

FACULTY OF SCIENCE

SYLLABI

For

**M. Sc. Applied Chemistry (Pharmaceutical)
(SEMESTER SYSTEM)**

EXAMINATION 2019-20

Ist SEMESTER

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated Colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

STRUCTURE OF THE COURSE

1st Semester

Paper Code	Subjects	Credit periods / week	Total periods	Marks
101	Organic Chemistry -I	6	60	75
102	Inorganic Chemistry	6	60	75
103	Physical Chemistry	6	60	75
104	Introduction to Pharmaceutical Sciences	6	60	75
105	Organic Chemistry Laboratory	6	60	50
106	Inorganic Chemistry Laboratory	6	60	50
107	Physical Chemistry Laboratory	6	60	50

2nd Semester

Paper Code	Subjects	Credit periods / week	Total periods	Marks
201	Organic Chemistry-II	6	60	75
202	Bioorganic Chemistry	6	60	75
203	Analytical Chemistry	6	60	75
204	Biophysical Chemistry	6	60	75
205	Organic Chemistry Laboratory	6	60	50
206	Bioorganic Chemistry Laboratory	6	60	50
207	Analytical Chemistry Laboratory	6	60	50

3rd Semester

Paper Code	Subjects	Credit periods / week	Total periods	Marks
301	Medicinal Chemistry	6	60	75
302	Physical Pharmacy	6	60	75
303	Unit Pharmaceutical Operations	6	60	75
304	Spectroscopic Instrumentation techniques	6	60	75
305	Physical Pharmacy / Medicinal Chemistry Laboratory	6	60	50
306	Unit Pharmaceutical Operations Laboratory	6	60	50
307	Spectroscopic Instrumentation techniques Laboratory	6	60	50

4th Semester

Paper Code	Subjects	Credit periods / week	Total periods	Marks
401	Bioinorganic Chemistry	6	60	75
402	Chemical Process Development	6	60	75
403	Industrial Aspects and Management	6	60	75
404	Quality Control & Quality Assurance	6	60	75
405	Industrial Project			150

Instructions for Paper setters and Candidates:

- 1. Examiner will set a total of NINE questions. TWO questions from each unit and ONE compulsory question of short answer type covering the whole syllabi.**
- 2. The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.**
- 3. All questions carry equal marks.**
- 4. The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours**

SEMESTER – I

PAPER 101: Organic Chemistry-I

OBJECTIVE OF THE COURSE

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Total marks: 75

Internal assessment: 15

Theory paper: 60

No. of lectures: 60

(6 periods/week)

UNIT I

Reactions in Organic Synthesis:

Mechanistic studies also to be undertaken. Intramolecular and intermolecular ring closures: Dieckmann and Claisen rxn. Robinson annulation. Michael-Robinson additions, Michael addition rxn., Mannich reactions, Cannizzaro reaction. Amine catalyzed condensation reaction, Stork-enamine reaction, Sharpless asymmetric epoxidation, Woodward and Prevost hydroxylation, Peterson's synthesis Aldol condensations, Perkin reaction, Wolff rearrangement and Arndt-Eistert synthesis

15

UNIT 2

Reagents in Organic Synthesis:

Use of following reagents in Organic Synthesis and functional group transformations: Complex metal hydrides, Stereoselectivity in hydride reduction, Catalytic hydrogenation (Homogeneous and Heterogeneous) and dissolving metal reductions, Lithium diisopropyl-amide (LDA), dicyclohexylcarbodiimide, Umpolung of reactivity (dipole inversions), trimethylsilyl iodide, tri-n-butyltin hydride, Oxidation of alcohols to carbonyl. Phenols to quinones, Osmium tetroxide, selenium dioxide, phase transfer catalysis, Crown ethers, conversion of alkene to epoxides and diols, Oxidative bond cleavages.

15

UNIT 3

Aliphatic Nucleophilic Substitution

The S_N2 , S_N1 , mixed S_N1 and S_N2 and SET mechanisms. The neighbouring group mechanism, neighbouring group participation by π and σ bonds, Classical and non-classical carbocations, norbornyl system. common carbocation rearrangements. The S_Ni mechanism. Nucleophilic substitution at an allylic, aliphatic, trigonal and a vinylic carbon.

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

15

UNIT 4

Aromatic Substitution Reaction (Electrophilic & Nucleophilic)

(i) Aromatic Electrophilic Substitution

(8 Hrs.)

The arenium ion mechanism, Evidences for arenium ion mechanism, role of π – σ complexes orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Examples of aromatic electrophilic substitution like nitration, sulphonation, halogenation and Friedal and Craft alkylation & acylation, Fries rearrangement, Diazonium coupling, Vilsmeier reaction.

(ii) Aromatic Nucleophilic Substitution

(7Hrs.)

The S_NAr , S_N1 , benzyne and $S_{RN}1$ mechanisms, Reactivity-effect of substrate structure, leaving group and attacking nucleophile. The Von Richter, Bucherer reaction, Sommelet-Hauser and smiles rearrangements.

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2. *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. Caruthers, W. *Some Modern Methods of Organic Synthesis*, 4th edition, Cambridge University Press, 2004.
2. Smith, M.B. *Organic Synthesis*, Chapters 1, 3, 4 & 5, McGraw International edition, 1994.
3. Corey, E.J.; Cheng, X.M. *The Logic of Organic Synthesis*, Chapters 1 & 2, John Wiley and Sons, 1989.
4. House, Herbert O.; Benjamin, W.A. *Modern Synthetic Reactions*, 2nd edition, Benjamin Inc., 1972.
5. Wills, Christine; Wills, Martin *Organic Synthesis*, Oxford University Press, 1995.
6. House, Herbert O. *Modern Synthetic Reactions*, 2nd edition, the Benjamin/Cummings Publishing Company, 1972.
7. Smith, D.M.; Mackie, R.K. *Guide Book to Organic Synthesis*, 3rd edition, Longman, 1999.

PAPER 102: INORGANIC CHEMISTRY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of Lectures: 60
(6 periods/week)

UNIT 1

Theory of Chemical Bonding : Molecular Orbital Theory: A brief introduction to LCAO method (homo and heteronuclear molecules). **Crystal Field Theory:** Stability of co-ordination complexes and factors affecting the stability; nephelauxetic effect. Calculation of CFSE values for octahedral and tetrahedral complexes. **Inorganic rings, chains and cages: Chains:** catenation, heterocatenation, isopolyanions and heteropolyanions. **Rings:** Borazines and homocyclic inorganic systems. **Cages:** boron cage compounds, boranes, carboranes and metallocene carboranes.

15

UNIT 2

Industrial Applications of Organometallics: Organometallic compounds-synthesis, bonding, structure and reactivity
General considerations, homogenous catalysis by organometallics (Alkene Hydrogenation, Hydroformylation, pi-acid metal complexes, activation of small molecules by coordination.

9

Inner transition elements – spectral and magnetic properties, analytical applications. anomalous magnetic moments, magnetic exchange coupling and spin crossover.

6

UNIT 3

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, Natural ionophores. Carboxylic ionophores.

11

Nuclear chemistry: Nuclear reactions, Fission and fusion, radio analytical techniques and activation analysis

4

UNIT 4

Metal II–Complexes

Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structure elucidation, important reaction of metal carbonyls. Preparation, bonding structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes.

8

Chemistry of Non-transition Elements: Polymorphism of carbon, phosphorus and sulphur. Synthesis, properties and structure of silicates carbides, silicones, phosphazenes, sulphurnitrogen compounds, phosphorus, sulphur and halogens, interhalogens pseudohalides and noble gas compounds.

7

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of NINE questions. TWO questions from each unit and ONE compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. Drago, R.S. *Physical Methods in Inorganic Chemistry*, Section 1 & 2, Affiliated East-West Press.
2. Gray, H.B.; Benjamin, W.A. *Electrons and Chemical Bonding*, Section 2, Benjamin Inc., New York, 1965.
3. Cotton, F.A.; Wilkinson, G.W. *Advanced Inorganic Chemistry*, John Wiley and Sons, 1999.
4. Huheey, J.E. *Inorganic Chemistry, Principles of Structure and Reactivity*, 6th edition, Harper Internationals.
5. Wilkinson, G.W. *Comprehensive Coordination Chemistry*, Vol. 3, Chapter 23, Pergamon Press.
6. Greenwood, N.N.; Earnshaw, A. *Chemistry of Elements*, Section 7, Pergamon Press, 1984.
7. Master, Christopher *Homogenous Transition Metal Catalysis*, Section 8.
8. Lever, A.B.P. *Inorganic Electronic Spectroscopy*, Elsevier Science Publishers, 1984.
9. Drago, R.S. *Physical Methods for Chemists*, 2nd edition, S.C.Publishing H.B.J.C. Publishers, 1992.

PAPER 103: PHYSICAL CHEMISTRY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of lectures: 60
(6 periods/week)

UNIT 1

Chemical and Statistical Thermodynamics: 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. **15**

UNIT 2

Phase Rule : 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. **15**

UNIT 3

Chemical Kinetics : 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 resonance method. (Numerical Problems).

Polymorphism of drugs: Definition of polymorphism, polymorphs, pseudopolymorphs, polymorphism of drugs and its importance, detection and identification of polymorphs, physical and chemical properties of polymorphs. **15**

UNIT 4

Surface Chemistry and Catalysis : Pressure difference across a curved phase boundary. Enhanced vapour pressure of small droplets (Kelvin Equation). Gibbs adsorption equation. surface catalysis, Salient features of Langmuir, Freundlich, Strydom-Frumkin (Temkin). B.E.T. (its derivation), Harkins-Jura equations of sorption. Mechanism of surface reactions.

15

Instructions for Paper setters and Candidates:

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2. *The students are required to attempt **FIVE** questions in all, **ONE** question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. Atkins *Physical Chemistry*, Oxford University Press, 2006.
2. Berry, R.S.; Rice, S.A.; Ross, J. *Physical Chemistry*, John Wiley and Sons, 1980.
3. Kapoor, K L *Physical Chemistry*.
4. Levine, Ira. N. *Physical Chemistry*, Tata McGraw-Hall Publishing Company, 2002.
5. Venulapalli *Physical Chemistry*, Prentice Hall of India, 1993.
6. Florence, A.T.; Attwood, D *Physicochemical Principles of Pharmacy*.
7. Kapoor, K.L. *Physical Chemistry, Dynamics of Chemical Reactions, Statistical Thermodynamics and Macromolecules*, Macmillian Indian Ltd., 2004.

PAPER 104: INTRODUCTION TO THE PHARMACEUTICAL SCIENCES

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of lectures: 60
(6 periods/week)

UNIT I

Orientation and Historical Background of the Profession: Orientation, introduction and scope of pharmacy profession, official compendia, important historical events which led to the development of this profession from middle ages to current era, ethics of pharmacy. Introduction of different dosage forms, definitions with examples, need for dosage forms. Pharmaceutical ingredients, definitions with examples. **15**

UNIT 2

Extraction and Extractives: Various methods of extraction, infusion, decoction, maceration, percolation and digestion. Various official extractives namely, infusions, decoctions, tinctures, extracts (liquid, soft and dry), oleoresins. **15**

UNIT 3

Liquid orals and Solutions: Formulation considerations, manufacturing considerations, organoleptic characteristics, compounding problems including preservation, stability and quality control testing. Methods of purifying water. Official pharmaceutical solutions, products for oral and topical use including syrups, elixirs, glycerines, mouth washes, gargles, spirits, nasal drops, aromatic waters, lotions and liniments. **15**

UNIT 4

Metrology: Introduction, units of weights and volume in both imperial and metric systems. Simple calculations involved in preparing solutions of solids in liquids, liquids in liquids based on imperial and metric systems. Methods of allegation. **10**

Comminution (size reduction) and grading of powders: Definition, objectives of size reduction, standards for powders, sieves and their usage in grinding, bulk powders, effervescent powders and granules. **5**

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of **NINE** questions. **TWO** questions from each unit and **ONE** compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt **FIVE** questions in all, **ONE** question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. Remington: The Science and Practice of Pharmacy, 19th ed, 1995, Mack Publishing Co., USA.
2. J W Cooper and G Gunn, Tutorial Pharmacy, 1st ed, 1956, Pitman Books Ltd., London, UK.
3. L Lachman, H A Lieberman and J L Kanig, The Theory and Practice of Industrial Pharmacy, 3rd ed, Lea and Febiger, Philadelphia, USA.
4. S J Carter, Dispensing for Pharmaceutical Students, 11th and 12th ed, 1967 and 1975, Pitman Books Ltd, London, UK.
5. H S Ansel and N G Popovich, Pharmaceutical dosage forms and Drug Delivery Systems, 6th ed.
6. E A Rowlinson, Bentley's Textbook of Pharmaceutics, Bailliere Tindall and Cox, London.

PAPER 105: ORGANIC CHEMISTRY LABORATORY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 50
Internal assessment: 10
Practical: 40
(6 periods/week)

Suggested Experiments

- A.** Synthesis of Simple Organic Compounds utilizing:
1. Grignard reaction
 2. Diazotization reaction
 3. Allylic bromination
 4. Deils-Alder Reaction
 5. Dehydration Reaction
 6. Epoxidation / Hydrolysis Reaction
 7. Acetylation reaction
 8. Coumarin synthesis.
- B.** Separation of a binary mixture of organic compounds and identification of their components.
Studies of column chromatography and paper chromatography for organic mixtures.

Note: Any other experiment(s) may be included in support of the theoretical aspects of the course.

PAPER 106: INORGANIC CHEMISTRY LABORATORY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 50
Internal assessment: 10
Practical: 40
(6 periods/week)

Suggested Experiments

1. Mixture analysis of 2 cations and 2 anions with 1 or 2 rare cations (Se, Te, W, Li, etc).
2. Colorimetric estimation of cations/anions.
3. Preparation, their purification, elemental analysis. M.W. determination and elucidation of the structures by available physical method(s). i.) Preparation of chloropentaamminecobalt (III) chloride and its conversion into nitro and nitrito isomers. ii). Preparation of ferrocene, bis(cyclopentadienyl)iron(II).
4. Preparation of $\text{Co}(\text{acac})_3$, its characterization using NMR, IR, UV-Vis and analysis of Cobalt. (ref. J. Chem. Edu., 1980, 57, 7, 525)
5. Preparation of $\text{Co}(\text{acac-NO}_2)_3$, its characterization using NMR, IR, UV-Vis and analysis of Cobalt. (ref. J. Chem. Edu., 1980, 57, 7, 525)
6. Complexometric titrations using EDTA, ZnSO_4 , MgSO_4 , CaCO_3 .

Note: Any other experiment (s) may be included in support of the theoretical aspects of the course.

PAPER 107: PHYSICAL CHEMISTRY LABORATORY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills

Total marks: 50
Internal assessment: 10
Practical: 40
(6 periods/week)

Suggested Experiments

Students must be introduced to data reporting and analysis with special reference to accuracy, precision and uncertainty.

1. Preparation of buffer solutions of pharmaceutical interest and determination of their pH.
2. Potentiometric titration of a polyprotic acid (phosphoric acid), using 0.1 N NaOH and standard potassium hydrogen phthalate acid solutions.
3. Determination of the rate constant and activation energy of reaction between iodine and acetone.
4. Determination of the molar conductivity of a weak electrolyte at different concentrations and calculation of the dissociation constant of an acid.
5. Determination of the molar conductivity of a strong electrolyte at different concentrations and hence examine the validity of the Onsager theory as a limiting law at very low concentrations.
6. Determination of CMC of a surface active agent.
7. To investigate the influence of chain length on surface activity of n-amyl alcohol and determine its surface tension-concentration curve in order to calculate the surface excess.
8. Determine the specific rotation of sucrose, tartaric acid and camphor.
9. Determination of the partition coefficient of a drug between water and octanol.
10. Compare the relative strength of acetic acid and chloroacetic acid from conductance measurements.

Note: Any other experiment(s) may be included in support of the theoretical aspects of the course.

SEMESTER - II

PAPER 201: ORGANIC CHEMISTRY-II

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Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of lectures: 60
(6 periods/week)

UNIT 1

Introduction: General introduction to Organic Synthesis, importance and types of organic synthesis, Linear and Convergent Synthesis, Rational and Irrational Synthesis. Planning an Organic Synthesis: Intuitive approach, Disconnection approach (the basic concepts and order of events). One group disconnections, synthetic equivalents to common Synthons, latent polarity and Functional group interconversions (FGI), Target molecules (TMs) with two functional groups. Chemoselectivity, Regioselectivity. Donor acceptor disconnection in carbon-carbon single bond formation reactions.

Design of Synthesis: Strategies for retrosynthetic analysis of simple molecules. **15**

UNIT 2

Concerted reactions, unimolecular rearrangement and elimination:

Electrocyclic sigmatropic and cycloaddition reactions, Correlation diagrams and FMO theory. Diels-Alder reactions, general feature, Dienophiles, Dienes (2+2) cycloadditions, Cope and Claisen rearrangement, Ene reaction.

Molecular orbital symmetry, frontier orbitals of ethylene, 1,3-butadiene and 1, 3, 5-hexatriene. Classification of pericyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach. Electrocyclic reactions conrotatory and disrotatory motions $4n$ and $4n + 2$ system. **15**

UNIT 3

Heterocyclic synthesis: Principles of heterocyclic synthesis involving cyclization reactions and cycloaddition Reactions.

Small Ring Heterocycles: Three- membered and four-membered heterocycles-synthesis and reactions of aziridines, oxiranes, thiranes, azetidines, oxetanes and thietanes

Benzo-Fused Five-Membered Heterocycles: Synthesis and reaction including medicinal applications of benzopyrroles, benzofurans and benzothiophenes.

15

UNIT 4

Grignard reagents, Organo lithium, Organo zinc, Organo cadmium and Organo Copper Compounds, Organo boron and Organo silicon compounds for organic synthesis, Coupling reactions of Organopalladium (Suzuki-Miyaura, Stille and Heck) and Organonickel complexes (Allylic alkylations of alkenes), Use of stabilised carbanions and related nucleophiles, Kinetic and thermodynamic enolates, O - Vs C-alkylation, carbanions stabilised neighbouring phosphorus or sulphur, Wittig reaction reaction. 15

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2. *The students are required to attempt **FIVE** questions in all, **ONE** question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. Warren S., Organic Synthesis – The Disconnection Approach, Pubs: Wiley Interscience. (1982).
2. Wills Christine and Wills Martin, Organic Synthesis, Pubs: Oxford University Press (1994).
3. Corey E.J. and X.M. Cheng, The logic of Chemical Synthesis, Pubs: Wiley Interscience(1989).
4. Thomas S.E., Organic Synthesis: The roles of Boron and Silicon, Pubs:Oxford University Press (1995).
5. Jenkins Paul R., Organometallic Reagents in Synthesis, Pubs: Oxford University (1995).
6. Eliet E.L., Wilen S.H., Stereochemistry of Organic Compounds, Pubs:John Wiley (1994).
7. Mackie R.K., Smith D.M., Guide book to Organic Synthesis, Pubs: Longman (1985).
8. Streitwieser A., Jr. and Heathcock C.H., Introduction to Organic Chemistry 3rd Edn., Pubs: MacMillan Pub. Co., N.Y,1992.
9. Isaccs N.S., Physical Organic Chemistry, Pubs:Longman Scientific & Technical,1987.

PAPER 202: BIOORGANIC CHEMISTRY

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Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of Lectures: 60
(6 periods/week)

UNIT 1

Carbohydrates: Different classes, structure and function of polysaccharides, homo and heteropolysaccharides, mucopolysaccharides, proteoglycans, bacterial polysaccharides, mucins blood group substances, lectins and their functions

Lipids: Simple and complex lipids, triacylglycerol phospholipids, plasmalogens, cardiolipids, glycolipids, gangosides and cerebrosides.

Proteins: Level of protein structure, forces maintaining secondary and tertiary structure of proteins, protein configuration and conformation, protein purification, criteria of protein purification, Lipoproteins, Nucleoproteins, Glycoproteins, metalloproteins.

Porphyrins: Structure, their importance in biological systems. **15**

UNIT 2

Nucleic acids: Structure of DNA and RNA, different methods for isolation of DNA and RNA, B-DNA and Z-DNA structure, effect of temperature and UV radiations on DNA, methods to study DNA structure, hypo and hyperchromaticity.

Metabolism of Biomolecules: Various pathways of carbohydrate metabolism; Glycolysis, Krebs Cycle, HMS pathway glycogenesis Glyconeogenesis, Glyoxalate Cycle. Regulation of carbohydrate metabolism.

Metabolic degradation and Bio-Synthesis of fatty acids. Cholesterol metabolism and its regulation, general reactions of amino acid metabolism, urea cycle, physiological role.

Purine and Pyrimidine metabolism, inhibitors of Nucleotide biosynthesis. Mitochondrial electron transport chain, oxidative-phosphorylation, mechanism of ATP synthesis, inhibitors of respiratory chain, uncouplers of oxidative phosphorylation. **15**

UNIT 3

Enzymes: Classification, Mechanism of action, kinetics of enzyme catalysed reactions, Michaelis-Menten equation, determination of K_M and V_{max} of enzymes. Enzyme inhibition, kinetics of competitive and non-competitive inhibition. Allosteric enzymes, Mechanism of enzymatic catalysis, zymogens and isozymes. Coenzymes: classification, structure and function of nicotinamide adenine dinucleotides (NAD and NADP), Riboflavin Nucleotides (FMN and FAD), Lipoic acid, Nucleoside tri- and di-phosphates. Tetrahydrofolic acid conjugates, Biotinyl coenzyme-A and thiamine pyrophosphate.

Immobilized enzymes, methods to immobilize enzyme: Adsorption, covalent binding, membrane entrapment, characteristics of immobilized enzymes, Enzyme based biosensors, application of immobilized enzymes.

15

UNIT 4

Genetic code: protein synthesis and role of various types of RNA, micro RNA and its functions, inhibitors of protein synthesis, enzyme induction, Operon concept.

DNA replication, recombinant DNA technology and genetic engineering, Plasmids, Vectors, gene cloning, gene libraries, screening of gene libraries, Insertion of foreign DNA into cells, Methods to study gene expression, Polymerase chain reaction.

Cell membrane structure: Fluid mosaic model of membrane structure, Membrane fluidity, Mechanism of organic solute transport, Ionophores and their applications, Membranes channels, Liposomes.

15

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3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. Immobilized biocatalysts, Winfried Hartmeister
2. Molecular Biotechnology, Glick and Pasteynak
3. Biochemical Techniques, Frifielder
4. Principles of Biochemistry, A.L. Lehninger
5. Biochemistry, L. Stryer
6. Biochemistry, Voietas Voiet
7. Recombinal DNA, J.D. Watson

PAPER 203: ANALYTICAL CHEMISTRY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of Lectures: 60
(6 periods/week)

UNIT 1

pH Measurements: Glass electrode, combination glass electrode and applications. **4**
Potentiometric measurements : Calomel electrode, Normal hydrogen electrode silver-silver chloride electrode, Quinhydrone electrode, general applications. **4**
Conductometric method : Introduction, theory ostwald's dilution, measurements of conductance conductivity cells, and applications. **4**
Polarography & Amperometry: Calculation of half wave potential, polarograph and amperometric titrations. **3**

UNIT 2

Refractometry & Polarimetry : Principle, Instrumentation & Applications of refractometry. Polarimetry: Theory, fundamentals of instrumentation. Optical rotatory dispersion (ORD), Circular Dichroism (CD), ORD/CD curves, instrumentation, applications. **6**

Flame Emission and Atomic Absorption Spectroscopy: 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 (Deuterium Arc, Zeeman Effect and Smith-Hieftje System); Schematic diagram of Flame photometer and Atomic Absorption Spectrophotometer. **9**

UNIT 3

Raman Spectroscopy : Introduction, Requirements & Comparison of Raman spectroscopy with infrared spectroscopy. 6

Solid phase extraction techniques: Extraction procedure, separation of drugs from excipients, liquid-solid, liquid-liquid extraction, separation of mixture by extraction, distribution law, successive extraction, the Craige's method of multiple extraction, continuous counter-current extraction, effect of temperature, pH, inert solute association, ion-pair formation, emulsion problem in extraction. 9

UNIT 4

Processes involving Chemical Composition Analyzer: Details of Chromatographic analysis; GC : GLC, GSC, instrumentation and application, GC-MS and GC-FTR, derivatization. HPLC : Partition, adsorption, ion exchange, size exclusion and Thin layer, HPLC and its pharmaceutical applications, HPLC-MS, super critical fluid chromatography, brief introduction to HPTLC. 6

Moisture analyzer, Electrolytic Hygrometer, Piezoelectric sorption hygrometer. 4

Industrial Process Analyzers: Introduction, Automatic Analyzers, Discrete and continuous flow analyzers, Beckman analyzer, Dupont analyzer, Process analyzer (specific and non-specific). 5

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of **NINE** questions. **TWO** questions from each unit and **ONE** compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt **FIVE** questions in all, **ONE** question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. H.H. Willard, D.D. Meritt, J.A. Dean and W.A. Settle, 'Instrumental Methods of Analysis', 6th Edition (for 1 & 3). (1986); 7th Edition (1988).
2. D.A. Skoof, "Principles of Instrumental Analysis", 3rd Edition. (1984), 4th Edition (1992).
3. R.L. Pecsok, "Modern Method of Chemical Analysis" (for 7 only). (1976).
4. Willard, H.H.; Memitt, L.L.; Dean, J.A. *Instrumental Methods of Analysis*, Wordsworth Publishing Company, 1988.

PAPER 204: BIOPHYSICAL CHEMISTRY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of Lectures: 60
(6 periods/week)

UNIT 1

Bioenergetics: Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP. **5**

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. **10**

UNIT 2

Thermodynamics of Biopolymer Solutions: Thermodynamics of biopolymer solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system. **9**

Cell Membrane and Transport of Ions: Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane transport. Nerve conduction. **6**

UNIT 3

Experimental Techniques for the Determination of Size, Shape and Molecular Mass of Biopolymers: **Viscosity:** Measurement, relation to geometry and correlation with hydrodynamic properties. **Diffusion:** Fick's law of diffusion, diffusion coefficient and its interpretation, frictional coefficient. **Ultra centrifugation:** Svedberg equation, sedimentation equilibrium, density gradient sedimentation. **Electrophoresis:** General Principles, Double layer Techniques Moving Boundary Electrophoresis, Zonal Electrophoresis, Isoelectric Focusing. **Osmotic Pressure:** Second virial coefficient, molecular mass and geometry from O.P. data, Donnan membrane effect, Drug absorption. **15**

UNIT 4

Optical Properties of Biomacromolecules: Light scattering, Fundamental concepts, Rayleigh scattering, Scattering by larger particles. **Solubility of Biomolecules:** As solutions of polyelectrolytes, Debye-Huckle theory, Applications to proteins purification. **Stability of Biomolecules in Solutions:** Denaturation, Method of Stabilization. Micelles, Reverse micelles and liquid membranes-conformation and bioprocess applications. 10

Application of calorimetry to the pharmaceutical problems. 5

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of NINE questions. TWO questions from each unit and ONE compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. Physical Chemistry and its Biological Applications by W.S. Brey (Chapter 5 and 12). Academic Press (1978).
2. Physical Biochemistry by K.E. Van Holde.
3. Physical Chemistry: Principles and Applications in Biological Sciences. By Tinoco I., Jr., Saver, K. and Wang, J.C., Prentice-Hall.
4. Biochemistry by D. Voet and J.G. Voet.
5. Biological thermodynamics, by D T Haynie, Cambridge Press.

PAPER 205: ORGANIC CHEMISTRY LABORATORY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 50

Internal assessment: 10

Practical: 40

(6 periods/week)

Suggested Experiments:

Multistep preparations and estimations:

Reactions should be carried out by TLC monitoring; R_f, yield, m.p.(where applicable) and I.R. data should be reported.

1. Preparation of *o*-chlorobenzoic acid from anthranilic acid. (diazotisation and Sandmeyer reaction).
2. Preparation of anthranilic acid from phthalic anhydride (nucleophilic addition of Hoffman degradation).
3. Preparation of benzpinacol from benzophenone (photoreduction).
4. Preparation of triphenylmethane from benzpinacolone (nucleophilic cleavage of C-C bond).
5. Preparation of triphenylmethyl bromide from triphenylmethane (free radical bromination by use of NBS).
6. Preparation of 1,5-Diphenyl-1,4-pentadiene-3-one from benzaldehyde and acetone (cross aldol condensation).
7. Preparation of *E/Z*- α -phenylcinnamic acid from benzaldehyde and phenylacetic acid (Perkin reaction).
8. Preparation of 1,3,5-tribromobenzene from aniline (diazotization, aromatic electrophilic substitution and deamination).
9. Preparation of 2,5-dihydroxy acetophenone from hydroquinone (Fries reaction).
10. Preparation of 3,5-diethoxycarbonyl-2,4-dimethylpyrrole from ethylacetoacetate (Knorr synthesis).

Note: Any other experiment(s) may be included in support of the theoretical aspects of the course.

PAPER 206: BIOORGANIC CHEMISTRY LABORATORY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 50

Internal assessment: 10

Practical: 40
(6 periods/week)

Suggested Experiments

1. To study absorption spectrum of Proteins and Nucleic acids and find out Y_{max}
2. Comparison of protein estimation methods in Biological fluids : Biuret vs Lowry's vs Barfoed methods
3. Determination of DNA/RNA by colorimetric methods.
4. Assay of serum alkaline phosphatase activity
5. To study effect of substrate concentration on enzyme activity from a given source. Determine the value of K_m and V_{max} .
6. To study effect of temperature of enzyme activity and determine E_a of the enzyme by Arrhenius analysis.
7. Estimation of Cholesterol in a given sample.
8. Determination of salivary amylase activity by Dinitrosilicate method.
9. Separation of Proteins by SDS-PAGE.
10. Determination of ion exchange capacity of a given ion exchange resin.
11. Determine the molecular weight of a protein by Gel filtration chromatography.
12. Separation of Phospholipids by TLC.
13. Separation and qualification of Amino acid mixture by paper chromatography.
14. Determination of T_m of double stranded DNA.
15. Immobilization of an enzyme in calcium alginate beads and determine its kinetic properties.

Note: Any other experiment(s) may be included in support of the theoretical aspects of the course.

PAPER 207: ANALYTICAL CHEMISTRY LABORATORY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 50
Internal assessment: 10
Practical: 40
(6 periods/week)

Suggested Experiments

1. Determination of water content by moisture balance and by Karl Fischer method.
2. Volumetric analysis of ibuprofen in tablets.
3. Analysis of ascorbic acid in given tablets.
4. Analysis of Ampicillin trihydrate.
5. Analysis of Dextrose.
6. Analysis of citric acid.
7. Determination of phenobarbitone in given cough syrup.
8. Determination of chloramphenicol in given capsules.
9. To perform I.P. monograph of tablets.
10. In-vitro comparative study of the release and penetration of drugs from topical preparations.
11. To determine dissociation constant of a dibasic acid potentiometrically.
12. Determine the molar refraction of a solid substance by dissolving it in a solvent and its refractive index.

Note: Any other experiment(s) may be included in support of the theoretical aspects of the course.

SEMESTER – III

PAPER 301: MEDICINAL CHEMISTRY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75

Internal assessment: 15

Theory paper: 60

**No. of Lectures: 60
(6 periods/week)**

Note: 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 given in parenthesis.

UNIT 1

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

Vitamins and Hormones: Progesterone, Folic acid.

Cardiovascular agents: Antihypertensive agents, constrictors and vasodilators, Antiarrhythmic drugs, Antileptic drugs (propranolol, nitroglycerine, prazosin, ceftopril).

Antibacterials: Penicillines, Cephalosporins, Tetracyclines, Aminoglycosides, Polypeptides antibiotics, Sulfonamides. **Antimycobacterials:** p-Aminosalicylic acid, Thiourea, Pyrazinamide, Cyclosporin, Dapsone, Chloramphenicol, Ethionamide and sulphoxone Na.

15

UNIT 2

General and Local Anesthetics: Introduction, medicinal aspects of anesthetics, MOA classification (Cyclopropane, Thiopentane sodium). **5**

Analgesics and Antitussives: Morphine and related drugs. Centrally acting antitussives, Opium alkaloid and their modification, synthetic analgesics and antitussive, Expectorants (Meperidine, dextromethorphan, Bromohexine). **5**

Antipyretics and Non-steroidal Anti-inflammatory drugs: (Indomethacin, and Phenylbutazone). **5**

UNIT 3

CNS Active Drugs: Hypnotics and sedatives: Barbiturates, Non-barbiturates, Amides and Imides, Aldehydes and derivatives. **Anticonvulsants:** Epilepsy introduction, Barbiturates, Hydanatoin, Oxazolidinediones. Succinimides. **CNS-stimulants:** CNS stimulants of natural origin and synthetic CNS stimulants. **Antipsychotics:** Phenthiazines. Antidepressants: Tricyclic antidepressants, monoamine oxidase drugs. Antianxiety drugs: Meprobamate and related drugs. Benzodiazepines, (Diazepam, Amitriptyline, Theophylline, Phenytoin sodium, Pentobarbitone sodium). 15

UNIT 4

Adrenergic and cholinergic drugs: Adrenergic hormones and drugs, storage, release and metabolism of Catecholamines (Isoprenaline, Adrenaline, salbutamol). **Cholinergic and anticholinesterases:** storage, release and metabolism of acetylcholine (Methocholine chloride). 7

Drug designing and synthesis: Introduction to drug designing, combinatorial chemistry approach, lead based methods, discovery of lead compounds, drug discovery without a lead-de-novo drug designing, Prodrug concepts for drug design, conceptual pharmacokinetics in drug designing. 8

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of NINE questions. TWO questions from each unit and ONE compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceuticals Chemistry, 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.C. Foye, Principles of Medicinal Chemistry, Lea & Febiger, Philadelphia, USA.
4. The Organic Chemistry of Drug Design and Drug Action, by R. B. Silverman, Academic Press, 1992.
5. Drug Designs - A series of monographs in medicinal chemistry edited by A. J. Ariens. 1st edition, Vol. I, II, V, VIII & IX (only relevant chapters).
6. Reuben, B.G.; Wittcoff, H.A. Pharmaceutical Chemicals in Perspective, John Wiley & Sons, New York, 1989.

PAPER 302: PHYSICAL PHARMACY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75

Internal assessment: 15

Theory paper: 60

**No. of Lectures: 60
(6 periods/week)**

UNIT 1

Surface activity and interfacial phenomenon : Surface tension and interfacial tension, Young - Laplace, Kelvin and Gibbs equations in explaining surface tension and allied subjects, 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.

15

UNIT 2

Colloids and Macromolecular System : Stability of colloidal systems. Sensitization of protective colloidal action.

10

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**

UNIT 3

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

15

UNIT 4

Chemical, Kinetics and drug stability: General consideration and concepts, 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. **10**

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

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of NINE questions. TWO questions from each unit and ONE compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. Martin, Physical Pharmacy, B. I. Waverly Pvt. Ltd., New Delhi (1994).
2. L. Lachman, H.A. Lieberman and J. L. Kaing, Theory and Practice of Industrial Pharmacy, III Eds. Varghese Publishing House, Bombay (1977).

PAPER 303: UNIT PHARMACEUTICAL OPERATIONS

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75

Internal assessment: 15

Theory paper: 60

No. of Lectures: 60

(6 periods/week)

UNIT 1

Mixing and Homogenization : 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, propeller mixer, Pharmaceutical applications of mixing.

10

Clarification and Filtration : Theory of filtration, filter media, filter aids, selection of filter, sterile filter operations. Study of plate and frame filter press, vacuum filter and membrane ultra-filters etc.

5

UNIT 2

Centrifugation : Principles of centrifugation, Advantages, Disadvantages, and use of Perforated Basket centrifuge (centrifugal filter), sedimentation type centrifuges (centrifugal sedimenters) and continuous centrifuges.

7

Compression and consolidation of pharmaceutical powders: 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 including study of compaction profiles.

8

UNIT 3

Evaporation: Selection of equipment; Types of evaporators, Heat transfer coefficient, Boiling point rise due to material rise in solutions, Durhings line, boiling point rise due to hydrostatic head, single and multiple effect evaporators, calculations, important factors in operation of evaporators.

9

Mass Transfer: Introduction, Fick's Law, mass transfer in binary mixtures through a stationary gas, diffusion in liquids, mass transfer through a phase boundary, two film theory.

6

UNIT 4

Distillation: Vapor Liquid Equilibrium, Dalton's Law and Henry's law, relative volatility. The methods of distillation, calculation of number of plates using McCabe-Thiele method, Efficiency of distillation, overall plate efficiency, azeotropic distillation, extractive distillation, steam distillation. **8**

Crystallization: Growth and properties of crystals, saturation, nucleation, crystallization rate, fractional crystallization, type of crystallizers. **4**

Drying: Definitions, drying operations, rate of batch drying, equipments. **3**

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of NINE questions. TWO questions from each unit and ONE compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended :

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

PAPER 304: SPECTROSCOPIC INSTRUMENTATION TECHNIQUES

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75

Internal assessment: 15

Theory paper: 60

**No. of Lectures: 60
(6 periods/week)**

UNIT 1

Ultraviolet & Visible absorption Spectroscopy : Introduction, Fundamental laws of photometry (Lambert Beer's Law); Radiation Sources (Hydrogen/Deuterium lamp, tungsten filament lamp, Xenon lamp); Monochromator, Prisms (Cornu, Littrow), resolution of prisms, Detectors (Photovoltaic cell, Phototubes Photomultiplier tubes, silicon photodiodes) Filters (glass & absorption) single & double beam spectrophotometer, Sample handling; Presentation of spectral data, Quantitative methods, Simultaneous determination, Derivative Spectroscopy & its applications. Woodward Fieser rules & their applications (Conjugated dienes and α,β -unsaturated ketones), Electronic transitions, Turbidity & Nephelometry- Standards, instrumentations.

11

Molecular Fluorescence & Phosphorescence: Theory, (single-triplet states, deactivation process) Quantum yield, Effect of concentration on fluorescence (derivation), Fundamentals of Instrumentation for fluorescence & phosphorescence, Applications.

4

UNIT 2

Infrared Spectroscopy: Introduction, Requirements of molecule to absorb in IR; Calculations of fundamental frequency; Correlation of infrared spectra with molecular structure; Quantitative measurements; Detailed study of vibrational frequencies of carbonyl compounds; ketones, aldehydes, esters, acid anhydrides, lactones, conjugated carbonyl compounds & nitrogen containing compounds (amides, amines, nitro compounds & lactams), Effect of hydrogen bonding of solvent on vibrational frequencies, overtones, combination bands & Fermi resonance.

15

UNIT 3

NMR Spectroscopy:

General introduction and definition. ^1H NMR: chemical shift, spin spin interactions, shielding mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) another nuclei (alcoholic, phenols, enols, carboxylic acids, amines, amides and mercapto), chemical exchange, effect of deuteration), Applications of ^1H NMR spectroscopy.

Applications of UV, IR, ^1H NMR and mass spectroscopy in structure determination of simple compounds.

15

UNIT 4

C-13 NMR spectroscopy:

General consideration, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic & carbonyl carbon) & coupling constants.

6

Mass Spectroscopy: Introduction, Components of Mass spectrometer, Dempster's mass spectrometer, Ionization sources-Electron impact ionization; field ionization, chemical ionization, Fast atom bombardment, Mass analyzer, Resolution of mass spectrometer, single focusing analyzer system, Double focusing analyzers, Quadrupole analyzer, Time of flight analyzer, spark source spectrometry, Ion collecting systems, correlation of mass spectra with molecular structure.

9

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of **NINE** questions. **TWO** questions from each unit and **ONE** compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt **FIVE** questions in all, **ONE** question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended :

1. H.H. Willard, D.D. Meritt, J.A. Dean and W.A. Settle, 'Instrumental Methods of Analysis', 6th Edition (for 1 & 3). (1986); 7th Edition (1988).
2. D.A. Skoof, "Principles of Instrumental Analysis", 3rd Edition. (1984), 4th Edition (1992).
3. R.L. Pecsok, "Modern Method of Chemical Analysis" (for 7 only). (1976).
4. Willard, H.H.; Memitt, L.L.; Dean, J.A. *Instrumental Methods of Analysis*, Wordsworth Publishing Company, 1988.

PAPER 305: PHYSICAL PHARMACY / MEDICAL CHEMISTRY LABORATORY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 50

Internal assessment: 10

Practical: 40

(6 periods/week)

Suggested Experiments

A.

1. To determine the relative viscosity of Newtonian fluid by Ostwald viscometer.
2. To study the particle size distribution of a given powder by sieve analysis method.
3. To determine the protein binding of a given drug by simple method.
4. To study the kinetics of degradation of aspirin at a given pH by titration method.

B.

5. Synthesis of selective drugs involving 2 step synthesis.
6. Synthesis of selective drugs involving multiple step synthesis.
7. Extraction of organic compounds from natural sources:
8. Isolation of Casein and lactose from milk. Isolation of Piperine from Black pepper.
9. Isolation of calcium citrate from lemon. Isolation of D(+)-glucose from sugar.

Note: Any other experiment(s) may be included in support of the theoretical aspects of the course.

PAPER 306: UNIT PHARMACEUTICAL OPERATIONS LABORATORY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 50

Internal assessment: 10

Practical: 40

(6 periods/week)

Suggested Experiments

1. Determination of heat transfer coefficient under forced convection.
2. Determination of heat transfer coefficient under natural convection.
3. Determination of absolute humidity, relative humidity, dew point, saturated volume and humid heat using psychometric charts.
4. Determination of coefficient of discharge by orifice meter.
5. Study of laminar flow.
6. Study of turbulent flow through pipes.
7. Study of pressure drop through a packed bed.
8. To determine rate constant of a reaction between ethyl acetate and caustic soda solution at two different temperatures and energy of activation.

Note: Any other experiment(s) may be included in support of the theoretical aspects of the course.

PAPER 307: SPECTROSCOPIC INSTRUMENTATION TECHNIQUES LABORATORY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 50

Internal assessment: 10

Practical: 40

(6 periods/week)

Suggested Experiments

1. Determine the concentration of Na^+ , K^+ and Ca^{2+} present in tap water using flame Photometer.
2. Determine the pH values of an amino acid by pH metry.
3. Titration of mixture of strong and weak acids with a strong base by conductivity.
4. Verify Lambert-Beer Law and determine the molar extinction coefficient : copper sulphate pentahydrate / or potassium dichromate.
5. Determination of iron in a vitamin tablet using 1-10 phenanthroline by visible spectrophotometry.
6. Determine the composition of a complex by job's method and determine the stability constant of the complex by spectrophotometry.
7. Simultaneous determination of Cr^{2+} and Mn^{2+} spectrophotometry.
8. The determination of aspirin and Caffeine in a proprietary Analgesic by spectrophotometry.
9. Measurement of optical rotation and study of muta-rotation in glucose.
10. Determination of water content of a Salt Hydrate.
11. Determination of composition of unknown sample by Refractometry. Molar refraction is an additive property.
12. Spectrophotometric determination of Paracetamol in tablets.
13. Determination of Structural identification from spectral data of different organic compounds.

Note: Any other experiment(s) may be included in support of the theoretical aspects of the course.

SEMESTER - IV

PAPER 401: BIOINORGANIC CHEMISTRY

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of Lectures: 60
(6 periods/week)

UNIT 1

Metal Ions in Biological Systems- essential and trace elements, periodic survey of essential and trace elements, biological importance and relative abundance, Na⁺/ K⁺ ion pump.

6

Transport and Storage of Dioxygen- oxygen carriers-Hb and Mb: Structure and mechanism of their function, cooperativity, inhibition and poisoning by ligands and metal ions, hemocyanins and hemerythrin, model complexes of iron, cobalt and copper.

9

UNIT 2

Bioenergetics and ATP Cycle- Process concept to phosphate hydrolysis, Nucleotide transfer-DNA polymerase, phosphate transfer pyruvate kinase, phosphoglucomutase, creatine kinase, ATPase. Photosynthesis and respiration – chlorophyll : structure, function and its synthetic model.

8

Bioredox Agents and Mechanism- Enzymes and their functioning, Vitamin B12 coenzyme, its function and application in organic syntheses, intake of alcohol and its remedy.

7

UNIT 3

Electron Transfer in Biology- Cytochromes-structure and function, CN- and CO poisoning, Ferredoxin and rubredoxim.

6

Nitrogenase- Biological N₂ fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems.

6

Metal Storage, Transport- Ferritin, transferring and siderophores.

3

UNIT 4

Metalloenzymes- Zinc enzymes-carboxypeptidase and carbonic anhydrase, Copper enzymes-superoxide dismutase.

5

Calcium in Biology- Calcium in living cell, transport and regulation, molecular aspects of intramolecular processes

5

Metals in Medicine- Metal deficiency and disease, toxic effects of antibiotics and related compounds, chelate therapy

5

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of NINE questions. TWO questions from each unit and ONE compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. Principles of Bioinorganic Chemistry, S. J. Lippard and Berg, University Science Books.
2. Inorganic Biochemistry, Vol I and II. Ed. G. L. Eichhorn, Elsevier.
3. J.E. Huheey : Inorganic Chemistry III & IV Ed. Pearson Education Asia – (2002).
4. F.A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry, 5th Edition.
5. Progress in Inorganic Chemistry, Vols 18 and 38 Ed. J. J. Lippard, Wiley

PAPER 402: CHEMICAL PROCESS DEVELOPMENT

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of Lectures: 60
(6 periods/week)

UNIT 1

Introduction to Chemical Industries : A general introduction to the world of industry and more specifically to those industries involving chemical processes; chemical process definition and its applications on an industrial scale; introduction to natural or primary raw materials and their potential use; introduction to the use of chemical agents in industry.

Mass and Energy Balances: Material balance: Mass balance calculations for systems with purge, recycle, bypass, chemical reactions, and physical separations; Energy balance calculations based on process systems mass balance; energy changes in chemical processes, combustion calculations.

15

UNIT 2

Introduction to Reaction Engineering: Types of reactions, single and multiple reactions, elementary and non-elementary reactions, molecularity and order of reaction, definition and representation of reaction rate.

Interpretation of Batch reactor Data: Integral method of analysis of data for zero, first and second order reactions, half life for n^{th} order reactions, irreversible reactions in parallel and in series, autocatalytic reactions, Differential method of analysis, constant and variable volume batch reactors.

15

UNIT 3

Single Ideal Reactors: Design equation for single ideal batch reactors, steady state mixed flow reactors, steady state plug flow reactors, holding and space time, problems.

Material of Pharmaceutical Plant Construction: Physical and chemical factors to be considered, various metals and non metals that can be used for construction, their advantages and disadvantages. 15

UNIT 4

Measuring Instruments: Temperature: Solid rod thermometer, bimetallic thermometer, thermocouple **Viscosity:** Capillary tube, viscometer, rotating concentric cylinder viscometer. **Liquid level:** Dip-stick method, sight glass method, hook gauge. **Pressure:** Liquid level manometers, pressure measurement devices, pressure transducers. 15

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of NINE questions. TWO questions from each unit and ONE compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended:

1. McCabe, W.L.; Smith, J.C. *Unit Operations of Chemical Engineering*, 5th edition, McGraw Hill International Edition New York, 1993.
2. Coulson, J.M.; Richardson I.F. *Chemical Engineering*, Volume 1 & 4, 5th edition, Pergamon Press, New York, 1996.
3. Peter, Max *Elementary Chemical Engineering*, 2nd edition.
4. Nakra, B.C.; Chaudhry, K.K. *Instrumentation Measurement and Analysis*, 6th Reprint, Tata McGraw Hill, New Delhi, 1991.
5. Harriott, Peter *Process Control*, Tata McGraw Hill, New Delhi.
6. Coughanowr, Donald R. *Process Systems Analysis and Control*, 2nd edition, McGraw Hill, New York.
7. Levenspiel, Octave *Chemical Reaction Engineering*, 2nd edition, Wiley International, New York.
8. Peters, Max; Timmerhaus, Klaus *Plant Design and Economics for Chemical Engineers*, 4th edition, McGraw Hill, New York.

PAPER 403: INDUSTRIAL ASPECTS AND MANAGEMENT

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of Lectures: 60
(6 periods/week)

UNIT 1

Atmospheric Pressure & Density, Gravity, Winds, Water and the evolution of atmosphere.

Air Pollution: Definition, Ambient air quality and standards, Types of Air Pollution, Smog, Haze, Emission Atmospheric Transport & Dispersion Means, Receptors and Criteria study. Pollutants and kinds of pollution, Concentration representation of Gaseous Pollutants (CO, CO₂, NO_x, SO_x, HC, etc.) Particulates (SiO₂, Iron oxides, Asbestos, Hg, Be, Pb, Odours).

15

UNIT 2

Atmospheric Effects : Visibility, Turbidity, Thermal air Pollution, Acidic deposition, Effects of Ozone layer on earth, Effects on Climate. **Health Effects :** Exposure, Impact of Pollutants on Human Body, Effects of Criteria Pollutants (CO, CO₂, SO_x, NO_x, Particulates, HC, O₃). **Atmospheric Air Pollution Control Methods :** Measurement of Air Pollution, Ambient Air quality and Source Emissions, monitoring, Methods of Analysis (Dispersive IR, Gas Chromatography, Electro chemistry, Photometry) Sampling Techniques & Standards. Selection of Control of Gaseous Emission (Absorption, Adsorption, Condensation, Chemical Reaction and Incineration) Control of Particulate Emission (Concept, Gravity settling Centrifugal and Cyclonic collection, Electrostatic Precipitation, Collection efficiency), Filtration Techniques, Wet Scrubbing Techniques.

15

UNIT 3

Water Pollution : Concept, water quality Parameters, Color Taste & Odour, Temperature, Turbidity Conductivity Dissolved Solids, suspended solids, Redox, Potential, Alkalinity, Acidity, Dissolved oxygen, BOD, COD, Sulphates, Phosphates, Chlorides, Silica, Hardness, Iron, Heavy Metals. **Sampling** : Sites, procedures, preservation and Handling of samples. Physicochemical analysis of water, (Alkalinity, Acidity, DO, BOD, COD, Hardness, Chloride, residual Chlorine). Water Pollution Indices, General concept, Nygard's and Polymer's Algal Pollution Indices.

15

UNIT 4

Waste Water Treatment Plants : Biological Waste Treatment, Primary Clarification, Activated Sludge Process, Anaerobic Lagoons, Aerobic & Facultative lagoons. Electrostatic Treatment of Water. **Waste Water Reuse or Recycling Techniques** : Objectives & Techniques (Brief introduction).

Waste Minimization Technology: a). Relationships of waste minimization technology to integrated hazardous waste management. b). Hazardous control, Disaster planning 'onsite and offsite.

15

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of NINE questions. TWO questions from each unit and ONE compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended :

1. Air Quality by Thad Godish.
2. Chemical and Biological Methods for Water Pollution Studies by R.K. Trivedy and P.K. Goel (1986).
3. Waste Water Engineering by Matcalf and Eddy, (1993).
4. Hazardous Waste Minimization by Harry Freeman (1990).
5. Pollution Control in Process industries by S. P. Mahajan, (1994).

PAPER 404: QUALITY CONTROL AND QUALITY ASSURANCE

OBJECTIVE OF THE COURSE

To teach the fundamental concepts of Chemistry and their applications. The syllabus pertaining to M.Sc. Applied Chemistry in the subject of Chemistry has been upgraded as per provision of the UGC module and demand of the academic environment. The course contents have been revised from time to time as per suggestions of the teachers of the Chemistry working in the Panjab University, Chandigarh and affiliated colleges. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual and laboratory skills.

Total marks: 75
Internal assessment: 15
Theory paper: 60
No. of Lectures: 60
(6 periods/week)

UNIT 1

Concept of Total Quality Management, philosophy of GMP's and GLPS, ISO 9000.

Organization and personnel, responsibilities, training, hygiene, personnel records.

Premises: location, design, plan layout, construction, maintenance of sterile areas, control of contamination. **15**

UNIT 2

Equipment, selection purchase specifications, preventive maintenance of equipment, cleaning of equipment.

Raw materials: purchase specifications stores selection of vendors, control on raw materials. Warehousing, good warehousing practices, materials management. **15**

UNIT 3

Quality control laboratory, responsibilities, good laboratory practice, routine controls, instruments reagents, sampling plans, standard test procedures, protocols, non-clinical testing, controls on animal house, data generation and storage, quality control documentation, retention samples, records. Complaints and recalls, evaluation of complaints, recall procedures, related records and documents. **15**

UNIT 4

Regulatory aspects of pharmaceutical and bulk drug manufacture. DRA, FDA, CPMP, ICH guidelines.

Validation: Qualification, validation and calibration of equipments.

Drug approval process, patent application and WHO certification.

15

Instructions for Paper setters and Candidates:

1. *Examiner will set a total of NINE questions. TWO questions from each unit and ONE compulsory question of short answer type covering the whole syllabi.*
2. *The students are required to attempt FIVE questions in all, ONE question from each unit and the Compulsory question.*
3. *All questions carry equal marks.*
4. *The Theory Examination shall be of 3 hours duration and practical examination shall of 4 hours*

Books Recommended :

1. GMP for Pharmaceuticals, Willings H, Mercei Dekker Inc., USA, 4th ed.
2. GLP, Sandy Weinberg, 2nd ed.
3. ISO9000 Concept Method, implementation, Tapan Bagehi, Wherler publication 1st ed.
4. How to practice GMP, P P Sharma, Vandana publication 2nd ed.

PAPER 405: INDUSTRIAL PROJECT

(1-1.5 month's Industrial Training)