FACULTY OF SCIENCES

SYLLABUS

FOR

M.Sc. Applied Chemistry (Pharmaceuticals)
(Credit Based Evaluation & Grading System)
(Semester: I - IV)

Examinations: 2019-20

GURU NANAK DEV UNIVERSITY
AMRITSAR

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER SYSTEM)
(Credit Based Evaluation & Grading System)

Course Scheme

Note : All Theory Papers having Mid Semester Marks : 20 & End Semester Marks : 80. Total Marks will be 100.

First Semester

Sr.No.	***Code***	***Theory Papers***	***Credit L-T-P***
1.	CYL471	Organic Synthesis-I	3-0-0
2.	CYL472	Physical Chemistry-1	3-0-0
3.	CYL473	Inorganic Chemistry-I	3-0-0
4.	CYL474	Organic Spectroscopy	3-0-0
5.	CYL475	Biological Chemistry	3-0-0
6.	CYL476	Pharmaceutical Processing and Technology	3-0-0
7.	CYP471	Instrumental Technique Lab-I	0-0-3
8.	CYP472	Organic Synthesis Lab	0-0-3

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Second Semester

Sr.No. Code	***Theory Papers***	***Credit L-T-P***
1.CYL481	Chemical Engineering-I	3-0-0
2. CYL482	Organic Synthesis-II	3-0-0
3. CYL483	Physical Chemistry-II	3-0-0
4. CYL484	Modern Instrumental and Spectroscopic Techniques	3-0-0
5. CYL485	Medicinal Chemistry-I	3-0-0
6.	Interdisciplinary course	4-0-0*
7. CYP481	Instrumental Technique Lab-II	0-0-3
8. CYP482	Pharmaceutical and Natural Products Lab	0-0-3

*** Interdisciplinary courses can be chosen from the four credit ID courses (PG) offered by the following departments:**

1. Department of Bio-Technology
2. Department of Botanical Sciences
3. Department of Food Science and Technology
4. Department of Microbiology
5. Department of Molecular Biology and Bio-chemistry
6. Department of Pharmaceutical Sciences

Note : PSL-053 ID Course Human Rights & Constitutional Duties (Compulsory Paper). Students can opt. this paper in any semester except the 1st Semester. This ID Paper is one of the total ID Papers of this course.

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Third Semester

Sr. No.	***Code***	***Theory Papers***	***Credit L-T-P***
1.	CYL571	Chemical Engineering-II	3-0-0
2.	CYL572	Medicinal Chemistry-II	3-0-0
2.	CYL573	Inorganic Chemistry-II	3-0-0
3.	CYL574	Drug Design and Drug Development	4-0-0
4.	CYL575	Photochemistry and Pericyclic reactions	3-0-0
5.	CYL576	Process Control and Plant Economics	3-0-0
6.	CYL577	Green Chemistry and Waste Treatment	3-0-0
7.	CYP571	Pharmaceutical and Biological Chemistry Lab	0-0-3
8.	CYP572	Analytical Lab	0-0-3

Course Scheme for Fourth Semester

Sr. No.	**Code**	**Paper**	**Credits**
1.	CYP-590	Dissertation	0-0-16
2.	CYP-591	Seminar (Audit Course)	0-0-4

The fourth semester will comprise of a dissertation of 16 credits to be executed in pharmaceutical/chemical industry. The credits of the fourth semester will be distributed as

1. Project report and Evaluation by Industrial supervisor
   The industrial supervisor will be award the performance of candidate as Excellent, Good or Average based on the following criteria:
   - Regularity of the candidate
   - Understands the nature, objective and scientific principles underlying the investigation
   - Familiar and understands the relevant literature
   - Comprehends appropriate techniques and analytical methods
   - Correctly interprets results and clearly explains research findings
   - Assesses the significance of findings in a thorough, logical and coherent manner

   The candidate will give an open presentation of the project work in the department.

2. The candidate will give a Seminar, the topic of which will be decided by the department.

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Organic Synthesis-I
CYL – 471

Credit 3-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Reaction Mechanism: Structure and Reactivity (12 Hrs)

Type of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes.
Effect of structure on reactivity- resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants.Taft equation.

Section-B

2. Aliphatic Nucleophilic Substitutions (10 Hrs)

The S_N2, S_N1, missed S_N1 and S_N2 and SET mechanisms.
The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance. Classical and nonclassicalcarbocations, phenonium ions, norbornyl system, common carbocation rearrangements. The S_{Ni} mechanisum, Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon.Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transferr catalysis and ultrasound, ambident nucleophile, regioselectivity. Gabriel synthesis

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Section-C

3. Aromatic Nucleophilic Substitution (5 Hrs)

The S_NAr, S_N1, benzyne an $S_{RN}1$ mechanisms, Reactivity – effect of substrate structure, leaving group and attacking nucleophile.The von Richter, Sommelet-Hauser, and Smiles rearrangements.

4. Elimination Reactions (6Hrs)

The E2, E1 and E1cB mechanisms and their stereochemistry. Orientation of the double bond. Reactivity – effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination.

Section-D

5. Aliphatic Electrophilic Substitutions (5 Hrs)

Bimolecular mechanisms- S_E2 and S_Ei. The S_E1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity, Hell-Volard-Zelinskyreactin ,

6. Aromatic electrophilic substitution (7 Hrs)

The arenium ion mechanism, orientation and reactivity in mono substitution and di-substituted aromatics, energy profile diagram, the ortho/para ratio, ipso attack, orientation in other ring systems, quantitative treatment of reactivity in substrates and electrophiles. Diazo coupling, Vilsmeir reaction, Gatterman-Koch reaction, Bechmann reaction, Hoben-Hoesch reaction.

Books Recommended:

1. Organic Reaction Mechanism by Jerry March, John Wiley Ed. 5, 2002.
2. Advanced Organic Chemistry by Francis Carey, Vol A and Vol B

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Physical Chemistry-I
CYL-472

Credit 3-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Chemical Thermodynamics (12Hrs)

Laws, state and path functions and their applications, thermodynamics description of various types of processes, Concepts of free energy, entropy, fugacity and activity.Partial molar properties and their determination. Maxwell's relations, spontaneity and equilibria, temperature and pressure dependence of thermodynamics quantities, Le Chatelier principle, elementary description of phase transitions, phase equilibria and phase rule, two component system and three component system with one example each, Thermodynamics of ideal and non ideal mixtures, dilute solutions, excess functions. Activity coefficients of electrolytes, mean ionic activity coefficient, Debye Huckle treatment of dilute electrolyte solutions. Numerical Problems

Section-B

2.Statistical Thermodynamics: (10Hrs)

Probability, ensembles, distribution law, Partition functions: translational, rotational, vibrational and electronic partition functions and their relations to thermodynamic quantities Maxwell-Boltzmann, Bose-Einstein and Fermi Dirac Statistics, calculation of thermodynamic functions and equilibrium constants from partition functions, theories of specific heat for solids, Numerical Problems.

Section-C

3. Chemical Kinetics (12 Hrs)

Recapitulation of first, second and third order rate laws opposing reactions, parallel reactions, consecutive reactions. Photochemical reactions, quauntum yield, transfer of excitation energy, actinometry, chain reactions, and oscillator reactions. Theories of reaction rates : Molecular collision theory, Unimolecular Theory, Transition state Theory, Comparison of results with Eyring and Arrhenius equations. Reactions in solutions: Kinetics in solution, salt effects, influence of the solvent. Fast reactions - Rate constants of fast reactions.Relaxation methods, temperature-jump method.Stopped-flowtechnique, flash photolysis and magnetic reasonance method.(Numerical Problems).

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Section-D

4. Surface Chemistry and Catalysis (11Hrs)

Pressure difference across a curved phase boundary. Enhanced vapour pressure of small droplets (Kelvin Equation). Gibbs adsorption equation. Homogenous catalysis, Acid-base catalysis as well as general acid-base catalysis, Surface catalysis, Salient features of Langmuir, Freundlich, Slygin-Frumkin (Temkin). B.E.T. (its derivation), Harkins-Jura equations of sorption.Mechanism of surface reactions.

Books Recommended :

1. Principles of Physical Chemistry by Samuel H. Maron and Carl F. Prutton Oxford and IBH Publishing Co. Pvt.Ltd., New Delhi (1985).

2. Thermodynamics for Chemists by S. Glasstone, East-West Press (1975).

3. Thermodynamics, Kinetic Theory and Statistical, Thermodynamics by F.W. Sears and G.L. Salinger, (Chapter-II) 3rd edition Narosa Publishing House (1991).

4. Text Book of Physical Chemistry by S. Glasstone, Macmillan India Press (1977).

5. Chemical Kinetics by K.J. Laidler (Chapters I and 2), Tata McGraw Hill (1995).

6. Basic Physical Chemistry W.J. Moore (Chapter 14 & 18), Prentice-Hall of India Pvt.Ltd., New Delhi (1986).

7. Physical Chemistry by P.W. Atkin& Julio de Paula, Oxford University Press, 7^{th} Edition (2002).

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-I)
(Credit Based Evaluation & Grading System)

Inorganic Chemistry-I
CYL-473

Credit 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Reaction Mechanism of Tranistion Metal Complexes (10Hrs)

Introduction, ligand replacement reactions, classification of mechanisms, Water exchange rates, formation of complexes from aqueous ions, anation, reaction, aquation and base hydrolysis attack on ligands, reactions, of square planar complexes, mechanism of ligand- displacement reactions; metal carbonyl reactions, reactions of binuclear carbonyls, associative reactions, species with 17 electron, electron transfer processes outer and inner sphere. The Marcus theory, doubly bridged inner-sphere transfer, other electron transfer reactions; two electron transfers, Non-complementary reaction, Ligand exchange via electron exchange, reductions by hydrated electrons, streochemical non-rigidity, stereochemically non-rigid coordination compounds,

Section-B

2.Organometallic Chemistry: (12Hrs)

The basis of 18e- Rule, Exceptions to eighteen electron rule, Preparation of olefin Transition Metal Complexes.Molecular orbital, Description of bonding of two electron ligands to Transition Metals.Preparation of ˜enyl complex, Molecular orbital descripition of ligands to transition metals, Molecular orbital picture of bonding in ferrocene, Organic Chemistry of cyelopentadienyl Transition Metal Complexes, preparation of bis -arene complexes, Bonding of Bisarene complexes,

Section-C

3. Bioorganometallic Chemistry And Organocatalysed Coupling Reactions: (12Hrs)

Bioorganometallic Chemistry. Enzymes that contain organometallic active site and the enzymes that catalyze organometallic reactions, Metals and Health: Part I - Metal-based drugs (cis-platin, carboplatin, platinum anti-cancer drugs, technetium radiopharmaceuticals, gadolinium MRI contrast agents, auranofin). Part II - Metal toxicity: iron overload, mercuric ion reductase, lead and porphobilinogen synthase.

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Section-D

4. **Organometallic reagents in organic Synthesis**: (**11 Hrs**)

Oxidative Coupling, Reductive Elimination, Migration Insertion, β-Elimination, Combined Problems based on these mechanistic pathways, Catalysis involving metal complex intermediates.Organpalladiumcatalysed Coupling Reactions: Suzuki Coupling, Stille Coupling, Sonogashira coupling, Heck Cooupling, Hyama Coupling, Negishi Coupling and Kumada Coupling

Books Recommended :

1. F.A. Cotton & G. Wilkinson, Advanced Inorganic Chemistry, 5th Edition.

2. William W. Porterfield, Inorganic Chemistry, Ist Edition.

3. K.F. Purcell and J.C. Kotz, An Introduction to Inorganic Chemistry.

4. M. Tstutsui, M.N. Levy, A Nakamura & Mori, Introduction to Metal Complex Chemistry, Plenum Press, New York, 1970.

5. C. Elschenbroich and A. Salzer, Organometalics: A concise Introduction, 2nd Ed., VCH 1992.

6. J.J. Eisch, The Chemistry of Organometallic Compounds, London, 1967.

7. G.E. Coates, M.L. H. Green and K.W. Wade, Organo Metal Compound, Vol. I, Chapman and Hall.

8. J.E. Huheey, Inorganic Chemistry, 3rd Edition.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-I)
(Credit Based Evaluation & Grading System)

Organic Spectroscopy
CYL-474

Credit 3-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1 Nuclear Magnetic Resonance Spectroscopy-1 (12Hrs)

Basic Introduction, Fundamentals: Physical basis, magnetic nuclei, resonance, relaxation processes, signal-sensitivity.b) Instrumentation: Continuous-Wave (CW) instrument, Pulsed Fourier Transform (FT) instrument, Functions, Relation with sensitivity, Sampling. ^{1}H NMR, correlation of structure with spectra: Chemical environment and shielding, chemical shift and origin of its concept, reference compound, local diamagnetic shielding and magnetic anisotropy, relation with chemical shift, chemical and magneticnon-equivalence, spin-spin splitting and its origin, Pascal's triangle, coupling constant, mechanism of coupling, integral, NMR solvents and their residual peaks, protons onheteroatoms, quadrupole broadening and decoupling, effect of conformations and stereochemistry on the spectrum, Karplus relationship, diastereomeric protons, Heteronuclear coupling to F and P, virtual coupling, long range coupling-epi, peri, bay effects. Shift reagents-mechanism of action, spin decoupling and double resonance.

Section-B

2 Nuclear Magnetic Resonance Spectroscopy-II (6Hrs)

^{13}C NMR, correlation of structure with spectra: Chemical environment, shielding and carbon-13 chemical shift, calculation, proton-coupled C Spectra, Proton-decoupled C spectra, Nuclear Overhauser Enhancement (NOE), Problem with integration, Distortion-less Enhancement by Polarization Transfer (DEFT), Heteronuclear coupling for carbon to deuterium, carbon to F, carbon to P.Explanation of spectra of some compounds and drugs.

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3 UV/Visible Spectroscopy (5Hrs)

Frank Condon Principle, Ground and first excited electronic states of diatomic molecules, relationship of potential energy curves to electronic spectra, Chromophores, auxochromes, blue shift, red shift, hypo and hyperchromic effect, n-σ*,π-π*, n-π* transitions in organic molecules. Woodward rules for conjugated dienesand , -unsaturated carbonyl groups, extended conjugation and aromatic sterically hindered systems

Section-C

4 Infrared and Mass Spectroscopy: (11Hrs)

Characteristic regions of the spectrum: Various modes of vibrations, Energy levels Correlation of structure with IR spectra: Influence of substituents, ring size, hydrogen bonding, vibrational coupling and field effect on frequency, Absorptions of common functional group, Molecular ion and metastable peak, fragmentation patterns, nitrogen and ring rules, McLafferty rearrangement, electron and chemical ionization modes

Section-D

5. Interpretation of Organic Compounds and Drugs Using NMR/UV Visible/IR/Mass Spectroscopy (11Hrs)

(a) Combined problems on NMR/IR/UV-Visible Spectroscopy
(b) Combined problems on Mass and NMR
(c) Combined problems on NMR/UV/IR and Mass Spectroscopy.

Books Recommended:

1. Pavia, Lampman&Kriz, Introduction to Spectroscopy.
2. C.N Banwell "Fundamentals of Molecular Spectroscopy".
3. R. M. Silverstein, G.C.Bassler, T.C. Morrill, "Spectrometic Identification of Organic Compounds.
4. W. Kemp, "Organic Spectroscopy".
5. D.H. Williams, I. Fleming, "Spectroscopic Methods in Organic Chemistry".
6. D.H. Williams, I. Fleming, "Spectroscopic Problems in Organic Chemistry", 1967.
7. R.C. Banks, E.R. Matjeka, G. Mercer, "Introductory Problems in Spectroscopy", 1980.
8. G.M. Barrow "Introduction to Molecular Spectroscopy".

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-I)
(Credit Based Evaluation & Grading System)

Biological Chemistry
CYL-475

Credit 3-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Bio-molecules (2 Hrs)
Broad classification and role of biomolecules.

2. Amino Acids and Proteins (10 Hrs)
Structural and functional classification of proteins.Structure, Physicochemical properties, configuration and optional properties of amino acids.Colour reactions of Proteins and Amino acids, Purification of proteins and Amino acid sequence determination, Peptide bond. Ramachandran Plot. Primary, Secondary Teritiary and quaternary structure of Proteins. Three dimensional structure of proteins, Structure and functioning of Hemoglobin.

Section-B

3. Enzymes (7Hrs)
Classification, Mechanism of enzymatic reactions, kinetics of enzymatic reactions, Michaelis Menton model, Measurement of significance of Km and Vmax perfect enzymes. Inhibition of enzymetic reactions. Kinetics of competitive and non-competitive Inhibition.Allosteric enzymes Mechanism of enzymatic catalysis by Lysozyme and carboxypeptidasc. Zymogens.

4. Carbohydrates and Metabolism (4Hrs)
Configuration and chemical Transformations of Carbohydrates.Absolute configuration of carbohydrates. General concepts, energetics and control on metabolic pathways. Glycolysis and Citric acid cycle.

Section-C

5. Co-enzymes (11Hrs)
Classification, Structure and Function of Nicotinamide adenine dinucleotides (NAD and NADP), Riboflavin Nuleotides (FMN and FAD), Lipoic acid, Cytocromes, Pyridoxal phosphate, Nucleoside diphosphates.Tetrahydrofolic acid conjugates, Biotinylconenzyme. Conenzyme - A, and Thiamine pyrophosphate.

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Section-D

6. Biotechnological Application of Enzymes (11Hrs)

Large scale production and purification of enzymes, techniques and method of immobilization of enzymes, effect of immobilization on enzyme activity, Application of immobilized enzymes, use of enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA technology.

Books Recommended :

1. Biochemistry by L. Stryer, GBS Publishers and Distributors, Second Edition, 1972.

2. Biochemistry by D. Voet and J.G. Voet, John Wiley & Sons, Ist Edition 1995.

3. Immobilized Enzymes : An introduction and application in Biotechnology by Michael D. Trevan and John Wiley.

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(Credit Based Evaluation & Grading System)

Pharmaceutical Processing and Technology
CYL – 476

Credit 3-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

(A) Pharmaceutical Processing (3Hrs)

1. ***Milling :*** Objectives of comminution factors affecting size reduction, processes of milling, theory of milling and energy requirements, milling rate and types of milling machines, size distribution, determination of size, microscopy, sieving and sedimentation of particles. Pharmaceutical applications of milling

2. Mixing and Homogenisation (3Hrs)

Fluid mixing mechanisms and equipment, their classification and feasibility of selection based upon Reynolds, Froude and power numbers; Equipment for solid mixing.Study of following mixers; planetary mixer, agitator, triple roller mill, propellor mixer, Pharmaceutical applications of Mixing.

3. Compression and Consolidation of Pharmaceutical Powers (4Hrs)

Definition, angles of repose, Flow rate through tubes and hoppers, mass - volume – force relationship, Granulation properties and strength of granules, compression and consolidation under high loads .

Section-B

(B) Pharmaceutical dosage forms

4. Preformulation considerations (4Hrs)

Analytical methods for Characterization of drugs, determination of PKa value, pH solubility profile and effect of temperature, stability, calculation of shelf life.

5. i) Processing of tablets (4hrs)

Advantages and disadvantages of tablets, types of tablets. Granulation – manufacture of granules, their basic characteristics and properties with reference to different types of substances. Various additives included in tablet formulations. Compression of tablets - compressing machines and their tooling, processing problems and their remedy.Evaluation of tablets as per official standards.

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ii) Tablet coating (3Hrs)

Coating principles and equipment.Coating processes-sugar coating, Film coating and enteric coating. Materials used in coating. Tensile strength of film. Evaluation of coated tablets, defects of films.

Section-C

6. Processing of Capsules (4hrs)

Hard gelatin capsules - Materials and production. Filling equipment, hand filling, semiautomatic and automatic filling.Operations, formulation.Finishing and evaluation. Soft gelatin capsules - manufacture process, nature of capsule shell and contents. Evaluation, physical stability and packing.

7. Microencapsulation (4Hrs)

Importance and applications of microencapsulation in Pharmacy. Various techniques and equipment employed for microencapsulation.

8. *Sustained release dosage forms* *(*4Hrs)

Advantages and disadvantages of sustained release medication types, formulation and manufacture, Theory of drug release, multiple dosing. In-vivo and In-vitromeasurements of drug availability.

Section-D

9. ***Liquid dosage forms :***Types, advantages and disadvantages.

a) Monophasic liquid dosage forms : (2Hrs)

Techniques of increasing solubility of drugs, other problems involved in preparation and stability of liquids.

b) Biphasic liquid dosage forms : (2Hrs)

*i) Suspensions :*Preparation and evaluation of suspensions, stability testing. Problems in suspension formulation, flocculated and non-floccuated suspensions.

*ii) Emulsions :*Advantages of emulsion dosage form, types, identification, selection of emulsifying agents, Preparation, Calculation of x^2B value and stability studies.

10. Semi – solid dosage forms (2Hrs)

A brief review of the preparation of ointments, creams and suppositories.

11. Pharmaceutical aerosols(3hrs)

Advantages of aerosol dosage form. Formulation of aerosol products and their standardization.

1. **Importance of Monographs**: (**3 hrs**)
   Comparative study of British Herbal Pharmacopoeia (BHP), Ayurvedic Pharmacopoeia of India (API), Chinese, Japanese and European Pharmacopoeias, US Formulary. WHO, EMEA and ESCOP guidelines.

Books Recommended :

1. A. Martin, Physical Pharmacy, 4th Edition, B. I. Waverly Pvt. Ltd., New Delhi (1995).
2. L. Lachman, H.A. Lieberman and J. L. Kanig, Theory and Practice of Industrial Pharmacy, III Eds. Varghese Publishing House, Bombay (1987).
3. C. W. Copper and G. Gunn, Dispensing Pharmacy, CBS Publishers & Distributors, Delhi.

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Instrumental Technique Lab-I
CYP – 471

Credit 0-0-3

Experiments

1. Verification of Bernaullistheorm.
2. Determination of Thermal conductivity (Metal Bar).
3. Determination of thermal conductivity of Insulating powers.
4. Determination of coefficient of discharge by V-Notch.
5. Determination of coefficient of discharge by orifice meter.
6. To determine the friction factor for given pipe and Chezy'scontant and Maning's constant.
7. Study of turbulent flow through pipes.
8. Study of Laminar flow.
9. Determination of flow rate using pipot tube.
10. Study of friction-losses in pipe lines, joints and bends.
11. To determine coefficient of contraction (CC), coefficient of velocity (CV) and coefficient of discharge (Cd) for circular / rectangular orifices.
12. Study of emissivity of metal plates.
13. Determination of total hardness, total alkalinity and chloride content of water.
14. Distribution of solute between two immiscible solvents.
15. Kinetics of hydrolysis of an ester and comparison of relative strength of two acids.
16. To determine the rate constant of a reaction between ethyle acetate and caustic soda solution at two different temperatures and energy of activation.
17. Study the effect of catalyst on the decomposition of hydrogen peroxide.
18. Study the phase diagram of Naphthalene and Benzoic acid.
19. Determination of consolute points (Upper or Lower or both).
20. Construct a phase diagram of 3-component system.

Books recommended:

2. Perry's Chemical engineer's handbook, by R.H. Perry and D.W. Green, McGraw Hill, 7th edition, New York, 1997.
3. McCabe W.L., Smith J.C., Unit Operations of Chemical Engineering, Fifth Edition, McGraw Hill International Edition New York, 1993.
4. Coulson J.M., Richardson J.F., Chemical Engineering, Volume 1, Fifth edition, Pergamon Press, New York,1996.
5. Process Heat Transfer by Donald Q. Kern, McGraw Hill International edition, , Singapore, 1965.
6. Perry's Chemical engineer's handbook, by R.H. Perry and D.W. Green, McGraw Hill, 7th edition, New York, 1997.
7. McCabe W.L., Smith J.C., Unit Operations of Chemical Engineering, Fifth Edition, McGraw Hill International Edition New York, 1993.
8. Coulson J.M., Richardson J.F., Chemical Engineering, Volume 1, Fifth edition, Pergamon Press, New York,1996.
9. Process Heat Transfer by Donald Q. Kern, McGraw Hill International edition, , Singapore, 1965.
10. Findlay's Practical Physical Chemistry.
11. Advanced Practical Physical Chemistry by J.B. Yadav.
12. Laboratory Handbook for Oil & Fat Analysis by L.V. Cock and C. van Rede.

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(Credit Based Evaluation & Grading System)

Organic Synthesis Lab
CYP – 472

Credit 0-0-3

S. No.	Experiment	Chemicals required	Apparatus	Reference
1	Prepare a sample of Ibuprofen and record its ^{1}H, ^{13}C NMR spectra			
2	Preparation of oil of Wintergreen form commercial aspirin tablets	Aspirin, methanol, sulphuric acid	Rbf, reflux condenser / microwave oven	*J. ChemEdu*., **2009**, 86, p475
3	Nitration of o-chlorobenzoic acid and o-chloroacetanilide – separation and identification of isomers	o-chlorobenzoic acid, o-chloroacetanilide, nitric acid, sulphuric acid, toluene, ethanol	Rbf, reflux condenser, reaction hood, gloves,	*J. ChemEdu*., **2008**, 85, p1541
4	Preparation of bromohydrin of α-methylstyrene	Methyl styrene, NBS, acetone	Rbf, stirrer	*J. ChemEdu*., **2008**, 85, p102
5	Dihydroxylation of cyclohexene with peracids and $KMnO_4$ – Product distribution by TLC	cycohexene, oxone, $KMnO_4$	Rbf, stirrer, TLC,	*J. ChemEdu*., **2008**, 85, p959
6	Preparation of carbene complex of Silver(1) Chloride	2,4,6-trimethylaniline, 40% glyoxal in water, ethanol, p-formaldehyde, toluene, HCl, dioxane, silver(1)oxide, dichloromethane	Rbf, sirrer, reflux condenser, filtration, rotavapor	*J. ChemEdu*., **2008**, 85, p416
7	Solvent free Cannizaro reaction using p-nitrobenzaldehyde	p-nitrobenzaldehyde, KOH, ethanol	Rbf, reflux condenser	
8	Synthesis of 1,1-diphenylethanol from phenyl magnesium bromide and acetophenone	Bromobenzene, Mg, anhydrous ether, acetophenone, amm. chloride	Two necked Rbf, condenser, dropping funnel, separatory funnel, drying tube,	*Modern projects and experiments in organic chemistry* By Jerry R. Mohrig, Christina N. Hammond, Paul, F. Schultz, Terence, C. Morill, 2nd Ed, **2003**, p124

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-I)
(Credit Based Evaluation & Grading System)

9	Reduction of 3-nitroacetophenone using i) $NaBH_4$ ii) using Sn and HCl. Identification of the products with NMR, UV, IR spectra	3-Nitroaceto-phenone, Sn, HCl, absolute ethanol, sodium hydroxide, sodium borohydride	Rbf, stirrer, water bath, centrifuge tube, filteration flask, Buchner funnel	*Modern projects and experiments in organic chemistry.* P193
10	Synthesis of N,N-diethyl-m-toluamide (mosquito repellent) from m-toluic acid	*m*-Toluic acid, thionyl chloride, anhydrous ether, diethyl amine	Two necked Rbf, dropping funnel, condenser, adapter, separatory funnel	*Modern projects and experiments in organic chemistry.* P 227
11	Synthesis of Aspirin, its mode of action and molecular modeling with cyclooxygenase	Salicylic acid, acetic anhydride	Rbf, filteration flask, Buchner funnel,	*Modern projects and experiments in organic chemistry.* P 29
12	Isolation of essential oils from Caraway seeds and orange peels – (S) – Carvone and (R) - Limonene	Caraway seeds (Shah Jeera)	Pestle mortar, Rbf, steam distillation apparatus, heating mantle/sand bath, separatory funnel	*Modern projects and experiments in organic chemistry.* P 40
13	Synthesis of styrene epoxide and ring opening reactions under neutral and acidic conditions	Styrene, *m*-CPBA,	Rbf, stirrer, suction filteration	
14	Introduction to chemical informatics			http://www.ch.ic.ac.uk/local/organic/3.html
15	Molecular modeling – Reactivity of Diels-Alder reaction; Hydrogenation of cyclopentadiene dimer	Software – Gaussian		
16	Diels – Alder reaction of a Danishefskydiene	Trans-4-methoxybutene-2-one, zinc chloride, triethyl amine, trimethylsilyl chloride, maleic anhydride/methyl vinyl ketone	Rbf, Buchner funnel, filteration flask	*J. Am. Chem. Soc., 1974, 96, 7807*
17	Synthesis and oxidation of 1-aminobenzotriazole – Benzyne trapping	o-nitroaniline, diethyl malonate, sodium nitrite, sodium acetate, Pd-C (10%), lead tetra-acetate,	Hydrogenator, Rbf, Buchner funnel, filtration flask,	*J. Chem. Soc. (C), 1969, 742*

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-II)
(Credit Based Evaluation & Grading System)

Chemical Engineering-I
CYL – 481

Credit 3-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1.Fluid Flow (6Hrs)
Types of fluids, Viscosity and its units, Reynolds Number, Bernoullis equation, concept of friction, friction factor, friction loss due to sudden enlargement and sudden contraction, Velocity distribution in pipes, Hagen-Poiseuille equation.

2. Mass Transfer (6Hrs)
Introduction, Fick's Law, mass transfer in binary mixtures through a stationary gas, diffusion in liquids, mass transfer across a phase boundary, two film theory.

Section-B

3. Transportation of Fluids (11Hrs)
Different types of pumps; Positive Displacement Pumps, Reciprocating pump, Rotary Pump, Centrifugal Pumps, Cavitation Suction Head and Net Positive Suction Head, and types of valves, Flow meters; orificemeter, venturimeter, pitot tube, Rotameter, Notches.

Section-C

4. Heat Transfer (11Hrs)
Modes of Heat Transfer, Conduction, Convection & Radiation, Heat Transfer by Conduction, Thermal Resistance in series under steady state conditions, Conduction through thick walled tube.Conduction through a sphere. Heat Transfer by convection. Natural Convection, Forced Convection, Heat transfer by forced convection in laminar and turbulent flow, Heat Exchangers, shell and Tube Heat Exchangers, Plate Type Heat Exchangers

Section-D

5. Measuring Instruments (11Hrs)
(a) **Temperature Measurements** : Solid rod thermometer, Bimetallic thermometer, Electric resistance thermometer, thermo electric sensors (Thermo couple).
(b) **Viscosity Measurement** : Capillary tube viscometer, Efflux type viscometer, rotating concentric cylinder viscometer, variable area viscometer.

(c) **Specific gravity & Density measurement**: Bubbler system, hydrometer method, total immersed float method, Nuclear absorption method, Fixed volume method.
(d) **Liquid Level Measurement**: Dip stick method, Sight glass method, Hook Gauge, Float gauge.
(e) **Pressure Measurements**: Liquid column manometers, Elastic element pressure measurement devices, Pressure transducers.

Books Recommended :

1. McCabe W.L., Smith J.C., Unit Operations of Chemical Engineering, Fifth Edition, McGraw Hill International Edition New York, 1993.

2. Coulson J.M., Richardson J.F., Chemical Engineering, Volume 1 & 4, Fifth edition, Pergamon Press, New York,1996.

3. Peter Max, Elementary Chemical Engineering, Second Edition, McGraw Hill London,1984

4. Nakra B.C. and Chaudhry K.K., Instrumentation Measurement and Analysis, Ninth Reprint, Tata McGraw Hill, New Delhi, 1994.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-II)
(Credit Based Evaluation & Grading System)

Organic Synthesis-II
CYL – 482

Credit 3-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Addition to Carbon-carbon and Carbon-Hetero Multiple Bonds (12Hrs)

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropanering.Hydrogenation of double and triple bonds, hydrogenation of aromatic rings.Hydroboration.Michael reaction.Sharpless asymmetric epoxidation.Addition of Grignard reagents, organozinc, organolithium and Gillman reagents to carbonyl and unsaturated carbonyl compounds. Use of other organometallic reagents in addition reactions. Wittig reaction, Mechanism of condensation reactions involving enolates – Aldol,.Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

Section-B

2. Oxidation Reactions (6Hrs)

Indtoduction.Different oxidative processes. Hydrocarbons- alkenes, aromatic rings, saturated C-H groups)activated and unactivated). Alcohols, diols, aldehydes, ketones, ketals and carboxyalic acids.Amines, hydrazines, and sulphides.

Oxidations with ruthenium tetraoxide, iodobenzenediacetate and thallium (III) nitrate, DDQ, PCC, CAN, selenium dioxide, peroxyacids, DCC. Oxidation reactions with special emphasis on Baeyer-villeger reaction, Cannizarro oxidation-reduction reaction,

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3. Rearrangements (6Hrs)

General mechanistic consideration – nature of migration, migratory aptitude, memory effects. A detailed study of the following rearrangements, Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofman, Curtius, Schmidt, Shapiro reaction, Fries rearrangement

Section-C

4. Reduction Reactions (11Hrs)

Introduction. Different reductive processes, Hydrocarbons- alkanes, alkenes, alkynes and aromatic rings, Carbonyl compounds – aldehydes, ketones, acids, ester and nitriles. Epoxides, Nitro, nitroso, azo and oxime groups, Hydrogenolysis. Sodium borohydride, sodium cyanoborohydride, LAH, disobutylaluminium hydride, tin hydride, trialkyl tin hydride, trialkylsilanes, alkoxy substituted LAH, DIBAL, diborane, diisoamylborane, hexyl borane, 9-BBN, isopinocamphenyl and disiopinocamphenylborane. Reduction reactions with particular emphasis on Wolf-Kishner reduction, Clemensen reduction.

Section-D

5. Free Redical Reactions: (10Hrs)

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactvity in the attacking radicals.The effect of solvents on reactivity.Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

Books recommended:

1. Organic Reaction Mechanism by Jerry March, John Wiley Ed. 5, 2002.
2. Advanced Organic Chemistry by Francis Carey, Vol A and vol B

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-II)
(Credit Based Evaluation & Grading System)

Physical Chemistry-II
CYL – 483

Credit : 3-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Liquid State: **(11Hrs)**
Introduction to liquid state, thermodynamic properties of liquids, vapour pressure and itsdetermination, enthalpy and entropy of vaporization, Trouton's rule. Intermolecular forces, models and theories of liquids, surface and transport properties, surface tension and its measurement, viscosity and its measurement. Liquid crystals, smectic, nematic and cholestericmeso phases.

Section-B

2. Solid State: **(11Hrs)**
Perfect and imperfect crystals, intrinsic and extrinsic defects-point defects, line and planed efects, Schottky and Frenkel defects, colourcentres, non-stoichiometry and defects, solidstate reactions. Metals, insulators and semiconductors, intrinsic and extrinsic semi conductors, doping semiconductors, superconductors, magnetic materials (ferrites) and their classification.

Section-C

3.Electrochemistry of Solutions **(12Hrs)**
Ion-solvent interactions, the Born model, electrostatic potential at the surface of a charged sphere, Born expression far the free energy of ion-solvent interactions, structural treatment
of ion-solvent interactions, ion-dipole moment, evaluation in the ion-dipole approach to heat of solvation, solvation number, static and dynamic pictures of ion-solvent interactions, hydration number, dielectric constant of water and ionic solutions, dielectric constant ofliquids containing associated dipoles, ion – solvent nonelectrolyte interactions, change insolubility of non-electrolyte due to primary and secondary solvations.

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Section-D

4. Photochemistry (11 Hrs.)

Difference between thermal photochemical reactions, laws of photochemistry, Jablonsi diagram, qualitative description of fluorescence, phosphorescence, non- radiative processes (IC, ISC), quantum yield, photosensitized reactions, nuclear geometries of electronically excited states, energy surface description of molecular photochemistry, Excimers and Exciplexes, kinetics of photochemical reactions, chemiluminescence, solar energy conversion and storage.

Books Suggested:

1. Principles of Physical Chemistry, S.H. Maron& C.F. Prutton.

2. Solid State Chemistry, C.N.R. Rao.

3. Principles of Solid State Chemistry, P.P. Budnikov& A.M. Ginstling.

4. Physical Chemistry, P.W. Atkins.

5. Modern molecular photochemistry, N.J Turro.

6. Fundamentals of Photochemistry, K.K. Rohtagi- Mukherjee.

7. Applications of Liquid Crystals, G.Meier, E. Sackmann& J.G. Grabmaier.

8. Modern Electrochemistry by John Bockris & Amulya K.N. Reddy, Plenum Press.

9. Principles of Physical Chemistry by Puri, Sharma, Pathania.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-II)
(Credit Based Evaluation & Grading System)

CYL – 484 : Modern Instrumental and Spectroscopic Techniques

Credit 3-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1.Spectroscopic Techniques: (12 Hrs)

a) **FT-NIR:** Principle (overtones, combinations, fermi resonance, interferences etc.), instrumentation (dispersion spectrometer and FT-NIR), advantage and disadvantage, qualitative and quantitative applications, including PATand non-destructive analysis.
b) **ATR:** Principle (total internal reflection, evanescent wave, etc.), instrumentation (ATR crystal, IR beam), advantages and disadvantages, pharmaceutical applications.
c) **FT-Raman:** Principle (absorption, diffraction, scattering and emission of wave, molecular interaction), instrumentation (Dispersive Raman, FT-Raman), advantage and disadvantage, pharmaceutical applications including detection of counterfeits.

Section-B

2 Thermal Techniques: (11 Hrs)

a) **DSC:** Principle, thermal transitions, instrumentation (Heat flux and powercompensation designs), Modulated DSC, Hyper DSC, experimental parameters (sample preparation, experimental conditions, calibration, heating and cooling rates resolution *etc*source of errors) and their influence, advantages and disadvantages, pharmaceutical applications.
b) **DTA:** Principle, instrumentation, advantage and disadvantage, pharmaceutical application, derivative differential thermal analysis (DDTA).
c) **TGA:** Principle, instrumentation, factors affecting results, advantages and disadvantages, pharmaceutical application.

Section-C

3.Chromatographic Techniques: (10Hrs)

a) HPLC: Principle, instrumentation, pharmaceutical applications.
b) UPLC: Principle and applications.
C) LC-MS and LC-NMR: Nature of interfaces, applications.
d) GC-Principle, instrumentations, pharmaceutical applications.

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Section D

4.Quality Control and Quality Assurance (12Hrs)

Good manufacturing practices and its applications to pharmaceutical industry. Basic principles and concepts of quality management viz. quality control, quality assurance, quality auditing and ISO system etc. Sampling, finished products labeling, distribution records, Document control: Issuance, storage and retrieval, Standard operating procedures:Change control procedure and annual product review, Basic principles of validation:Validation protocols, analytical method validation and process validation, Technology transfer from R & D to manufacturing, Market complaint and handling of returned goods,

Books Recommended :

1. D.A. Skoog& J.J. Leary, “Principles of Instrumental Analysis”, 4th Edition.SaundersCollege Publishers (1992).
2. H.H. Willard, L.L. Meritt, J.A. Dean & F.A. Settle.Wadsworth Publishers USA"Instrumental Methods of Analysis", 6th Edition (1986) and 7th Edition (1988).
3. Practical Instrumental Analysis: Methods, Quality Assurance and Laboratory Management, Sergio Petrozzi, Wiley-VCH (2012).
4. Quality Assurance in Analytical Chemistry, Elizabeth Prichard and Vicki Barwick, John Wiley and Sons Limited, (2007).
5. Instrumental Method of Analysis, B. Sivasankar, Oxford University Press, New Delhi (2012).

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-II)
(Credit Based Evaluation & Grading System)

Medicinal Chemistry-I
CYL – 485

Credit 3-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Introduction to Pharmaceuticals (3Hrs)
Historical Development, Classification of Drugs, Nomenclature of Pharmaceuticals, Drug metabolism reactions, Structure, stereochemistry, nomenclature, mode of action, specific clinical applications and structure activity relationships of following classes of drugs and synthesis/commercial routes to specified drugs.

2. Antiamoebic and Antiprotozoal Drugs: (**8 Hrs**)
Metronidazole, Diloxanidefuroate, Bilamical hydrochloride, Hydroxystilbamidineisothinate, Pentamidineisothionate, Nifurtimox, Suramin sodium, Carbarsone, Glycobiarsol, Melarsoprol, Sodium stibogluconate, Dimercaprool, Diethylcabamazine citrate, Centarsone, Acetarsone, Antimony potassium tartarate, Bismuth sodium thioglycollate, Sulphonamide, Stibiophen. Bismuth sodium thioglycollamate, Furazolidone.

Commercial synthetic routes to: Metronidozole, ronidazole, flunidazole, iodoquinol, nifurfimax,benzindazole, tryparsamide.

Section-B

3. **Antibacterials**: **(12Hrs)**
Penicillines, Cephalosporins, Tetracyclines, Aminoglycosides, Chloramphenicol, Macrolides, Lincomycins, Polypeptides antibiotics, Polyene antibiotics. Sulfonamides and Sulfonesfluoroquinolines, Trimethoprim and other unclassified antibiotics.**Antimycobacterials**: Sulfanilamides, p-Aminosalicyclic acid derivatives, Thioamides, Thiourea, derivatives, Thiosemicarbonazones, Isoniazid, Kanamycin sulfate, Capreomycin, Rifaampin, Pyrazinamide, Anthionamide, Clofazimine, Cyclosporin, Dapsone, Sulfazem.

Commercial synthetic / semi-synthetic routes to : 6-aminopenicillanic acid, ampicillin, amoxycillin,production of penicillin, 7-aminocephalsporanic acid, cephalexin, ceftizoxime, cefaclor, cephslothin, **Tetracyclins**: doxycycline, nalidixic acid, sulfadiazine, Norflaxacin, Ciproflexacin, O-flaxacin,Amiflaxacin, Difloxacin, Chloramphenicol, Nitroflurantion, Sulfamethyoxazole, Acetysulfoxiazole,

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(Credit Based Evaluation & Grading System)

Section-C

4.Cardiovascular drugs: (5Hrs)

Vasodilators, Antihypertensive agents, Antihypercholesterolemic drugs, Antiarrhythmic, drugs, Sclerosing agents, Coagulants and anticoagulants, Cardiotonic compounds, Synthetic hypoglycemic agents. **Commercial Synthetic route to :**Papverine, oxprenolol, atenolol, , Nafidipine, Quinidine, Clofibrate, captopril, Diltiazem, Verapamil, clonidine, prazosine, Enalarpil,

5. Diuretics: **(6 Hrs)**

Osmotic agents, Acidfyingsalts.Mercurials, Purines and related heterocycles, Sulfonamides, Benzothiadiazene and related compounds, Chlorothiazides and analogs, Sulfamoylebenzoic acid and analogs, Endocrine antagonists, miscellaneous diuretics.

Commercial Synthetic routes to Furosemide, Methalthiazidemethylchlothlazide: Chlorothiazide, Triameterene, Hydrochlothiazide, Ameloride, Chlorthalidone.

Section-D

6. Analgesics and Antitussives(3Hrs)

Morphine and related opioids, Narcotic antagonists, **Synthetic analgesics-Antitussives**: Opium alkaloid, Morphine analogs, Synthetic non-narcotic antitussives, mucolytic agents.

Commerical routes to: Meperidine, Methadone, dextro-Propoxyphene,Pentazocine, dextromrthorphane, Papaverine,.

7. **Anthelmintics**: **(8Hrs)**

Introduction, Tetrachloroethylene, Piperazines, Gentian violet, Pyrviniumpamoate, Thiabendazole, Mabendazole, bapheniumhydroxynaphthoate, Dichlophene, Niclosamide, Levamisole hydrochloride, Tetramisole, Niridazole, Biothional, Antimonypotassiumtartarate, Stibiophen, Sodium Stibiocaptate.

Books Recommended:

1. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceuticals Chemsitry, 8th edition, edited by R.F. Doerge, J.B. Lippincott Company, Philadelphia, 1982.
2. Pharmaceutical Chemicals in Perspective, B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York, 1989.
3. W.O. Foye, T.L. Lamke, D.A. Williams, Principles of Medicinal Chemistry, 5th edition, Lippencott Williams and Wilkins, 2002.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-II)
(Credit Based Evaluation & Grading System)

Instrumental Technique Lab-II
CYP – 481

Credit 0-0-3

1. Determine the concentration of Na^+, K^+ and Ca^{2+} present in tap water using flame Photometer.
2. Standardization of an acid with a standard solution of base using pH-meter.
3. Determine the pk values of an amino acid by pH metry.
4. Titration of a strong acid vs strong base, weak acid vs strong base and weak acid vs weak base by conductometry.
5. Titration of mixture of strong and weak acids with a strong base by conductivity.
6. Determination of dissociation constant of acetic acid by conductometry.
7. Verify Lambert-Beer Law and determine the molar extinction co-efficient : copper sulphate pentahydrate / or potassium dichromate.
8. Determination of iron using 1-10 phenanthroline by spectrophotometry.
9. Determine the composition of a complex by job's method and determine the stability constant of the complex by spectrophotometry.
10. Simultaneous determination of Cr^{2+} and Mn^{2+} spectrophotometry.
11. The determination of aspirin and Caffein in a proprietary Analgesic by spectrophotometry.
12. Measurement of optical rotation and study of muta rotation in glucose.
13. Titration of HCL with NaOH using potentiometer.
14. Determination of water content of a Salt Hydrate.
15. Determination of composition of unknown sample by Refractometry. Molar refraction is an additive property.
16. Heat of solution by solubility method.
17. Partial molar volume studies.
18. Determination of CMC of a surface active agent.
19. Determination of atomic parachor values of C.H.O.
20. Estimation of glucose and Ascorbic acid.
21. Study of adsorption of organic compounds on charcoal.

Books recommended:

1. Findlay's Practical Physical Chemistry.
2. Advanced Practical Physical Chemistry by J.B. Yadav.
3. Laboratory Handbook for Oil & Fat Analysis by L.V. Cock and C. van Rede.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-II)
(Credit Based Evaluation & Grading System)

Pharmaceutical and Natural Products Lab
CYP – 482

Credit 0-0-3

1. Preparation / multistep synthesis, purification and spectroscopic characterization of organic Pharmaceuticals and intermediate given below.

Acetanilide, Aspirin, Barbituric acid, Hippuric acid, 3.4 - dihydro-3-(p-methylphenyl)-I-(2H)-Benzoxazine, Diketopiperazine, Paracetamol, Thenacetin, Antipyrene 2-amino-5 bromopyridine, Nitrazepam, Azosulfomarides, sulfarilamide, Sulfathiazole, Diphenylhydantoin, Phenylbutazone, Nifedipine, Alclofenac, Baclofen, Brimindiene, Tolmetin, Procarbazine, Ketoprofen, I-phenyl-3-alkylthioureas, Sodium-7-iodo-8-quinoline-1, 5-sulfonate, NDichloroacetyl-N-methyl-p-hydroxy aniline, Amphetamine, Aminopyrine, Oxolamine, hydralazine, tetrahydroiso-quinolines.Oxazolidine-I, 4-dione.

2. Extraction and analysis of the following natural products.

a). Eugenol from cinnanan leaf oil or cloves.

b). Piperine from black pepper.

c). Cucumarin from turmeric.

d). Pectins from orange peels.

e). Carotene from carrots.

f). Oleo-resin from ginger.

g). Alkaloid from cinchona bark.

h). Trimyristin and tetraclecanoic acid from nutmeg.

Books Recommended:

1. Vogel's Text book of Practical Organic Chemistry, Brian S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tatchell, Fifth Edition, Published by John Wiley and Sons, Inc. New York, 1989.
2. Practical Pharmacognosy: Kokate, C.K. VallabhPrakashan, New Delhi.
3. Practical Pharmacognosy: Khandewal, K.R. NiraliPrakashan, Pune
4. Phytochemical methods by J.B. Harborn

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-III)
(Credit Based Evaluation & Grading System)

Chemical Engineering-II
CYL - 571

Credit 3-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Evaporation (7Hrs)
Liquid characteristics, Types of Evaporators, Boiling Point rise due to material in Solutions, Duhring's rule, Boiling Point Rise due to Hydrostatic head, Single and Multiple effect evaporators, Enthalpy balance for single-effect evaporators.

2. Crystallization (4 Hrs)
Growth and Properties of Crystals, Saturation, Nucleation, Crystallization rate, Fractional Crystallization, vacuum crystallizers, Draft tube-Baffle crystallizers.

Section-B

3. Filtration (11Hrs)
Introduction, Classification of Filters, Filter presses, Plate-and Frame presses, Leaf filters, Rotary continuous filters, Filter aids, Filtration theory, Kozeny-Carman equation, Limitations of the Kozeny equation, constant-pressure filtration, correction for filter cloth resistance, Constant-rate filtration, Rotary-drum filters, Principle of centrifugal filteration, Batch top-driven centrifuges, Batch underdriven centrifuges, Continuous centrifuges, Disc type centrifuges.

Section-C

4. Distillation (12 Hrs)
Vapour Liquid Equilibrium, Partial Vaporisation and Partial Condensation, Dalton's and Raoult's Laws, relative Volatility. Methods of Distillation, Two-component mixture; The Fractionating Column, Calculation of number of Plates using the Lewis-Sorrel Method, Calculation of Number of Plates using the McCabe-Thiele method, The q-line concept, Plate Efficiency, Azeotropic Distillation, Extractive Distillation, Steam Distillation, Packed Columns; General description, Types of Packings.

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Section-D

5. Absorption of Gases (7 Hrs)

Mechanism of Absorption, rate of Absorption, Capacity of Packed Towers, Height of column based on condition in gas film, Height of column based on liquid film, The operating line and graphical integration of Height of columns, The transfer unit, Plate Towers for gas absorption, Number of plates by use of Absorption factor.

6. Leaching and Extraction (4hrs)

Factors influencing the rate of Extraction, Number of Stages for Counter-Current washing, Graphical Methods, Mixing of Liquid Systems, Calculation of the number of theoretical stages in extraction operation (Cocurrent contact with Partially Miscible Solvent Co-current Contact with Immiscible Solvents, Counter current contact with Partially Miscible Solvents), Bollman Extractor.

Books Recommended:

1. McCabe W.L., Smith J.C., Unit Operations of Chemical Engineering, Fifth Edition, McGraw Hill International Edition New York, 1993.
2. Coulson J.M., Richardson J.F., Chemical Engineering, Volume 2, Fifth edition, Pergamon Press, New York, 1996.
3. Peter Max, Elementary Chemical Engineering, Second Edition. McGraw Hill London,1984.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-III)
(Credit Based Evaluation & Grading System)

Medicinal Chemistry-II
CYL – 572

Credit 3-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Structure, stereochemistry, Mode of action, Structure activity relationships, specific clinical applications of following classes of pharmaceuticals with synthetic/commercial route to the indicated examples.

Section-A

1. CNS Active Drugs: **CNS Depressants: Hypnotics and Sedatives**: **(12Hrs)**
Barbiturates, Non-barbiturates,Amides and Imides, Glutethimide, Bezodiazepines, Aldehydes and derivatives, Methaqualone and other miscellaneous agents. **Anticonvulsants**: Barbiturates, Hydanatoins, Oxazolidinediones. Succinimides, Bezodiazepines, Thenacemide, Glutethimide. **CNS-stimulants & Psychoactive Drugs**: Analeptics, Purines, Psychomotor stimulants, Sympathomimetics, Monamine oxidase inhibitors, Tricyclic antidepressants, Miscellaneous psychomotor stimulants. Hallucinogens **(Psychodelics, Psychomimetics)**: Indolethylamines, R-phenylethylamines, Butyrophenones and other miscellaneous drugs.
Commercial Synthetic routes to : Thioridazine, Haloperidol, Chloropromazine, Phyenytoin,Phenobarital, Methaquolane, Oxazepam, Diazepam, Cholridazepoxide, Lorazepam, Alprazolam, Amitriptyline, Imipramine, Amphetamine, Protriptyline, Chloripramine, Iproniazide,

Section-B

2. Antiviral Agents: **(11Hrs)**
Target for Anti HIV Drugs. Anti HIV Agents: HIV-Protease inhibitors, Amprenavir,Foseprenavir, Alazanavir etc. Anti- HIV Nucleosides: Lamivudine, Retrovir, Videx, Hivid, Zlarit, Viread, Carbovir, Delavirdine, Ziduvidine, Etavirenz, Mixed type integerase and Protease inhibitors: Calanolide, Capravine, Nevirapine. DNA Polymerase inhibitors: Acyclovir, Ganciclovir, Penciclovir, Famicilovir, Valaciclovir, Valomaciclovir, Codofvir.
Commercial synthetic routes to: Acyclovir, Ganciclovir, Zidovudine, Enviroxime, Lamivudine,Idoxuridine, Disoxaril.

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Section-C

3 Antineoplastic Agents: **(10Hrs)**

Alkylating agents (Nitrogen mustards, Aziridines, Sulfonic acid Esters,Epoxides, Nitrosoureas, Triazenes, Phosphamides, Mitomycin, Comparative activity of alkalyting agents). **Antimetaboilities**: Antifolates (Methotrexate), Mercaptopurine, Thioguanine, Flourouracil, Floxuridine, Cytarabine, Azathioprine,

Commercial synthetic routes to: Methtrexate, Trimetrexate, Adatrexate, Dromostanolone, Cytarabine, Fludarabine, ,Dezaguanine, Bisanterene,

Section-D

4. Non-Steroidal Anti-inflammatory drugs (NSAIDS) (7Hrs)

Selective (COX- 2 Inhibitors-Computer aided designing, Molecular docking and 3D QSAR. Design of Selective inhibitors using pharmacophoremodel.Nimesulide and methanesulfonamides. 1,5-Dialypyrazoles: Celecoxib, Rolecoxib, Vladecoxib, Atoricoxib, Calebrex, 1,2-Diarylimidazoles. Diarylspiro[2,4] heptenes. Indomethacin and analogues.
Terphenyls, Aryl-/heteroaryl-propionic acid derivativses. (S)-Etodolac, (S)-ketorolac.

5. **Antimalarials:** **(5Hrs)**

Cinchona alkaloids, 4-Aminoquinolines, 8-Aminoquinolines,
9-Aminoacridines, Biguanides, Pyramidines and Sulfones, Mefloquine, Sulfonamides.

Commercial synthetic routes to: Chloroquine, pamaquine, primaquine,
proguanil, Amodiaquine,Mefloquine,
Pyremethamine, Sontoquine.

Books Recommended:

1. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceuticals Chemistry, 8th Edition, edited by R.F. Deorge, J.B. Lippincott Company, Philadelphia, 1982.
2. Pharmaceutical Chemicals in Perspective. B.G. Reuben and H.A. Wittcoff, John Wiley & Sons, New York, 1989.
3. W.O. Foye, T.L. Lamke, D.A. Williams, Principles of Medicinal Chemistry, 5th Edition, Lippencott Williams and Wilkins, 2002.
4. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceuticals Chemistry, 8th edition, edited by R.F. Deorge, J.B. Lippincott Company, Philadelphia, 1982.
5. Pharmaceutical Chemicals in Perspective. B.G. Reuben and H.A. Wittcoff, John Wiley &Sons, New York, 1989.
6. W.O. Foye, T.L. Lamke, D.A. Williams, Principles of Medicinal Chemistry, 5th Edition, Lippencott Williams and Wilkins, 2002.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-III)
(Credit Based Evaluation & Grading System)

Inorganic Chemistry-II
CYL-573

Credit 3-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1.Theory of Chemical Bonding : (7Hrs)
a) **Valence Bond Theory :**Concepts of VB theory. Hybridization (sp, sp^2, dsp^2, sp^3, sp^3d, dsp^3, sp^3d^2, d^2sp^3).Application of V.B theory to simple inorganic molecules and transition metal complexes.Inner and outer orbital complexes.
b) **Molecular Orbital Theory :**A brief introduction to ICAD method. Resonance integral, energy level diagrams for O_2, F_2, CO, CO_2, PH_3, BF_3, NO, NO_2, NO_3 and H_2O, Molecular orbital description of tetrahedral and octahedral complexes of transition metals.
2 Introduction to Ligands, Complexes and their Reactivity: **(5 Hrs)**
Thermodynamics stability in aqueous medium, General classification of ligands, Ligand substitution or exchange reaction to 4-coordinate square planner complexes and 6-coordinate octahedral complexes. Redox or electron transfer reactions. Outer and inner sphere mechanisms for multielectron redox reaction and ligand field considerations. Photochemical reaction of chromium and ruthenium complexes.Fluoxional molecules iso- and heteropolyacids, metal clusters. Spin crossover in coordination compounds.

Section-B

3. **Bioinorganic Chemistry :(11Hrs)**
Metal ions in Biology, Molecular mechanism of ion transport across membranes; ionophores.Photosynthesis, PSL, PSH; nitrogen fixation, oxygen uptake proteins, cytochromes and ferrodoxins.Iron-sulphur proteins.

Section-C

4. **Metals in Biology:** **(11 Hrs)**
Role of zinc in biology – zinc enzymes – carboxypeptidase, carbonic anhydrase and alcohol dehydrogenase. Zinc enzymes – medicinally important zinc proteins – glyoxalase systems, angiotensins and angiotensin converting enzyme, zinc and hypertension, Biological importance of nickel – Urease: conversion of urea to ammonia. Noble prize for urease crystals, structure of urease, reaction mechanism, synthetic models for urease, Role of Copper in medicinal chemistry, Copper enzymes: tyrosinase and galactose oxidase. Conversion of L-tyrosine to adrenalin via DOPA.Modeling tyrosinase and galactose oxidase.

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Section-D

5. **Chemistry of Non-transition Elements**: **(6 Hrs)**

Polymorphism of carbon, phosphorus and sulphur. Synthesis, properties and structure of boranes, carboranes, borazines, silicates carbides, silicones, phosphazenes, sulphur nitrogen compounds, phosphorus, sulphur and halogens, interhalogenspseudohalides.

6. **Macrocyclic Ligands and Macrocyclic effects**: **(5Hrs)**

Crown ethers and coronanads, Cryptands, Cation selectivity. Factors influencing selectivity such as nature of donor atoms, the number of & special arrangement of donor atoms cavity shape and size, conformational rigidity and flexibility of ligand lipophilicity and electronic influences.

Books Recommended :

1. R.S. Drago, Physical Methods in inorganic Chemistry, Affiliated East-West Press (Section 1& 2) 2nd Edition, Reinhold New York (1968).
2. H.B. Gray, Electrons and Chemical Bonding. (Section 2), W.A. Benjamin, London (1965).
3. F.A. Cotton and G.W. Wilkinsonn, Advanced Inorganic Chemistry. John Wiley and Sons, 6th edition, John Wiley New York (1999).
4. J.E. Huheay, Inorganic Chemistry, Principles of Structure and Reactivity, Harper International, SI Edition, 3rd Edition, Harper London (1978).
5. G. Wilkinson (Ed.) Comprehensive Coordination Chemistry Vol. 3 Chapter 23, Pergamon, Pergamon Oxford (1982).
6. N.N. Greenwood and A. Earnshaw Chemistry of Elements, Pergamon Press, (Section7) (1984).
7. Christopher Master, Homogenous Transition metal catalysis (Section 8) (1981).

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-III)
(Credit Based Evaluation & Grading System)

Drug Design and Drug Development

CYL – 574

Credit 4-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Introduction History and Objective of drug designing : (5Hrs)

Economic aspects of drug designing. Procedures followed in drug designing. Lead based methods. Approaches to lead discovery.Drug discovery without a lead-de Novo drug designing.

2. Structure Activity Relationships : (10Hrs)

Quantitative analysis of structure activity relationships.Hansch Paradigm for pharmaceuticals - Apparent lack of structure-activity relationships.Apparent structure activity relationships, True structure activity relationships.**Extra-thermodynamic parameters:** Electronic, Steric and Hydrophobic substituents constant..Hansch analysis, Free and Wilson method Physicochemical parameters, Craig Plot, Toplis operational scheme. Cluster analysis. Pattern recognition.Partition coefficient and its significance.

Section-B

3. Drug Designing and molecular orbital method : (10Hrs)

Molecular orbital calculations and chemical reactivity.Perturbation theories of drug action. Pullman's dipositive bond theory. Role of charge transfer processes in drug action. Conformational aspects and molecular orbital calculations.

4. Pharmacokinetics in Drug designing-I : (5Hrs)

Pharmacokinetics, Environmental pharmaockinetics.Single and two compartment pharmacokinetics.Pharmacokinetics of drug metabolism.Dissection of a drug molecule into biofunctional moieties.

Section-C

5. Pharmacokinetics in Drug designing-II : (5Hrs)

Modulation of pharmacokinetics by molecular manipulations : modulation of distribution of pharmacea over various compartments, modulation of time-concentration relationship.

6. Drug Receptor - Interaction : (10Hrs)

Historical, Receptor theories and forces involved in drug receptor interaction.Stereochemical and conformational aspects of drug receptor interaction.Agonists and Antagonists.Designing or receptor antagonists.Receptor binding as a tool in designing biologically active steroids.

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Section-D

7. Designs of Enzyme inhibitor : (8Hrs)

Mechanism of enzymatic catalysis. Transition state analogs as enzymeinhibitors. Kinetics of irreversible enzyme inhibition. Design of Reversible and irreversible enzyme inhibitors with following examples: chymotypsin. Subtilison, Elastase. Pepsin.Cholinerterase.Carboxypeptidase.Trisophosphateisomerase, Aldolase, Enolase, Creatine Kinase, adenylate kinases.Asparatatetrancarbamolyase.Natural products as enzyme inhibitors. Penicillin, Cephalsporin, Nojrimycin, Pentastatin, Captopril,

8. **Prodrug Approach : (7 Hrs)**

Basic concept, Common promoities.Reversal of prodrugs - chemical and enzymatic.Application of prodrug approach to alter taste and odour, reduction of pain at injection site, reduction of gastrointestinal irritability.Alteration of drug solubility, increasing chemical stability.Prevention of pre-systematic metabolism.Prolongation of drug action, site specific drug delivery.Reduction in drug toxicity.Alteration of drug metabolism.

Books Recommended :

1. The Organic Chemistry of Drug Design and Drug Action, by R. B. Silverman, Academic Press, 1992.
2. Drug Designs - A series of monographs in medicinal chemistry edited by A. J. Ariens. Ist edition, Vol. I, II, V, VIII & IX (only relevant chapters).
3. Comprehensive Medicinal Chemistry, Peragmon Press, 1990, Vol. 4.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-III)
(Credit Based Evaluation & Grading System)

Photochemistry and Pericyclic Reactions
CYL-575

Credits: 3-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Photochemical Reactions **2Hrs**
Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, actinometry.

2. Determination of Reaction Mechanism **3 Hrs.**
Classification, rate constants and life times of reactive energy states – determination of rate constants of reactions. Effect of light intensity on the rate of photochemical reactions. Types of photochemical reactions – photo-dissociation, gas-phase photolysis.

3. Photochemistry of Alkenes **6 Hrs.**
Intramolecular reactions of the olefinic bond- geometrical isomerism, cyclisation reactions, rearrangement of 1, 4-dienes,

Section-B

4. Photochemistry of Carbonyl Compounds **8Hrs**
Intramolecular reactions of carbonyl compounds – saturated, cyclic and acyclic, β,γ-unsaturated and α,β -unsaturated compounds, Cyclohexadienones.
Intermolecular cyloaddition reactions – dimerisations and oxetane formation.

5. Photochemistry of Aromatic Compounds **4 Hrs**
Isomerisations, additions and substitutions.

Section-C

6. Pericyclic Reaction **12Hrs**
Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3- butadiene, 1,3,5- hexatriene andallyl system. Classification of pericyclic reactions. Woodward ---Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions --- conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadddition – antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions.

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(Credit Based Evaluation & Grading System)

Section-D

7. Sigmatropic Rearrangements **5Hrs**

Suprafacial and antarafacial shifts of H, sigmatropic shifts
involoving carbon moieties, 3,3- and – sigmatropic rearrangements. Claisen, Cope and aza-Cope rearreangements. Fluxional tautomerism.Ene reaction.

8. Miscellaneous Photochemical Reactions **5Hrs**

Photo-Fries reactions of anilides.Photo-Fries rearrangement.
Barton reaction.Singlet molecular oxygen reactions.Photochemical formation of smog.
Photodegradation of polymers.Photochemistry of vision.

Books:

1. Fundamental of Photo Chemistry By K.K. Rohtagi Mukherji
2. Molecular Photochemistry By N.J. Turro and W.A. Benjamin
3. Introductory Photochemistry By A. Cox and T. Camp
4. Modern Organic Photochemistry By W. H. Horsepool

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-III)
(Credit Based Evaluation & Grading System)

Process Control and Plant Economics

CYL-576

Credit 3-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1. Fundamental of Automatic Control: (**11**)

The general control system, open and closed loop systems, feedback control, forward feed control, Block diagram. Transfer functions by the use of Laplace transform, First order systems, Response of thermometric bulb, General response to step inputs, Response of liquid level systems, Response of mixing process, Linearization, Transportation Lag.

Section-B

2. **Types of control systems:**
Control system, Block diagram, Negative and positive feedback, Development of block diagram,measuring element. Block diagram of a chemical reactor control system
(**6**)

Control valves, On-off control, proportional control, Integral derivative action, proportional integralcontrol, proportional derivative control, proportional Integral derivative control. **(5)**

Section-C

3. **Applications of Control Systems**: **(7)**
Overall transfer function for single loop system, for change in set point, for change in load and for multi loop control system. Control of a steam jacketed kettle, analysis of valve, block diagram, response ofa gas absorber and heat exchanger.

4. Chemical Process Development: Types of Design, feasibility survey, scale up in design, factorsaffecting plant location and plant layout, plant operation and control. **(5)**

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Section-D

5. Cost Estimation: Factors affecting investment and production costs, cost factors on capital investment, estimation of total product cost, service life, salvage value, present value, types of depreciation, methodsfor determining depreciation. **(6)**

6. Optimization Methods: General procedure for determining optimum conditions, comparison of graphical and analytical methods, optimum flow rate of cooling water, optimum reflux ratio.

5)

Books Recommended:

1. Coughanowr Donald R., Process Systems Analysis and Control, Second Edition, McGraw Hill, New York, 1991.
2. Max. S. Peters and Klaus D. Timmerhaus, Plant Design and Economics for Chemical Engineers, Fourth Edition McGraw Hill, New York, 1991.

3. Thomas E. Martin, Process Control, International Edition, McGraw-Hill Singapore, 1995.
4. Harriott Peter, Process Control, Twelfth reprint, Tata McGraw Hill, New Delhi, 1994.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-III)
(Credit Based Evaluation & Grading System)

Green Chemistry and Waste Treatment

CYL-577

Credit 3-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

Section-A

1 Green Chemistry- (12Hrs)
Concepts and principles, Green process metrics. Green Catalysis – heterogeneous, homogeneous, phase transfer, Biocatalysis, and photocatalysis. Green solvents – Supercritical fluids (carbon dioxide and water), water, ionic liquids and fluorous biphasic solvents. Design for efficiency – photochemical reactions, Microwaves, sonochemistry and electrochemical synthesis.

Section-B

2. **Application of Green Chemistry in organic Synthesis**: (**10Hrs**)
Concept of atom-economy: Synthesis of ibuprofen, microbes in synthesis of adipic acid and catechol, Green reactions – Strecker reaction, halide free synthesis of aromatic amines, selective methylation using dimethylcarbonate.

Section-C

3.**Water Pollution and Waste Treatment (12Hrs)**
Definition, Water quality parameters, Colour, Taste and odour, Temperature, Turbidity conductivity, Dissolved solids, Acidity, Alkalinity, Dissolved oxygen, Biochemical oxygen demand, Chemical oxygen demand, Sulphates, Chloride, Silica, Iron Hardness Heavy metals. **Sampling *:***Selection of sampling sites, Sampling procedures & handling of samples. **Water Pollution Analysis** :Physico -Chemical analysis of Water. Alkalinity, Hardness, Acidity, Dissolvedoxygen, Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Sulphte, Residual chlorine Iron.Water pollution indices-general concept.

Section-D

4. **Waste Water Treatment Plants**
(11Hrs)
Biological waste treatment, Primary clarification, Activated sludge process, Anaerobic lagoons, aerobic & facultative lagoons. **Waste Minimization Technology*:*** Relationship of waste minimization technology to integrated hazard waste management. **Hazardouscontrol :**Disaster planning onsite and offsite. **Wastewater Treatment: Objectives**, Classificationof Waste water treatment, Reuse of wastewater.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-III)
(Credit Based Evaluation & Grading System)

Books Recommended :

1. R.K. Trivedi& P.K. Goel, "Chemical and Biological Methods for Water Pollution Studies" Environmental Publications Karad, (1986).
2. Matcalf and Eddy, "Waste Water Engineering" Tata McGraw-Hill Publishing Company Ltd. (1993).
3. Harry Freeman,"Hazardous Waste Minimization" McGraw Hill Publishers (1990).
4. Lancaster, M.; *Green Chemistry an Introductory Text*, Royal Society of Chemistry, Cambridge, UK 2002. ISBM 0-85404-620-8.
5. Cann, M.C.; Connelly, M.E. *Real World Cases in Green Chemistry*, American Chemical Society: Washington DC. 2000. ISBN 0-8412-3733-6 (Paperback) (RWCGC).
6. Anastas, P. T.; Warner, J. C. *Green Chemistry: Theory and Practice,* Oxford University Press: Oxford 2000. ISBN: 0 19 850698 8 (Paperback)
7. Matlack, A.S., *Introduction to Green Chemistry*, Marcel Dekker, Inc., New York, 2001.
8. Tundro, P.; Anastas, P., *Green Chemistry Challenging Perspectives*, Oxford Press, Oxford, 2000.
9. Anastas, P.T.; Williamson, T.C., *Green Chemistry, Frontiers in Benign Chemical Syntheses and Processes*, Oxford University Press, Oxford, 1998.

M.Sc. APPLIED CHEMISTRY (PHARMACEUTICALS) (SEMESTER-III)
(Credit Based Evaluation & Grading System)

Pharmaceuticals and Biological Chemistry Lab
CYP – 571

Credit 0-0-3

Unit-I

Experiments

1. Preparation of tablets by dry / wet granulation method and their evaluation.
2. Coating of granules and tablets and their evaluation.
3. Microencapsulation and evaluation in microcapsules.
4. Preparation of sustained release tablets and capsules and their evaluation.
5. Filling sealing and evaluation of hard galatin capsules.
6. Preparation of Shampoo.
7. Preparation of simple syrup and evaluation.
8. (i) Preparation of iodine solution and evaluation.
   (ii) Preparation of strong iodine solution and evaluation.
9. Preparation of magnesium hydroxide mixture and evaluation.
10. Preparation of Calamine lotion.
11. Preparation of Boric acid glycerin/tannic acid glycerin/phenol glycerin.
12. Preparation of cough mixture.
13. Preparation of peppermint water / rose water.
14. Preparation of cresol with soap solution.
15. Preparation of non-staining iodine ointment cum methyl salicylate.
16. Formulation of suppositories.
17. Formulation of ointment(s).
18. Preparation of cold cream, vanishing cream, Tooth-Paste and after-shave lotion.
19. To carry out accelerated stability studies of tablets / capsules / syrups.
20. To find out base adsorption for a given drug.
21. Evaluation of packing materials (strip packs &Blisher Packs)
    i) Thickness of Aluminium foil and lamination.
    ii) Water permeability and quality of printing.

Unit-II

Experiments:

1. Estimation of glucose in blood.
2. Estimation of liver glycogen.
3. Estimation of proteins in serum.
4. Determination of creatinine and creatin in blood and urine.
5. Estimation of chloride in serum & urine.
6. Estimation of free fatty acids in serum.
7. Estimation of uric acid in serum & urine.
8. Determination of acid & alkaline phosphatase.
9. Determination of SGOT and SGPT in serum.
10. Determination of blood cholesterol.
11. Estimation of RNA and DNA.
12. Electropheretic separation of serum proteins.
13. Fat determination in milk.

M.Sc. Applied Chemistry (Pharmaceuticals) (Semester-III)
(Credit Based Evaluation & Grading System)

Analytical Lab
Lab Paper : CYP-572

Credit:0-0-3

List of Experiments

1. To analyse water quality of given water sample i.e. pH, electrical conductivity, total dissolved salts (TDS), alkalinity, and total hardness (Ca and Mg).
2. To determine dissolved oxygen content in given water sample using Winkler Method.
3. To determine copper content in given solution by iodometry/AAs/MPAES.
4. To determine formal redox potential of Fe^{2+} -Fe^{3+} redox system.
5. To determine the composition of a mixture of strong and weak acids (HCl + CH_3COOH) by conductometric titrations.
6. To determine acid and base dissociation constants of amino acid using pH measurements.
7. To determine the concentration of ions (Na^+/K^+) in given solution by drawing calibration curve.
8. Determine the molar refractivity for water/DMSO/DMF/acetone/dioxane/CCl_4 /$CH_3COOC_2H_5$ and their mixtures and verify the additivity rule. Predict about the interaction between two compounds of mixture by plotting refractive indices vs. mole fraction.
9. To determine fluoride content by SPANS Spectrophotometric method.
10. Synthesis of ZnO nanoparticles using organic template and their characterization using XRD and UV techniques.
11. Determination of Strength of Sodium Carbonate in washing soda.
12. Determination of Strength of given oxidizing agent e.g. Hydrogen Peroxide.
13. Determination of Strength of given reducing agent e.g. Sodium dithionite.
14. Determination of Strength of given cationic surfactant
15. Determination of Strength of given anionic surfactant
16. Determination of cloud point of non-ionic surfactant

SEMESTER-IV

PROJECT WORK (INDUSTRIAL TRAINING)