and including characterisation methods.
- Be able to account for the different dosage forms, included excipients and their function.
- Be able to account for manufacturing processes for the most common dosage forms.
- Be able to account for quality assurance and Good Manufacturing Practice (GMP) in connection with drug production.
- Having received skills in production and quality control of drug compoundings

Unit-I

Quality Control and Quality Assurance

Definition and classification of impurities in pharmaceutical products, origin of impurities, types of impurities: process impurities, degradation impurities, and contamination impurities. Nature of impurities: organic, inorganic, and residual solvent impurities. Differences between impurities and degradation products. Impurity-drug interaction. Toxicological perspectives of impurities in pharmaceutical products: Classes of genotoxic impurity, analytical challenge of genetic toxins, determination of genotoxic impurities.

Introduction, regulatory standards for drug stability, drug decomposition mechanisms: (i) Hydrolysis and acyltransfers (ii) Oxidation (iii) Photolysis, solid state chemical decomposition: Pure drugs, drug excipient and drug-drug interaction in solid state, factors affecting drug degradation and methods of stabilization.

Unit-II

Formulation Process

Introduction to preformulation studies, Essential information helpful in designing the preformulation evaluation of new drug; Pre-formulation studies of solids, liquid, semisolid, sterile dosage forms, controlled release formulation and occular preparations.

Types of tables, granulation – manufacture of granules, their basic characteristic and properties, Various additives included in formulation of tablets, standardization and evaluation of tablets as per official standards. Coating of Tablets: Principles and equipment; Taste masking sugar coating; tensile strength of films, evaluation of coated tablets, defects of films.

Processing of Capsules

Hare gelatin capsules, materials and production, Introduction of filling equipment, Soft gelatin capsules, manufacturing process, nature of capsule shell and contents, physical stability, packing and evaluation. Microencapsulation: Its importance and applications in pharmaceutical formulations, techniques and equipment for microencapsulation.

Suggested Reading:

1. Cooper and Gunn's, *Dispensing for Pharmaceutical Students,* 12th Ed., S.J. Carter, CBS Publishers & Distributors, (2008).
2. Cooper J.W. and Gunn's, *Tutorial Pharmacy,*Carter, CBS Publishers, (2005).
3. Lachman L., Lieberman Herbert A., Kaing Joseph L., *Theory and Practice of Industrial Pharmacy,* Lea &Fabiger, 3rd Ed., (1986) Digitized (2008).
4. Bentley and Drivers, *A Textbook of Pharmaceutical Chemistry,* Oxford Press, (1969).
5. *Indian Pharmacopoeia,* Govt. of India, Ministry of Health and Family Welfare
6. *British Pharmacopoeia*
7. *Indian Patent Act,* PDF (1970).

References:

1. ISO Annual Reports.
2. A. Osol, Remington, *The Science and Practice of Pharmacy,* 22nd Ed., Lippincultz, William and William, (2006).

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- One course to be selected among 708A1/708A2.
- The course would be offered with a minimum of 7 students.

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SECTOR-16C, DWARKA, NEW DELHI-110078

HEAT AND MASS TRANSFER

Course Code: **MaximumMarks: 25 + 25(CE)**
PC-708(A2) (2 0 0)** **Heat and Mass Transfer Credit: 2**

Instruction to Paper Setters: **Time: 2 hours**
Attempt three questions **Maximum Marks: 25**

Question Paper shall contain **three Units.**

- Student has to attempt **three questions** from three units..
- Unit **I** is compulsory and it is of 9 marks and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II & III** shall have 2 questions in each unit and the student needs to attempt only one question from each unit.
- Unit **II & III** are of 8 marks each question.

Course Objective:

1. The course is aims to understand the basic principles of phenomena of heat and mass transfer to develop methodologies for solving a wide variety of practical engineering problems in drug industry.

Course/Learning Outcomes:

- Upon successful completion of this course, the student will be able to:
- Understand the basic laws of heat transfer.
- Understand the mechanisms of heat transfer under steady and transient conditions.
- Learn and explain various modes of heat and mass transfer operations

Unit-I

Heat Transfer

Introduction, modes of heat transfer, Fourier's law of heat flow, thermal conductivity, steady state conduction. Equipment: Finned tube (extended surface) heat exchanger, plate heat exchanger, spiral heat exchanger, scraped heat exchanger and air cooled heat exchanger.

Distillation

Introduction, vapour – liquid equilibrium, partial vaporization, partial condensation, volatility, relative volatility, methods of distillation for two component systems-fractional distillation, azeotropic distillation, steam distillation, extractive distillation.

Filtration

Introduction, classification of filters, plate & frame filter presses, candle filter, filter media, filter aids, washing of filter cakes, filtration theory – constant pressure filtration, constant rate

filtration, filtration cycle, centrifuges, batch top driven centrifuge, batch under driven centrifuge, disk type centrifuge.

Drying

Introduction, rate of drying, constant rate period, critical moisture content, falling rate period, equilibrium moisture, free moisture, bound and unbound moisture, drying equipment – tray dryers, drum dryers, rotary dryers, spray dryers, flash dryers.

Crystallization:

Introduction, supersaturation, modes of generation of supersaturation, nucleation, primary nucleation, secondary nucleation, crystal growth, law of crystal growth, growth rate and growth coefficients, crystallization equipment – Tank crystallizers, circulating magma – vacuum crystallizers, circulating liquid evaporator crystallizers.

Unit-II

Fluid Flow:

Introduction, Newtonian and non-Newtonian fluids, viscosity, effect of temperature on viscosity, kinematic viscosity, laminar and turbulent flows, Reynolds number, Bernoullis equation without friction, orificemeter, venturimeter, pumps, types of pumps.

Reactors

Introduction to reactor design, ideal batch reactor, space time, space velocity, steady state mixed flow reactor, steady state plug flow reactor.

Chemical Process Development:

Process design development, types of design process development, plat location, plant layout, plant operation and control, material handling.

Safety and Loss Prevention:

Health and safety hazards, source of exposure, exposure evaluation, exposure hazard control, fire and explosion hazard, safety regulation, loss prevention.

Suggested Reading:

1. Warren L. Mac Cabe, Smith Julian C., Harriott P., *Unit Operations of Chemical Engineering,* 7th Ed. McGrawl Hill, (2004).
2. Naurman E. Bruce, *Chemical Reaction De Optimization and Scale Up,* 1st Ed., McGraw Hill, (2002).
3. WestreterpK.R., Van Swaaij W.P.M., Beanackers AACM, *Chemical Reactor Design and Operation,* Wiley (1987).
4. Peters Max Store, *Elementary Chemical Engineering,* 2nd Ed., McGraw Hill, (1984).

References:

1. Coulson J.M., Haker J.H. & Richardson, *Chemical Engineering: Chemical Engineering Series,* 5th Ed., Butter Worth, (2002)

**One course to be selected among 708A1/708A2

The course would be offered with a minimum of 7 students

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SECTOR-16C, DWARKA, NEW DELHI-110078

BIO-STATISTICS

Course Code: 710(A1) (2 0 0)* **	**Bio-Statistics**	**MaximumMarks: 25 + 25(CE)PC-C edit: 2**

Instruction to Paper Setters: **Time: 2 hours**
Attempt three questions **Maximum Marks: 25**

Question Paper shall contain **three Units.**

- Student has to attempt **three questions** from threeunits..
- Unit **I** is compulsory and it is of 9 marks and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II &III** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.
- Unit **II & III** are of 8 marks each question.

Course Objective:

1. This course represents an introduction to the field and provides a survey of data and data types.
2. There are some formulae and computational elements to the course, the emphasis is on interpretation and concepts.

Course/Learning Outcomes:

On completion of the course the students are able to:

- Recognize and give examples of different types of data arising in public health and clinical studies
- Interpret differences in data distributions via visual displays
- Calculate standard normal scores and resulting probabilities
- Calculate and interpret confidence intervals for population means and proportions
- Interpret and explain a p-value
- Perform a two-sample t-test and interpret the results; calculate a 95% confidence interval for the difference in population means
- Select an appropriate test for comparing two populations on a continuous measure, when the two sample t-test is not appropriate
- Understand and interpret results from Analysis of Variance (ANOVA), a technique used to compare means amongst more than two independent populations
- Choose an appropriate method for comparing proportions between two groups; construct a 95% confidence interval for the difference in population proportions

- Understand and interpret relative risks and odds ratios when comparing two populations
- Understand why survival (timed to event) data requires its own type of analysis techniques

Unit-I

Introduction and Scope of Biostatistics

Use of statistics in Pharmacy. Population and sample collection. Stages of research, types of data and methods of data collections.Data arrangement and presentation, formation of table and charts.

Measures of Central Tendency

Computation of means, median and mode from grouped and ungrouped data.

Measure of Dispersion: Computation of variance, standard deviation, standard error and their coefficients.

Unit-II

Measured Correlation and Regression

Experimental designing, planning of an experiment, replication and randomization. Probit analysis.

Probability Rules:

Binomial, poison and normal distribution.

Hypothesis Testing:

Student't' test, Chi square test, analysis of variance (ANOVA): 1-way, 2-way, 3-ways.

Suggested Reading:

1. Sokal, R.R. and Rohlf, F.J. *An Introduction to Biostatistics,*W.H. Freeman and Company, (1987).
2. Bailey, N.T.J. *Statistical Methods in Biology,* 3rd Ed., English University Press, (1995).
3. Gupta S.P., *Statistical Methods,* Sultan Chand & Sons.

References:

1. Indrayan A., *Medical Biostatistics,* 3rd Ed., Star Publisher (2012)

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- One course to be selected among 710A1/710A2/710A3.
- The course would be offered with a minimum of 7 students.

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BIO-ETHICS

Course Code: **Maximum Marks: 25 + 25(CE)PC-**
710(A2) (2 0 0)* **Bio-Ethics** **Credit: 2**

Instruction to Paper Setters: **Time: 2 hours**
Attempt three questions **Maximum Marks: 25**

Question Paper shall contain **three Units.**

- Student has to attempt **three questions** from threeunits..
- Unit **I** is compulsory and it is of 9 marks and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II &III** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.
- Unit **II & III** are of 8 marks each question.

Course Objective:

The field of bioethics will be dealt with the following five themes:

1. **Respecting Autonomy:** This deals with the importance of respecting the autonomy, or self determination, of patients and research subjects. Why is it so important? What are its limits? And what about the autonomy of doctors and nurses?
2. **Bioethics and the Human Body:** These explore issues around the human body like disability, normal and enhancing the body.
3. **Bioethics at the Beginning of Life:** This topic includes collaborative reproduction-new ways creating babies and ways building families. And some of the ethical issues they raise.
4. **Bioethics at the End of Life:** This topic deals with the other bookend of life including the persistent vegetative state, for instance and parameters to guide decision making.
5. **Global Bioethics:** It explores the bioethical issues in an increasingly globalized world including climate change, environmental justice, medical tourism and outsourcing medical research to develop countries and food securities in 21st century.

Course/Learning Outcomes:

On completion of the course the students are able to:

- Differentiate between ethical questions and non-moral questions. Summarize and analyze arguments for a particular ethical conclusion.
- Identify ethical issues when they arise in the context of healthcare, biotechnology, and the role of a physician.
- Form and defend a well-supported position on issues in bioethics.
- See the relevance of philosophy to the life sciences and social policy.
- Identify how very general concepts such as “person”, “woman”, “death” and so on work in arguments in bioethics.

- Overcome the ungrounded assumption that "anything goes" in philosophical or ethical discussion

Unit-I

Patient Autonomy

A brief historical overview of the concept, autonomy and medical paternalism, informed consent, physician truth telling, rights to refuse life-saving care, and parental rights regarding medical decisions about the children.

Provider Autonomy

"Medical conscientious refusal", Autonomy Rights, Negative and Positive Rights, Obligation and Autonomy Providers, Conscitious Objection, Complicity, Institution and Complicity.

Disability

Introduction, Models of Disability, Genetic Testing and Paradox of Harm, Critics of Routine Prenetal Testing, Creating a Deaf Child.

Enhancement: Concept of Biomedical Enhancement, Enhancement and the Ends of Medicine, Performance Enhancing Drugs, Radical Enhancement and the Human Good, Altering the Human Genome.

Unit II

Collaborative Reproduction

Parent, Right to be a Parent, Gamete Donation, Reproduction, Markets and Commodification, Surrogacy and Exploitation.

Abortion: Concept of Moral Status, Restrictive Views of Abortion, Human Dignity, Permissive Views of Abortion.

Death and Surrogacy Decision Making

Ending Life Support for Other, A Definition of Death, Ending Life-Support, Surrogacy Decision Making, Futility.

Voluntary Euthanasia: Concept of Euthanasia, Three Approaches to the Value of Human Life, Argument from Autonomy and Beneficence, Hypocrisy.

Climate Change

Cost and Options, Models of Moral Responsibility, Climate Change and Human Rights, Individual Responsibilities.

Global Issues in Bioethics: Medical Tourism, Bioethics Crossing Borders, Exploitation, Autonomy and Benefit, Feeding the World in 2050, Fairness and Concentration of Market Values-Horizontally concentrated and Vertically Integrated.

Suggested Reading:

1 Moskop J.C., *Informed Consent in the Emergency Department,* Emerg Med. Clin North Am. (1999).

2 Derse A.R., *What part of 'No' don't you understand? Patient refusal of recommended treatment in the emergency department,* Mt. Sinai J. Med. (2005).

3 Thewes J. Fitz Gerald D., Sulmasy D.P., *Informed consent in emergency medicine: ethics under fire,* Emerg Med Clin North Am. (1996).

4 Keyes L.E., English D.K., *Cultivating conscience: learning to make end of life decisions in the emergency department,* Ann Emerg Med., (1999).

5 Withers E. Sklar D.P., Crandall C.S., *Impairment and Severity: how ED physicians decide to override an impaired patient's refusal,* Am J. Emerg Med. (2008)
6 Magauran B.G., *Jr. Risk Management for the emergency physician: competency and decision making capacity, informed consent, and refusal of care against medical advice,* Emerg Med Clin North Am. (2009).
7 Moskop J.C., *Informed consent and refusal of treatment: challenges for emergency physicians,* Emerg Med Clin North Am, (2006).
8 Arun Bhatt, Clinical Trials and Good Clinical Practice in India, 1st edition, D.K. Publications, Mumbai (2006).

References:

1. Appelbaum P.S., Assessment of patients, *Compelence to consent to treatement,* N. Engl. J. Med. (2007).
2. Derse A.R., *Ethics and the law in emergency medicine,* Emerg Med Clin N Am., (2006).
3. Lippincott Williams & Wilkins, The Science and Practice of Pharmacy, vol. I & II, 21st edition, Remington, Wolters Kluwer Health (India) Pvt. Ltd., New Delhi (2005).

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- One course to be selected among 710A1/710A2/710A3.
- The course would be offered with a minimum of 7 students

CENTRE OF EXCELLENCE IN PHARMACEUTICAL CHEMISTRY
GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
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INTELLECTUAL PROPERTY RIGHTS

Course Code: **MaximumMarks: 25 + 25(CE)**
PC-710(A3) (2 0 0)* **Intellectual Property Rights** **Credit: 2**

Instruction to Paper Setters: **Time: 2 hours**
Attempt three questions **Maximum Marks: 25**

Question Paper shall contain **three Units.**

- Student has to attempt **three questions** from three units.
- Unit **I** is compulsory and it is of 9 marks and it should have objective or short answer type questions and should cover the entire syllabus.
- Unit **II &III** shall have 2 questions in each unitand the student needs to attempt only one question from each unit.
- Unit **II & III** are of 8 marks each question.

Course Objective

To give an idea about IPR, registration and its enforcement.

Course/Learning Outcomes:

On completion of the course the students are would have adequate knowledge of:

- The fundamental aspects of Intellectual property Rights
- Patents, patent regime in India and abroad and registration aspects
- The copyrights and its related rights and registration aspects
- The trademarks and registration aspects
- Geographical Indication (GI), Plant Variety and Layout Design Protection and their registration aspects
- Current trends in IPR an Govt. steps in fostering IPR.

Unit I

Overview of Intellectual Property

Introduction and the need for intellectual property right (IPR) - Kinds of Intellectual Property Rights: Patent, Copyright, Trade Mark, Design, Geographical Indication, Plant Varieties and Layout Design – Genetic Resources and Traditional Knowledge – Trade Secret - IPR in India : Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention, 1883, the Berne Convention, 1886, the Universal Copyright Convention, 1952, the WIPO Convention, 1967,the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994

Nature of Copyright

Subject matter of copyright: original literary, dramatic, musical, artistic works; cinematograph films and sound recordings - Registration Procedure, Term of protection, Ownership of copyright, Assignment and licence of copyright - Infringement, Remedies & Penalties – Related Rights - Distinction between related rights and copyrights

Concept of Trademarks

Different kinds of marks (brand names, logos, signatures, symbols, well known marks, certification marks and service marks) - Non Registrable Trademarks - Registration of Trademarks - Rights of holder and assignment and licensing of marks - Infringement, Remedies & Penalties - Trademarks registry and appellate board

Patents

Elements of Patentability: Novelty , Non Obviousness (Inventive Steps), Industrial Application - Non - Patentable Subject Matter - Registration Procedure, Rights and Duties of Patentee, Assignment and licence , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties - Patent office and Appellate Board.

Unit II

Other forms of IP

Design

Design: meaning and concept of novel and original - Procedure for registration, effect of registration and term of protection

Geographical Indication (GI)

Geographical indication: meaning, and difference between GI and trademarks - Procedure for registration, effect of registration and term of protection

Plant Variety Protection

Plant variety protection: meaning and benefit sharing and farmers' rights – Procedure for registration, effect of registration and term of protection

Layout Design Protection

Layout Design protection: meaning – Procedure for registration, effect of registration and term of protection

Current Contour

India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies

Suggested Reading:

1. Bouchoux Deborah E., *Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets*, Cengage Learning, Third Edition, (2012).
2. Edited by Derek Bosworth and Elizabeth Webster, *The Management of Intellectual Property*, Edward Elgar Publishing Ltd., (2013).
3. GangulPrabuddha ,*Intellectual Property Rights: Unleashing the Knowledge Economy*, McGraw Hill Education, 201

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PROJECT/DISSERTATION

COURSE CODE:		**MaximumMarks: 200**
PC-800	**Project/Dissertation**	**Credit: 8**

Dissertation work would comprise of research work carried out by each student during semester IV under the supervision of a particular faculty member. The student would carry out the review of literature on the topic of research and formulate the plan of work in consultation and in the supervision of the mentor.The student would then conduct the research experiments for the proposed work. Towards the end of semester IV, the student will compile the research work including review of literature, aims and objectives, methodology and results and discussion in the form of a dissertation in the supervision of the mentor. At the end of semester 4, students would make presentations in the prese ce of all faculty members and would be collectively judged by the faculty members. Marks will be assigned to each student collectively by the fac lty based on his/her performance, work and continuous assessment throughout the year by the mentor.

#2 Credit of third semester and final to be evaluated after IV semester