FACULTY OF SCIENCES

SYLLABUS

FOR

M. Sc. Applied Chemistry (Pharmaceuticals)
(SEMESTER: I-IV)
(Under Credit Based Continuous Evaluation Grading System)

Examinations: 2012-13

GURU NANAK DEV UNIVERSITY
AMRITSAR

M.Sc. Applied Chemistry (Pharmaceuticals) Semester-I

(Under Credit Based Continuous Evaluation Grading System)

Course Scheme for First Semester:

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

Course Scheme for Second Semester:

Sr. No.	*Code*	*Theory Papers*	*Credit L-T-P*
1.	**CYL481**	Chemical Engineering-II	3-0-0
2.	**CYL482**	Organic Synthesis-II	3-0-0
3.	**CYL483**	Biophysical Chemistry	3-0-0
4.	**CYL484**	Spectroscopy and Instrumental Techniques	3-0-0
5.	**CYL485**	Pharmaceutical Processing and Technology	3-0-0
6.	**CYL486**	Medicinal Chemistry-I	3-0-0
7.	**CYP481**	Chemical Engineering and Instrumental Technique Lab-II	0-0-3
8.	**CYP482**	Pharmaceutical and Natural Products Lab	0-0-3

M.Sc. Applied Chemistry (Pharmaceuticals) Semester-I
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Course Scheme for Third Semester

Sr.No.	***Code***	**Paper Title**	**Credit Hrs L-T-P**
1	CYL-571	Reaction Engineering	**3-0-0**
2	CYL-572	Medicinal Chemistry-II	**3-0-0**
3	CYL-573	Physical Pharmacy	**3-0-0**
4	CYL-574	Inorganic Chemistry-II	**3-0-0**
5	CYL-575	Drug Design and Drug Development-I	**3-0-0**
6	CYL-576	Inorganic Spectroscopy	**3-0-0**
7	CYL-577	Process Control and Plant Economics	**3-0-0**
8	CYL-578	Pollution Control and Waste Treatment	**3-0-0**
9	CYP - 571	Pharmaceuticals and Biological Chemistry Lab	**0-0-3**
10	CYP - 572	Pharmaceutical Technology and Pollution Chemistry Lab	**0-0-3**

First five courses (CYL571-CYL575) are compulsory. Students can chose two courses from courses CYL576- CYL578.

Sr.No.	***Code***	**Paper Title**	**Credit Hrs L-T-P**
1	CYL - 581	Medicinal Chemistry-III	**3-0-0**
2	CYL – 582	Drug Design and Drug Development-II	**3-0-0**
3	CYP-581	***Dissertation***	**0-0-18**
Dissertation to be submitted by 15th June of the current year. Viva will be held in July.			

CYL – 471: Chemical Engineering-I

Credit 3-0-0

1. Fluid Flow: (8 Hrs)

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. Transportation of Fluids: (8 Hrs)

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.

3. Heat Transfer: (10 Hrs)

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.

4. Mass Transfer: (07 Hrs)

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.

5. Measuring Instruments: (12 Hrs)

(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, Mc Graw 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-I

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CYL – 472: Organic Synthesis-I

Credit 3-0-0

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.

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 nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. Application of NMR spectroscopy in the detection of carbocations. 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

3. 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-Zelinsky reactin ,

4. 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.

5. **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.

6. Free Radical Reactions: (6 Hrs)

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

CYL-473: Physical Chemistry

Credit 3-0-0

A. **Chemical and Statistical Thrmodynamics** **(16 Hrs)**

Brief review of laws of thermodynamics, Concepts of free energy, entropy, fugacity and activity. Partial molar properties and their determination. 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. Probability, ensembles, distribution law, Partition functions: translational, rotational, vibrational and electronic partition functions, 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.

B. Phase Rule **(8 Hrs)**

Recapitulation of thermodynamic derivation of Phase rule, Two component systems, determination of solid liquid equilibria, Classification of two component systems with one example each.

Three Component systems, method of graphical representation. Partially miscible, three-liquid systems with examples.

(i) One Partially miscible pair, (ii) Two Partially miscible pairs (iii) Three partially miscible pairs. Effect of temperature. Rochelle's salt (explanation). Systems composed of two salts and water and their application in crystallization of pure components.

C. 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-flow

technique, flash photolysis and magnetic reasonance method. (Numerical Problems).

D. Surface Chemistry and Catalysis (9 Hrs)

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, 7th Edition (2002).

M.Sc. Applied Chemistry (Pharmaceuticals) Semester-I

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CYL-474: Inorganic Chemistry-I

Credit 3-0-0

1. Symmetry and Group Theory: (10 Hrs)

Molecular symmetry, Representation of symmetry operations as matrices, set of symmetry operations of molecules satisfying the conditions of point groups, multiplication tables. Representation: basis of representations, representations of point groups. Great orthogonality theorem and various relationships derived from it. Derivation of character Tables of C_{2v}, and C_{3v}, point groups. Projection

operators and direct products – Directed valence. Using character tables O_h, T_d, and D_{4h} points groups for finding the orbitals that take part in hybridization to from the respective geometries.

2. Theory of Chemical Bonding: (10 Hrs)

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.

3. Chemistry of Transition Metals: (25 hrs)

(a) LS coupling, derivation of spectroscopic terms for d^1 to d^9 electronic configurations, correlation diagram for d^2 ion in octahedral field, splitting of d^1 to d^9 terms in an octahedral and tetrahedral field.

(b) Selection rules of d-d transitions. Vibronic and spin orbit coupling, effecting of weak to strong cubic fields on R-S terms, Comparison of CFSE values of d^1 to d^9 ions in terms of orbit splitting and R-S term splitting. Effect of CFSE on thermodynamic properties, lattice energy, heat of hydration heat of ligation and spinal structure. Orgel and Tenabe Sugano diagrams, spectra of octahedral, tetrahedral, distorted octahedral (Jahn Teller Effect) and square planner complexes spectrochemical series, nephelauxetic effect.. Calculation of and 10 Dq from spectral data.

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. A.B.P. Lever, Inorganic Electronic-Spectroscopy, 2nd Edition.
7. B.N. Figgis: Introduction to Ligand Fields, New Delhi, Wiley Eastern (1976).

CYL-475: Molecular Spectroscopy-I

Credit 4-0-0

1. General Features of Spectroscopy (5 Hrs)

Units and conversion factors. Introduction to spectroscopy, Nature of radiation. Energies corresponding to various kinds of radiation, Experimental techniques, intensities of spectral lines, Selection rules and transition moments, Line widths, Broadening.

2. UV and Visible Spectroscopy of Organic Molecules: (15 Hrs)

Photometry laws, Radiation sources, monochromators, filters, prisms, single and double beam spectrophotometer, oscillator strength and intensity of the electronic transition, 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- * transitions in organic molecules, Woodward rules for conjugated dienes and , - unsaturated carbonyl groups, extended conjugation and aromatic sterically hindered systems, Quantitative applications.

3. Infrared Spectroscopy: (10 hrs)

Introduction, Requirements to adsorb in infrared region, Derivation of fundamental vibrational frequency, Modes of virbations, Radiation Sources, (Incandescent wire source, Nernst glower, Globar, Mercury arc and laser source); Detectors (thermocouples, bolometer, pyroelectric, golay pneumatic, photoconductive & photovottace); Dispersive and nondispersive infrared spectrometers, Schemetic representation of double beam IR spectrometer; Fourier transform infrared spectrometer - Michelson's interferometer, Sample handling techniques for gases liquid & solid samples; Quantitative measurements, correlation of infrared spectra with molecular structure, Uses of IR spectrum.

4. Nuclear Magnetic Resonance Spectroscopy (20 Hrs)

PMR: The spinning nucleus, effect of external magnetic field, precessional motion and frequency, Energy transitions, Chemical shift and its measurements. Factors influencing chemical shift, anisotropic effect; Integrals of protons, proton exchange, spin-spin coupling- splitting theory, one, two and three bond coupling, virtual, long range and allylic coupling, magnitude of coupling constant; factors affecting the coupling constant, Chemical and magnetic equivalence, First and second order spectra, A_2, AB, AX, AB_2, AX_2, A_2B_2 and A_2X_2 spin systems, Simplification of complex spectra (solvent effect, field effect, double resonance and lanthanide shift reagents), CW and FT NMR, Relaxation processes, Applications of PMR in structural elucidation of simple and complex compounds, Brief introduction to C^{13} NMR.

5. Mass Spectra: (10 Hrs)

Introduction, methods of ionization Electron Impact ionization & Chemical Ionization, Brief description of LD, Fast Atom Bombardment, Secondary Ion Mass Spectrometry, Field Desorption etc., Ion analysis methods (Analyzer), isotope abundance, Metastable ions, general rules predicting the fragmentation patterns. Nitrogen rule, determination of molecular ion peak, index of H deficiency, fragmentation patterns for aliphatic compounds, amines, aldehydes, Ketons, esters, amides, nitriles, carboxylic acids ethers, aromatic compounds etc.

Books Recommended:

1. D.A. Skoog, “Principles of Instrumental Analysis”, 3rd Edition, Saunders College Publishers (1984)
2. Pavia, Lampman & Kriz, Introduction to Spectroscopy.
3. C.N Banwell "Fundamentals of Molecular Spectroscopy".
4. R. M. Silverstein, G.C.Bassler, T.C. Morrill, "Spectrometic Identification of Organic Compounds.
5. W. Kemp, "Organic Spectroscopy".
6. D.H. Williams, I. Fleming, "Spectroscopic Methods in Organic Chemistry".
7. G.M. Barrow "Introduction to Molecular Spectroscopy".

CYL-476: Biological Chemistry

Credit 3-0-0

1. Bimolecules (2 Hrs)

Broad classification and role of bimolecules.

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.

3. Enzymes (8 Hrs)

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. Coenzymes (10 Hrs)

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, Biotinyl conenzyme. Conenzyme - A, and Thiamine pyrophosphate.

5. Biotechnological Application of Enzymes (10 Hrs)

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.

6. Carbohydrates and Metabolism (6 Hrs)

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

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.

CYP – 471: Chemical Engineering and Instrumental Technique Lab-I

Credit 0-0-3

Unit-I

Experiments:

1. Verification of Bernaullis theorm.
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's contant 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.

Unit-II

1. Determination of total hardness, total alkalinity and chloride content of water.
2. Distribution of solute between two immiscible solvents.
3. Kinetics of hydrolysis of an ester and comparison of relative strength of two acids.
4. To determine the rate constant of a reaction between ethyle acetate and caustic soda solution at two different temperatures and energy of activation.
5. Study the effect of catalyst on the decomposition of hydrogen peroxide.
6. Study the phase diagram of Naphthalene and Benzoic acid.
7. Determination of consolute points (Upper or Lower or both).
8. Construct a phase diagram of 3-component system.
9. Heat of solution by solubility method.

10. Partial molar volume studies.
11. Determination of CMC of a surface active agent.
12. Determination of atomic parachor values of C.H.O.
13. Estimation of glucose and Ascorbic acid.
14. Study of adsorption of organic compounds on charcoal.

Books recommended:

1. Perry's Chemical engineer's handbook, by R.H. Perry and D.W. Green, Mc Graw Hill, 7th edition, New York, 1997.
2. McCabe W.L., Smith J.C., Unit Operations of Chemical Engineering, Fifth Edition, McGraw Hill International Edition New York, 1993.
3. Coulson J.M., Richardson J.F., Chemical Engineering, Volume 1, Fifth edition, Pergamon Press, New York,1996.
4. Process Heat Transfer by Donald Q. Kern, Mc Graw Hill International edition, , Singapore, 1965.
5. Perry's Chemical engineer's handbook, by R.H. Perry and D.W. Green, Mc Graw Hill, 7th edition, New York, 1997.
6. McCabe W.L., Smith J.C., Unit Operations of Chemical Engineering, Fifth Edition, McGraw Hill International Edition New York, 1993.
7. Coulson J.M., Richardson J.F., Chemical Engineering, Volume 1, Fifth edition, Pergamon Press, New York,1996.
8. Process Heat Transfer by Donald Q. Kern, Mc Graw Hill International edition, , Singapore, 1965.

CYP – 472: Organic Synthesis Lab

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. Chem Edu*., **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. Chem Edu*., **2008**, 85, p1541
4	Preparation of bromohydrin of α-methylstyrene	Methyl styrene, NBS, acetone	Rbf, stirrer	*J. Chem Edu*., **2008**, 85, p102
5	Dihydroxylation of cyclohexene with peracids and $KMnO_4$ – Product distribution by TLC	cycohexene, oxone, $KMnO_4$	Rbf, stirrer, TLC,	*J. Chem Edu*., **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. Chem Edu*., **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
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 Danishefsky diene	Trans-4-methoxybutene-2-one, zinc chloride, triethyl amine, trimethyl silyl 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*

CYL – 481: Chemical Engineering-II

Credit 3-0-0

1. Evaporation: (9 Hrs)

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. Filtration: (8 Hrs)

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.

3. Leaching and Extraction: (5 hrs)

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.

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.

5. Crystallization: (4 Hrs)

Growth and Properties of Crystals, Saturation, Nucleation, Crystallization rate, Fractional Crystallization, vacuum crystallizers, Draft tube-Baffle crystallizers.

6. 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.

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. Mc Graw Hill London, 1984.

CYL – 482: Organic Synthesis-II

Credit 3-0-0

1. Addition to Carbon-carbon and Carbon-Hetero Multiple Bonds (15 Hrs)

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. 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.

2. Elimination Reactions (5 Hrs)

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

3. Oxidation Reactions (7 Hrs)

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

4. Reduction Reactions (10 Hrs)

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 cyano borohydride, LAH, disobutyl aluminium hydride, tin hydride, trialkyl tin hydride, trialkyl silanes, alkoxy substituted LAH, DIBAL, diborane, diisoamyl borane, hexyl borane, 9-BBN, isopinocamphenyl and disiopinocamphenyl borane. Reduction reactions with particular emphasis on Wolf-Kishner reduction, Clemensen reduction.

5. Rearrangements (8 Hrs)

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

Books:

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

CYL – 483: Biophysical Chemistry

Credit 3-0-0

1. **Water**: Structure and Interactions, Water as a solvent, proton mobility.
2. **Biophysical Interactions**: Intermolecular interactions effecting conformation of biomolecules; non-covalent interactions e.g., ionic bonds, dipole-dipole interactions, hydrophobic interactions, hydrogen bonds, dispersion forces etc. 6
3. **Bioenergetics**: Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP. 3
4. **Statistical Mechanics in Biopolymers**: Chain configuration of macromolecules, statistical distribution end to end dimensions, calculation of average dimensions for various chain structures. Polypeptides and proteins structures, Introduction to protein folding problem. 5
5. **Thermodynamics of Biopolymer Solutions**: Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system. 4
6. **Cell Membrane and Transport of Ions**: Structure and functions of cell membrane, ion transport through cell membrane, inversible thermodynamic treatment of membrane transport. Nerve conduction. 3
7. **Experimental Techniques for the Determination of Size, Shape and Molecular Mass of Biopolymers**:

i). **Viscosity**: Measurement, relation to geometry and correlation with hydrodynamic properties.

ii). **Diffusion**: Fick's law of diffusion, diffusion coefficient and its interpretation, frictional coefficient.

iii). **Ultra centrifugation**: Svedberg equation, sedimentation equilibrium, density gradient sedimentation.

iv). **Electrophoresis**: General Principles, Double layer, Techniques : Moving Boundary Electrophoresis, Zonal Electrophoresis, Isoelectric Focusing.

v). **Osmotic Pressure**: Second virial coefficient, molecular mass and geometry from O.P. data, Donnan membrane effect, Drug absorption.

vi). **Optical Properties of Biomacromolecules**: Light scattering, Fundamental concepts, Rayleigh scattering, Scattering by larger particles.

vii). **Solubility of Biomolecules**: As solutions of polyelectrolytes, Debye-Huckle theory, Applications to proteins purification.

viii). **Stability of Biomolecules in Solutions**: Denaturation, Method of Stabilization.

ix). Micells, Reverse micelles and liquid membranes-conformation and bioprocess applications. 24

Books Recommended:

1. Physical Chemistry and its Biological Applications by W.S. Brey (Chapter 5 and 12). Academic Press (1978).
2. Physical Chemistry for the Biosciences by Raymond Chang University Science Books, California, (2005).
3. Principles of Physical Biochemistry by Kensal E. van Holde, W. Curtis Johnson and P. Shing Ho, Prentice-Hall International, Inc., New Jersey (1998).
4. Physical Chemistry for the Life Sciences by Peter Atkin and Julio de Paula, W.H. Freeman and Company, New York (2006).
5. Biochemistry by D. Voet and J.G. Voet, John Wiley and Sons, 1995.
6. Physical Chemistry: Principles and Applications in Biological Sciences. By Tinoco I., Jr. Sauer, K., Wang, J.C. and Puglisi, J.D. 4th Edition, Pearson Education, Inc., New Delhi (2007).

CYL – 484: Spectroscopy and Instrumental Techniques

Credit 3-0-0

1. Photoluminescence: (5 Hrs)

Fluorescence, phosphorescence, Jablonski diagram various deactivation processes, Quantum yield of fluorescance/ phosphorescence, Derivation of relationship between concentration & fluorescence, Instrumentation, Spectrofluorometer, Spectrophosphorimeter, Applications.

2. Raman Spectroscopy: (5 Hrs)

Introduction, Raman effect, Requirement, Comparison of Raman spectroscopy with infrared spectroscopy, Instrumentation-sources & sample handling.

3. Flame Emission and Atomic Absorption Spectroscopy: (10 Hrs)

Introduction, Atomization, Continuous Atomizers, Discrete atomizers; Flames, Nebulizer-Burner system (concentric, cross flow, laminar flow), Non-flame techniques (Electrothermal analyzers, Cold vapour technique); Radiation sources (hollow cathode lamp and Electrodeless discharge lamp), monochromator, Detectors, Interference (spectral, chemical, ionization, matrix effect, molecular absorption); Background Effects, Background correction methods (Deutrium Arc, Zeeman Effect and Smith-Hieftje System), Schematic diagram of flame photometer and Atomic absorption spectrophotometer.

4. Refractometry & Polarimetry: (5 Hrs)

Introduction, Principle, Measurement of refractive iodex, Instrumentation-Abbe's refractrometry. Polarimetry: Theory, plane & Circularly polarized light. Optical rotatory dispersion (ORD), Circular dichroism (CD), Curves, Measurement of optical rotation & Applications polarimeter-components.

5. Analytical Techniques: (20 Hrs)

i). **Chromatographic analysis** : Introduction, Gas chromatography and High pressure liquid chromatography Chromotographs, detectors.

ii) **Conductometric methods :** Introduction, theory ostwald's dilution law, Measurements of conductance, Conductivity cells, and Applications.

iii) **Potentiometric measurements** : Calomel electrode, Normal hydrogen electrode silver-silver chloride electrode, Quinhydrone electrode, Applications.

iv) **pH Measurements:** Glass electrode, combination glass electrode and applications.

v) **Polarography & Amperometry**: Introduction, Dropping mercury electrode, polarograph, polarogram, Calculation of half-wave potential and Amperometric titrations, Applications.

vi) **Industrial Process Analyzers**: Introduction, Automatic Analyzers, Discrete and Continuous flow analyzers, Beckman analyzer, Dupont analyzer, Process analyzer (specific and non-specific), Moisture analyzer (Electrolytic Hygrometer, Piezoelectric sorption hygrometer).

Books Recommended:

1. D.A. Skoog & J.J. Leary, "Principles of Instrumental Analysis", 4th Edition. Saunders College 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. Vogel's Textbook of Quantitative Chemical Analysis, ELBS Longman.
4. D.A. Skoog, "Principles of Instrumental Analysis, 3rd Ed. Saunders College Publishers (1984).

CYL – 485: Pharmaceutical Processing and Technology

Credit 3-0-0

Pharmaceutical Processing: (3 Hrs)

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: (3 Hrs)

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: (5 Hrs)

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.

Pharmaceutical dosage forms:

4. Preformulation Considerations: (2 Hrs)

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: (5 hrs)

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.

ii) Tablet Coating: (3 Hrs)

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.

6. Processing of Capsules: (4 hrs)

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: (3 Hrs)
Importance and applications of microencapsulation in Pharmacy. Various techniques and equipment employed for microencapsulation.

8. *Sustained release dosage forms* (4 Hrs)
Advantages and disadvantages of sustained release medication types, formulation and manufacture, Theory of drug release, multiple dosing. **In-vivo and In-vitro** measurements of drug availability.

9. *Liquid dosage forms:* Types, advantages and disadvantages.
a) Monophasic liquid dosage forms: (2 Hrs)
Techniques of increasing solubility of drugs, other problems involved in preparation and stability of liquids.
b) Biphasic liquid dosage forms : (3 Hrs)
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 (2 Hrs)
A brief review of the preparation of ointments, creams and suppositories.

11. Pharmaceutical aerosols (3 hrs)
Advantages of aerosol dosage form. Formulation of aerosol products and their standardization.

Books Recommended:

1. 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. W. Copper and G. Gunn, Dispensing Pharmacy, CBS Publishers & Distributors, Delhi.

CYL – 486: Medicinal Chemistry-I

Credit 3-0-0

1. Introduction to Pharmaceuticals (2 Hrs)

Historical Development, Classification of Drugs, Nomenclature of Pharmaceuticals, Drug metabolism reactions.

2. 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.

i) Vitamin and Hormones (12 Hrs)

Hormones: Sex hormones and related compounds. (Estrogens, Androgens, Progestational agents, Anabolic steroids, Contraceptives), Adrenal cortex hormones, Thyroid hormones and antithyroid drugs, Pancreatic hormones, Hypothalamus hormones.

Vitamins: Fat soluble vitamins (A, D, E and K), water soluble vitamins (Folic acid, B_{12} and C).

Commercial routes to: Testosterone, cortisone, Progesterone, Vit. A, D, E, K Folic acid and Vit. C.

ii) **Cardiovascular drugs: (8 Hrs)**

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

iii) General and Local Anesthetics: (5 Hrs)

Theories of General Anesthetics, Electronacrosis, Ethers, Halogenerated hydrocarbons, Cyclopropane, Nitrous oxide, Barbiturates, Adjuncts to general anesthetics, metabolism of volatile anesthetics. Local anesthetics: Cocoa alkaloids-Cocaine and Synthetic compounds, Esters, Amides, Miscellaneous anesthetics.

Synthesis of Phenobarbital, Allobarbital, Pentobarbital. Theopental sodium, Midazolam.

iv) Analgesics and Antitussives (6 Hrs)

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, Buprinorophine, Pentanorphine, Pentazocine, dextromrthorphane, Bromohexine, Papaverine, Levopropoxyphene, cyclazocine.

v) Antipyetics and Non-steroidal Anti-inflammatory Agents: (6 Hrs)

Salicyclic acid derivatives. Indolyl and Arylacetic acid derivatives. Pyrazole derivatives. Aminophenol derivatives, Arylpropionic acid derivatives, Salol Principle, Anti-Gout Drugs.

Commercial Synthetic Route To: Ibuprofrn, Naproxen, Fenoprofen, Piroxicam, Indomethacin, Sulindac, Diclofenac, Ibufenac, Ketoprofen, Oxyphenbutazone, Phenylbutazone, Zompirac.

vi) Diuretics: **(6 Hrs)**

Osmotic agents, Acidfying salts.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, Methalthiazide methylchlothlazide: Chlorothiazide, Triameterene, Hydrochlothiazide, Ameloride, Chlorthalidone.

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.

CYP – 481: Chemical Engineering and Instrumental Technique Lab-II

Credit 0-0-3

1. Determination of heat transfer coefficient under forced convection.
2. Determination of heat transfer coefficient under natural convection.
3. To determine efficiency of PIN-FIN in natural and forced convection.
4. To plot log Re vs. Porosity for a fluidized bed.
5. Study of pressure drop through a packed bed.
6. Determination of absolute humidity, relative humidity, dew point, saturated volume and humid heat using psychometric char.
7. To compare efficiencies of simple and differential manometers.
8. Study of effect of insulating materials on lass of heat.
9. Study of rate of cooling through various colours.
10. To study the effect of viscosity on rate of sedimentation.
11. To study the effect of viscosity on rate of filtration.
12. To verify Darcy's law.

Books recommended:

1. Perry's Chemical engineer's handbook, by R.H. Perry and D.W. Green, Mc Graw Hill, 7^{th} edition, New York, 1997.
2. McCabe W.L., Smith J.C., Unit Operations of Chemical Engineering, Fifth Edition, McGraw Hill International Edition New York, 1993.
3. Coulson J.M., Richardson J.F., Chemical Engineering, Volume 1&2, Fifth edition, Pergamon Press, New York,1996.
4. Heat Transfer by J.P. Holman, Mc Graw Hill Book Company, SI Metric Edition, Singapore, 1989

Unit-II

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.

CYP – 482: Pharmaceutical and Natural Products Lab

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-ethylphenyl)-I-(2H)-Benzoxazine, Diketopiperazine, Paracetamol, Thenacetin, Antipyrene 2-amino-5 bromopyridine, Nitrazepam, Azo sulfomarides, 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 organe 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. Vallabh Prakashan, New Delhi.
3. Practical Pharmacognosy: Khandewal, K.R. Nirali Prakashan, Pune
4. Phytochemical methods by J.B. Harborne
5. Perry's Chemical engineer's handbook, by R.H. Perry and D.W. Green, Mc Graw Hill, 7^{th} Edition, New York, 1997.
6. McCabe W.L., Smith J.C., Unit Operations of Chemical Engineering, Fifth Edition, McGraw Hill International Edition New York, 1993.
7. Coulson J.M., Richardson J.F., Chemical Engineering, Volume 1 & 2, Fifth Edition, Pergamon Press, New York, 1996.
8. Heat Transfer by J.P. Holman, Mc Graw Hill Book Company, SI Metric Edition, Singapore, 1989.

Reaction Engineering
CYL – 571

Credit 3-0-0

1. **Kinetics of Homogenous Reactions:** 5 Hrs

Types of reactions, single and multiple reactions, elementary and non-elementary reactions, molecularity and order of a reaction, definition and representation of a reaction rate. Temperature dependency of rate from Arrhenius, Collision and transition state theories.

2. **Interpretation of Batch Reactor Data :** 7 Hrs

Integral method of analysis of data for Zero, first and second order reactions, half life for nth order reactions, irreversible reactions in parallel and in series, differential method of analysis, constant and variable volume batch reactors.

3. **Single Ideal Reactors :** 5 Hrs

Design equations for single ideal batch reactors, steady state mixed flow reactors, steady state plug flow reactors, Holding and space time, problems. Size comparison of single reactors.

4. **Nonelementary Homogenous Reactions :** 8 Hrs

Active intermediates, pseudosteady state hypothesis, mechanism for hydrogen bromide reaction, polymerization reaction; steps in free radical polymerization, developing the rate law for net rate of reaction, enzymatic reactions, Michaelis-Menten equation.

5. **Non-Isothermal Reactor Design :** 10 Hrs

Continuous flow reactors at steady state; application to the mixed flow reactor, adiabatic plug flow reactor, plug flow reactor with heat exchange, unsteady state operation of batch, mixed and plug flow reactors.

6. **Multiple Reactor Systems :** 10 Hrs

Plug flow reactors in series or in parallel, Equal sized mixed flow reactors in series, mixed flow reactors of different sizes in series, reactors of different types in series, recycle reactors, Qualitative discussion and quantitative treatment for series, parallel, series-parallel reactions in batch, steady state mixed flow and steady state plug flow reactors.

Books Recommended:

1. Levenspiel Octave, Chemical Reaction Engineering, Second Edition, Wiley International, New York, 1972.
2. H.S. Fogler, Elements of Chemical Reaction Engineering, Second Edition, PHI, New Delhi, 1992.
3. C.D. Holland, R.G. Anthony, Fundamentals of Chemical Reaction Engineering Second edition, Prantice-Hall International Series, 1989.
4. C.G. Hill Jr., An Introduction to Chemical Engineering Kinetics and Reactor Design, John Wiley & Sons, New York, 1977.

Medicinal Chemistry-II
CYL – 572

Credit 3-0-0

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

1. **Antibacterials**: Penicillines, Cephalosporins, Tetracyclines, Aminoglycosides, Chloramphenicol, Macrolides, Lincomycins, Polypeptides antibiotics, Polyene antibiotics. Sulfonamides and Sulfones fluoroquinolines, 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, Trimethoprim. **(13 Hrs)**

2. **Antimalarials:** 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. **(7 Hrs)**

3. **Antiamoebic and Antiprotozoal Drugs:** Emetine hydrochloride, 8-Hydroxyquinoline, Iodochlorohydroxyquinol, Metronidazole, Diloxanide furoate, Bilamical hydrochloride, Hydroxystilbamidine isothinate, Pentamidine isothionate, 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. **(8 Hrs)**

4. **Anthelmintics**: Introduction, Tetrachloroethylene, Piperazines, Gentian violet, Pyrvinium pamoate, Thiabendazole, Mabendazole, baphenium hydroxynaphthoate, Dichlophene, Niclosamide, Levamisole hydrochloride, Tetramisole, Niridazole, Biothional, Antimonypotassium tartarate, Stibiophen, Sodium Stibiocaptate. **(8 Hrs)**

5. **Antifungal Drugs**: Fatty acids and their derivatives (Propionic acid, zinc propionate, sodium caprylate, zinc caprylate, undecylenic acid, Zinc undecylenate, Triacetin), Salicylanilids, Salicyclic acid, Tolnaftate, pchloromethoxylenol, Acrisocrin, Fluconazole, Itraconazole, Haloprogin, Clotrimazole, Econazole, Miconazole, Ketoconazole, Flucytosine, Griseofulvin, Polyene antibiotics (Nystatin, Amphoetericin-B), Chlorophenesin, Dithranol.

Commercial synthetic routes to: Miconazole, Clotrimazole, Econoazole, Fluconazole, Griseofulvin, Ketoconazole, Nafttidine, Tolnaftate, Flucytosin. **(9 Hrs)**

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.

Physical Pharmacy
CYL – 573

Credit 3-0-0

1. **Surface Activity and Interfacial Phenomenon:** Surface tension and interfacial tension, Young - Laplace, Kelvin and Gibbs equations in explaining surface tension and allied subjects, surface active agents and their chemical classification, hydrophile - Lipophile balance, solubilization, critical micelle concentration, solubilization, emulsification, wetting detergency etc. Interfacial films, Unimolecular film formation, diffused double layer and zeta potential, thickness of double layer, state of aggregation and crystal growth. Pharmaceutical applications of surface phenomenon.

(10 Hrs)

2. **Colloids and Macromolecular System:** Dispersed systems method of preparation of colloidal dispersions, size and shape of colloidal particles. Pharmaceutical applications. Types of colloidal systems. Optical, kinetics and electrical properties. Stability of colloidal systems. Sensitization of protective colloidal action. **(8 Hrs)**

3. **Solubility and Related Phenomenon :** General considerations, solubility expressions, determination of solubility, solute-solvent interactions/solubility of gases in liquids, liquids and solids in liquids, Presentation of solubility data, solubility parameters, solubility curves, solubility product effect of co-solvents, pH and other factors. **(5 Hrs)**

4. **Rheology :** Shear rate-shear stress relationship and its measurement, pseudoplastic, thixotropic and dilatant types of flow, isoelastic properties, Couette viscometer, Cup and bob viscometer, Redwood viscometer, Brookfield viscometer, Cone and Plate viscometer and Penetrometer, Applications of Rheology in Pharmaceuticals, Solving of numerical problems related to rheology.

(9 Hrs)

5. **Chemical, Kinetics and Drug Stability :** General consideration and concepts, complex reactions, influence of temperature, light, heat, oxygen, solvent, catalytic species and other factors in stability of drugs, Prediction of stability of common pharmaceutical substances. Thermodynamic considerations and mechanisms in general. **(8 Hrs)**

6. **Complexation :** Metal complexes, organic molecular complexes, inclusion/occlusion compounds and analysis. **(5 Hrs)**

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).

Inorganic Chemistry-II
CYL – 574

Credit 3-0-0

1. **Introduction to Ligands, Complexes and their Reactivity**:
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. **(5 Hrs)**

2. **Macrocyclic Ligands and Macrocyclic effects**: 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. Cation transfer, Naturally occurring ionophorous agents, Natural ionophores. Carboxylic ionophores. **(10 Hrs)**

3. **Bioinorganic Chemistry :** 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. **(10 Hrs)**

4. **Chemistry of Non-transition Elements**: General discussion on the properties of the nontransition elements; special features of individual elements; synthesis, properties and structure of their halides and oxides, 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, interhalogens pseudohalides and noble gas compounds. **(10 Hrs)**

5. **Inorganic for Water Purification** : Industrial water conditioning, physical and chemical purification of Water and Waste Water using ion exchangers, cold-lime softening process, Quality of Water for various purposes, Solvent extractions. **(10 Hrs)**

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).

Drug Design and Drug Development-I
CYL – 575

Credit 3-0-0

1. ***Introduction History and Objective of drug designing :*** 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. **(4 Hrs)**

2. ***Structure Activity Relationships :*** 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. Structural and theoretical parameters. Bioisostreism. Hansch analysis, Free and Wilson method Physicochemical parameters, Craig Plot, Toplis operational scheme. Cluster analysis. Pattern recognition. Partition coefficient and its significance. **(8 Hrs)**

3. ***Drug Designing and molecular orbital method :*** 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. Molecular orbital approach to drug design with specific example of thiadiazine antihypertensives. **(8 Hrs)**

4. ***Pharmacokinetics in Drug designing :*** Pharmacokinetics, Environmental pharmaockinetics. Single and two compartment pharmacokinetics. Pharmacokinetics of drug metabolism. Dissection of a drug molecule into biofunctional moieties. Modulation of pharmacokinetics by molecular manipulations : modulation of distribution of pharmacea over various compartments, modulation of time-concentration relationship. Biopharmaceutics. Generic equivalence and non-equivalence. Role of biopharmaceutics in Drug designing. **(8 hrs)**

5. ***Drug Receptor - Interaction :*** 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. **Peptidomimetics :**Rational design of Peptidomimetics, nonpeptide, ligands for peptide receptors, Applications of oligonucleotides in antiviral and antitumoral chemotherapy. Antisense nucleotides desig. **(10 Hrs)**

6. ***Prodrug Approach :*** 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 presystematic metabolism. Prolongation of drug action, site specific drug delivery. Reduction in drug toxicity. Alteration of drug metabolism. **(7 Hrs)**

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.

Inorganic Spectroscopy
CYL-576

Credit 3-0-0

1. Nuclear Quadruple Resonance Spectroscopy (5 Hrs.)

Introduction, experimental considerations, fundamentals of NOR spectroscopy, origin of EFG, measurement of energy differences between two nuclear spin states, the assymetry paremeter, effects of the magnetic field, interpretation of the spectra, application of the technique to halogen compounds, group, elements, transition metals, complications in the spectra. (book 1,2).

2. Mossbauer Spectroscopy (10 Hrs.)

Experimental considerations, the spectrum and its parameters, simple spin states (1/2, 3/2), higher spin states (I > 3/2), magnetic splitting significance of parameters obtained form spectra, quadrupole splitting, additive model, interpretation of Mossbauer spectra of ion-57, tin-119, complications like unusual intensities, non zero asymetry parameter recol fraction, magnetic ordering and relaxation. (book 1,2).

3. Electron Paramagnetic Resonance Spectroscopy (15 Hrs.)

Introduction, principle, Presentation of spectrum, hyperfine splitting in isotropic systems involving more than one nucleus, est spectrum of benzene radical anion, methylmedical. CH2OH cyclopentedfienyl cycloheptarienyl radical, pyrazine anion, pyrazine anion with 23 Na and 30K counter ion, Nitrosyl nitroxide factors affecting magnitude of g values, zero field splitting and Krammer's degeneracy. Qualitative survey of EPR spectra of first row transition metal ion complexes (d^1, d^2, d^3, low spin d^5, d^5, high spin d^6, d^7, d^9 system). (book 1,2).

4. Nuclear Magnetic Resonance (15 Hrs.)

Recaptulations, NMR of inorganic compounds, ^{1}H NMR of organometalics- chemical shift, coupling effects, phosphorous and arsine ligands, hydrides, coupling to metals, Main group hydrides, transition metal hydrides, coupling to phosphine ligands, more than one hydride, coupling to metal, effect of trans ligand, dihydrogen complexes, Isotopes other than ^{1}H e.g. ^{31}P, ^{13}C, ^{14}N, ^{15}N, ^{19}F, ^{27}Al, ^{29}Si, transition metals. (books 1, 2 & 3)

Books Recommended:

1. R.S. Drago, Physical Methods in Chemistry, W.B. Saunders Company.
2. R.V. Parish, NMR, NQR, EPR and Mossbauer spectroscopy in Inorganic Chemistry, Eds Elis Horwood.
3. E.A.V. Ebsworth, D.W.H. Rankin and S.J. Cradock, Structural methods in Inorganic Chemistry, Blackwell Scientific, Oxford, 1987.

M.Sc. Applied Chemistry (Pharmaceuticals) (Semester-III)

Process Control and Plant Economics

CYL-577

Credit 3-0-0

1. Fundamental of Automatic Control:

(a) 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. **(10)**

(b) Control system, Block diagram, Negative and positive feedback, Development of block diagram, measuring element. Block diagram of a chemical reactor control system. **(5)**

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

(d) Overall transfer function for single loop system, for change in set point, for change in load and for multiloop control system. Control of a steam jacketed kettle, analysis of valve, block diagram, response of a gas absorber and heat exchanger. **(10)**

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

3. 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, methods for determining depreciation. **(5)**

4. 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)

Pollution Control and Waste Treatment
CYL-578

Credit 3-0-0

1. **Atmosphere:** Environment, Segments of atmosphere, Physical characteristics, Chemical composition, Solar radiations, Albedo, Thermal radiations. Vertical temperature profile, Atmospheric Pressure & Atmospheric density, Gravitational force, Water, Absolute, Relative humidity, Atmospheric motion-winds, Evolution of atmosphere. **(3 Hrs)**

2. **Air Pollution*:*** Pollutant, Contaminant, Source of air pollution, Types of smog, Haze, Concentration expression of gaseous pollutants, Atmospheric transport & dispersion, Receptors & criteria study, Generation of aerosols, Gaseous pollutants & Sinks of oxides of carbon, Oxides of sulphur, Oxides of nitrogen, Ammonia, Hydrocarbons etc. Photochemical oxidants, Particulate matter & its size variation. Ambient air quality standards. **(7 Hrs)**

3. (i) **Effects:** Visibilty, Light scattering, Thermal air pollution, Precipitation, Acidic deposition, Effects on Climate, Ozone layer & its effects, Stratospheric ozone depletion. (ii) **Health Effects*:*** Air pollution & Respiratory diseases, Effects on human body, Health effects of pollutants (COx, SOx, NOx, Hydrocarbons, particulate matter, ozone, lead), Hazardous air pollutants. (iii) **Welfare Effects*:*** Effects on vegetation, major & minor phytotoxic pollutants, domesticated animals & effects of pollutants on various materials. **(6 Hrs)**

4. **Air Pollution Control:** Ambient air quality definition, Air quality monitoring, Measurement of air pollution, Sampling techniques. Analytical procedures for analysis (wet chemistry, chemiluminescence, electrochemistry, Infrared, Ultraviolet absorption, Photometry, chromatography), Control of gaseous emission (adsorption, absorption condensation, combustion), Control of particulate matter-cyclone collectors, Multiple tube collectors, Fabric filters, Electrostatic precipitators, Scrubbers & Collection efficiency. **(9 Hrs)**

5. (i) **Water Pollution *:***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. (ii) **Sampling *:*** Selection of sampling sites, Sampling procedures & handling of samples. (iii) **Water Pollution Analysis** : Physico-Chemical analysis of Water. Alkalinity, Hardness, Acidity, Dissolved oxygen, Biochemical oxygen demand (BOD), Chemical oxygen demand (COD), Sulphte, Residual chlorine Iron. Water pollution indices-general concept.

(iv) **Waste Water Treatment Plants *:*** Biological waste treatment, Primary clarification, Activated sludge process, Anaerobic lagoons, aerobic & facultative lagoons. (v) **Waste Minimization Technology*:*** Relationship of waste minimization technology to integrated hazard waste management. (vi) **Hazardous control :** Disaster planning onsite and offsite. (vii) **Wastewater Treatment :** Objectives, Classification of Waste water treatment, Reuse of wastewater.

(20 Hrs)

Books Recommended :

1. Thad Godish, "Air Quality", 3rd Ed. Lewis Publishers (1997).
2. R.K. Trivedi & P.K. Goel, "Chemical and Biological Methods for Water Pollution Studies" Environmental Publications Karad, (1986).
3. Matcalf and Eddy, "Waste Water Engineering" Tata McGraw-Hill Publishing Company Ltd. (1993).
4. Harry Freeman,"Hazardous Waste Minimization" McGraw Hill Publishers (1990).

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 emulsion and evaluation.
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 magnesiumuhydroxide 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 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.

Pharmaceutical Technology and Pollution Chemistry lab
CYP – 572

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 emulsion and evaluation.
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 magnesiumuhydroxide 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 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.

M.Sc. Applied Chemistry (Pharmaceuticals) (Semester-IV)

Medicinal Chemistry-III
CYL - 581

Credit 3-0-0

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.

1. CNS Active Drugs: **CNS Depressants: Hypnotics and Sedatives**: 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, Carbamazipine valproic acid, Methaquolane, Nitrazepam, Oxazepam, Diazepam, Cholridazepoxide, Lorazepam, Flurazepam, Triazolam, Alprazolam, Amitriptyline, Imipramine, Amphetamine, Protriptyline, Chloripramine, Iproniazide, tranylcypromine, Doxepin, phenteramine, caffeine. **(12 Hrs)**

2. Antiviral Agents: 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. **(10 Hrs)**

3 Antineoplastic Agents: 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, Antitumor, antibiotics, Dactinomycin, Daunorubricin, Aclacinomycin, Mithramycin, Bleomycin, **Miscellaneous compounds**: Cisplatin, Taxol, Gunazole, Pipobromin. **Antitumor alkaloids**: Vincristine, Vinblastine. **Hormones agonist and antiagonists**: Steroids, Tamoxifen, Mitotane, Dromastanolone propionate, Testalactone, Megestrol acetate Immunotherapy.

Commercial synthetic routes to: Methtrexate, Trimetrexate, Adatrexate, Mercaptopurine, Dromostanolone, Cytarabine, Fludarabine, Thioguanine, Dezaguanine, Bisanterene, Acivicin, Piroxanthrone. **(15 Hrs)**

4. **Non-Steroidal Anti-inflammatory drugs (NSAIDS)** Selective (COX-2 Inhibitors-Computer aided designing, Molecular docking and 3D QSAR. Design of Selective inhibitors using pharmacophore model. 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.
(8 Hrs)

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.

M.Sc. Applied Chemistry (Pharmaceuticals) (Semester-IV)

Drug Design and Drug Development-II

CYL – 582

Credit 3-0-0

1. ***The Importance of Biotechnology for the Discovery of Better and Safer Drugs :*** Introduction, Production of Human Proteins, the First Generation of New Drugs from Recombinant DNA, Natrual Proteins, as leads for structurally modified proteins: The Second Generation of Products from Biotechnology, Examination of the Structure and Function of Proteins as Tools for the Evaluation of Pathological Processes: The Third Generation of Products from Biotechnology.

(8Hrs)

2. ***Designs of Enzyme inhibitor :*** Mechanism of enzymatic catalysis. Transition state analogs as enzyme inhibitors. Kinetics of irreversible enzyme inhibition. Design of Reversible and irreversible enzyme inhibitors with following examples: chymotypsin. Subtilison, Elastase. Pepsin. Cholinerterase, Deraminases. Carboxypeptidase. Glutamin synthetase, Trisophosphate isomerase, Aldolase, Enolase, Decarboxylases, Lysozyme and other glycosyl transferring enzymes. Creatine Kinase, adenylate kinases. Asparatate trancarbamolyase. Natural products as enzyme inhibitors. Penicillin, Cephalsporin, Leupeptin. Nojrimycin, Pentastatin, Captopril, Sulphonamids.

(8 Hrs)

3. ***Computer Aided Drug Designing :*** Computer requirement hardware, software, Data base and information retrieval techniques. Graphical description of chemical structure. Molecular interactions and interactive graphics. Modelling in medicinal chemistry-uses and limitations. Logico structural approaches. Activity feature selection within a group of compounds, Activity profile selection. Topological and topographical descriptors. **(10 Hrs)**

4. ***Search for Better and Safter Drugs: Impact of External Factors- The Social, Financial, and Working Environment:*** Drug Therapy and Pubic Opinion, Drug Research and Financial Constraints, Working Climate for Innovative Drug Research. **(4 Hrs)**

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.
4. Modern Drug Research , Paths to Better and Safer Drugs, Medicinal Research Series, Volume 12, Edited by Yvonne Connolly Martin Eberhard Kutter Vokhard Austel