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Item No. 4.102

UNIVERSITY OF MUMBAI

Manual on

CREDIT and GRADING SYSTEM

for

B. Pharm. Programme

under

FACULTY OF TECHNOLOGY

(with effect from the academic year 2012–2013)

1 INTRODUCTION

1.1 Recommendations of National Regulatory Authorities

The University Grants Commission (UGC), the **National Assessment and Accreditation Council (NAAC),** the **Distance Education Council (DEC)** and even the **National Knowledge Commission (NKC)** have time and again come out with recommendations for improving the quality and effectiveness of Higher education provisions in the country. The ministry of Human Resource Development at the Central level and the Ministry of Higher & Technical Education, Govt. of Maharashtra have also repeatedly stressed on the need for universities to pay prompt attention to improve the quality of education.

An important concern voiced more strongly in recent times, is the need to develop a Choice-Based Credit System (CBCS) in tune with global trends and the adoption of a sound grading system for reflecting learner performance. To quote Shri S. K. Tripathi, former Secretary, Dept. of Secondary and Higher Education, Ministry of Human Resource Development, Govt. of India, "*..... The demand for socially relevant, economically productive, globally competitive, culturally sustaining and individually satisfying programmes that cater to the needs of the present times is fast growing. The constraints of pursuing programmes and participation in pre-determined combination of Courses pose rigidities not in keeping with the demands of the changing times…*". ***There is a need for a fully convertible credit-based system acceptable to other universities.***

Recommendation of the UGC in its *Action Plan for Academic and Administrative Reforms* (Ref. UGC letters January 2008; March 2009) "……. *Curricular flexibility and learners' mobility is an issue that warrants our urgent attention. These can be addressed by introducing credit based courses and credit accumulation. In order to provide with some degree of flexibility to learners, we need to provide flexibility in course selection and also a minimum as well as a maximum permissible span of time in which a course can be completed by a learner… The Choice-Based Credit System (CBCS) imminently fits into the emerging socioeconomic milieu, and could effectively respond to the educational and occupational aspirations of the upcoming generations. In view of this, institutions of higher education in India would do well to invest thought and resources into introducing CBCS. Aided by modern communication and information*

technology, CBCS has a high probability to be operationalised efficiently and effectively — elevating learners, institutions and higher education system in the country to newer heights…".

The **National Knowledge Commission (NKC)** under the chairmanship of Mr. Sam Pitroda, in its report to the Prime Minister on 29th November 2006) has also reiterated the importance of higher education and the contribution it has made to economic development, social progress and political democracy in independent India. However, the Commission has also pointed out to a "serious cause for concern" at this juncture. According to Mr. Pitroda, " …. *it is important for us to recognize that there is a quiet crisis in higher education in India which runs deep. And the time has come to address this crisis in a systematic, forthright manner. …. There is a need for a transition to a course credit system where degrees are granted on the basis of completing a requisite number of credits from different courses, which provides learners with choices".*

1.2 Rationale for introduction of Credit and Grading System

The UGC while outlining the several unique features of the Choice-Based Credit System (CBCS) has, in fact, given in a nutshell, the rationale for its introduction. Among the features highlighted by the UGC are: *Enhanced learning opportunities, ability to match learners' scholastic needs and aspirations, inter-institution transferability of learners (following the completion of a semester), part-completion of an academic program in the institution of enrolment and part-completion in a specialized (and recognized) institution, improvement in educational quality and excellence, flexibility for working learners to complete the program over an extended period of time, standardization and comparability of educational programs across the country, etc.*

This credit and grading based system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning, not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. It can be concluded from the above discussion that it is very much essential to implement the credit and grading based higher education in India and University of Mumbai has taken a lead in implementing the system at University level through its many affiliated Institutes. In this regard it is very much essential to train and educate the faculty and staff in the new approach of education system for successful implementation of credit and Grading based education. The easily accessible information is essential and same will be provided through the credit and grading manual. In this manual focus is mainly on two aspects, one is course credit structure and another is examination/assessment and grading as discussed in the next chapters.

2. ADMISSION

2.1 Admission Criteria

Admission to the B. Pharm. program of Mumbai University is governed by the rules and regulations of Mumbai University and is as per norms of the Govt. of Maharashtra through the Directorate of Technical Education (DTE) and the All India Council for Technical Education (AICTE, New Delhi).

Learner should have passed the HSC (Std.XII) examination of Maharashtra State Board of Secondary and Higher Secondary Education or its equivalent examination with subjects English, Physics, Chemistry and Biology/Mathematics AND Secured minimum 45% marks (minimum 40% marks in case of candidates of Backward class categories and Physically Handicapped belonging only to Maharashtra State) in the subjects Physics, Chemistry and Biology/Mathematics added together (Maximum of marks obtained in Biology/Mathematics shall be considered for the purpose of addition)

Minimum qualification for admission into Bachelor of Pharmacy program would be according to the rules and regulations of AICTE, DTE and Mumbai University in force at the time of admission.

2.2 Minimum qualification for admission into Semester III of Bachelor of Pharmacy (Lateral Entry to Second Year B. Pharm.)

A learner with an aggregate of 50% marks at the Diploma of Pharmacy (ER 91) Examinations, conducted by any Pharmacy college established in India by law and duly approved by PCI u/s 12 of the Pharmacy Act 1948, is eligible for admission to Semester III of Second Year B. Pharm. The rules/regulations and qualifications for admission will be those in effect at the day and time of admission. However, such a learner with Diploma in Pharmacy must keep terms for the following subject heads (only theory papers) of 'Physical Pharmacy I of Semester I and Physical Pharmacy II of Semester II, henceforth referred to as 'Remedial Subjects'. They will be assessed both by Internal Assessment and by the End Semester Examination in the Remedial Subjects.

Learners would attend classes for Physical Pharmacy - I and would normally be evaluated (both Continuous evaluation and End Semester Evaluation- refer infra) while studying in Semester III of the B. Pharm. program and they would attend classes for Physical Pharmacy – II and would normally be evaluated (both Continuous Evaluation and End Semester Evaluation) while studying in Semester IV of the B. Pharm. program.

3. COURSE CREDIT STRUCTURE

As the requirements for a particular degree (undergraduate or postgraduate), a certain quantum of academic work measured in terms of credits is laid down in general. Every semester by satisfactorily clearing courses/other academic activities a learner earns credits. The amount of credit associated with a course is dependent upon the number of hours of instruction per week in that course. Similarly the credit associated with any of the other activities is dependent upon the quantum of work expected to be put in for each of the other activity per week.

3.1 Credit Assignment

3.1.1 Theory and Laboratory Courses:

Courses are broadly classified as *Theory Courses* and *Practicals.* Theory courses consist of lecture (**L**) and /or tutorial (**T**) hours, and Practicals (**P**) are hours spent in the laboratory. Credits (**C**) for a course is dependent on the number of hours of instruction per week in that course, and is obtained by using a multiplier of one (**1**) for lecture and tutorial hours, and a multiplier of half (**1/2**) for practical (laboratory) hours. Thus, for example, a theory course having **four** lectures per week throughout the semester carries a credit of **4**. Similarly, a practical having **four** laboratory hours per week throughout semester carries a credit of **2**.

3.2 Minimum Credit Requirements

The minimum credit required for award of a B. Pharm. degree is **206**. This is normally divided into Theory courses and Practicals over the duration of eight semesters. The credits are distributed semester-wise as shown in the syllabus manual. Courses generally progress in sequences, building competencies and their positioning indicates certain academic maturity on the part of the learners. Learners are expected to follow the semester-wise schedule of courses given in the syllabus manual of the respective programmes.

4. EXAMINATION / ASSESSMENT AND GRADING

Semester wise performance assessment of every registered learner is to be carried out through various modes of examinations. These include Internal Assessment and End Semester Examination. Normally weighting of Internal Assessment and End Semester Examination is 30 and 70 percentage, respectively, in both Theory Courses and Practicals. Internal Assessment includes Mid-Term assessments *i.e.*, Periodic Tests and Continuous mode of evaluation as given in Tables 1 and 2 for Theory Courses and Practicals.

Table 1: Scheme of assessment for Theory Courses of the B. Pharm. program.

Internal assessment		End Semester examination	Total for each Theory Course
Continuous mode	Mid-Semester Exam (Periodic Test)		
15 marks	15 marks	70 marks	100 marks

Table 2. Scheme of assessment for Practicals in the B.Pharm. program

Internal assessment		End Semester Examination	Total for each Practical
Continuous mode of evaluation	Mid-Semester Exam (Periodic test)		
7 marks	8 marks	35 marks	50 marks

4.1 Conduct of End Semester Examinations

The End Semester Examinations in Semesters I, II, III, IV, V and VI of the B. Pharm. Degree course will be conducted by the respective institutions/colleges where the learner has been admitted following rules and regulations. The examinations in Semesters VII and VIII will be conducted by the university.

4.1.1. A common time-table and common question papers for all the theory examinations of different semesters will be prepared/set by the university as per the procedure.

4.1.2. The question papers for the Theory courses in Semesters I, II, III, IV, V, VI, VII, VIII will be set by examiners and paper-setters appointed by the University.

4.1.3. The assessment and moderation of the answer booklets for the examinations in Theory courses in Semesters I to VI will be carried out by respective institutions/colleges by the examiners and moderators appointed by the principals of the institutions/colleges for each paper from the panel approved by the ad-hoc Board of Studies in Pharmacy.

4.1.4. Principals of the respective institutions/colleges are authorized to appoint examiners in the Practical examinations at Semesters I to VI on behalf of the university, only from the panel of suitable persons for appointment as examiners prepared by the competent authority as per the procedure laid down by the university.

4.1.5. The assessment and moderation of the answer booklets of the Theory courses in Semesters VII and VIII will be conducted by the University through Central Assessment Programme (CAP).

4.1.6. Non University Exam System (NUES) subjects

The question papers for NUES courses will be set by examiners and paper-setters appointed by principals of the institutions/colleges and will be evaluated at the institutional level following the same pattern as that for other theory subjects and marks and grade will be forwarded to the university.

4.2 Modes of Assessment/Evaluation

4.2.1 Modes of Evaluation for Theory Courses

Of the 15 marks reserved for Continuous mode of Internal Assessment (Table 1), 5 marks are to be reserved for attendance, 5 marks for 5 quizzes to be taken randomly over the semester without prior notice to learners and 5 marks for learner-teacher interaction during lecture hours.

For attendance the allotment of marks are as follows: For 90% or more attendance the complete 5 marks may be given, for 85-89% attendance 4 marks, for 80-84% 3 marks and 75-79% 2 marks and below 75% zero mark.

Learners will not be given a second chance to reappear for any quiz for which they have been absent.

Marks for learner-teacher interaction may be given based on the learner’s drive to ask questions in class, be ready to be part of discussions raised in class, actively participating in class projects and other activities that are part of the lecture class.

For the theory subjects, there will be one mid-semester test (Periodic Test) which will be held as per the schedule fixed in the Academic Calendar of the institutions. The Periodic Test will be of 1 hour duration.

Details of the internal assessment of all learners (which is a combination of both continuous mode of evaluation and mid semester (periodic test)) should be sent to the academic office of the University by the Principal/Director of the college/institution at least 15 days before the End Semester examination

The End Semester Examination will be held as per the university schedule and would be of 70 marks. The paper will be of 3 hours duration and will cover the full syllabus of the course. The End Semester Examination is mandatory. The grade for courses can be awarded only after successful completion of both Internal Assessment and End Semester Examination of the respective course.

4.2.2 Modes of Evaluation for Practicals

For the Practicals, continuous assessment should be carried out and appropriate weighting should be given to each practical/assignment/course project and proper record of the same to be preserved by the concerned faculty for the purpose of inspection as and when required. The assessment in Practicals will be based on regular supervision of the learner's work during the practicals, her/his performance in *viva-voce* examinations, and the quality of their work as prescribed through laboratory journals and an End Semester Examination. It is obligatory to maintain a laboratory journal as prescribed by the course instructor.

Of the 15 marks reserved for internal assessment (Table 2), the 7 marks for Continuous evaluation would be given to the leaner's work/performance at the practical classes, and a mid-semester periodic test would be conducted for 8 marks.

The End Semester Examination for Practicals for Semesters I to VI would be done at the institutional level by a pair of examiners appointed by the institution.

For Semesters VII and VIII, the University would appoint two examiners for each Practical prescribed in Semesters VII and VIII. Evaluation would be done by the examiners appointed by the University at the place and time announced by the University. The examination in each Practical would be of 4 hours duration and would be for a total of 35 marks.

4.3. Attendance

Attendance for all Theory courses and Practicals is compulsory. As per the University Ordinance 119, 75% attendance is compulsory for **keeping the term**.

4.4. Heads of Passing

The End Semester Examination (ESE) and the **Combined** End Semester and Internal Assessment for both Theory and Practicals are defined as the Heads of Passing.

4.5. Promotion of Learner and Award of Grades

A learner will be declared **PASS** and eligible for **grade** in a particular course of **undergraduate** programme if a learner secures **at least 40% marks in each head of passing** mentioned above. In simple words, to pass, the learner has to secure a minimum of 28 marks out of 70 marks in the End Semester Exam in each Theory course and a minimum of 14 marks out of 35 marks in the End Semester Exam in each Practical and **further**, a minimum of 40 marks out of 100 in the Combined End Semester Exam and Internal Assessment in each Theory Course and a minimum of 20 marks out of 50 in the combined End Semester Exam and Internal Assessment in each Practical.

4.6. Carry Forward of Marks

In case a learner **FAILS** in the **End Semester Examination** or fails to secure the minimum 40% in Theory and Practicals as specified in Section 4.4, then s/he shall reappear for the **End Semester Examination** of that course. However his/her marks of the **Internal Assessment** shall be **carried over** and he/she shall be entitled for grade obtained by him/her on passing.

4.7. Reexamination of Internal Assessment

A learner will have the opportunity to **improve** his/her performance **only once** in the Periodic Test component of the Internal Assessment. The marks obtained by the learner for attendance and quizzes/learner-teacher interaction will be carried over. The re-conduct of the periodic test should be completed before the commencement of next semester theory examination.

Reexamination of **End Semester Examination** will be conducted as per the schedule planned by University of Mumbai

4.8 Allowed to Keep Terms (ATKT):

No learner will be admitted to any examination unless he/she keeps term at the institution/college affiliated to the University.

ATKT rules are applicable only to those learners who have appeared for the examination in all the subject heads.

4.8.1 A learner who is admitted to the Odd Semesters i.e. Semester I / III / V / VII shall be eligible to the next even Semester i.e. Semester II / IV / VI / VIII even if the learner fails in all the courses at the Odd Semester.

4.8.2. A learner failing in not more than two Theory courses and one practical of Semester I and II taken together shall be promoted to Semester III. However, if he/she fails in more than two Theory courses and one Practical of Semesters I and II taken together he/she will **not** be promoted to Semester III, until the number of failure subject heads is less than two Theory courses and one Practical in Semesters I and II taken together.

4.8.3. A learner failing in not more than two Theory courses and one Practical of Semester III and IV taken together shall be promoted to Semester V provided he/she has cleared all the subjects (Theory courses and Practicals) of Semesters I and II. However, if he/she fails in more than two Theory courses and one Practical of Semesters III and IV taken together, he/she will not be promoted to Semester V, until the number of failure subject heads is less than two Theory courses and one Practical in Semesters III and IV taken together

4.8.4. A learner failing in not more than two Theory courses and one Practical of Semesters V and VI taken together shall be promoted to Semester VII provided he/she has cleared all the subjects of Semesters I to IV

4.8.5. A lateral entry learner will be allowed for the Third Year B. Pharm. Semesters V and VI provided he/she should have passed Semester III and Semester IV **or** passed Semester III and ATKT for Semester IV **or** ATKT for Semester III and passed Semester IV **or** ATKT for Semester III and Semester IV and passed/failed in the Remedial Subjects for Semesters I and II.

4.8.6. A lateral entry learner failing in the Remedial Subjects of Semesters I and II shall be allowed to keep terms to the higher semester upto Semester VI irrespective of the number of subject heads failed in Semester I and II.

However, for admission for Semester VII of the course, the learner must pass the specified Remedial subject heads of Semesters I and II.

Note: **Grade ABS** should be considered as **failed** and treated as one head for deciding **ATKT.**

5. GRADING OF PERFORMANCE

5.1 Letter Grade and Grade Point Allocation

The credit and grading system will be effective from the academic year 2012-2013 for Faculty of Technology of University of Mumbai. In every course, based on the combined performance in all assessments in a particular semester as per the curriculum/syllabus, the learner is awarded a letter grade. These letter grades not only indicate a qualitative assessment of the learner's performance but also carry a quantitative (numeric) equivalent called the Grade Point. The letter grades and their equivalent grade point applicable for **undergraduate** program are given below:

Percentage of Marks Obtained	Letter Grade	Grade Points	Performance
90.00 to 100.00	O+	10	Brilliant
80.00 – 89.99	O	9	Outstanding
70.00 – 79.99	A	8	Excellent
60.00 – 69.99	B	7	Good
50.00 – 59.99	C	6	Average
40.00 – 49.99	D	5	Pass
Less than 40.00	F	0	Fail

A learner who remains **absent** in any form of **evaluation/examination, letter grade** allocated to him/her should be **assigned a letter grade of ABS** and a corresponding **grade point** of **zero.** S/he should reappear for the said evaluation/examination in due course.

5.2 SGPA/ CGPA Calculation

5.2.1 Semester Grade Performance Average (SGPA)

The performance of a learner in a semester is indicated by a number called Semester Grade Performance Average (SGPA). The SGPA is the weighted average of the grade points obtained in all the courses by the learner during the semester. For example, if a learner takes five courses (Theory/Practicals) in a semester with credits C_1, C_2, C_3, C_4 and C_5 and the learner's grade points in these courses are G_1, G_2, G_3, G_4 and G_5, respectively, then learners' SGPA is equal to:

$$\boldsymbol{SGPA = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4G_4 + C_5G_5}{C_1 + C_2 + C_3 + C_4 + C_5}}$$

The SGPA is calculated to two decimal places.

It should be noted that, the SGPA for any semester will take into consideration the F and ABS grade awarded in that semester. For example if a learner has a F or ABS grade in course 4, the SGPA will then be computed as:

$$\boldsymbol{SGPA = \frac{C_1G_1 + C_2G_2 + C_3G_3 + C_4 * ZERO + C_5G_5}{C_1 + C_2 + C_3 + C_4 + C_5}}$$

5.2.2 Cumulative Grade Performance Average (CGPA)

The CGPA is calculated for Semesters VII and VIII to two decimal places and is indicated in final grade report card and is the weighted average of the grade points obtained in all the courses by the learner during Semesters VII and VIII.

The CGPA will reflect the **failed status** in case of **F grade(s),** till the course(s) is/are **passed**. When the **course(s)** is/are **passed** by obtaining a **pass grade** on subsequent examination(s) the **CGPA** will only reflect the **new grade** and not the **fail grades** earlier**.**

The CGPA is calculated as:

$$\boldsymbol{CGPA = \frac{C_1G_1 + C_2G_2 + C_3G_3 + \ldots + C_i * ZERO + \ldots + C_nG_n}{C_1 + C_2 + C_3 + \cdots + C_i + \ldots + C_n}}$$

where C_i is the Credits for course i and G_i is the grade for course i. Even if a learner has **failed** in a course **more than once,** the course will figure **only once** in the **numerator** as well as the **denominator**. At the end of semester VIII s/he has appeared for examination for ***n*** number of

courses including the **backlog course *i*** and has cleared all the courses including the **backlog course,** the CGPA at the end of semester VIII is calculated as,

$$CGPA = \frac{C_1G_1 + C_2G_2 + C_3G_3 + \ldots + C_i * G_i + \ldots + C_nG_n}{C_1 + C_2 + C_3 + \cdots + C_i + \ldots + C_n}$$

5.3 Semester Grade Report

At the end of each semester, the current semester grade report, which reflects the performance of the learner in that semester, is prepared and issued to the learner.

The Grade Card will reflect the letter grade obtained by the learner, credit points of the individual courses of a particular semester, calculation of SGPA for each semester. The CGPA will be calculated for all the successfully completed courses of B. Pharm. Programme.

This report includes the fail grades as awarded. SGPA will be calculated and reflected in the current semester grade report only if the learner has passed in all heads. SGPA will not be calculated and reflected in the current semester grade report if the learner does not pass in all heads of passing. When the learner obtains a grade of D or higher on subsequent attempts a new semester grade report will be issued to the learner. The existing system of displaying the carried forward marks/grades and the marks/grades obtained in the current attempt must be used. The abbreviations for the same shall be displayed in the Grade Card as a footnote. (Refer to circular no. UG/181 of 2002 dated 24.04.2002).

The Grade Card for Lateral entry learners of the Second Year (Semesters III and IV) B. Pharm. Course must indicate the results of the Remedial subjects of F. Y. B. Pharm. Semesters I and II respectively i.e. the Grade Card for Semester III will indicate the result for Physical Pharmacy I (subject in Sem. I) and the Grade Card for Semester IV will indicate the result for Physical Pharmacy II (subject in Sem. II)

DETAILED SYLLABUS CONTENT FOR AC 6/6/12 4.103

F.Y. B.Pharm

SEMESTER-I

Physical Organic Chemistry 4 hours / week

Sr. No.	Topic	Hours
1.	**Introduction to structure and models of bonding** Review of basic bonding concepts – quantum numbers, atomic orbitals, electron configuration, electronic diagrams, Lewis structures, formal charge, VSEPR, hybridization involving s, p and d orbitals, polar covalent bonds, electronegativity, different scales of electronegativity, electrostatic potential surfaces, inductive effects, group electronegativities, hybridization effects, bond dipoles, molecular dipoles, and quadrupoles with examples, resonance, polarizability The teacher could try to relate some of these concepts to drug effects on macromolecular targets	10
2 2.1 2.2 2.3 2.4 2.5 2.6 2.7	**Modern Theory of Organic Bonding** Molecular Orbital Theory, Strengths and drawbacks Concept of Group orbitals Qualitative Molecular Orbital Theory (QMOT), Rules of QMOT Symmetry and Symmetry Operations, e.g. MH_3 and MH_3Y systems M.Os of planar methyl, Walsh diagram – pyramidal methyl, bonding in planar and pyramidal forms of methyl Consideration of NH_3 and BH_3 The orbitals of CH_2 group, M.Os of MH_2 group, molecular orbitals of H_2O Building larger molecules e.g. ethane, ethylene, formaldehyde, methyl chloride, allyl system, boranes Orbitals of reactive intermediates – carbocations, carbenium ions, carbanions, radicals and carbene Bonding in organometallics	12
2 2.1 2.2 2.3 2.4 2.5	**Kinetics and Reaction Mechanisms**. Energy surfaces, reaction coordinate diagrams, activated complex/transition state rate and rate constants, reaction order and rate laws Transition state theory and its relationship to Arrhenius Rate law, Boltzmann distributions and dependence on temperature, methods of determination of activation parameters and Arrhenius parameters with some examples Principles of Kinetic Analysis Kinetic Experiments, First order kinetics, second order kinetics, pseudo-first order kinetics, equilibrium kinetics and initial-rate kinetics, some ideas about methods for following kinetics Temperature dependence on Reaction rates, kinetic isotope effects Hammond Postulate, reactivity vs selectivity, Curtin-Hammett Principle, microscopic reversibility, kinetic vs thermodynamic control	12
3	**Acid-Base Catalysis** General principles of catalysis, Forms of catalysis – electrophilic catalysis, acid-base catalysis, nucleophilic catalysis, covalent catalysis, phase transfer catalysis, Brønsted Acid-base catalysis, correlation of reaction rates with acidity functions.	7
4	**Charge transfer complexes and reactions** Definition of complex, charge-transfer transition, donors and acceptors, ground state charge-transfer contribution The teacher could try to relate these concepts to drugs effects on macromolecular targets	4
	Total	**45**

In ALL subjects the teacher should adopt the latest edition of the books, hence the specific edition and year of publication have been omitted

Books

1. Eric V Ansyln and Dennis A Dougherty, Modern Physical Organic Chemistry, John Wiley. (Main Book to be adopted for teaching this course).

2. Neil Isaacs, Physical Organic Chemistry, Pearson Education.

3. Louis P Hammett, Physical Organic Chemistry, McGraw Hill Education.

4. Edward M Kosower, An Introduction to Physical Organic Chemistry, John Wiley and Sons, Inc

5. Atkins' Physical Chemistry, Peter Atkins and Julio De Paula, International Student Edition, Oxford University Press.

Physical Pharmacy I **4 hrs/week**

Sr. No	TOPICS	HOURS
1.	**States of matter:** ▪ The Gaseous state: Ideal and Real gases, The Ideal gas Law, Kinetic Molecular Theory, The van der Waals equation for real gases, Critical phenomenon, critical constants and their determination (Problems) ▪ The Liquid state: Liquefaction of gases and methods (Linde's, Claude' s and Faraday's method), application of liquefaction in aerosols – introduction to the concept, vapour pressure of liquids, Clausius – Clapeyron equation (No derivation) ▪ The Solid State: Crystalline solids, Polymorphism, Solvates, Amorphous solids, melting point and heat of fusion, melting point and intermolecular forces ▪ The Liquid Crystalline state: Structure, properties and significance of liquid crystals ▪ The Supercritical fluid state	**12**
2.	**Physical properties of Drug Molecules** ▪ Additive, constitutive and colligative properties with examples ▪ Dipole moment, Dielectric constant and significance to pharmacy, concept of polarizability, molar polarization ▪ Refractive index and molar refraction, Principle and working of Abbe's refractometer, Application of molar refraction to determine structures ▪ Optical rotation, Specific rotation and its applications	**6**
3.	**Solutions of Non-electrolytes** ▪ Units for expressing concentration ▪ Ideal and real solutions, Raoult's law, deviation from Raoult's law Methods to measure vapour pressure lowering and its application (problems) ▪ Distillation of binary mixtures and azeotropic distillation. Concept of steam distillation ▪ Elevation of boiling point and determination of molecular weight (problems). Depression of freezing point and determination of molecular weight (problems) ▪ Osmotic pressure: Concept, methods to determine osmotic pressure, molecular weight determination from osmotic pressure.	**12**
4.	**Thermodynamics** ▪ Definition, Applications and Limitations ▪ Homogenous and Heterogenous systems, Types of systems – Open, Closed, Adiabatic, Isothermal ▪ Types of properties – Intensive and Extensive property ▪ Equilibrium and Non-equilibrium states, ▪ Types of processes - Isothermal, Adiabatic, Isobaric, Isochoric, Cyclic process, Reversible and irreversible process ▪ First law of thermodynamics ▪ Enthalpy, heat capacity, Cp – Cv = R (Derivation) ▪ Work of expansion against constant pressure, ▪ Isothermal work of expansion against variable pressure ▪ Thermochemistry: ▪ Heat of reaction, Heat of formation, Heat of combustion, Heat of solution- Differential and Integral heat of solution, ▪ Bond energy – Calculation of Heat of reaction from bond energy data, Kirchoff's equation, Hess's law of constant heat summation ▪ Second law of thermodynamics	**12**

	▪ Carnot theorem, Efficiency of heat engine, Entropy ▪ Third law of thermodynamics ▪ Free energy and its applications: Pressure and Temperature coefficients of free energy, Maximum net work, Criteria for equilibrium, ▪ Chemical potential (only definition), ▪ Gibbs Helmholtz equation, ▪ Clausius Clapeyeron equation (No derivation), ▪ van't Hoff equation (No derivation) ▪ Problems	
5.	**Properties of solutions of Electrolytes** ▪ Electrolysis ▪ Faradays laws of electrolysis ▪ Electrolytic conductance, Specific conductance, Equivalent conductance, Molecular conductance ▪ Transport number ▪ Measurement of conductance ▪ Variation of equivalent conductance with dilution ▪ Arrhenius theory of electrolytic dissociation- colligative properties activity coefficient, coefficient expressing colligative properties ▪ Theory of strong electrolytes ▪ Degree of dissociation ▪ Kohlrausch's law of independent migration of ions ▪ Applications of conductivity measurements - Conductometric titrations and solubility of a sparingly soluble salt ▪ Equivalent conductance of a weak electrolyte at infinite dilution ▪ Degree of dissociation of a weak electrolyte ▪ Problems	**6**
	Total	**48**

Books

1. P. J. Sinko, 'Martin's Physical Pharmacy and Pharmaceutical Sciences' Fifth edition, Lippincott Williams and Wilkins, Indian Edition distributed by B.I.Publications Pvt Ltd, 2006.
2. Bahl and Tuli, 'Essentials of Physical Chemistry' S.Chand and Company Ltd. Ramnagar, New Delhi-110055.
3. U. B.Hadkar,' A Textbook of Physical Pharmacy', 9th Edition, Nirali Prakashan, Pune 2008.
4. U. B.Hadkar, T.N.Vasudevan and K.S. Laddha, 'Practical Physical Pharmacy', Yucca Publishing House, Dombivali, 1994
5. Findlay, 'Practical Physical Pharmacy' revised and edited by J.A. Kitchener, 8th Ed. Longmans, Green and company Ltd. 1967.

Anatomy, Physiology and Pathophysiology – I 4 hrs/Week

Sr.no.	Details	Hours
1.	Brief introduction to human body and organization of human body	1
2.	Structural and functional characteristics of following tissues 1) Epithelial 2) Connective 3) Nervous 4) Muscle	2
3.	Detailed structure of cell membrane and trans-membrane movement of substances	2
4.	Components and functions of lymphatic system • Lymphatic organs and tissues • Organization of lymph vessels • Formation and flow of lymph	3
6.	Pathophysiology of following diseases • AIDS • Autoimmune diseases (Rheumatoid arthritis, Grave's disease, Myasthenia Gravis, Rheumatic fever) • Hypersensitivity and types of hypersensitivity reactions.	2
7.	Haematology • Composition of blood • Functions of blood elements • Erythropoiesis and life cycle of RBC. • Synthesis of Haemoglobin • Leucopoiesis • Immunity: Basics and Types • Coagulation of blood • Blood groups	8
8.	Pathophysiology of following diseases • Anaemias – Types of anaemias • Polycythemia : Physiological and polycythemia vera • Leucopenia • Leukocytosis • Thrombocytopenia • Leukemia	3
9.	Basic mechanism involved in the process of inflammation and repair. • Alteration in vascular permeability and blood flow. • Migration of WBC • Acute and chronic inflammation • Brief outline of the process of repair.	5
9.	Structure and properties of following muscles • Cardiac muscles • Smooth muscles • Skeletal muscles • Neuromuscular transmission and contraction of skeletal muscle • Energy metabolism in the muscle • Types of muscle contractions • Muscle tone	9
	Total	**35**

REFERENCES FOR ANATOMY, PHYSIOLOGY & PATHOPHYSIOLOGY

Latest editions of the following books can be referred

1. Ross & Wilson, Anatomy & Physiology in Health & Illness by Anne Waugh and Allison Grant, Published by Churchill Livingstone

2. Gerard J. Tortora & Bryan Derrickson, Principals of Anatomy & Physiology, Published by John Wiley and Sons, Inc.

3. A. C. Guyton & J. E. Hall, Textbook of Medical Physiology, Published in India by Prism Books Ltd. on arrangement with W. B. Saunders Company, USA.

4. McNaught & Callander, Illustrated Physiology by B. R. Mackenna & R. Callander
Published by Churchill Livingstone

5. Kaplan, Jack, Opheim, Toivola, Lyon, Clinical Chemistry: Interpretation & Techniques

6. Praful B. Godkar, Textbook of Medical Laboratory Technology, Published by Bhalani Publishing House, Mumbai, India

8. Harsh Mohan, Text book of Pathology, Published by Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi

Environmental Science **3 hrs/week**

Objectives

1	To study the importance of environmental science and environmental studies
2	To know the importance of key to the future of mankind.
3	To study continuing problems of pollution, loss of forget, solid waste disposal, degradation of environment, issues like economic productivity and national security
4	Study of Global warming, the depletion of ozone layer and loss of biodiversity have made everyone aware of environmental issues.

Sr. No.	Details	Hrs
1	**Multidisciplinary Nature of Environmental Studies:** • Scope and Importance • Need for Public Awareness • Depleting Nature of Environmental resources such as Soil, Water, Minerals, and Forests. • Global Environmental Crisis related to Population, Water, Sanitation and Land. • Ecosystem: Concept, Classification, Structure of Ecosystem, overview of Food chain, Food web and Ecological Pyramid	5
2	**Sustainable Development** • Concept of sustainable development • Social, Economical and Environmental aspect of sustainable development. • Control Measures: 3R (Reuse, Recovery, Recycle), Appropriate Technology, Environmental education, Resource utilization as per the carrying capacity**.**	5
3	**Environmental Pollution:** • Air Pollution: Sources, Effects of air pollution with respect to Global Warming, Ozone layer Depletion, Acid Rain, Photochemical smog, Two Control Measures, Bag house Filter, Venturi scrubber. Case Study: Bhopal Gas Tragedy • Water Pollution: Sources and Treatment, Concept of waste waters - Domestic &Industrial and treatment. Case Study: Minamata Disease. • Land Pollution: Solid waste, Solid waste Management by Land filling, Composting. • Noise Pollution; Sources and Effects • E-Pollution: Sources and Effects.	10
4	**Environmental Legislation:** • Overview • Ministry of Environment and Forests (MoE&F). Organizational structure of MoE&F. • Functions and powers of Central Control Pollution Board. • Functions and powers of State Control Pollution Board. • Environmental Clearance, Consent and Authorization Mechanism. • Environmental Protection Act • Any two case studies pertaining to Environmental Legislation.	5
5	**Renewable sources of Energy:** • Limitations of conventional sources of Energy. • Various renewable energy sources. • Solar Energy: Principle, Working of Flat plate collector & Photovoltaic cell.	5

	• Wind Energy: Principle, Wind Turbines. • Hydel Energy: Principle, Hydropower generation. • Geothermal Energy: Introduction, Steam Power Plant	
6	**Environment and Technology** • Role of Technology in Environment and health • Concept of Green Buildings, Indoor air pollution • Carbon Credit: Introduction, General concept. • Disaster Management: Two Events: Tsunami, Earthquakes, Techniques of Disaster Management • Case Study: Earthquake in Japan	5
	Total	35

Books

1. Hazardous Waste Incineration, Brunner R.C., McGraw Hill Inc
2. Global Biodiversity Assessment, Heywood V.H and Waston R.T., Cambridge Univ. Press
3. Environmental Science systems & Solutions, Mckinney M.L. and School R.M., Web enhanced edition.
4. Fundamentals of Ecology, Odum E.P., W.B. Saunders Co. USA.
5. Textbook of Environmental studies by Erach Bharucha, University Press.
6. Environmental Studies by R. Rajagopalan, Oxford University Press.
7. Essentials of Environmental Studies by Kurian Joseph & Nagendran, Pearson Education
8. Renewable Energy by Godfrey Boyle, Oxford Publications.
9. Perspective Of Environmental Studies, by Kaushik and Kaushik, New Age International
10. Environmental Studies by. Anandita Basak, Pearson Education
11. Textbook of Environmental Studies by Dave and Katewa, Cengage Learning
12. Environmental Studies by Benny Joseph, Tata McGraw Hill

Communication Skills **3 hrs/week**

S.No.	(Topic)	Hours
1.0	Remedial study of grammar, Review of grammar and vocabulary. Effective use of dictionary, Phonetics	10
1.1	Conditionals/Tenses, relative clauses, subject–verb agreement, passive voice	
2.0	Written Communication	7
2.1	Discuss a topic of general interest, but related to science in about 300 words. (Analyze, comment, argue, reflect, persuade, etc.) (can also be used for oral presentations by the students, followed by discussion).	
3.0	Oral Communication	5
3.1	Consulting a dictionary for correct pronunciation (familiarity with phonetics symbols and stress-marks only)	
3.2	(ii) Dialogue	
4.0	Scientific Writing	8
4.1	Writing a Scientific Report on a project undertaken or an experiment conducted (theory + practice)	
5.0	Soft Skills	
5.1	Gestures/ postures – Body language, gesture, posture.	2
5.2	Group discussion – Giving up of PREP, REP Technique, how body language during group discussion.	2
5.3	Presentation skills: (i) How to make a Power Point presentation (ii) Body language during presentation; Resume writing: Cover letter, Career objectives, Resume writing (tailor made)	4
5.4	Mock Interview: Each student to face an interview and to demonstrate the above taught skills.	2
	Total	40

Books

1. English Grammar, Beaumont Digty and Colin Granger, An International reference practice book, London, Heinmann.
2. The right word at the right time A guide to the English language and how to use it, Elison John, The Reader's Digest
3. Study writing, Hamplyons Liz & Ben Heasley, Cambridge University Press.
4. Basic Business Communication, Lesiker Raymond.V and Maire E Hatley, New York, Tata McGraw Hill

Physical Pharmacy Laboratory - I **4 hrs/week**

1. Determination of refractive index, molar refraction. Using water as a reference standard, to determine refractive index of two organic solvents and their mixtures and to determine composition of unknown. To determine RI of a solid (KCl) from two concentrations of solid solutions.
2. Viscosity: To determine the composition of the unknown binary mixture.
3. Polarimetry: Different concentrations of sugar, determination of unknown concentration and specific rotation.
4. Determination of molecular weight by Rast camphor method.
5. Determination of heat of solution of benzoic acid.
6. Partition coefficient of benzoic acid between benzene and water.

Demonstration
Landsberger method.

Books
U.B. Hadkar, T.N.Vasudevan, K.S.Laddha, 'Practical Physical Pharmacy', Yucca Publishing House, Dombivali

Anatomy, Physiology and Pathophysiology – Lab.I (4 hr./week)

Sr.no.	Details	Hours
1.	Hematology 1. Red Blood Cell (RBC) Count 2. Total Leukocyte Count 3. Differential Leukocyte (WBC) Count 4. Hemoglobin content of blood 5. Bleeding / Clotting Time 6. Blood groups 7.Erythrocyte Sedimentation Rate (ESR) / Hematocrit (Demonstration)	
2.	Study of human skeleton	
3.	Microscopic study of permanent slides Tissues : - Columnar, Cuboidal, Squmaous, Ciliated Epithelium - Cardiac / Skeletal / Smooth muscle - Ovary, Testis, Liver, Pancreas, Thyroid, Tongue, Stomach, Intestine, Kidney, Lung, Spinal Cord, Cerebrum, Artery, Vein	
4.	Measurement of blood pressure	
5.	Tutorial / Discussion on some common investigational procedures used in diagnosis of diseases with the help of charts / slides Name and Importance of following tests : 1. Electroencephalogram (EEG) in diagnosis of Epilepsy 2. Use of Positron emission tomography (PET) Computed tomography scan (CT Scan), Single photon emission computed tomography (SPECT) in diagnosis. 3. Use of flow cytometry as a diagnostic tool. 4. Electrocardiogram (ECG) in diagnosis of cardiac arrhythmia 5. Liver Function Tests – - Serum Bilirubin, - serum glutamate oxaloacetate transaminase (SGOT) - serum glutamate pyruvate transaminese (SGPT) - Urine Bilirubin, - Urine Urobilinogen, 6. Kidney Function Tests – Serum Creatinine, – Serum Urea, Uric Acid – Blood Urea Nitrogen (BUN) 7. Blood Glucose 8. Serum Cholesterol / Triglycerides 9. Serum Alkaline phosphatase (ALT) 10. Serum Acid phosphatase (APT) 11. Serum Lipase 12.Serum Amylase 13. Serum Calcium 14. Serum lactate dehydrogenase (LDH) 15. Thyroid Function Tests – T_3, T_4 16. Prothrombin time (PT) 17. Partial thromboplastin time (PTT) 18. Activated partial thromboplastin time (APTT) 19. Diagnostic tests for infectious diseases like - Malaria - Tuberculosis - Dengue - H1N1 swine flu -Typhoid	

Books

1. McNaught & Callander, Illustrated Physiology by B. R. Mackenna & R. Callander, Published by by Churchill Livingstone

2. Kaplan, Jack, Opheim, Toivola, Lyon, Clinical Chemistry: Interpretation & Techniques, Published by Elseviers Publications

3. Praful B. Godkar, Textbook of Medical Laboratory Technology, Published by Bhalani Publishing House, Mumbai, India

4. C. L. Ghai, Text book of Practical Physiology, Published by Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi

Computer Lab **4 hrs/week**

Sr. No.	Topic	Hours per week
1	Introduction to Computers.	2
2	History of Computer development and respective generation: Abacus, Napier's Bones, Slide rule, Pascal's Calculator. General use of computers in everyday life. Computer Classification: Mainframe, Mini and Micro Computers, comparison of Analog & Digital Computers, Hardware and Software. Calculator and Computer	3
3.1 3.2	Operating Systems: Introduction to types of operating systems, UNIX, MS-DOS, etc. RAM, ROM, Virtual Memory etc Students should learn on Windows and Linux OS based systems use of basic Windows and Linux commands	3 3
4.1 4.2	Type of Languages: Conventional languages; their advantages, limitations; C, Pascal, FORTRAN, Programming of these languages Students should be taught some programming in BASIC and C	4 4
5.1 5.2	Introduction to Computer Networks: Architecture of seven layers of communications Students should be taken to a computer lab with has a network and shown the basic connections and operation of different types of networks.	3 2
6.1 6.2	Introduction to Data Structure: Like Queues, list, trees, Binary trees algorithms, Flow chart, Structured Systems, Analysis and development, Ingress-SQL, Gateways etc. Statistics, methodologies. Basic Language: Constants and Variables: Character set, constants, variables, Naming the variables getting data into memory, LET, INPUT, READ. DATA, Print Statement Expressions: Arithmetic expression, Hierarchy of operations, Rules of Arithmetic, Evaluation of expressions, Relational expressions, Logical operations, Library functions Printer Control: Comma and semicolon control, the TAB function, PRINT, LPRINT Functions and Subroutines: User defined functions, subroutines, subscripted variables The above concepts should be introduced practically to students with examples, while working on a computer system.	9
7	Computer Graphics:	2
8	Computer applications in pharmaceutical area and in clinical studies	3

Books

1. Basic Electronics and Computer Applications, Rajiv Khanna, New Age International Publishers

2. Fundamentals of Computers, V. Rajaraman, Prentice Hall of India Pvt. Ltd.

3. Schaums Outline Series, Theory and Problems of Introduction to Computer Science, Francis Scheid, McGraw Hill Book Co.

Detailed Syllabus for

SEMESTER-II

Pharmaceutical Chemistry I 3 hours / week

An outline of methods of preparation, uses, sources of impurities, tests for purity and identity, including limit tests for iron, arsenic, lead, heavy metals, chloride, sulphate and special tests if any, of the following classes of inorganic pharmaceuticals included in Indian Pharmacopoeia.		
Sr. No.	**Topic**	**Hours per week**
1	Acids and Bases: Buffers, Water	3
2	Gastrointestinal Agents : Acidifying agents, Antacids, Protectives and Adsorbents, Cathartics	4
3	Major Intra-and Extra-cellular Electrolytes: Physiological ions. Electrolytes used for replacement therapy, acid-base balance and combination therapy	4
4	Essential and Trace Elements: Transition elements and their compounds of pharmaceutical importance : Iron and haematinics, mineral supplements	4
5	Cationic and anionic components of inorganic drugs useful for systemic effects	3
6	Topical Agents: Protectives, Astringents and Anti-infectives	4
7	Gases and Vapours : Oxygen, Anesthetics and Respiratory stimulants	3
8	Dental Products: Dentifrice, Anti-caries agents	3
9	Complexing and chelating agents used in therapy	3
10	Miscellaneous Agents: Sclerosing agents, expectorants, emetics, poisons and antidotes, sedatives etc. Pharmaceutical Aids Used in Pharmaceutical Industry. Anti-oxidants, preservatives, filter aids, adsorbents, diluents, excipients, suspending agents, colorants etc.	5
11	Inorganic Radio Pharmaceuticals: Nuclear radio pharmaceuticals, Reactions, Nomenclature, Methods of obtaining their standards and units of activity, measurement of activity, clinical applications and dosage, hazards and precautions.	5
	Total	**41**

Books

1. Inorganic medicinal and pharmaceutical chemistry, J. H. Block, E. B. Roche, T. O. Soine, and C. O. Wilson. Lea & Febiger, Philadelphia, PA.
2. Modern Inorganic Pharmaceutical Chemistry, Clarence A. Discher. Wiley, New York.
3. Remington: the science and practice of pharmacy, Beringer, P. Lippincott Williams & Wilkins.
4. Inorganic Pharmaceutical Chemistry, Bothara, K. G., Nirali Prakashan.
5. Inorganic Pharmaceutical Chemistry, A. S. Dhake, H. P. Tipnis, Career Publication.

Biochemistry I **4 hrs/week**

S. No.	Topic	Hrs/Week
1	**Introduction to carbohydrates, proteins, lipids** Introduction to common monosaccharides ranging from trioses to hexoses Introduction to common disccharides sucrose, cellobiose, maltose, lactose Introduction to common polysaccaharides starch and glycogen Introduction to amino acids, their classification, three letter and one letter codes Introduction to hierarchy of protein structures Introduction to common saturated and unsaturated fatty acids Intoduction to triacyl glycerol, phospholipids, sphingolipids Introduction to the concept of glycoproteins, proteoglycans, lipopolysaccharides, glycolipids, lipoproteins, proteolipids with examples.	18
2	**Enzyme Kinetics** Introduction to the factors affecting enzyme activity, concept of initial velocity, derivation of enzyme kinetic equation based on steady state assumptions, direct, Lineweaver Burk and Eadie Hofstee plots of enzyme kinetic data. Modulation of enzyme activity by reversible and irreversible inhibitors. Effects of these inhibitors on enzyme kinetic parameters and the detection of type of inhibitors through Lineweaver Burke and Eadie Hofstee plots. Introduction to the nomenclature of enzymes and names of enzymes that are important drug targets/have diagnostic value and the reactions they catalyze (structures included) (Thymidylate synthase, DHFR, ACE, Renin, HMGCoA reductase, cyclcooxygenase, MAO, COMT, 14-alpha demethylase, aromatase, squalene epoxidase, DNA polymerase, Reverse transcriptase, protease, carbonic anhydrase, proton pump ATPase, acetylcholinesterase, telomerase, SGOT, SGPT, LDH, HIV protease, HIV reverse transcriptase, DNA polymerase, cell wall synthesis enzymes.). Examples of drugs modulating enzyme activity (inhibitors) that are used as drugs with emphasis on the inhibition mechanism. Endogenous regulation of enzyme activity (compartmentalization, positive and negative feedback, cascade systems (phospholipase based cascade as an example), repression/induction through repressor/promoter elements (the lac operon), post-translation modification to control enzyme activity (protein kinases).	14
3	**Vitamins** Vitamins as co-enzymes and their significance. Metals as co-enzymes and their significance. Biochemical roles of all the vitamins with details of the mechanisms of their functions. (riboflavin, thiamine, pyridoxal, nicotinamide, biotin, folic acid, ascorbic acid, pantothenic acid, cyanocobolamine, inositol, vitamins A, D, E, K)	14
4	**Biochemical Energetics** Introduction to the concept of free energy, standard free energy, transformed free energy. Thermodynamically favorable or unfavorable reactions. Spontaneous versus thermodynamically favorable reactions. Oxidations as a source of energy in biological systems. ATP, NADH and FADH2 as energy carriers. Introduction	6

	to the concepts of anabolism and catabolism. Convergence of metabolic pathways and divergence of anabolic pathways	
5	**Digestion** Digestion of food and absorption of food (carbohydrates, lipids and carbohydrates). Fate of absorbed nutrients and relationship with regard to immediate use, storage, release and interconversion. Role of liver, kidney, muscle, adipose tissue, brain and special features of rbcs.	3
	Total	55

Books

1. Lehninger, Principles of Biochemistry, Replika Press.

2. Stryer L, Biochemistry, W. H. Freeman & Co.

3. Harper's Biochemistry, Appleton and Lange, USA.

4. Conn E, Stumpf PK, Brueing G and Doi Roy H, Outlines of Biochemistry, Wiley Liss, USA.

5. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Willliams and Wilkins, USA

6. Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins, USA.

Pharmaceutics I **4 hrs/week**

Sr. No.	Topic	Hours
1	a) Historical back ground of the Profession of Pharmacy in India in brief b) Brief overview of status of Pharmaceutical Industry in India	1
2	Introduction to Pharmacopoeias: Development of Indian Pharmacopoeia and other compendia including B.P,U.S.P-NF, Ph. Eur, International Pharmacopoeia	2
3	a) Definition of drug and concept of dosage form & formulation-Scope of Pharmaceutics. b) Introduction to route of administration and physiological considerations c) Classification of dosage form and their applications	4
4	Drug Administration: Introduction to absorption, distribution and fate of drug. Introduction to Bioavailability and Biopharmaceutics. Concept of drug efficiency and dose response.	3
5	Pharmaceutical calculations: Reduction and enlargement of formulae, formula by weight(w/v, w/w, v/v), in parts	2
6	Introduction to Good Manufacturing Practices and Quality Assurance	2
7	Introduction to alternate systems of medicine: Ayurveda, Homeopathy, Unnani and Siddha	1
8	Rheology: definition and concept, types of flow, and measurement of flow properties	3
9	Concept of Monophasic liquid dosage forms:-Preformulation and Formulation Aspects: a) Organoleptic properties, Purity, Solubility and solubilisation technique, Dissociation and Partition coefficient, Polymorphism, Stability and Interaction with excipients. b) General consideration of liquid dosage form design & manufacture: Selection of vehicle, stabilizing and organoleptic additives, large scale manufacturing including unit operations like liquid mixing, filtration and clarification-concept and equipments, filling operations, packaging and quality control tests. c) Brief coverage of various monophasic liquid dosage forms: Solutions, Aromatic waters, Syrups, Elixirs, Linctuses, Nasal and Ear drops, Paints, Sprays, Lotions & Liniments. d) Packaging of Pharmaceuticals-General concepts: Package and its components, containers and types of containers, closures and types of closures, packaging material- glass, plastic, metal, rubber and paper, quality control tests.	15
10	Micromeritics & Powder Technology a) Fundamental and derived properties of powders and their measurement b) Size Reduction c) Size separation d) Formulation, Large scale manufacturing (including powder mixing), Packaging and Quality Control of powders. e) Brief coverage of following powders : Dusting powders, Oral Rehydration	10

	powders, Dry Syrup formulations	
11	Complexation : Classification of complexes, Pharmaceutical applications of complexation and Analysis of Complexes	2
12	Diffusion & Dissolution a) Fick's laws and steady state diffusion, measurement of diffusion b) Dissolution rate, Noyes – Whitney equation, Factors affecting dissolution, Intrinsic Dissolution Rate, Hixson – Crowell Law	3
	TOTAL	48

Books

2. Lachman Leon, Lieberman Herbert A, Kanig Joseph L., "The Theory and Practice of Industrial Pharmacy, Varghese Publishing House, Mumbai.
3. Lieberman Herbert A., Rieger, "Pharmaceutical Dosage Forms – Dispersed Systems", Volume 1/2/3, Marcel Dekker Inc, New York.
4. Remington, The Science and Practice of Pharmacy, Vol I & II, B.L. Publications Pvt. Ltd.
5. Martin A., Physical Pharmacy, 4th Edition, Lea &Febiger, Philadelphia, London.
6. M.E. Aulton, Ed, Pharmaceutics-The Science of Dosage Form Design, Churchill Livingstone Medical Divn. Of Longman Group, UK Ltd.
7. Rawlings, Bentley's Text Book of Pharmaceutics, Bailliere Tindall, London.
8. Atmaram Pawar, "Introduction to Pharmaceutics", Career Publications, Nashik.

Physical Pharmacy – II **3 hrs/week**

Sr. No	TOPICS	HOURS
1.	**Ionic equilibria and buffers** ▪ Arrhenius Theory, Bronsted – Lowry Theory, Lewis Electronic Theory ▪ Sorensens pH scale, calculation of pH, effect of pH on ionization of weak acids and bases, calculation of fraction unionized ▪ Buffers in pharmaceutical and biological systems, concept of tonicity, isotonic buffer solutions, application of buffers and concept of tonicity in pharmacy ▪ Problems	**5**
2.	**Solubility and distribution phenomenon** ▪ Solvent – solute interactions ▪ Solubility of gases in liquids, Henry's law and applications ▪ Solubility of liquids in liquids, miscible and partially miscible liquids ▪ Phase equilibria and Phase rule (one, two and three component systems) ▪ Solubility of solids in liquids, ideal and non ideal solutions, solubility parameters and prediction of solubility in regular solutions ▪ Partition phenomenon and partitioning of weak electrolytes and applications	**6**
3.	**Chemical kinetics** ▪ Molecularity, order of a reaction and specific rate constant ▪ Zero order, First order and Second order reaction (problems) ▪ Methods to determine order of a reaction ▪ Energy of activation, Arrhenius equation and application ▪ Collision theory and transition state theory ▪ Accelerated stability studies – concepts and application ▪ Problems	**8**
4.	**Interfacial phenomena** ▪ Surface tension, Interfacial tension, Surface free energy, Pressure differences across curved interfaces, Measurement of surface and interfacial tension-capillary rise method ▪ Drop weight method, Du Nuoytensiometer method, Spreading of liquids, Spreading coefficient, Hydrophilic-Lipophilic balance ▪ Types of monolayers at liquid interfaces, Soluble monolayers, Gibbs adsorption equation (No derivation), Insoluble monolayers and film balance, Adsorption at solid interfaces, Adsorption isotherms, Freundlich adsorption isotherm, Langmuir adsorption isotherm, Wetting angle and contact angle ▪ Problems	**8**
5.	**Electromotive force** ▪ Electrochemical cell ▪ Types of electrodes ▪ Nernst equation and cell emf ▪ pH meter and measurement of pH ▪ Ion sensitive electrodes ▪ Oxidation reduction indicators ▪ Concentration cells	**4**
6.	**Colloids** ▪ Classification, ▪ Preparation, colloid properties such as optical, kinetic and electrical ▪ Gold number ▪ Protective colloid ▪ Schultz Hardy rule	**5**

	TOTAL	**36**

Books

1. P. J. Sinko, 'Martin's Physical Pharmacy and Pharmaceutical Sciences', Lippincott Williams and Wilkins, Indian Edition distributed by B. I. Publications Pvt. Ltd.
2. Bahl and Tuli, 'Essentials of Physical Chemistry' S. Chand and Company Ltd. Ramnagar, New Delhi.
3. U. B .Hadkar,' A Textbook of Physical Pharmacy', Nirali Prakashan, Pune.
4. U. B. Hadkar, T. N. Vasudevan and K. S. Laddha, 'Practical Physical Pharmacy', Yucca Publishing House, Dombivali.
5. A. Findlay, 'Practical Physical Pharmacy' revised and edited by J.A. Kitchener, Longmans, Green and company Ltd.

Anatomy, Physiology and Pathophysiology – II **4 hrs/week**

Sr.no.	Details	Hours
1.	Principles of cell injury and adaptation • Causes of cell injury • Pathogenesis and morphology of cell injury. • Cellular adaptation • Cellular atrophy and hypertrophy.	3
2.	Disturbances of growth of cells • Differences between benign and malignant tumor • Classification of malignant tumors • Etiology and pathogenesis of cancer- Invasion, metastasis and patterns of spread of cancer.	3
3.	Biological effects of radiation • Nuclear radiation • U.V. radiation. • X-ray and other radiations.	2
4.	Anatomy and Physiology of Respiratory System • Exchange of gases • External and internal respiration • Mechanism and regulation of respiration • Lung volumes and lung capacities	4
5.	Pathophysiology of following diseases • Asthma • Pneumonia • Bronchitis • Emphysema • Respiratory Acidosis and Alkosis	2
6.	Endocrine System Anatomy and physiology of following endocrine glands : • Pituitary • Thyroid & Parathyroid • Adrenal • Pancreas	9
7.	Pathophysiology of hypo and hyper secretion of above endocrine glands and related diseases	4
8.	Nervous System Neurons, Neurotransmitter and neurotransmission Anatomy and physiology of **:** • Central Nervous System (CNS) - Autonomic Nervous System (ANS) - Cranial and spinal nerves - Sensory and Motor pathways	9
9.	Pathophysiology of following diseases • Epilepsy • Parkinsonism • Alzheimer's Disease • Cerebral Hypoxia • Stroke (Cerebrovascular disease) • Anxiety & Depression • Mania and Schizophrenia	3

10.	Structure and Function of following sensory organs • Eye • Ear • Tongue • Nose • Skin	6
	Total	**45**

Books

Latest editions of the following books can be referred

1. Ross & Wilson, Anatomy & Physiology in Health & Illness by Anne Waugh and Allison Grant, Published by Churchill Livingstone

2. Gerard J. Tortora & Bryan Derrickson, Principals of Anatomy & Physiology, Published by John Wiley and Sons, Inc.

3. A. C. Guyton & J. E. Hall, Textbook of Medical Physiology, Published in India by Prism Books Ltd. on arrangement with W. B. Saunders Company, USA.

4. McNaught & Callander, Illustrated Physiology by B. R. Mackenna & R. Callander, Published by Churchill Livingstone

5. Kaplan, Jack, Opheim, Toivola, Lyon, Clinical Chemistry: Interpretation & Techniques

6. Praful B. Godkar, Textbook of Medical Laboratory Technology, Published by Bhalani Publishing House, Mumbai, India

8. Harsh Mohan, Text book of Pathology, Published by Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi

Pharmaceutical Chemistry Lab. I **4 hours / week**

1. The background and systematic qualitative analysis of inorganic mixtures of up to four radicals.
2. Six mixtures to be analyzed, preferably by semi-micro methods.
3. Identification tests for pharmacopoeial inorganic pharmaceuticals and qualitative tests for cations and anions should be covered.

Pharmaceutics Lab. - I **4 hrs./week**

List of experiments

Aromatic waters

Chloroform water I.P.'66.
Concentrated Dill water I.P.'66.
Concentrated Anise water B.P.C. '73.
Gripe water.

Syrups

Syrup I.P.'66
Artificial syrup
Cough syrup-Codeine phosphate syrup B.P.C.

Linctus

Simple linctus B.P.C.

Elixirs

Piperazine citrate elixir B.P.C.

Ear drops

Chloramphenicol ear drops B.P.C.

Nasal drops

Ephedrine sulphate nasal drops B.P.C.

Glycerites

Glycerine of starch I.P.'55
Glycerine of boric acid I.P.'55
Glycerine of tannic acid I.P.'66

Solutions

Aqueous iodine solution I.P.'66
Paracetamol solubilised paediatric drops
Cresol with soap solution I.P.
Magnesium citrate oral solution NF XIV.
Chlorinated soda solution, surgical B.P.C.
Iodine paint compound B.P. C.'68.

Powders

Oral rehydration salt (ORS)
Evaluation of a)liquids for specific gravity and viscosity and b) powders for bulk density, flow rate and angle of repose

Physical Pharmacy Laboratory. II **4 hrs/week**

Kinetics:

1. Relative strength: Hydrochloric acid/Sulphuric acid
2. Second order reaction (saponification)
3. Determination of order by equal fraction method (first order reaction)
4. Ostwald's isolation method to determine order

Non-kinetics

1. Surface tension – 1. Determination of surface tension of water, toluene, n – hexane, parachor and critical solution temperature determination. 2. Determination of CMC
2. Phenol water – Critical solution temperature and composition
3. Determination of molecular weight of a polymer from solution viscosity
4. Adsorption – Surface area determination

Demonstrations

1. HLB of a surfactant
2. Potentiometry – Titration and Determination of buffer capacity

Books

1. U.B. Hadkar, T. N. Vasudevan, K S. Laddha, 'Practical Physical Pharmacy', Yucca Publishing House, Dombivali.

AC 27/2/2013 Item no 4.86

UNIVERSITY OF MUMBAI

Revised Syllabus

Program: B.Pharm

Semester III & IV

(Credit Based Semester and Grading System
with effect from the academic year 2013–2014)

S. Y. B. Pharm.

Syllabus Framework

No	Semester- III	Credits	Contact hrs/week	Weightage		Marks
	Subject			**Continuous internal assessment**	**End Semester Examination**	
1	Organic Chemistry - I	4	4	30	70	100
2	Biochemistry-II	4	4	30	70	100
3	Dispensing Pharmacy	3	3	30	70	100
4	Pharmaceutical Engineering	3	3	30	70	100
5	Anatomy, Physiology and Pathophysiology- III	3	3	30	70	100
6	Mathematics	3	3	30	70	100
	Total	**20**	**20**	**180**	**420**	**600**
	Practicals					
7	Organic Chemistry Lab - I	2	4	15	35	50
8	Biochemistry Lab	2	4	15	35	50
9	Dispensing Lab	2	4	15	35	50
	Total	**6**	**12**	**45**	**105**	**150**
	Total Teaching Hrs.		**32**			
	Total Credits	**26**				
	Total Marks			**225**	**525**	**750**

No.	Semester IV					
1	Organic Chemistry-II	3	3	30	70	100
2	Pharmaceutical Analysis- I	3	3	30	70	100
3	Pharmaceutics -II	3	3	30	70	100
4	Microbiology	3	3	30	70	100
5	Pharmacology - I	3	3	30	70	100
6	Mathematics and Statistics	3	3	30	70	100
	Total	**18**	**18**	**180**	**420**	**600**
	Practicals					
7	Pharmaceutical Analysis Lab- I	2	4	15	35	50
8	Pharmaceutics Lab- II	2	4	15	35	50
9	Pharmacology Lab- I	2	4	15	35	50
10	Microbiology Lab	2	4	15	35	50
	Total	**8**	**16**	**60**	**140**	**200**
	Total Teaching Hrs.		**34**			
	Total Credits	**26**				
	Total Marks			**240**	**560**	**800**

S. Y. B. Pharm.

Scheme of Examination

No	Semester- III	No of papers	End Semester Examination			Internal Assessment			Maximum marks	Minimum marks for passing the subject
						Periodic Test		Continuous Evaluation		
	Subject - Theory		**Duration (hrs)**	**Maximum marks**	**Minimum for passing**	**Duration (hrs)**	**Maximum marks**	**Maximum marks**		
1	Organic Chemistry - I	1	3	70	28	1	15	15	100	40
2	Biochemistry - II	1	3	70	28	1	15	15	100	40
3	Dispensing Pharmacy	1	3	70	28	1	15	15	100	40
4	Pharmaceutical Engineering	1	3	70	28	1	15	15	100	40
5	Anatomy, Physiology and Pathophysiology - III	1	3	70	28	1	15	15	100	40
6	Mathematics	1	3	70	28	1	15	15	100	40
	Practicals									
7	Organic Chemistry Lab - I	1	4	35	14	4	8	7	50	20
8	Biochemistry Lab	1	4	35	14	4	8	7	50	20
9	Dispensing Lab	1	4	35	14	4	8	7	50	20

No	Semester- IV	No of papers	End Semester Examination			Internal Assessment			Maximum marks	Minimum marks for passing the subject
						Periodic Test		Continuous Evaluation		
	Subject - Theory		**Duration (hrs)**	**Maximum marks**	**Minimum for passing**	**Duration (hrs)**	**Maximum marks**	**Maximum marks**		
1	Organic Chemistry-II	1	3	70	28	1	15	15	100	40
2	Pharmaceutical Analysis - I	1	3	70	28	1	15	15	100	40
3	Pharmaceutics - II	1	3	70	28	1	15	15	100	40
4	Microbiology	1	3	70	28	1	15	15	100	40
5	Pharmacology - I	1	3	70	28	1	15	15	100	40
6	Mathematics and Statistics	1	3	70	28	1	15	15	100	40
	Practicals									
7	Pharmaceutical Analysis Lab - I	1	4	35	14	4	8	7	50	20
8	Pharmaceutics Lab - II	1	4	35	14	4	8	7	50	20
9	Pharmacology Lab - I	1	4	35	14	4	8	7	50	20
10	Microbiology Lab	1	4	35	14	4	8	7	50	20

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Syllabus

Semester III

Organic Chemistry – I **4 hrs/week**

Unit	Topics	Hours
1.	Basic concepts	11
1.1	Electronegativity, Inductive effect, Dipole moment, Polarizability	1
1.2	Resonance in aliphatic and aromatic systems: Rules of resonance, Stability of the resonating structures	2
1.3	Tautomerism (including types of tautomerism), Hyperconjugation	2
1.4	Reactive Intermediates in Organic Chemistry: Electrophiles and Nucleophiles (including charged and neutral species), Carbocations, Carbanions, Carbenes and Carbon radicals: Geometry, stability and properties. Concept of leaving groups, alkyl shift, migratory aptitude.	3
1.5	Acidity and Basicity (Excluding discussion of acidity and basicity of heterocyclic compounds).	3
1.6	Basics of mechanism writing using curved arrows-Homolytic, Heterolytic, Homogenic, Heterogenic.	
2.	Nomenclature of multifunctional organic compounds.	6
2.1	Writing common names of some common compounds.	
2.2	Writing IUPAC nomenclature of compounds containing multiple functional groups, use of priority charts.	
2.3	Writing structures of compounds containing multiple functional groups given the Nomenclature.	
2.4	Nomenclature of stereo isomers including cis/trans, D/L, E/Z and R/S designations.	
3.	Stereochemistry-I	9
3.1	Concept of configuration and chirality, axis of symmetry, plane of symmetry, centre of symmetry, representation of molecules by the use of projection formulae: Fischer, Wedge, Sawhorse and Newman.	2
3.2	Geometric isomerism: Methods of determination of configuration of geometric isomers, Optical isomerism: Enantiomers and diastereoisomers, Resolution of a racemic mixture, Atropisomerism in biphenyls.	2
3.3	Stereospecificity and stereoselectivity in organic reactions: S_N1, S_N2, E1, E2 and E1cb reactions, syn and anti additions of H_2 to alkynes, addition of halogens (X_2),Halogens in water (X_2 and H_2O), $KMnO_4$, OsO_4 and alkaline H_2O_2 to alkenes, Hydroboration-Oxidation, Oxymercuration-Demercuration of alkenes.	5
4.	Benzene and aromaticity	6
4.1	Concept of aromaticity: Huckel's rule for aromaticity, identification of aromatic, non-aromatic and anti aromatic systems based on planarity, conjugation and Huckel's rule.	1
4.2	Electrophilic Aromatic Substitution: Reactions of benzene (with mechanism and structures of intermediate/s involved) like nitration, sulphonation, protonation, halogenation, Friedel-Crafts alkylation and acylation. Classification and influence of substituent groups on orientation and reactivity, orientation in disubstituted benzenes.	3
4.3	Nucleophilic Aromatic Substitution: Bimolecular displacement mechanism with evidence, reactivity and orientation in nucleophilic aromatic substitution, Elimination-Addition mechanism.	2
5.	Functional group Chemistry	16
	Discussion of the following classes of compounds in brief, with regard to sources, methods	

	of preparation, general reactions with mechanism.	
5.1	Alkanes: Physical properties, Preparation of alkanes: Hydrolysis of Grignard reagent, reduction of alkyl halides by metal and acid, Corey House reaction, Wurtz reaction; Reactions: halogenation of alkanes (Mechanism and orientation)	2
5.2	Alkenes: Physical properties, Preparation of Alkenes: Dehydrohalogenation of Alkyl halides (Mechanism and orientation of E1 and E2), dehydration of alcohols, dehalogenation of vicinal dihalides, conversion of aldehydes and ketones to alkenes (Wittig reaction, Peterson reaction, Shapiro reaction). Reactions: Addition of H_2, HX (Markovnikov and Anti-Markovnikov), H_2SO_4, H_2O, free radicals, alkenes (dimerization), alkanes (Alkylation), ozonolysis, Michael addition, Simmons-Smith reaction, epoxidation, halogenation by allylic substitution.	6
5.3	Dienes: Resonance in conjugated dienes, electrophilic addition to conjugated dienes: 1, 2 and 1, 4 additions.	1
5.4	Alkynes: Physical properties, Preparation of alkynes: dehydrohalogenation of alkyl dihalides, reaction of metal acetylides with primary alkyl halides; Addition reactions: Addition of X_2, addition of HX, addition of H_2O (Hydration), formation of metal acetylides.	2
5.5	Alkyl halides: Physical Properties, Preparation: Hunsdieker reaction (other methods are covered under reactions of other functional groups). Reactions: Nucleophilic Aliphatic Substitution reaction (Mechanism, Factors affecting S_N1 and S_N2 reactions to be discussed in detail), SNi reaction.	5
	Conversions to be discussed	
	Total	**48**

Books (Latest Editions to be adopted)

1. Organic Chemistry by R.T. Morrison and R.N.Boyd, 6th edition,Prentice Hall Publications
2. Organic Chemistry by Pine, Stanley H.; Hendrickson, James B.; Cram, Donald J.; Hammond, George S., 4th edition. The Macgraw hill publications
3. Organic Chemistry by I.L. Finar, Vol 1& 2, 6th edition, Pearson education
4. Advanced Organic Chemistry: Reactions, Mechanisms, Structures by Jerry March, John Wiley and sons
5. Organic Chemistry, Part A: Structures and Mechanism, Part B: Reactions and Synthesis, Francis and Carry, Richard J Sundberg. Springer publications
6. A Guidebook to Mechanism in Organic Chemistry, 6th edition, Peter Sykes, Pearson Education
7. Peter Sykes, Essentials of Organic chemistry by Paul M Dewick, Wiley, Pine
8. Essentials of Organic chemistry by Paul M Dewick, Wiley
9. Eliel, Kalsi, Organic Chemistry by L.G.Wade, Jr., Maya Shankar Singh, Pearson Education, 6th Ed, Organic Chemistry, 2nd Ed., Thomas Sorrell, University Science Books
10. Stereochemistry: Conformation and Mechanism, b) Organic Reactions And Their Mechanisms. By P. S. Kalsi. New age International
11. Organic Chemistry through Solved Problems, *Goutam Brahmachari*. Edition, Morgan & Claypool
12. Organic Name Reactions: A Unified Approach. *Goutam Brahmachari. Alpha Science publications*

Biochemistry II **4 hrs/week**

Unit	Topics	Hours
1	**Carbohydrate metabolism discussed with respect to the structures of intermediates, enzymes and cofactors, energy yield/requirements and regulation. Examples of drugs modulating carbohydrate metabolism.**	**12**
1.1	Glycolysis (Embden Meyerhoff Pathway), TCA cycle (Kreb's Cycle, Citric acid Cycle) and glyoxalate shunt. Entry of sugars other than glucose into glycolytic pathway. Discussion of shuttle systems to transfer NADH to the mitochondria.	04
1.2	Electron Transport Chain discussed with respect to the components of the ETC, explanation of oxidative phosphorylation vs substrate level phosphorylation. Discussion of proton motive force and generation of ATP using proton gradients. Discussion of uncouplers of oxidative phosphorylation.	04
1.3	Discussion of pentose phosphate pathway, glycogenesis, glycogenoysis, gluconeogenesis and other systems involved in carbohydrate metabolism	04
2.0	**Lipid metabolism discussed with respect to the structures of intermediates, enzymes and cofactors involved, energy yield/requirements and regulation.**	**08**
2.1	Beta oxidation pathway for catabolism of saturated and unsaturated even number fatty acids, catabolism of odd number carbon containing fatty acids, formation of ketone bodies,	03
2.2	Acetate mevalonate pathway to cholesterol biosynthesis,	02
2.3	Biosynthesis of fatty acids and phospholipids.	02
2.4	Examples of drugs modulating lipid/cholesterol metabolism.	01
3	**Nucleic Acid Metabolism discussed with respect to the structures of intermediates, enzymes and cofactors, energy yield/requirements and regulation**	**08**
3.1	Discussion of biosynthesis of purines.	03
3.2	Discussion of biosynthesis of pyrimidines.	02
3.3	Salvage pathways for nucleic acid metabolism. Examples of drugs modulating purine/pyrimidine biosynthesis.	03
4	**DNA replication**	**08**
4.1	Details of DNA replication, differences between prokaryotes/eukaryotes. Brief description of telomeres and telomerase activity. DNA polymorphisms and SNPs. Examples of drugs modulating these pathways (polymerase inhibitors, telomerase inhibitors, topoisomerase inhibitors) and polymorphisms involved in disease states.	04
4.2	Discussion of solid phase DNA synthesis, DNA synthesizers and comparison between biosynthesis and chemical synthesis.	02
4.3	Discussion of DNA sequencing (Sanger dideoxy method)	02
5	**Protein biosynthesis**	**10**
5.1	Details of DNA transcription and RNA translation. Transcriptional and translational differences in prokaryotes and eukaryotes especially with respect to post-transcriptional and post-translational modifications. Examples of drugs modulating these pathways with emphasis on protein synthesis inhibitors used as drugs.	06
5.2	Discussion of solid phase peptide synthesis, peptide synthesizers and comparison between biosynthesis and chemical synthesis.	02
5.3	Discussion of peptide sequencing (Edman method and its automation). Utility of peptidases and chemical agents to cleave proteins in preparation for sequencing.	02
	Total	**48**

Books

1. Lehninger, Principles of Biochemistry, Replika Press.
2. Stryer L, Biochemistry, W. H. Freeman & Co.
3. Harper's Biochemistry, Appleton and Lange, USA.
4. Conn E, Stumpf PK, Brueing G and Doi Roy H, Outlines of Biochemistry, Wiley Liss, USA.
5. Wilson and Gisvolds Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Willliams and Wilkins, USA
6. Foye's Principles of Medicinal Chemistry, Lippincott Williams and Wilkins, USA.

Dispensing Pharmacy **3 hrs/week**

Unit	Topics	Hours
1.	**Introduction.**	6
1.1	Introduction to compounding and dispensing.	
1.2	Prescription and its parts.	
1.3	Types of prescriptions.	
1.4	Pricing and recording of prescriptions.	
1.5	Types of dispensed preparations.	
1.6	Weights and measures including imperial weights (Apothecary system).	
2.	**General dispensing.**	6
2.1	Fundamentals of compounding and dispensing including good practices.	
2.2	Formulation of dispensed products.	
2.3	Containers and closures/packaging for dispensed products.	
2.4	Storage and stability of dispensed products.	
2.5	Labeling of dispensed preparations.	
2.6	Latin Terms and abbreviations.	
2.7	Preparation of stock solutions.	
2.8	Dispensing of proprietary medicines.	
3.	**Calculations.**	4
3.1	Calculations based on expressions of concentration and dilution (percentage,	
3.2	parts, alligation) ,proof strength.	
3.3	Calculations based on Isotonicity.	
3.4	HLB calculations.	
	Posology.	
4.	**Solutions.**	2
4.1	Solutions taken orally.	
4.2	Solutions used in body cavities.	
4.3	Solutions for external use.	
5.	**Suspensions.**	3
5.1	Suspensions containing diffusible solids.	
5.2	Suspensions containing indiffusible solids.	
5.3	Suspensions containing poorly wettable solids.	
5.4	Suspensions containing precipitate forming liquids.	
5.5	Dispersion of oil in inhalation.	
5.6	Suspensions produced by chemical reaction.	
6.	**Emulsions**	3
6.1	Types of Emulsions.	
6.2	Emulsifying agents.	
6.3	Compounding and preservation of Emulsions.	
6.4	Emulsions for external use (Creams).	
7.	**Ointments, Pastes and Gels.**	3
7.1	Types of Ointment bases.	
7.2	Preparation Of Ointments.	
7.3	Pastes and Poultices.	
7.4	Gels.	
8.	**Dispensed Oral Solid Dosage forms.**	4
8.1	Powders.	
8.2	Granules.	
8.3	Tablet Triturates.	
8.4	Pills.	
8.5	Lozenges and Pastilles.	

8.6	Capsules.	
9. 9.1 9.2	**Suppositories and Pessaries.** Types of Suppository base. Compounding of Suppositories.	2
10. 10.1 10.2	**Incompatibilities.** Physical Incompatibilities. Chemical Incompatibilities.	3
	Total	**36**

Comment on Prescriptions to be covered for all types of formulations listed in the syllabus.

Books

1. Cooper and Gunns Dispensing for Pharmaceutical Students, Edns. 11 and 12; Edited by S.J.Carter, Indian Edition, CBS Publishers, Delhi.
2. Pharmaceutical Practice; Edited by D.M.Collet and M.E.Aulton; Churchill Livingstone, ELBS Edition, 1991.
3. Pharmaceutical Practice Edited by A.J.Winfield and R.M.E. Richards, Second Edition, Churchill Livingstone, 1998.
4. Pharmaceutical Practice; Edited by A.J. Winfild and R.M.E. Richards, Third Edition, Churchill Livingstone, 2004.
5. Husa's Pharmaceutical Dispensing, Edited by Eric Martin, Sixth Edition, Mack Publishing Company, 1996.
6. Pharmaceutical Calculations, A.C. Ansel and M.J.Stoklosa, Lippincott Williams and Wilkins, 2006.
7 Pharmaceutical Calculations – Bradley, Gustafson and Stoklosa, Third Edition, Lea and Febiger, 1957.

Pharmaceutical Engineering 3 hrs/week

Coverage: Only theory, principles, equipments and pharmaceutical applications to be covered. Mathematical derivations and numerical problems are not within the scope.

Unit	Topics	Hours
1	**Fluid flow**	3
1.1	Mention fluid properties such as viscosity, compressibility and surface tension of fluids. Hydrostatics influencing fluid flow. Fluid dynamics- Bernoulli's theorem, flow of fluids in pipes, laminar and turbulent flow.	
2	**Fluid and pressure measurements**	4
2.1	• Measurement of flow- Classification of flow meters, venturimeter, orificemeter, pitot tube, rotameter and current flow meters.	2
2.2	• Pressure measurement- Classification of manometers, simple manometer, U tube manometer and modifications, Bourdon gauge.	2
3	**Pumps:**	2
3.1	• Positive displacement pumps-reciprocating pumps, rotary pumps.	1
3.2	• Centrifugal pumps	1
4	**Heat and Mass transfer**	4
4.1	• Modes of heat transfer- conduction, convection and radiation, Heat exchangers-tubular and plate, Temperature measurement-basic principles and devices Mass transfer in turbulent and laminar flow	3
4.2	• Concept of interfacial mass transfer	1
5	**Conveying of solids**	1
	• Belt conveyor, Bucket conveyor, Screw conveyor and Pneumatic conveyor.	
6	**Crystallization**	6
6.1	• Crystal forms and crystal habits, Theory of crystallization-Supersaturation-Mier's theory of supersaturation, Nucleation, Crystal growth.	2
6.2	• Crystallizers- Classification, Tank crystallizers, Agitated tank crystallizers, Swenson Walker crystallizer, Vacuum crystallizer and its modifications, Krystal or Oslo crystallizer.	3
6.3	• Factors affecting crystallization and Caking of crystals	1
7	**Evaporation:**	4
7.1	• Introduction, factors influencing rate of evaporation, including scale formation, Evaporators classification- Pan evaporators, Tubular evaporators (Horizontal tube evaporator, Vertical tube evaporators- short tube vertical evaporator, Multiple effect evaporator, Long tube evaporators -Climbing film evaporator, Falling film evaporator, Forced circulation evaporator,) Wiped film evaporator , Centrifugal rotary evaporator.	2
7.2	• Evaporator accessories- condensers, vacuum pumps, expansion and bucket traps, entrainment separators	2
8	**Distillation:**	6
8.1	• Revision of Vapour-liquid equilibrium,Distillation methods- Equilibrium distillation, Simple distillation	1
8.2	• Fractional distillation- Theory of batch fractionation, Columns (only construction and working) Bubble cap, sieve plate columns, packed columns. Concept of plate efficiency and HETP (no detailed theories and derivations).	3
8.3	• Distillation under reduced pressure- Theory of molecular distillation and	2

	equipments. Falling film and centrifugal molecular distillation still, applications. Azeotropic and Extractive distillation- Theory and applications. Steam distillation- Theory and applications	
9	**Refrigeration:** • Refrigeration –equipment and concept of refrigeration load, concepts of brine systems and absorption systems.	1
10 10.1	**Materials of construction and Corrosion:** • Classification into metals and non-metals. Ferrous and its alloys-cast iron, mild steel and stainless steel. Copper and its alloys. Nickel and its alloys. Aluminium and its alloys. Plastics- Classification into thermoplastics and thermosetting plastics, properties and applicationsof polyvinyl chloride, polyethylene, polyporopylene, polystyrene, polyester, ABS, phenolic and epoxy plastics, fluorocarbon plastics, chlorinated plastics and polycarbonated plastics.	5 2
10.2	Corrosion: • Mechanism and types of corrosion. Factors influencing rate of corrosion. Methods of combating corrosion.	3
11	**Industrial Hazards and safety regulations:** • Mechanical hazards and prevention. • Electrical hazards and prevention • Chemical hazards and prevention • Fire hazards and extinguishers	2
	Total	**38**

BOOKS (Latest editions of all books to be referred)

1. K. Sambamurthy, Pharmaceutical Engineering, New age international (P) Limited Publishers, 1998.
2. Dr. A. R. Paradkar, Introduction to Pharmaceutical Engineering, 10th Edition, Nirali Parakashan, 2007.
3. James Swarbrick & James C. Boylon, Encyclopedia of Pharmaceutical Technology, Marcel Dekker, INC, New York, 1994.
4. Walter I. Badger & Julius T. Bancher, Introduction to Chemical Engineering, Mc Graw Hill Inc, 1995.
5. M. E. Aulton, Ed, Pharmaceutics-The Science of Dosage Form Design, Churchill Livingstone Medical Division Of Longman Group UK Ltd, 2002.
6. S. J. Carter, Cooper and Gunn's Tutorial Pharmacy, 6th Edition, CBS Publishers & Distributors, New Delhi, 2005.
7. Robert H. Perry, Don W. Green, Perry's Chemical Engineers Handbook,7th Edition, Don W. Green, James O. Maloney, McGraw Hill,1997.
8. G. K. Jani, Pharmaceutical Engineering, Vallabh Prakashan.

Anatomy, Physiology and Pathophysiology- III **3 hrs/week**

Unit	Topics	Hours
1.	Reproductive system - Anatomical and Physiological considerations of male and female reproductive system - Reproductive and endocrine functions of testes and ovaries - Menstrual cycle	4
2.	Pathophysiology of following diseases - Infertility - Sexually transmitted diseases (STD) - Dysmenorrhea	2
3.	Cardiovascular System - Functional anatomy of heart - conducting system of heart - cardiac cycle, Electrocardiogram (ECG) -Physiology of blood circulation - Functional anatomy of blood vessels - Blood pressure and factors regulating blood pressure - Baroreceptors, chemoreceptors, vasomotor center - Humoral and neuronal control of blood pressure and circulation	8
4.	Pathophysiology of following diseases - Hypertension - Congestive Cardiac Failure - Cardiac Arrhythmia - Angina Pectoris - Ischemic Heart Disease - Arteriosclerosis/Atherosclerosis	4
5.	Urinary system - Anatomy and Physiology of Urinary System - Formation of urine - water balance, electrolyte balance & acid – base balance	5
6.	Formation of body fluids and fluid compartments.	3
7.	Pathophysiology of following diseases - Renal failure - Glomerulonephritis - Renal calculi / kidney stones - Urinary Tract Infections (UTI)	3
8.	Digestive System - Anatomy and physiology of digestive system - Digestion and absorption of carbohydrates, proteins and fats	6
9.	Pathophysiology of following diseases - Peptic ulceration - Zollinger – Ellison's Syndrome -Inflammatory Bowel Disease (Ulcerative colitis, Crohn's disease) - Cholecystitis & Cholelithiasis - Jaundice - Hepatitis - Pancreatitis - Achalasia - Reflux esophagitis	3
	Total	**38**

Books Latest editions of the following books to be referred

1. Ross & Wilson

Anatomy & Physiology in Health & Illness by Anne Waugh and Allison Grant, Published by Churchill Livingstone

2. Gerard J. Tortora & Bryan Derrickson, Principals of Anatomy & Physiology, Published by John Wiley and Sons, Inc.
3. A. C. Guyton & J. E. Hall, Textbook of Medical Physiology, Published in India by Prism Books Ltd. on arrangement with W. B. Saunders Company, USA.
4. McNaught & Callander, Illustrated Physiology by B. R. Mackenna & R. Callander, Published by by Churchill Livingstone
5. Kaplan, Jack, Opheim, Toivola, Lyon, Clinical Chemistry: Interpretation & Techniques
6. Praful B. Godkar, Textbook of Medical Laboratory Technology, Published by Bhalani Publishing House, Mumbai, India
8. Harsh Mohan, Text book of Pathology, Published by Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi

Mathematics **3 hrs/week**

Unit	Topics	Hours
1	**Differential Calculus**	05
1.1	Successive Derivatives	
1.2	Lebnitz's Rule fourth derivative	
1.3	Lagrange's and Rolle's Mean Value Theorems (Statements only)	
1.4	Taylors and Maclaurins Series (No proof) with application	
2	**Partial Differentiation**	05
2.1	Functions of two or three variables	
2.2	Change of variables	
2.3	Application to errors, maxima and minima	
3	**Integral Calculus**	**07**
3.1	Integration by parts	
3.2	Properties of definite integrals and reduction formulae	
3.3	Determination of the length of the curve, are and volume	
4	**Differential Equations**	**07**
4.1	Formation of differential equations	
4.2	Solution of first-order and first-degree equations	
4.3	Linear differential equations of higher order with constant coefficients	
4.4	Simple applications to chemical reactions and biopharmaceutics	
5	**Determinants and Matrices**	07
5.1	Properties of determinants and applications	
5.2	Solution of simultaneous equations with three variables by Cramers method	
5.3	Types of matrices, inverse of matrix, rank of a matrix, eigen value and eigen vectors	
5.4	Caley Hamilton Theorem	
6.0	**Numerical Methods**	06
6.1	Finite difference operators (delta and E)	
6.2	Interpolation of equal and unequal intervals – Newtons method and Lagrange method	
6.3	Numerical integration – Trapezoidal rule, Simpsons $1/3^{rd}$ and $3/8^{th}$ rules	
	TOTAL	**37**

Books – Latest Editions to be adopted

1. Mathematics for Pharmacy Students (Vol. 1), Gujar, K. N., Bhavale Ashok, Career Publications.
2. Differential Calculaus; Nareyan, S., S. Chand Publication
3. Applied Mathematics – I, Baphana R. M., Techmax Publication.
4. Textbook of Applied Mathematics, Vols. I and II, Wartikar, P. N. Pune Vidyarthi Griha Prakashan.
5. Integral Calculus, Shanti Narayan, S. Chand Publication.
6. A Textbook of Matrices, Shantinarayan, S. Chand Publication.

Practicals

Organic Chemistry Lab. – I **4 hrs/week**

1) Laboratory safety measures to be taken for:
   a. Fire and burns
   b. Spillage
   c. Inhalation of toxic fumes
   d. Dress code in a laboratory
   e. First aid measures to be taken in cases of accidents
   f. Use of fume hood, eye shower, body shower.
2) Organic spotting: Minimum eight samples of mono-functional groups and two samples of bifunctional groups to be taken.
3) Theoretical aspects of physical constant determination, and detection of functional groups.

Books

1. A laboratory hand book of Organic qualitative analysis and separations, V.S. Kulkarni, S.P.Pathak, D. Ramchandra & Co., Pune
2. Text book of organic practical chemistry, V.S. Kulkarni, S.P.Pathak, D. Ramchandra & Co., Pune.
3. R. L. Shriner, R. C. Fuson and D. Y. Curtin, The systematic Identification of Organic compounds, 6th Ed., Wiley, New York, 1980
4. A. I. Vogel, A textbook of practical organic chemistry, 4th edition, Wiely New York, 1978
5. Comprehensive Practical Organic Chemistry: Qualitative Analysis, V.K. Ahluwalia, S. Dhingra, Universities Press (India) Limited, 2000
6. Comprehensive Practical Organic Chemistry: Preparation and Quantitative analysis, V.K. Ahluwalia, Renu Aggarwal, Universitites Press (India) Limited, 2000

Biochemistry Lab. **4 hrs/week**

1. Qualitative tests for carbohydrates and confirmatory tests by ozasone formation
2. Qualitative test and simple color reactions for amino acids and proteins. Precipitation reactions of proteins.
3. Chromatographic separation of amino acids.
4. Quantitative estimation of glucose (Willstaters and Lane & Eynon's methods). Estimation of sucrose. Colorimetric estimation of glucose.
5. Quantitative estimation of proteins by Biuret method and Folin method (one titrimetry and one by colorimetry)
6. Estimation of enzyme activity – ptyline (amylase) in saliva and alkaline phosphatase (including plotting of data to determine Km and Vmax for any one of these enzymes)
7. Quantitative estimation of properties of lipids – acid value, iodine value, saponification value.
8. Quantitative estimation of RNA and DNA.
9. Demonstrations of estimation of blood glucose, SGOT or SGPT using commercial kits (suggest that students should volunteer for fasting and post prandial glucose determinations)
10. Demonstration of isolation of DNA.

Books

1. An Introduction to Practical Biochemistry – Plummer D.T., Tata Mcgraw Hill, N Delhi, India
2. Laboratory Manual In Biochemisty, Jayaraman J, Wiley Easter, N Delhi. India

Dispensing Lab **4 hrs/week**

Dosage form	Representative preparations
1. Solutions	1. Potassium Permanganate Solution 2. Zinc Chloride and Zinc sulphate Mouthwash BPC 1973 3. Sodium Bicarbonate Ear Drops BP 4. Paediatric Ferrous Sulphate Oral Solution BP 1988
2. Suspensions	1. Menthol and Eucalyptus oil inhalation 2. Paediatric Chalk Mixture BP 1988 3. Kaolin Mixture BP 1988
3. Emulsions And Creams	1. Arachis Oil Emulsion 2. Calciferol Emulsion 3. Aqueous Calamine cream IP 2010 4. Medicated cream 5. Buffered Cream BP 1988
4. Ointment	1. Zinc and Castor Oil Ointment BP 1988 / Calamine Ointment IP 2010
5. Gel	1. Lubricating Jelly
6. Paste	1. Compound Zinc Paste BP 1988/ Zinc and Salicylic Acid paste BP 1988 2. Kaolin Poultice BP 1988
7. Powder	1. Bulk Powder : Compound Magnesium trisilicate Oral Powder BP 1988 / Zinc, Starch and Talc Dusting Powder BPC 1973 2. Divided Powder : Hyoscine Hydrobromide Powder 3. Siedlitz Powder
8. Granules	1. Isapguhl Granules 2. Effervescent Granules
9. Tablet triturate	1. Boric acid / Riboflavin tablet triturate
10. Capsule	1. Chlordiazepoxide capsules BP
11. Pills	1. Compound Rhubarb Pills BPC 1960 / Potassium Permanganate Pills
12. Pastilles	1. Medicated Pastille
13. Lozenge	1. Brompton Cough Lozenge BPC 1973 / Compound Bismuth Carbonate Lozenge BPC 1973
14. Suppository	1. Compound Bismuth Subgallate Suppositories BP 1980
15. Incompatability	1. Eutectic Mixture

Books

1. Relevant editions of IP, BP, BPC
2. Cooper and Gunns Dispensing for Pharmaceutical Students, Edns. 11 and 12; Edited by S.J.Carter, Indian Edition, CBS Publishers, Delhi.
3. Pharmaceutical Practice; Edited by D.M.Collet and M.E.Aulton; Churchill Livingstone, ELBS Edition, 1991.
4. Pharmaceutical Practice Edited by A.J.Winfield and R.M.E. Richards, Second Edition (1998), Third Edition (2004) Churchill Livingstone.

Semester IV

Organic Chemistry – II **3 hrs/week**

Unit	Topics	Hours
1.	**Functional Group Chemistry and Molecular Rearrangements**	
1.1	**Aldehydes and Ketones** Methods of preparation :Dry distillation of anhydrides, Oxidation of primary and secondary alcohol, Oxidation of methylbenzene, Reduction of acid chlorides, from Reaction of acid chloride with organocopper. Oxidation with $Ag(NH_3)_2$, $KMnO_4$, $K_2Cr_2O_7$, $NaOH/I_2$, Reduction with H_2/Pt or Ni or Pd, $LiAlH_4$, $NaBH_4$, Clemmesons & Wolf Kishner Reduction, reduction. Nucleophilic additions like Cyanohydrin, Acetal formation, Grignard, Derivatives of ammonia, $NaHSO_3$, organolithium compounds. Condensations with discussion of mechanism of aldol (Acid and Base catalyzed), Mixed aldol, crossed aldol, nitroaldol, retroaldol, Claisen-Schmidt, Halogenation of ketones, Perkin, Knovengeal, Dobener-Knovengeal, Reformatsky, Micheal, Benzillic acid alkylations, Dakin oxidation, Benzoin Condensation, Wittig with Ph_3P, Wolff, Bayer-Villiger Oxidation, Diazomethane reaction, Stobbes, Willgerodt, Favorskii, Cannizzaro reduction. Problems related to above reactions.	7
1.2	**Amines** Methods of preparation : From alkyl halides, Reduction of nitro compounds with Metal/HCl and Na_2S_2/NH_4S_6, Reduction of amides, Reduction of cyanides, Reduction of oximes, Reductive amination, Leukart method, Gabriel-pthalimide method, discussion and Mechanism of Curtius, Lossen, Scmidt rearrangement. Discussion on physical properties Reactions of amines : With acid, with alkyl halides, conversion to amides, Schotten-Baumann technique, ring substitution in aromatic amines, Hoffman elimination from alkylation ammonium, salts. Mechanism of Steven & Sommelet alkylations, Diazotization with mechanism and its application including Sandmeyer reaction mechanism and Gomberg reaction mechanism Problems related to above reactions.	6
1.3	**Carboxylic acids** Methods of alkylation: Oxidation of alcohols, Oxidation of alkylbenzene, from alkylation reagent, hydrolysis of nitriles, malonic ester synthesis of carboxylic acid with alkylation Reactions with Base, with $SOCl_2$, $PCl_3.PCl_5$ SO_2Cl_2, with alcohol, Conversions to amides, Reduction, Hell-Volhard-Zelinsky reaction Condensation reactions like Dieckmann condensation with mechanism. Problems related to all reactions	3
1.4	**Amides** Methods of preparation of amides, imides Reactions of amides: Hoffmann and Beckmann alkylations and its mechanism including transformations. Identification test like diazotization after acidic hydrolysis	2
1.5	**Esters** Methods of preparation Reactions: Basic and acidic hydrolysis of esters with mechanism, conversions to amides, transesterification, reaction with Grignard & organolithium, catalytic hydrogenation of esters, reduction with $LiAlH_4$, Claisen condensation, mixed Claisen, crossed Claisen Problems related to above reactions.	2
1.6	**Alcohols**	2

	Physical Properties, Preparation of alcohols using Grignard synthesis, Aldol Condensation, Reduction of acids, esters carbonyl compounds. Reactions: HX, PX_3, with metal, esterification, oxidation, Pinacol-Pinacolone rearrangement. Problems related to above reactions.	
1.7	**Phenols** Physical Properties. Preparation of Phenols: Hydrolysis of diazonium salts, from aryl sulphonates. Reactions: Ester formation, Electrophilic substitution reaction-Nitration, sulponation, alkylations, Freidel-crafts alkylation, nitrosation, Fries rearrangement, Kolbe-Schimdt reaction, Reimmer-Tiemman reaction, Schotten- Baumann reaction	2
1.8	**Ethers** Physical Properties, Preparation Willimason's synthesis, alkoxymercuration-demercuration, Industrial sources of ethers. Reaction with HX and Wittig reaction	1
2.	**Polycyclic aromatic compounds: naphthalene,anthracene and phenanthrene: preparations and reactions** (Reactions of derivatives not included) Methods of preparation of polycyclic aromatic compounds- : Fittig reaction, Friedel-Crafts reaction, Elbs reaction, Pschorr synthesis, Haworth synthesis for naphthalene and phenanthrene, Stobbe condensation, Bardhan-Sengupta synthesis, Bogert-Cook synthesis, resonance and nomenclature, Reactions of naphthalene- oxidation	3
3.	**Stereochemistry** Conformation of ethane, Butane, Cyclohexane Types of strains: Angle strain, Transannular strain, Bayer strain, Pitzer strain stability, optical activity and conformational analysis of mono and disubstituted cyclohexanes (1,2/1,3/1,4 disubstituted with –OH, -X, t-butyl, -COOH like groups)	6
4.	**Redox Reactions** **Reagents used in Oxidation :** perbenzoic acid, CF_3CO_3H, V_2O_5, lead tetracetate, Al-isopropoxide and reactions using these reagents. **Reagents used in Reduction :** $NaBH_4$, $LiAlH_4$, $SnCl_2$, Na/alcohol, Na/Liq. NH_3, Raney Ni, Na dithionate and reactions using these reagents, Birch reduction	4
	Total	**38**

Books (Latest Editions to be adopted)

1. Organic Chemistry by R.T. Morrison and R.N.Boyd, 6th edition,Prentice Hall Publications
2. Organic Chemistry by Pine, Stanley H.; Hendrickson, James B.; Cram, Donald J.; Hammond, George S., 4th edition. The Macgraw hill publications
3. Organic Chemistry by I.L. Finar, Vol 1& 2, 6th edition, Pearson Education
4. Advanced Organic Chemistry: Reactions, Mechanisms, Structures by Jerry March, John Wiley and sons
5. Organic Chemistry, Part A: Structures and Mechanism, Part B: Reactions and Synthesis, Francis and Carry, Richard J Sundberg. Springer publications
6. A Guidebook to Mechanism in Organic Chemistry, 6th edition, Peter Sykes, Pearson Education
7. Name Reactions: A Collection of Detailed Reaction Mechanisms. Jie Jack LiJi Jack Lee, Springer publications
8. Organic Chemistry, 9th Ed, T. W. Graham Solomons, Craig Fryhle. John Wiley & Sons
9. a) Stereochemistry: Conformation and Mechanism, b) Organic Reactions And Their Mechanisms. By P. S. Kalsi. New age International
10. Organic Chemistry through Solved Problems, *Goutam Brahmachari*. Edition, Morgan & Claypool
11. Organic Name Reactions: A Unified Approach. *Goutam Brahmachari. Alpha Science publications*

Pharmaceutical Analysis – I **3 hrs/week**

Unit	Topics	Hours
1	**Introduction to Pharmaceutical Analysis**	**4**
1.1	• Scope of Pharmaceutical Analysis, Classification of Quantitative Analytical techniques (Instrumental and Non-Instrumental). • **Introduction to pharmacopoeial monograph** - Drug and formulation (As API-Aspirin, Calcium gluconate and Dried aluminium hydroxide gel. formulation-Soluble Aspirin tablets and Calcium gluconate injection).	**2**
1.2	• **Types Of Errors –** Determinate and indeterminate: Causes of errors and ways to minimize them. • **Concept and numerical of –**Mean, Median, Standard deviation, relative standard deviation, Absolute and relative errors, precision, accuracy, significant figures.	**2**
2	**Aqueous acid-base titrations.**	**7**
2.1	• **Theoretical terms*:*** Titrimetric analysis, Titrant, Titrand, Theoretical end point or equivalence point, end point of titration, Titration error, Conditions for titrimetric analysis, Classification of reactions for titrimetric analysis, *Expression of concentration of Standard solutions*-Molarity-(Analytical and equilibrium molarity), Molality, percent concentration, ppm, ppb, Normality, Primary and Secondary standards. • Law Of Mass Action, Equilibrium Constant, Application Of Law of Mass Action to solutions Of Weak Electrolytes, pH, pKa, pKb, hydrolysis of salts (weak base-strong acid, weak acid-strong base, weak acid, weak base), Buffer solutions, Buffer Capacity.	**2**
2.2	• **Neutralisation curves-**(strong acid by strong base, weak acid by strong base, weak base by strong acid, and weak acid by weak base). • **Neutralisation indicators-**different theories (Ostwald's theory, Resonance theory), Mixed indicators, concept of range of indicators, Choice of indicators.	**2**
2.3	• **Methods of titration –**Direct titration, back titration and need, blank determination use, significance (One Example for each type) and concepts of factor calculation for assay. • **Problems related to calculation of**- pH and its numericals with respect to neutralisation curve, Strength of Electrolytes (molarity, normality, and milliequivalence), and assay. • Applications.	**3**
3	**Non-aqueous titrations**	**2**
3.0	• **Theoretical considerations-**Need, Types of non-aqueous solvents (aprotic, protophilic, protogenic, amphiprotic), Characteristics of solvents for non-aqueous titrations (acid-base character, dielectric constant, leveling and differentiating effect), Indicators for non-aqueous titrations, Determination of Bases and Acids (solvent, titrants and indicator used). • **Applications**.	**2**
4	**Complexometric titrations**	**3**

	• **Terms-**Complex, complexing agents (Complexones), Chelate, Ligand, Dentate and types, Co-ordination number, Chelating agent, Sequestering agent, Metal – Ligand complex. • **Aspects in complex formation with respect to Disodium Edetate-** Dissociation constant, pH, Stability, colouration, titrability of polyvalent metal ions, pM indicators, presence of auxiliary complexing agent, and general structure of complexes formed with di-, tri-, and tetravalent metal ions. • **Complexometric titrations:** Direct method, back titration, Replacement titration, Titration of mixture of metal ions, masking agent (auxiliary ligand) and demasking agents, and Titration curve w. r. t Disodium Edetate. • **Applications:** Determination of individual cations (aluminium by back titration, nickel by direct titration), determination of mixture of lead, zinc and magnesium in a sample, and assay of calcium gluconate injection.	**3**
5	**Oxidation – Reduction Titrations**	**6**
5.1	• **Terms:** Oxidation –Reduction, Oxidising and reducing Agents, Standard Reduction Potential, Nernst Equation, redox titration curve and Equivalence point potential.	**1**
5.2	• Theory, indicators, and titrants for : Permaganatometry and Cerrimetry, • Applications- Assay of hydrogen peroxide solution (Permaganometry), Assay of Ascorbic acid tablets/ Dried Ferrous sulphate, Paracetamol (Cerrimetry).	**2**
5.3	• Theory, indicators, and titrants for : Iodometry, Iodimetry, Potassium dichromate, potassium iodate titrations, and Potassium bromate titrations. **Applications-**Assay of hydrogen peroxide solution, Assay of Ascorbic acid API (Iodimetry), Assay of $KMnO_4$ (Back Iodometry), Assay of Potassium iodide (Iodate titration).	**2**
5.4	• **Balancing Of Redox Equation-**half cell reaction and net reaction.	**1**
6	**Precipitation Titration**	**3**
6.1	• **Theoretical considerations-**Common Ion Effect, Solubilty Product, Factors affecting solubility of precipitates, Fractional precipitation.	**1**
6.2	• **Types** Of Precipitation Titration (Argentometric, Non– Argentometric), Argentometric Titration methods -Mohr's method, Volhard's Method and Adsorption Indicator Method. • **Applications:** Standardisation of silver nitrate, Assay of NaCl and KCl.	**2**
7	**Gravimetry**	**3**
7.1	• **Theory** mass as measurement signal and precipitation equilibria, **Unit operations** in gravimetric analysis, Organic and inorganic **precipitants,** precipitation from homogeneous solution. • **Problems** associated with gravimetric analysis and methods to overcome (co-precipitation and reprecipitation, Ostwald's ripening, degree of supersaturation or von Weimarn ratio, solubility of precipitate, peptisation).	**2**
7.2	• **Applications**-Assay of Nickel by dimethylglyoxime, Assay of aluminium by oxine reagent, Assay of Ba^{+2} as $BaSO_4$. • **Numerical related to gravimetric factor.**	**1**
8	**Miscellaneous methods**	**2**

8.0	• **Oxygen flask combustion method-**technique, apparatus, principle and determination of organically bound halogens, sulphur and phosphorus, **Application**- Diloxanide furoate. • **Nitrite titrations-** Concept of external indicator and application- Assay of Sulphacetamide sodium • **Determination of nitrogen (Kjeldahl method)-**Technique (direct and indirect method), reagents & apparatus used, reaction & factor calculation and numerical for estimation of nitrogen. **Application-Assay of Urea (API)**	
9	**Electro Analytical Techniques:**	**6**
9.1	**Polarography-** • **Apparatus-**Construction and working of Dropping mercury electrode (DME), advantages and disadvantages of DME. • **Theory-**Current-Voltage curve (Polarogram), supporting electrolyte, Oxygen wave, polarographic maxima, Ilkovic equation, factors affecting limiting current, half wave potential. • **Applications-**In brief. • **Pulse polarography-**Normal pulse polarography and Differential pulse polarography and square wave polarography)**.**	**2**
9.2	• **Amperometry-**DME cell, four types of end points in amperometric titrations, advantages, general applications and Biamperometric titrations**.** • **Aquametry by Karl Fischer titration:** principle, composition and stability of KFR, standardization of KFR as per I.P, determination of water in a sample-e.g.Amoxycillin trihydrate.	**2**
9.3	• **Coulometry and High Frequency Titration-**Faraday's first law of electrolysis, Current vs Time plot, Cells for coulometric titration and generation of titrant, Types of coulometric methods (potentiostatic and amperostatic), primary and secondary coulometric titrations, advantages of coulometric titrations, and applications in brief.	**1**
9.4	• **Electrogravimetry-** Theory of electrolysis – constant current electrolysis and constant potential electrolysis, theory of electrogravimetry- Ohm's Law, Faraday's second law of electrolysis, Terminology: polarization, overvoltage, current density, current efficiency, decomposition potential, polarized electrode, types of polarization-concentration and kinetic, apparatus for electrogravimetric determinations, characteristics of the deposit, factors affecting physical properties of the deposit, applications in brief.	**1**
10	**Liquid-Liquid Extraction**	**2**
10.0	• **Terms:** Nernst Distribution law and partition coefficient, Distribution coefficient, Distribution Ratio, Percent extraction or extraction efficiency, Separability factor. • **Types-**Single extraction (Batch), Multiple extractions, Countercurrent Distribution and Continuous. • **Factors** influencing solvent extraction, Emulsion formation problem in extraction and ways to minimise. • Applications.	**2**
10.1	• Problems based on distribution coefficient.	
	Total	**38**

Reference books and textbooks (Please refer latest editions if available)	
1	Practical Pharmaceutical Chemistry by Beckett, A H & Stenlake, J B , 2005, 4th edition, Part I and II, CBS Publishers and Distributors, India.
2	A Textbook of Pharmaceutical Analysis by Kenneth A Connors, 2002, 3rd edition, John Wiley and Sons, Canada.

3	Principles of Instrumental Analysis by Douglas A. Skoog, F.James Holler, 1992, 5th edition, Saunders College Publishing, USA.
4	Fundamentals of Analytical Chemistry by Douglas A. Skoog, Donald M. West, F. James Holler, 1991, 7th edition, Saunders College Publishing, USA.
5	Analytical Chemistry by Gary D. Christian, 6th edition, John Wiley & Sons, Singapore.
6	Vogel's textbook of quantitative chemical analysis by Mendham J, R.C. Denney, J.D. Barnes, M.Thomas, 2002, 6th edition, Pearson Education Ltd.
7	Pharmaceutical Drug Analysis by Ashutosh Kar, 2005, 2nd edition, New Age International (P) Ltd Publishers, India.
8	Instrumental Methods of Analysis by Dr. Supriya S. Mahajan, 2010, 1st edition, Popular Prakashan Pvt Ltd, India.
9	Instrumental methods of chemical analysis (Analytical Chemistry) by Gurudeep R. Chatwal and Sham.K.Anand, 2008, 5th revised and enlarged edition, Himalaya Publishing House Pvt Ltd.
10	Indian Pharmacopoeia.
11	Instrumental Method of Analysis by Willard H.H.L. L. Merrit & John A. Dean, 1986, 6th edition, CBS Publishers & Distributors, New Delhi.
12	Pharmaceutical Analysis –A textbook for pharmacy students and pharmaceutical chemists by David G Watson, second edition, Pub: Elsevier, Churchill Livingstone
13	Undergraduate instrumental analysis by J.W. Robinson, E.M. Skelly Frame and G.M. Frame II, Pub. Marcel Deker, 2009
14	Analytical Chemistry, A modern approach to analytical science, second edition, R. Kellnar, J.M.Mermet, M.Otto, M. Valcarcel, H.M.Widner, Pub: WILEY-VCH
15	Analytical chemistry by Open learning Pub: John Wiley and sons Classical methods Vol. 1 by and Chris Doran Classical methods Vol.2 by John Mendham and Derek Cooper Principles of electroanalytical methods by Tom Riley and Colin Tomlinson Polarography and other voltammetric methods by Tom Riley and Arthur Watson

Pharmaceutics – II **3 hrs/week**

Unit	Topics	Hours
1 1.1	**Disperse Systems: Suspensions and Emulsions** Introduction and Physicochemical principles, (Revision) surface & interfacial tension, surface free energy, Gibb's equation , concepts of thermodynamic & kinetic stability of disperse systems and challenges to formulator, Classification of disperse systems	**15** 1
1.2	A)Suspensions:- Definition, advantages and disadvantages, desirable features and pharmaceutical applications B) Emulsions:- Definition, advantages and disadvantages, pharmaceutical applications	1
1.3	Theoretical aspects of Suspensions:-Wetting phenomenon, particle-particle interactions, DLVO theory, flocculated and deflocculated systems, Schulze Hardy rule, Sedimentation in suspensions, Ostwald ripening and crystal factors, rheology	3
1.4	Theoretical aspects of Emulsions:-Need for emulsifier Emulsifiers- mechanisms, droplet stabilization, classification, Selection of emulsifiers-HLB method, Davies method, PIT method, Cloud point method	3
1.5	Preparation of suspensions:- Precipitation methods and dispersion method. Formulation additives	2
1.6	Preparation of Emulsions-Other formulation additives, rheological aspects, physical stability of emulsions, symptoms of instability.	2
1.7	Large scale manufacture of emulsions & suspensions.with layout of manufacturing area and equipments for each step Quality control tests for emulsions & suspensions- including stress testing -Examples of official formulations.	3
2 2.1	Factors influencing skin penetration-physiological and physicochemical factors, vehicles and penetration enhancers, methods to evaluate skin penetration.	**6** 2
2.2	Raw materials for semisolids, types of vehicles, ointment bases, pastes, gels, poultice, Formulation additives.	2
2.3	Large scale manufacture with equipments involved in each step and layout, Quality control tests, Examples of official formulations.	2
3 3.1	Suppositories: Introduction, definition, advantages and disadvantages, desirable features of suppositories, factors affecting rectal absorption.	**7** 2
3.2	Suppository bases- specifications and desired features, classification and selection of suppository bases, special bases.	2
3.3	Formulation and specific problems involved in formulating suppositories, large scale manufacture with equipments involved in each step, packaging.	2
3.4	Quality control tests, Examples of official formulations.	1
4 4.1	Blood products: Need, problems/hazards, blood banking procedures	**6** 1
4.2	Whole human blood, Red cell concentrate, Platelet concentrate, Plasmapheresis, plasma, serum. Fractionation of plasma, study of some fractions-clotting factors like fibrinogen, AHF, factor IX complex, prothrombin, albumin preparations, γ globulin preparations. Quality control aspects of blood products	3

4.3	Plasma substitutes (plasma volume expanders)- need, desired properties, examples- hydrolyzed gelatin based products, HETA starch, Dextran (in detail – source, preparation, official injections)	2
5 5.1	Sutures/ligatures: Definition, classification, cat gut manufacturing and processing, other absorbable sutures-natural & synthetic	**4** 2
5.2	Nonabsorbable sutures- silk, linen, polyamides, polyesters, polyolefins, and metallic wires.	2
5.3	Quality control tests for sutures/ligatures	1
	Total	**38**

Books (Latest editions should be referred)

1. Lachman Leon, Liberman Herbert A., kaing Joseph L., "Theory and practice of Industrial Pharmacy" 3rd edition,1987, Varghese Publishing house,Mumbai.
2. Liberman Herbert A., rieger, "Pharmaceutical dosage Forms-Disperse Systems", vol 1/2/3, 2nd edition,2005, Marcel Dekker Inc., New York.
3. Allen, Loyd v V.Jr, "Remingtons- the Science and Practice of Pharmacy, Vol 1 / 2, 22nd edition, Pharmaceutical Press
4. Patrik Sinko Ed."Martin's Physical Pharmacy and Pharmaceutical Sciences", 6th edition, 2010, Lippincott Williams and Wilkins.
5. M.E. Aulton Ed.,"Pharmaceutics-The Science of Dosage Form Design"3rd edition,2007, Churchill livingstone Elsevier Ltd., UK.
6. E.A. Rawlins Ed.,"Bentley's Textbook of Pharmaceutics", 2010, Elsevier Publications.
7. S.J.Carter Ed.,"Tutorial Pharmacy-Cooper & Gunn", 6th edition,1986, CBS Publishers & distributors, India.
8. Pharmacopeias-IP, BP, USP-latest editions

Microbiology **3 hrs/week**

Unit	Topics	Hours
1 1.1	**Introduction to Microbiology** Brief history, Scope of Microbiology-Basic & Applied, Relevance and Applications in Pharmaceutical Industry	**2** 1
1.2	Classification of Microorganisms, Procaryotic and eukaryotic microorganisms, Microbes and the environment.	1
2 2.1	**Microscopy** Simple microscope, Compound microscope, resolving power, magnification, angular aperture, numerical aperture, oil immersion objective.	**3** 1
2.2	Dark field microscopy, phase contrast microscopy, fluorescent microscopy, electron microscopy.	2
3 3.1	**Techniques to study and characterize microorganisms** Staining of microorganisms-Monochrome stain; Negative staining; Differential staining (Gram staining & Acid fast staining), Capsule, Flagella, Cell wall, Spore staining; Study of motility by hanging drop technique	**2** 1
3.2	Information used to characterize and identify microorganisms (in brief) - morphological, cultural, metabolic, antigenic, pathogenic, genetic.	1
4 4.1	**Bacteria** Morphology, Cell characteristics, Habitat, Nutritional requirements, Cultivation of bacteria, Culture media- Cultivation & Storage media, Enrichment media, Differential media, Assay media, Cultivation of aerobes and anaerobes.	**9** 5
4.2	Pure culture, Methods to isolate pure cultures, Preservation of cultures.	1
4.3	Reproduction of bacteria, Growth phases, Measurement of growth, factors affecting growth, continuous cultivation, enumeration of bacteria.	1
4.5	Overview of bacterial diseases and the pathogens causing them- Mycobacterium sp., Salmonella sp., Shigella sp., Staphylococci sp., Pseudomonas sp., Klebsiella sp., Clostridium sp	2
5 5.1	**Viruses & related microorganisms** Morphological characteristics, Nutritional aspects, Cultivation and reproduction, HIV and Oncogenic viruses.	**3** 2
5.2	Rickettsiae and Chlamydiae- Morphological characteristics, Cultivation, Rickettsial & Chlamydial diseases.	2
6 6.1	**Major groups of Eucaryotic microorganisms** Fungi-Morphological characteristics, Classification, Reproduction of fungi, Cultivation of fungi, Culture media	**7** 2
6.2.	Study of some important fungi-Penicillium, Aspergillus, Candida, Saccharomyces. Fungal infections-Mycoses	1
6.3	Algae - Classification, Morphological characteristics, reproduction, economic significance of algae.	2
6.4	Protozoa- Morphological characteristics and classification, reproduction, pathogenic protozoa like Amoeba, Paramecium, Trichomonas, Plasmodium	2
9 9.1	**Control of Micro-organisms** Fundamentals of Microbial Control - Pattern of Death in a Microbial population, Conditions affecting Antimicrobial activity, Mechanisms of microbial cell damage, Survivor curves and concepts of D - value and Z- value.	**10** 1

	Sterility assurance and Inactivation factor.	
9.2	Sterilization methods & Equipments- Heat Sterilization methods (Moist heat, dry heat, low temperature sterilization methods), Radiation Sterilization (Ionizing and non-ionizing radiations), Filtration Sterilization, Gaseous Sterilization	4
9.3	Chemical agents used for control of microorganisms- Terminology of Chemical agents, Ideal properties, Major groups of disinfectants and antiseptics (with mechanisms and applications), Chemical sterilants, Evaluation of potency- Tube dilution & Agar plate methods, Phenol Coefficient technique	2
9.4	Introduction to Aseptic techniques (no equipments), Sterilization control and sterility assurance- Various types of sterilization indicators, Test for sterility	2
	Total	**36**

Books: (Latest editions should be referred)

1. M.J. Pelzer Jr., E.C.S. Chan and N.R. Krieg "Microbiology Concepts and Applications" McGraw ill, Inc., USA, 1993.
2. M.Frobisher, R.D. Hinsdill, K.T. Crabtree and C.R. Goodheart "Fundamentals of microbiology", 9th Edn. Saunders College Publishing, Philadelphia 1968.
3. W. B. Hugo and A. D. Russel "Pharmaceutical Microbiology" 6th Edn. Blackwell science Ltd. UK, 2003.
4. R. Ananthianarayan and Ck. J. Paniker "Text Book of Microbiology", 7th edn. Orierit Longman Pvt. Ltd. Hydrabad, 2005.

Pharmacology – I **3 hrs/week**

Unit	Topics	Hours
1.	General Principles of Pharmacology • Introduction to Pharmacology • Routes of drug administration with special reference to their advantages and disadvantages. • Drug Absorption, Distribution, Metabolism & Excretion (ADME)	6
2.	Mechanisms of drug action • Brief introduction to physiological receptors • Structural and functional families of receptors • Mechanisms of drug action: -Drug receptor interaction -Dose response curve (DRC) -Drug antagonism	4
3.	Factors modifying actions of drugs	1
4.	Toxic effects of drugs on different organs and systems.	2
5.	Autonomic nervous system • Autonomic neurotransmission • Parasympathomimetics • Parasympatholytics • Sympathomimetics • Sympatholytics • Drugs acting on autonomic ganglia • Skeletal muscle relaxants	12
6.	Cardiovascular system • Drugs used in the treatment of: - Congestive cardiac failure - Hypertension - Cardiac arrhythmia - Angina pectoris - Hyperlipoproteinemia	10
7.	Diuretics	3
	Total	**38**

Books (Latest edition of following books to be referred)

1. Goodman & Gilmans Pharmacological Basis of Therapeutics; Joel. G, Hardmon Lee, E. Limbird, Alfred Goodman Gilman; 11th Ed.; The Mcgraw-Hill Companies, Inc; 2011.
2. Pharmacology and Pharmaco therapeutics; R.S. Satoskar, S.D. Bhandarkar, Nirmala N. Rege; 20th Ed.; Popular Prakashan; 2007.
3. Pharmacology; Rang and Dale; 7th Ed.; Churchil Livingstone; 2012.
4. Lippincott's illustrated reviews: Pharmacology, Lippincott-Raven; 3rd Ed.; Howland & Nycets Publishers, N.Y.; 2006.
5. Lewis Pharmacology; Crossland; 5th Ed. Churchill Livingstone.
6. Clinical Pharmacology- Lawrence, D.R and Bennet- 9th Ed.; Elsevier, N.Y. 2006.
7. Clinical Pharmacology- B.G. Katzung; 11th Ed.; Appleton & Lange Publications. 2009.
8. Pharmacology; George M. Brenner, Craig W. Stevens; 2nd Ed.; Elsevier Publishers, 2006.

Mathematics and Statistics **3 hrs/week**

Unit	Topics	Hours
1	**Measurement of Central Tendency:** Arithmetic Mean, median and mode	10
2	**Measures of Dispersion**	18
2.1	Range, quartile deviation, mean deviation and standard deviation	
2.2	Coefficients of variation, moments, skewness and kurtosis, generating moments	
2.3	Probability expectations and variance	
2.4	Binomial, Poisson and Normal Distributions	
2.5	Fitting of curves by the method of least squares {$Y = a + bX$, $Y = a + bX + cX^2$, $Y = aX^b$, $Y = ab^X$, $Y = ac^{bX}$}	
3	**Sampling distribution for mean and proportion.**	08
3.1	Test of hypothesis for specified values of mean and proportion for large samples	
3.2	Testing equality of two means and proportions	
3.3	Students "t" test for single sample and paired observation, F-test and analysis of variance, testing of attributes, Chi-square distribution.	
	Total	**36**

Books – Latest Editions to be adopted

1. Fundamentals of Statistics, Gupta S. C., Himalaya Publication.
2. Mathematics for Pharmacy Students (Vol. I), Gujar K. N., Bhavale Ashok, Career Publicaiton.
3. Measurement, Statistics of Computation, C Cornmich D, John Wiley and Sons.
4. Biostatistics in Pharmaceutical Industry, Buchner R. C., Marcel Decker Inc.
5. Integral Calculus, Shanti Narayan, S. Chand Publication.

Practicals

Pharmaceutical Analysis Lab. – I **4 hrs/week**

NOTE: For all the experiments, the latest edition of the Indian Pharmacopoeia 2010 has to be referred, except for gravimetric analysis.

Acid-Base titrations:

1) Assay of Aspirin API (with special emphasis on the test for salicylic acid).
2) Assay of Aspirin tablets.
3) Estimation of Total alkalinity in a solution of Sodium Hydroxide.
4) Assay of Benzoic acid.

Redox titrations:

5) Assay of hydrogen peroxide solution (Permanganatometry).
6) Assay of Ascorbic acid API (Iodimetry)
7) Assay of Sodium metabisulphite API (Iodometry)
8) Assay of $KMnO_4$ (Back Iodometry)
9) Assay of Ascorbic acid tablets/ Dried Ferrous sulphate/ Ferrous fumarate/ Paracetamol (Cerrimetry).
10) Assay of Potassium iodide (Iodate titration)

Complexometric titrations:

11) Assay of Calcium gluconate injection.
12) Assay of Zinc sulphate.
13) Assay of Magnesium sulphate.

Miscellaneous titrations:

14) Assay of Sulphacetamide sodium using external indicator.
15) Assay of Soluble Aspirin tablets (Solvent extraction followed by Bromometry-iodometry).

Gravimetric analysis: (Ref. Vogels' Textbook of Quantitative Chemical Analysis by Mendham J, Denney R C, Barnes J D, Thomas N, 2002, 6th Edition, Pearson Education Ltd**.)**

16) Ni^{2+} using Dimethyl glyoxime/ Al^{3+} as Al-oxinate.
17) Ba^{2+} as $BaSO_4$.

Demonstration titrations:

18) Assay of Pyridoxine hydrochloride/ Sodium benzoate using non-aqueous titration method.
19) Assay of Sodium chloride.
20) Assay of Potassium chloride.

P. B. Standardization of all volumetric solutions has to be done

Pharmaceutics Lab. – II **4 hrs/week**

1. SUSPENSIONS: (a) Antacid Suspension (Aluminium Hydroxide gel I.P' 2010/ Magnesium hydroxide oral suspension I.P' 2010) (b) Paracetamol Suspension (c) Calamine Lotion I.P' 2010 (d) Microscopic evaluation, rheology and sedimentation rate studies for any one of the above suspensions.
2. EMULSIONS: (a) Liquid Paraffin Emulsion I.P ' 2010 (b) White Liniment B.P.C, 73 (c) Turpentine Liniment I.P ' 66 (d) Benzyl Benzoate Application I.P ' 2010 (e) Microscopy of any one of the above emulsion
3. OINTMENTS: (a) Simple Ointment I.P ' 66 (b) Sulphur ointment I.P ' 66 (Microscopic evaluation) (c) Emulsifying ointment I.P ' 66 (d) Compound Benzoic acid ointment I.P' 2010 in emulsifying ointment base (e) Iodine ointment, Non – staining B.P.C 68 (f) Iodine ointment, Non – staining with methyl salicylate B.P.C 68
4. CREAMS: (a) Cetrimide cream I.P' 2010
5. GELS: (a) Diclofenac sodium gel
6. PASTES: (a) Titanium dioxide paste B.P.C' 73
7. SUPPOSITORIES: (a) Indomethacin Suppositories I.P' 2010

Books

1. Relevant editions of Indian Pharmacopoeia, British Pharmaceutical Codex.
2. Lachman Leon, Liberman Herbert A., kaing Joseph L., "Theory and practice of Industrial Pharmacy" 3rd edition, 1987, Varghese Publishing house, Mumbai.
3. Allen, Loyd V.Jr, "Remingtons- the Science and Practice of Pharmacy, Vol 1 / 2, 22nd edition, Pharmaceutical Press.

Pharmacology Lab. – I **4 hrs/week**

Sr. No.	Experiment
1.	Dose response curve (DRC) of Ach using suitable isolated tissue preparation (e.g. Cock ileum)
2.	Demonstrations: Effect of drugs on isolated frog heart (CDs) -Adrenaline, ACh -Atropine, propranolol -Effect of excess calcium and potassium on isolated heart -Effect of lack of calcium and potassium on isolated frog heart -Effect of digitalis on hypodynamic heart
3.	Simulated experiments (CDs) -Effect of drugs on eye -Effect of drugs on GI motility
4.	Demonstration with the help of CDs or kymograph recordings: –Effect of neostigmine on DRC of Ach –Effect of pancuronium on DRC of Ach (Give the readings to the students and ask them to plot the graphs and draw conclusions from the results eg. Identify type of antagonism existing between two drugs by studying the nature of the graphs, competitive and non competitive. Find out the potency of the drugs by studying the DRC and determining IC50 values) -Calculation of pA2 value of atropine using Ach as an agonist
5.	Tutorials -Laboratory animal handling -Care and ethics in animal experimentation

Books: Latest editions of following books to be referred.

1. Kulkarni, S.K. Handbook of Experimental Pharmacology; 3rd Ed.; Vallabh Prakashan, New Delhi. 2005.
2. Gosh M.N. Fundamentals of Experimental Pharmacology, 3rd Ed.; Hilton & Company, Calcutta. 2005.
3. S.B. Kasture A Handbook of Experiments in Pre-Clinical Pharmacology- 1st Ed.Career Publications. 2006.
4. W.I.M. Perry, Pharmacological Experiments on Isolated Preparations. 2nd Ed.; E & S Livingstone, Edinburgh & London, 1970.

Microbiology Lab **4 hrs/week**

1. Study of microscope and common laboratory equipments.
2. Gram Staining
3. Monochrome staining
4. Negative staining
5. Cell wall staining
6. Spore staining
7. Capsule staining
8. Motility by hanging drop technique
9. Preparation and sterilization of nutrient broth, agar slants, plates and inoculation techniques.
10. Isolation of pure culture by pour plate and streak plate methods. Colony characterization and growth patterns in broth of cocci and bacilli.
11. Total counts by Breeds smear method
12. Growth by optical density, total plate count
13. Study of yeast, Aspergillus and Penicillum with respect to morphology
14. Observation on prepared slides of malarial parasites in blood smear, intestinal amoeba in stools.

Books

1. C. R. Kokare “Pharmaceutical Microbiology Experiments and Techniques”, Career Publication, Nashik.
2. R. S. Gaud and G. D. Gupta “Practical Microbiology”, Nirali prakashan, Pune.
3. C. H. Collins, Patricia M. Lyne, J. M. Grange “Microbiological Methods “7th Edn. Butterworth-Heinemann Ltd Oxford, London

Framework for the Third Year B. Pharm. (Credit Based System)

Syllabus Framework

No	Semester- V	Credits	Contact hrs/week	Weightage		Marks
	Subject			**Continuous internal assessment**	**End Semester Examination**	
1	Organic Chemistry - III	4	4	30	70	100
2	Cosmeticology	3	3	30	70	100
3	Pharmaceutical Biotechnology	4	4	30	70	100
4	Pharmacology-II	4	4	30	70	100
5	Pharmaceutical Management	3	3	30	70	100
	Total	**18**	**18**	**150**	**350**	**500**
	Practicals					
6	Organic Chemistry Lab - II	2	4	15	35	50
7	Pharmaceutical Biotechnology Lab	2	4	15	35	50
8	Cosmeticology Lab	2	4	15	35	50
	Total	**6**	**12**	**45**	**105**	**150**
	Total Teaching Hrs.		**30**			
	Total Credits	**24**				
	Total Marks			**195**	**455**	**650**

No.	Semester -VI					
1	Pharmaceutical Chemistry-II	3	3	30	70	100
2	Pharmaceutical Analysis- II	3	3	30	70	100
3	Pharmaceutics -III	3	3	30	70	100
4	Pharmacognosy & Phytochemistry-I	4	4	30	70	100
5	Hospital Pharmacy and Drug Store Management	3	3	30	70	100
	Total	**16**	**16**	**150**	**350**	**500**
	Practicals					
6	Pharmaceutical Chemistry Lab - II	2	4	15	35	50
7	Pharmaceutical Analysis Lab - II	2	4	15	35	50
8	Pharmaceutics Lab - III	2	4	15	35	50
9	Pharmacognosy & Phytochemistry Lab - I	2	4	15	35	50
	Total	**8**	**16**	**60**	**140**	**200**
	Total Teaching Hrs.		**32**			
	Total Credits	**24**				
	Total Marks			**210**	**490**	**700**
	Credits Sem V plus Sem VI	48				

Scheme of Examination

No	Semester- V	No of papers	End Semester Examination			Internal Assessment			Maximum marks	Minimum marks for passing the subject
						Periodic Test		Continuous Evaluation		
	Subject - Theory		**Duration (hrs)**	**Maximum marks**	**Minimum for passing**	**Duration (hrs)**	**Maximum marks**	**Maximum marks**		
1	Organic Chemistry - III	1	3	70	28	1	15	15	100	40
2	Cosmeticology	1	3	70	28	1	15	15	100	40
3	Pharmaceutical Biotechnology	1	3	70	28	1	15	15	100	40
4	Pharmacology-II	1	3	70	28	1	15	15	100	40
5	Pharmaceutical Management	1	3	70	28	1	15	15	100	40
	Practicals									
7	Organic Chemistry Lab - II	1	4	35	14	4	8	7	50	20
8	Pharmaceutical Biotechnology Lab	1	4	35	14	4	8	7	50	20
9	Cosmeticology Lab	1	4	35	14	4	8	7	50	20

No	Semester- VI	No of papers	End Semester Examination			Internal Assessment			Maximum marks	Minimum marks for passing the subject
						Periodic Test		Continuous Evaluation		
	Subject - Theory		**Duration (hrs)**	**Maximum marks**	**Minimum for passing**	**Duration (hrs)**	**Maximum marks**	**Maximum marks**		
1	Pharmaceutical Chemistry-II	1	3	70	28	1	15	15	100	40
2	Pharmaceutical Analysis- II	1	3	70	28	1	15	15	100	40
3	Pharmaceutics -III	1	3	70	28	1	15	15	100	40
4	Pharmacognosy & Phytochemistry-I	1	3	70	28	1	15	15	100	40
5	Hospital Pharmacy and Drug Store Management	1	3	70	28	1	15	15	100	40
	Practicals									
6	Pharmaceutical Chemistry Lab - II	1	4	35	14	4	8	7	50	20
7	Pharmaceutical Analysis Lab - II	1	4	35	14	4	8	7	50	20
8	Pharmaceutics Lab - III	1	4	35	14	4	8	7	50	20
9	Pharmacognosy & Phytochemistry Lab - I	1	4	35	14	4	8	7	50	20

Detailed Syllabus
Semester V

Organic Chemistry – III **4 Hrs/week**

Unit	Topic	Hours
1	**Heterocyclic Chemistry**	**27**
1.1	Nomenclature of mono, bi- and tri-cyclic hetero-aromatic, fused heterocyclic ring and bridge head system of the drug molecules.	2
	Synthesis, properties and reaction of the following heterocycles	
1.2	Furan : Synthetic methods including synthesis using carbohydrates, oxazoles, Diels-Alder Adduct, Paal-Knorr synthesis. Reactions with acids, bases, Electrophilic Aromatic Substitution (EAS), carbenes, nitrenes, oxidizing and reducing agents, Diels-Alder reaction.	9
	Pyrrole : Synthetic methods including synthesis using furan, ammonium mucate, primary amines, Knorr synthesis, Paal-Knorr synthesis, Hantzsch synthesis, Piloty-Robinson synthesis. Reactions with acids, bases, alkylation, Electrophilic Aromatic Substitution (EAS), carbenes, nitrenes, oxidizing and reducing agents, Diels-Alder reaction.	
	Thiophene : Synthetic methods including synthesis using Na- succinate, Ring closure, Paal-Knorr synthesis and Hinsberg synthesis. Reactions with acids, Electrophilic Aromatic Substitution (EAS), carbenes, nitrenes, nucleophiles, Free Radicals, aldehydes and ketones, oxidizing and reducing agents, Diels-Alder reaction.	
1.3	Imidazole: Synthetic methods including synthesis from imidazolines, α-haloketones, Radiszewskii reaction. Reactions with acids, Electrophilic Aromatic Substitution (EAS), nucleophiles, oxidizing and reducing agents, imidazoles as catalysts in ester hydrolysis.	9
	Pyridine : Synthetic methods including synthesis using 1,5-diketones, cyclic diketones, other ring systems, Hantzsch synthesis. Reactions with acids, Electrophilic Aromatic Substitution (EAS), alkyl and aryl halides, nucleophilic substitution, Hetaryne formation, oxidizing and reducing agents, Diels-Alder reaction, ring opening.	
	Pyrimidine : Synthesis using malonic ester; 2,4-dichloropyridine, amidine and maleic acid **Reactions** with acids, Electrophilic Aromatic Substitution (EAS), nucleophiles, hydrazines, oxidizing and reducing agents.	
1.4	Quinoline : Synthetic methods including Skraup synthesis, Doebner-Miller synthesis, Friedlander synthesis, Pfitzinger synthesis, Pictet synthesis, Conrad-Limpach synthesis. Reactions with acids, Electrophilic Aromatic Substitution (EAS), nucleophiles, oxidizing and reducing agents, reaction with S and Hg.	7
	Isoquinoline : Synthetic methods including Bischler-Napieralski, Pictet-Gams, Pomeranz-Fritsch, Pictet-Spengler syntheses. Reactions including EAS, nucleophiles, oxidizing and reducing agents.	
	Indole : Synthesis by Fischer indole synthesis, Mandelung synthesis, Reissert synthesis and Bischler synthesis. Reactions with acids, EAS, Metallic K, Mannich reaction, oxidizing and reducing agents.	
2	**Pericyclic Reactions**	**10**
2.1	HOMO and LUMO of pi systems, molecular orbitals and pericyclic reactions, concerted and pericyclic reactions.	

2.2	Electrocyclic reactions and stereochemistry, Woodward Hoffmann rule [4n and 4n+2] (conrotatory and disrotatory),Diel's Alder, Retro Diel's Alder.	
2.3	Cycloaddition: $2\pi+2\pi$and $4\pi+2\pi$.	
2.4	Sigmatropic rearrangement:1,5 rearrangement, 3,3-rearrangements (Cope and Claisen).	
3	**Synthon Approach:**	**6**
3.1	Definition of reterosynthesis or disconnection approach, synthon, synthetic equivalent, functional group interconversion, functional group addition, functional group removal.	
3.2	Strategies for disconnection approach.	
3.3	Disconnection of simple alcohols, alkyl halide, ethers, olefins, esters, carboxylic acids, aryl ketones,heterocyclics ring.	
3.4	Design of retrosynthesis of drugs: Paracetamol, benzocaine, sulfadiazines, atenolol, ibuprofen.	
4	**Chemistry of Steroids**	**7**
4.1	Definition of steroids and sterols, numbering and ring letters, orientation of projection formulae, stereochemistry of ring junction and side chain attachments, stereochemistry of substituents in the side chain.	
4.2	Types of steroid hormones:, androgens, estrogens, progestins, corticosteroids. Structure and synthesis of steroids, squalene, cholesterol, pregnenolone Conformation and chemical reactivity, steroid specific reactions of A and B rings, Addition-elimination, epoxide opening, relative rates of esterification, oxidation of epimeric alcohols, reduction of ketones.	
5	**Application of Catalysis in Organic Chemistry**	**10**
5.1	Role of catalysis and its development -Classical and non-classical organic synthesis with examples like hydroquinone, amino acid ester synthesis.	
5.2	Catalysis by solid acid-base and its application in Friedal Craft reaction, Beckmann rearrangement, H-USY as solid acid catalyst and hydrocalcite base catalyst, application of base catalyst in condensation reactions. Catalytic hydrogenation and application in chemoselective synthesis of saquinavir intermediate, zeolite based MPV reduction. Catalytic oxidation by stable free radical and application in progesterone synthesis, application in sigmatropic reaction e.g. citral, catalytic oxidation with H_2O_2 under phase transfer catalysis. Catalytic C-C bond formation and its application in lozabemide, naproxen and in synthesis of biaryl compounds by Suzuki, Negishi, Kumada coupling. Biocatalysis and its significance, applications in 6-APA, aspartame, heteroaromatic oxidation mediated by yeast, vitamin B-6. Enantioselective catalysis and application in menthol synthesis.	
5.3	Application of catalysis in sustainable technology: Concept of E-factor and atom efficiency	
	Total	**60**

Latest editions of following books to be adopted.

1. I. L. Finar: Organic chemistry- Volumes 1 and 2, Pearson Education, Ed:5
2. Morrison and Boyd, Organic chemistry, Prentice Hall.
3. Clayden and Greeves, Organic chemistry, Oxford University Press.
4. S. H. Pine et al, Organic chemistry, McGraw-Hill Science/Engineering/Math.
5. S. Warren, Designing organic synthesis, and the disconnection approach, Wiley India Pvt. Ltd.
6. Corey and Chelg, The logic of chemical synthesis, JOHN WILEY & SONS, New York.
7. R. P. Iyer and A. Prabhu, Synthesis of drugs : A synthon approach.
8. D. Lednicer: Steroid chemistry at a glance, Wiley.
9. I. Arends, R. Sheldon, U. Hanefeld, Green chemistry and catalysis, WILEY-VCH Verlag GmbH & Co. KGaA, Weinheimpp 1-48.
10. J.G. Vries, A.H M. Vries, Innovations in pharmaceutical technology, Chemical Technology.
11. C. A. Busacca, D. R. Fandrick, J. J. Song, and C. H. Senanayakea, Adv. Synth. Catal. 2011, 353, 1825 – 1864 " The growing impact of catalysis in the pharmaceutical industry-Review"

Cosmeticology **3 Hrs/week**

Unit	Topic	Hours
1.	**General Aspects in Cosmeticology**	**11**
1.1	Definition of cosmetics, historical background, classification. Structure of skin, hair, nails, teeth **(self study).** Regulatory aspects- Schedules to Drug and Cosmetics Rules - M II, S, Q.	1 1 1
1.2	Raw materials including colours, perfumes, antioxidants, preservatives and water, herbal products **(self study).**	3 2
1.3	Microbiological aspects of cosmetics.	1
1.4	Toxicology of cosmetics-irritation and sensitization reactions to cosmetics, sensitivity testing and safety aspects.	2
2.	**Skin care products - raw materials, formulation, large scale manufacturing and quality control (including BIS) and functional evaluation.**	**7**
2.1	Skin creams and lotions - Cleansing, cold, vanishing, moisturizing, hand and body products, face packs.	3
2.2	Sunscreen, suntan and anti-sunburn preparations.	2
2.3	Protective preparations-Barrier products, anti-acne, anti-wrinkle, bleach products.	2
3.	**Colored cosmetics products- raw materials, formulation, large scale manufacturing and quality control (including BIS).**	**8**
3.1	Foundation, face powders. Rouge **(self study).**	1 1
3.2	Eye makeup products.	1
3.3	Lipsticks.	2
3.4	Nail speciality products-cuticle softener, nail bleach, nail strengthener, nail whites.	1
3.5	Nail lacquer.	2
4.	**Hair care products -raw materials, formulation, large scale manufacturing and quality control (including BIS) and functional evaluation.**	**7**
4.1	Shampoos (including antidandruff and antilice)	2
4.2	Hair grooming, hair waving, hair straighteners and conditioners.	2
4.3	Hair colorants.	2
4.4	Depilatories.	1
5.	**Shaving preparations raw materials, formulation, large scale manufacturing and quality control (including BIS) and functional evaluation.**	**4**
5.1	Wet shaving preparations-foaming and brushless.	3
5.2	Dry shaving preparations and after shave products.	1
6.	**Oral and personal hygiene products - raw materials, formulation, large scale manufacturing and quality control (including BIS) and functional evaluation.**	**8**
6.1	Toothpaste, medicated toothpaste. Toothpowder **(self study).**	2 1
6.2	**Self study.** Mouthwashes and denture cleansers. Bath products-shower gels, body washes, bubble washes, bath salts.	3
6.3	**Self study.** Antiperspirants and deodorants, insect repellants. Baby toiletries - Oils, creams & lotions, shampoos, powders.	2
	Total	45

Latest editions of following books to be adopted

1. Harry's Cosmeticology Edited by J. B. Wilkinson and R. J. Moore, Longman Scientific & Technical Publishers
2. Cosmetics Science and Technology, Edited by M. S. Balsam, E. Sagarin, S. D. Gerhon, S. J. Strianse and M. M. Rieger, Volumes 1,2 and 3.Wiley-Interscience, Wiley India Pvt. Ltd.

3. Poucher's Perfumes, cosmetics & Soaps, Editor- Hilda Butler, Klewer Academic Publishers, Netherlands
4. Cosmetic Technology, Ed. By S. Nanda, A. Nanda and R. Khar, Birla Publications Pvt. Ltd., New Delhi
5. Handbook of Cosmetic Science and Technology, edited by M. Paye, A. O.Barel, H. I. Maibach, Informa Healthcare USA, Inc.
6. Encyclopedia of Pharmaceutical Technology, Vol. 6, Eds. James Swarbrick, James C. Boylan, Marcel Dekker Inc.
7. BIS Guidelines for different cosmetic products.

Pharmaceutical Biotechnology **4 Hrs/week**

Unit	Topic	Hours
1	**Introduction to Biotechnology**	**4**
1.1	Definitions, scope, relevance to Pharma Industry. Microbiological limit tests – Need, standards for raw materials of natural origin (Pharmacopoeial with some examples)	2
1.2	Microbiological assays - Diffusion bioassays, turbidometry, end point assays. Self study : Historical perspectives.	2
2	**Fermentation Technology**	**7**
2.1	Example of products of fermentation (microbial, animal and plant), types of fermenters (mechanically stirred, air-lift, tray), design of fermenter, factors affecting fermentation (innoculum preparation, temperature, pH, media composition, aeration, agitation, antifoam agents, strain optimization, growth kinetics) and down stream process.	4
2.2	Production of penicillin, single cell protein. Self study : Production of dextran, tetracycline, amylase.	3
3	**Recombinant DNA technology**	**11**
3.1	Steps involved in rDNA technology, enzymes involved in DNA technology with reference to restriction endonucleases and ligase, vectors (Plasmid, Cosmid, YAC), Gene expression/Host- (Bacterial expression system, yeast expression system, animal expression system, plant expression system)	8
3.2	Application of rDNA technology for production of pharmaceutical products e.g. Insulin. Self study : Production of human growth hormone, interferon. Preparation of a list of approved biotech derived products.	3
4	**Techniques used in molecular biology**	**9**
4.1	Introduction to polymerase chain reaction, DNA sequencing (Sanger, Maxam and Gilbert), RFLP, DNA fingerprinting, cDNA library, gene library, Southern blotting technique, Northern blotting, Western blotting, introduction to gene therapy, transgenic animal and transgenic plants.	8
4.2	Self study: SDS- PAGE.	1
5	**Enzyme and cell immobilization.**	**6**
5.1	Methods for enzyme immobilization (adsorption, covalent binding, entrapment, microencapsulation) with examples and applications. Introduction to biosensor and applications e.g. glucose oxidase, penicillinase.	5
6	**Immunology**	**15**
6.1	a) Host-microbe interactions, Introduction to terms-infection, infestation, pathogen, resistance, susceptibility etc. b)Factors affecting pathogenicity and infection, c) Innate defense mechanism – first line of body defense, physiological phenomena-inflammatory response, fever, cellular, mediators; soluble (humoral) mediators, phagocytosis. d)Specific defense Mechanism – Characteristics, Antigen, Cell-mediated immunity, humoral immunity. e) Antibody structure and types, pathways of immune response, clonal selection theory. Self study: organization of immune system-organs & cells involved.	8
6.2	**Serology-**Precipitation , agglutination, complement fixation tests, immunofluoroscence, RIA, ELISA. Introduction to Hypersensitivity & Allergy.	2
6.3	Immunodeficiency states- Primary & acquired, autoimmunity. Hybridoma technology – Production and application of monoclonal antibodies.	5

7	**Vaccines & Sera-** Definitions and classification, outline of general method of preparation of bacterial & viral vaccines, typical examples of each type (diphtheria,TAB, polio), antisera (anti-tetanus sera) Q. C. aspects, recent trends in vaccines (recombinant vaccines) Self study: Outline of general method of preparation of BCG and rabies vaccine	**4** 2 2
8	**Cell culture (plant and animal)** Tissue culture media, primary cell culture, continuous cell culture, pharmaceutical applications of animal cell culture. Stem cell culture, cryopreservation/stem cell bank Self study: Media and media composition (typical) for plant and animal cell culture, names of commonly used animal cell lines, their tissue origin and typical applications.	**4** 2 2
	Total	**60**

Latest editions of the following books to be adopted.

1. R. C. Dubey , A textbook of biotechnology
2. B. D. Singh, Biotechnology.
3. S. P. Vyas and Dixit, Pharmaceutical Biotechnology, CBS publisher & distributers.
4. S. S. Kori , Pharmaceutical Biotechnology.
5. H. D. Kumar, Biotechnology, Affiliate East-West press Pvt. Ltd New Delhi.
6. Ananthnarayan, A textbook of microbiology, Orient Longman Pvt. Ltd.
7. W. B. Hugo and A. D. Russell, Pharmaceutical Microbiology, Blackwell Science.
8. David, Nelson, Lehninger - Principle of Biochemistry, W. H. Freeman & Co.
9. Pelezar, Chan & Krieg, Microbiology-Concepts and Applications, International Edn., McGraw Hill, Inc.,
10. Weir Stewart: Immunology, Churchill Livingstone.
11. Chandrakant Kakote, Pharmaceutical Biotechnology.
12. Desmond S.T. Nicholl, An introduction to genetic engineering, Panima Publishing Corporation, New Delhi.

Pharmacology – II **4 Hrs/week**

Unit	Topic	Hours
1	**Chemotherapy**	**30**
1.1	Introduction to chemotherapy including drug resistance.	2
1.2	Sulfonamides, trimethoprim, fluoroquinolones, nitrofurantoin.	3
1.3	Penicillins, cephalosporins and cephamycins.	3
1.4	Tetracyclines, chloramphenicol, macrolides, clindamycin, linezolid, streptogramins and fusidic acid.	3
1.5	Aminoglycosides and spectinomycin.	2
1.6	Antifungal agents.	2
1.7	Antiviral agents including anti-HIV agents.	2
1.8	Chemotherapy of tuberculosis, leprosy, and malaria.	3
1.9	Chemotherapy of amoebiasis.	1
1.10	Anthelmintic drugs.	1
1.11	Chemotherapy of neoplastic diseases (Anticancer drugs).	3
1.12 1.13	SELF STUDY Rational use of antimicrobials. General principles of chemotherapy of infection.	 3 2
2	**Immunomodulators**	**9**
2.1	Immunology: Regulation of immune system, signalling pathways for its activation and inhibition.	1
2.2	Immunostimulants and immunosuppressants.	2
2.3	Immunomodulators in the treatment of HIV and Cancer.	2
2.4	SELF STUDY Physiology of immune system.	 4
3	**Drugs in Endocrine Disorders**	**11**
3.1	Thyroid and anti-thyroid drugs.	2
3.2	Insulin, antidiabetic agents including DPP-IV inhibitors.	3
3.3	Agents affecting bone mineral homeostasis.	1
3.4	Oxytocics.	1
3.5	Oral contraceptives.	1
3.6	SELF STUDY Corticosteroids	3
4	**Drugs in Haematological Disorders**	**10**
4.1	Drugs used in anemia.	2
4.2	Coagulants and anti-coagulants.	3
4.3	Thrombolytics and anti-platelet agents.	2
4.4	SELF STUDY Physiology of blood coagulation.	 3
	Total	**60**

Latest editions of the following books to be adopted

1. Goodman & Gilman's Pharmacological Basis of Therapeutics, McGraw Hill Companies Inc.
2. Satoskar R.S. Bhandarkar S.D. & Rege N. N. Pharmacology & Therapeutics, Popular Prakashan.
3. Rang & Dale Pharmacology, Churchill Livingstone.
4. Lippincott's Illustrated Reviews: Pharmacology- Lippincott-Raven Howland & Nyeets Publishers NY.
5. Laurence D. R. & Bennett Clinical Pharmacology, Elsevier NY.

6. Kulkarni S. K. Handbook of Experimental Pharmacology, Vallabh Prakashan, New Delhi.
7. Katzung B. G. -Basic and Clinical Pharmacology, Appleton and Lange publications.
8. Ghosh M. N. Fundamentals of Experimental Pharmacology Hilton & Company, Kolkata.

Pharmaceutical Management **3 Hrs/week**

Unit	Topic	Hours
1	**Understanding of health care industry**	**5**
1.1	Different components of health care industry/ What constitutes health care industry	1
1.2	Indian pharmaceutical industry (in today's scenario and its potential as your career option)	1
1.3	Details of therapy segment, major companies and major brands	1
1.4	Elements of pharmaceutical industry in order to understand its working uniqueness of medical products marketing-C&F agent, stockist & retailer/chemist.	1
1.5	Different working style of acute, chronic and OTC therapy segment	1
2.	**Financial Management**	**2**
2.1	Understanding basic concept of market share, growth, profitability	1
2.2	Basics of balance sheet and profit and loss account	1
3	**SWOT analysis**	**3**
31	Basic concept SWOT analysis.	1
3.2	Application of SWOT analysis considering any therapeutic class of a drug.	2
4	**Brand Plan**	**4**
4.1	Importance of brand plan.	1
4.2	Basic elements of a brand plan	3
5	**Identifying Market Segments and Targets (STP)**	**3**
5.1	Segmentation: Geographic, demographic, psychographic and behavioral Targeting: Effective segmentation criteria, evaluation and selection of market segment	1
5.2	Positioning: Understanding the importance of positioning based on indication with live examples from pharmaceutical industry	2
6	**Product Life Cycle (PLC)**	**4**
6.1	Importance of PLC	1
6.2	How to manage product at different stages of PLC	3
7	**4 P's of Marketing Mix (Product, Price, Promotion, Place)**	**3**
7.1	Product: Different types of pharmaceutical products (acute, chronic and OTC) Pricing: How to determine the pricing of products, determination of NRV (Net Retail Value) and MRP (Maximum Retail Price) Place: All India, Hospitals, Govt./ Corporate purchasers, ESIS schemes, NGOs. Promotion: direct distribution, direct home delivery, dispensing, scheme, etc.	2
7.2	Packaging: importance of packaging in pharmaceutical products, types of packing and its importance.	1
8	**Important Marketing models**	**4**
8.1	BCG matrix	2
8.2	Porter's 5 force model	2
9	**Soft skills and self development**	**2**
9.1	Human resource management: Leadership, motivation, delegation, conflict management and communication, time management, multitasking, planning and organizing and stress management	1
9.2	Skills to excel in interview: dress code, body language and handling difficult situations, dos and donts of resume making **(Self Study)**	1
10	**Pharmaceutical quality and legal regulatory bodies**	**6**
10.1	DPCO- meaning and its role	1
10.2	Quality management: FDA regulations and approvals, WHO requirements,	1
10.3	General awareness of Global requirements of MHRA/ MCA/ TGA/ USFDA/ ISO up gradation/ Six sigma concept,	2
10.4	Clinical research, patent registration and IPR	2

11	**Case Studies**	**5**
12	**Presentations**	**4**
	Total	**45**

Latest editions of the following books to be adopted

1. Kotler, Loshy & Jha , Marketing Management.
2. Dr. Rajan Saxena, Marketing Management.
3. Adrian Palmer, Introduction to Marketing Management.
4. Prasanna Chandra, Financial Management.
5. M. Pandey, Financial Management.
6. K. Ashwathapa, Human Resource management.
7. Subba Rao, Personnel & Human Resource Management.
8. K. Ashwathapa, Production & Operations Management.
9. S. N. Chary, Production & Operations Management.
10. S. A. Chunawala, Production & Operations Management.
11. Ronald Ballon, Business Logistics/ Supply Chain Management.
12. Robert Hanfiels, Introduction to Supply Chain Management.

Organic Chemistry Lab. – II **4 Hrs/week**

1) Separation and quantification of binary mixtures by physical and chemical methods.
   Identification of one component and confirmation by preparation of a suitable derivative.
   Minimum eight binary mixtures, covering a wide variety of types to be studied
2) Theoretical aspects of recrystallization
3) Recrystallization of organic compounds: at least two with the use of different solvents.

Latest editions of the following books to be adopted

1. A laboratory hand book of organic qualitative analysis and separation, V.S. Kulkarni, S. P. Pathak, D. Ramchandra & Co., Pune.
2. Text book of organic practical chemistry, V.S. Kulkarni, S. P. Pathak, D. Ramchandra & Co., Pune.
3. R. L. Shriner, R. C. Fuson and D. Y. Curtin, The systematic Identification of Organic compounds, 6th Ed., Wiley, New York, 1980.
4. A. I. Vogel, A textbook of practical organic chemistry, 4th edition, Wiley New York, 1978.
5. Comprehensive Practical Organic Chemistry: Qualitative Analysis, V. K. Ahluwalia, S. Dhingra, Universities Press (India) Limited, 2000.
6. Comprehensive Practical Organic Chemistry: Preparation and Quantitative analysis, V.K. Ahluwalia, Renu Aggarwal, Universities Press (India) Limited, 2000.

Pharmaceutical Biotechnology Lab. **4 Hrs/week**

1. Air microbiology by solid and liquid impingement methods.
2. Coliform count of water by MPN technique.
3. Test for sterility as per IP (Injection water/ nonabsorbent cotton/soluble powder/ear drops).
4. Microbial limit test on excipients as per I.P. – Hard gelatin, tragacanth, starch, lactose
5. Studies on selective media: McConkey Agar, Cetrimide Agar, Vogel Johnson, Salt mannitol agar.
6. Antibiotic sensitivity test by disc method.
7. Widals test tube agglutination method
8. Biochemical tests (Catalase, Oxidase, Urease, Nitratase, Protease, Amylase and IMVIC).
9. Antimicrobial assay of antibiotic, introduction to zone of inhibition and calculation.
10. Immobilization of enzymes/cells by calcium alginate/gelatin/agar.
11. Isolation of DNA.
12. Selection and isolation of bacteria by replica plating.
13. Determination of thermal death time and thermal death point.
14. Effect of Ultra-Violet exposure on growth of E coli.
15. Demonstration of electrophoresis either by PAGE or Agarose gel electrophoresis.

Latest editions of the following books to be adopted

1. Medical Laboratory Technology: A Procedure Manual for Routine Diagnostic Tests (Vols. I, II & III), Kanai L. Mukherjee (Chief Editor), Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. An Introduction to GENETIC ENGINEERING, 2nd Edition, Desmond S. T. Nicholl, Cambridge University Press.
3. Biotechnology: A Textbook of Industrial Microbiology, 2nd Edition, Wulf Crueger & Anneliese Crueger, Panima Publishing Corporation, New Delhi/Bangalore.

Cosmeticology Lab **4 Hrs/week**

Formulation and evaluation of the following cosmetic products:

1. Cleansing milk/lotion
2. Cold cream
3. Vanishing cream
4. Sunscreen cream
5. Foundation makeup
6. Moisturizing Lotion
7. Anti-acne cream
8. Anti-wrinkle cream
9. Clear liquid shampoo
10. Eye shadow
11. Nail lacquer
12. Lipstick
13. Toothpaste/medicated toothpaste
14. Mouthwash
15. Lather shaving cream
16. Brushless shaving cream
17. Aftershave lotion
18. Face powder
19. Facepack

Latest editions of the following books to be adopted

1. Harry's Cosmeticology Edited by J.B. Wilkinson and R. J. Moore, Longman Scientific & Technical Publishers
2. Cosmetics Science and Technology, Edited by M.S. Balsam, E. Sagarin, S. D. Gerhon, S. J. Strianse and M. M. Rieger, Volumes 1,2 and 3.Wiley-Interscience, Wiley India Pvt. Ltd.
3. Poucher's Perfumes, cosmetics & Soaps, Editor- Hilda Butler, Klewer Academic Publishers, Netherlands
4. Cosmetic Technology, Ed. By S. Nanda, A. Nanda and R. Khar, Birla Publications Pvt. Ltd., New Delhi
5. Handbook of Cosmetic Science and Technology, edited by M. Paye, A. O. Barel, H. I. Maibach, Informa Healthcare USA, Inc.
6. Encyclopedia of Pharmaceutical Technology, Vol. 6, Eds. James Swarbrick, James C. Boylan, Marcel Dekker Inc.
7. BIS Guidelines for different cosmetic products.

Semester –VI

Pharmaceutical Chemistry – II **3 Hrs/week**

Unit	Topic	Hours
1	**Pharmacodynamics**	**5**
1.1	Drug targets at molecular level – Cell Structure. Lipids, carbohydrates, proteins and nucleic Acids as drug targets.	2
1.2	Intermolecular bonding forces like electrostatic, hydrogen bonding, van der Waal's interactions, dipole-dipole and ion-dipole interactions and hydrophobic interactions.	3
2	**Proteins as Drug Targets**	**9**
2.1	Primary, secondary, tertiary and quarternary structure of proteins and post translational modifications (Self Study).	1
2.2	Proteins as drug targets / Drugs. Monoclonal antibodies, peptides. Introduction to proteomics.	2
2.3	Enzymes as Drug targets	
2.3.1	Enzyme Inhibitors – Reversible and irreversible (Self Study).	1
2.3.2	Enzyme Inhibitors against microorganisms, viruses, body's own enzymes.	1
2.4	Receptors as Drug Targets.	
2.4.1	Types of receptors and signal transduction - Ion Channels, G-protein coupled receptor (GPCR), Kinases, nuclear receptors.	3
2.4.2	Concept of agonist, antagonist, partial agonist, inverse agonist, concept of desensitization/sensitization, tolerance, affinity, efficacy, potency (Self Study).	1
3	**Nucleic Acids as Drug target**	**8**
3.1	Primary, secondary and tertiary structure of DNA (Self Study)	1
3.2	DNA intercalation, DNA alkylation, antisense therapy	1
4	Pharmacokinetics and Physicochemical Properties of Drug Action	
4.1	Solubility, partition coefficient, acidity-basicity, pK_a, bioisosterism, stereochemistry (geometrical, optical and conformational), Protein Binding	2
4.2	Drug metabolism – Phase I and Phase II Reactions	4
5	**Tools of the Trade (Structure Activity Relationship – SAR)** **Introduction to the concepts of SAR –A Case Study**	**1**
Discussion on the following classes of drugs including enzyme/receptor structure, classification, chemical nomenclature, structure including stereochemistry, generic names, chemistry, SAR, metabolism, molecular mechanism of action, introduction to rational development, drug resistance, if any, of following classes of drugs		
6	**Antiinfective Agents**	**10**
6.1	Antibiotics Penicillins (natural and semisynthetic penicillins like Penicillin G, Penicillin V, ampicillin*, amoxicillin, cloxacillin*, oxacillin, naficillin, methicillin and ampicillin prodrugs like bacampicillin and hetacillin). □-lactamase inhibitors like clavulinic acid, (self study – tazobactam). Cephalosporins (cephalexin, cefadroxil, cefazolin, cefamandole, cefoxitin, cefuroxime, cefotaxime, ceftriaxone, cefpodoximeproxetil) Tetracyclines (tetracycline, chlortetracycline, oxytetracycline, doxycycline, and minocycline and its prodrug – rolitetracycline); Macrolides, (erythromycin, roxithromycin, azithromycin - only highlights of structure to be discussed). Aminoglycosides (gentamicins, and neomycins, - only highlights of structure to be discussed) Carbapenems (Emepenem, meropenem). Monobactams (Aztreonam, Tigemonam). Chloramphenicol, Linezolid. Only highlights of structures of Vancomycin, Bacitracin, Polymyxin B.	7
6.2	Sulfonamides (Self study) Short, intermediate and long acting sulfonamides, sulfonamides for ophthalmic infections,	1

	ulcerative colitis and for reduction of bowel flora. Sulfamethoxazole, sulfadiazine*, sulisoxazole, sulfacetamide, sulfasalazine.	
6.3	Fluoroquinolones Norfloxacin, ciprofloxacin*, sparfloxacin, gatifloxacin, levofloxacin, lomefloxacin.	2
7	**Antiparasitic Agents**	**6**
7.1	Antimalarial Agents Natural products like cinchona alkaloids (with stereochemistry and drug action) and artemisinin and its derivatives like artether, artemether and artesunate, synthetic antimalarials such as 8- aminoquinolines e.g. primaquine*, 4- aminoquinilines e.g. chloroquine*, Quinolinemethanols e.g. mefloquine; misc like halofantrine, lumefantrine and; DHFR inhibitors like pyrimethamine* and proguanil, cycloguanil, atovaquone, sulfadoxine Combination therapy.	3
7.2	Drugs for treatment of amoebiasis, giardiasis and trichomoniasis (Self Study). Metronidazole*, tinidazole, secnidazole, diloxanide furoate*, nitazoxanide.	1
7.3	Anthelmintics Albendazole, mebendazole*, thiabendazole, diethylcarbamazine, ivermectin, praziquantel, pyrantel pamoate	1
7.4	Drugs for the treatment of pneumocystis, trypanosomiasis, leishmaniasis(Self Study) Atovaquone, pentamindine, co-trimoxazole, trimetrexate, benznidazole, eflornithine, melarsoprol, suramin, nifurtimox, sodium stibogluconate, miltefosine)	1
8	Antimycobacterial Agents Antitubercular drugs - PAS*, ethionamide, isoniazid, pyrazinamide, ethambutol*, antitubercular antibiotics (streptomycin, rifampin, rifapentine, capreomycin, cylcoserine – the first four only highlights of structure to be discussed), fluoroquinolones, bedaquiline. Antileprotic drugs.- Dapsone*, clofazimine, rifampin. Combination therapy	3
9	Antifungal Agents Natural products like griseofulvin , amphotericin B and nystatin (later two only general aspects of structure related to activity). Antifungal azoles like clotrimazole*, miconazole, ketoconazole, fluconazole, and itraconazole. Allyl amines like naftifine, butenafine and terbinafine. Flucytosine and tolnaflate.	3
	Total	**45**

***Synthesis to be taught**

Latest editions of the following books to be adopted.

1. Graham L. Patrick, An Introduction to Medicinal Chemistry, Oxford University Press.
2. Gareth Thomas, Fundamentals of Medicinal Chemistry, Wiley, New York.
3. Richard B. Silverman, The Organic Chemistry of Drug Design and Drug Action, Academic Press.
4. Thomas L. Lemke, David A Williams, Foye's Principles of Medicinal Chemistry, Lippincott Williams & Wilkins.
5. John M. Beale, John H. Block, Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Lippincott Williams & Wilkins.
6. Ashutosh Kar, Medicinal Chemistry, New Age International Publishers.
7. Alex Gringauz, Introduction to Medicinal Chemistry, Wiley.
8. Daniel Lednicer, Lester A. Mitscher, The Organic Chemistry of Drug Synthesis, John Wiley and Sons.
9. H. J. Roth & A. Kleemann, Pharmaceutical Chemistry, Volume 1, Organic Synthesis, Ellis Horwood Series in Pharmaceutical Technology, Halsted Series.
10. Ruben Vardanyan and Victor Hruby, Synthesis of Essential Drugs, Elsevier.
11. Kleemann & Engel, Pharmaceutical Substances: Syntheses, Patents, Applications, Thieme Publications.

Pharmaceutical Analysis – II **3 Hrs/week**

Unit	TOPIC	Hours
1	**Basis of spectrophotometry**	**8**
1.1	***Terms-*** • Electromagnetic radiation, Visible light and electromagnetic spectrum, wavelength, wave number, frequency, absorbance, transmittance ***(Self study-0.5h)***, singlet state, triplet state, fluorescence, phosphorescence and energy transitions. • Atomic spectra, molecular spectra, atomic absorption spectroscopy, atomic emission spectroscopy, molecular absorption spectroscopy, molecular emission spectroscopy.	2
1.2	Instrumentation for: UV-Vis, Fluorescence ***(Self study-1 hr)***, FTIR spectroscopy • Sources of electromagnetic radiation • Monochromators (Filters, prisms, gratings) • Sample cells • Detectors	4
1.3	• Colorimeter & UV-Vis Spectrophotometers-Single beam and Double beam (including Block diagram & ray diagram). • Filter fluorimeter (including Block diagram) and Spectrofluorimeter. • Interferometer in FTIR	2
2	**Atomic absorption spectroscopy (AAS) and Flame emission spectroscopy (Flame photometry)**	**3**
2.1	• Principle, partial emission spectrum of sodium • Difference between atomic absorption spectroscopy and flame emission spectroscopy, Advantages and disadvantages ***(Self study-1 hr)*** • Instrumentation: Radiation sources (For AAS-Hollow cathode lamp, Electrode discharge lamps; For Flame photometry-Inductively coupled plasma source, Direct current plasma source); Flame atomization (types of flames, flame structure, flame atomizers).	2
2.2	• Sample preparation • Spectral Interferences and Chemical Interferences in AAS. • Cationic, Anionic and Physical interferences in Flame photometry. • Pharmaceutical applications.	1
3	**UV-Visible spectroscopy**	**7**
3.1	***Terms***-chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromism, hypochromism, wavelength maxima, specific absorbance, molar absorptivity, cut-off wavelength for solvents.	1
3.2	• General concepts-Types of absorbing electrons, electronic transitions, • Beer-Lambert's law-statement, derivation of mathematical expression, limitations. • Choice of solvents ***(Self study-0.5 h)*** • Chemical derivatization.	2
3.3	• Application of Beer's law in quantitative spectrophotometric assays-Single component assays-use of a standard absorptivity value -use of a calibration graph -single and double point standardization • Measurement of Equilibria constant. • Measurement of rate constant.	2
3.4	Numericals based on Beer-Lambert's law.	2
4	**Fluorescence spectroscopy**	**3**
4.1	Origin of fluorescence and phosphorescence spectra, Fundamental equation for fluorescence intensity, factors affecting fluorescence intensity (intensity of radiation source, quantum yield, molecular structure and rigidity, temperature, solvents, pH, dissolved oxygen, quenchers & concentration).	2

4.2	Chemical derivatization of non-fluorescent compound to fluorescent compound (e.g: use of Dansyl chloride, Fluoresamine, o-phthalaldehyde) ***(Self study-0.5 h)***, Choice of fluorimetry over UV-Vis spectroscopy with respect to Sensitivity and Specificity. Pharmaceutical Applications ***(Self study-0.5 h)***	1
5	**Infrared / Near IR spectroscopy**	**6**
5.1	I.R. regions, requirements for I.R. absorption, vibrational and rotational transitions, dipole changes, types of molecular vibrations, potential energy diagrams (harmonic oscillator and anharmonic oscillator), Vibrational frequency, factors influencing vibrational frequencies, force constants, vibrational modes (normal mode, combination bands and overtone bands), Finger print region	2
5.2	• Sample preparation for I.R spectroscopy-Solids (mulling, pelleting & thin film deposition, and in solution form), Liquids (Neat and in solution form). • Sample handling: Attenuated Total Reflectance and Diffuse Reflectance. • Pharmaceutical applications of IR spectroscopy (including characteristic IR absorption frequencies of some common bond types such as hydroxyl stretch, nitrile stretch and carbonyl stretch of aldehydes and ketones, aliphatic and aromatic C-H stretch) ***(Self study-1 hr)*** • Pharmaceutical applications of Near IR spectroscopy including PAT (Process Analytical Techniques).	4
6	**Raman Spectroscopy**	**3**
6.1	• Principle of Raman scattering. • Comparison between I.R. Spectroscopy and Raman Spectroscopy ***(Self study-0.5 h)*** • Raman instrumentation-Sources of light, Sample illumination system (Liquid, solid and fibre optic sampling), Block diagram of Raman spectrometer. • Applications***(Self study- 0.5 h)***	3
7	**Thermal methods of analysis**	**4**
7.1	• Principle, instrumentation, working and applications of thermogravimetry(TG) • Factors affecting TG curve	2
7.2	Principle, instrumentation, working and applications of : • Differential Thermal Analysis (DTA) ***(Self study-1 hr)*** • Differential Scanning Calorimetry (DSC)	2
8	**Radiochemistry and Radiopharmaceuticals**	**5**
8.1	Fundamentals of radioactivity: • Properties of radionuclide, Radionuclide, Radioisotope, Radioactive decay, half-life of radioactivity, specific activity, Becquerel, curie, Sievert and Gray***(Self study-0.5 h)*** • Relative biological effectiveness, Radionuclidic purity, Radiochemical purity, Geiger-Muller Counting, liquid Scintillation Counting • Safety aspects of radiopharmaceutical laboratory ***(Self study-0.5 h)***	2
8.2	Quality control of radiopharmaceuticals: Physical, Chemical (Radionuclidic purity, Radiochemical purity), and pharmaceutical properties ***(Self study-0.5 h***-apyrogenicity, pH and absence of particulate), Isotope dilution analysis (Direct and Inverse), 99mTc generator.	3
9	**X-Ray Diffraction Technique**	**2**
9.1	• Fundamentals- Origin of X-ray, Bragg's law & its mathematical derivation, and Miller indices ***(Self study-0.5 h)*** • Pharmaceutical applications	2
10	**Statistical data handling**	**4**
10.1	• Normal Distribution Numericals based on: • Confidence limits & Tests of significance (F-test, Student t-test-paired and unpaired) • Linear regression analysis and correlation coefficient	

	• Rejection of results (Q-test)	
	Total	**45**

Latest editions of the following books to be adopted

1 D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, Saunders College Publishing, USA.
2 K. A. Connors, A Textbook of Pharmaceutical Analysis, John Wiley and Sons, Canada.
3 A. H. Beckett and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I and II, CBS Publishers and Distributors, India.
4 D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of Analytical Chemistry, Saunders College Publishing, USA.
5 G. D. Christian, Analytical Chemistry, John Wiley & Sons, Singapore, reprint by Wiley India Pvt. Ltd.
6 H. H. Willard, L. L. Merrit and J. A. Dean, Instrumental Method of Analysis, CBS Publishers & Distributors, New Delhi.
7 Ashutosh Kar, Pharmaceutical Drug Analysis, New Age International (P) Ltd. Publishers, India.
8 S. S. Mahajan, Instrumental Methods of Analysis, Popular Prakashan Pvt Ltd., India.
9 G.R. Chatwal and S. K. Anand, Instrumental methods of chemical analysis, Revised and enlarged, Himalaya Publishing House Pvt. Ltd.
10 Indian Pharmacopoeia, The Indian Pharmacopeia Commission, Ghaziabad, Government of India.
11 United States Pharmacopoeia.
12 J. Mendham, R. C. Denney, J. D. Barnes, M.J. K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed., Pearson Education Ltd.
13 D.G. Watson, Pharmaceutical Analysis –A textbook for pharmacy students and pharmaceutical chemists, Churchill Livingstone Elsevier.
14 J.W. Robinson, E. M. S. Frame and G. M. Frame II, Undergraduate Instrumental Analysis, Marcel Dekker, New York, USA.
15 R. Kellnar, J. M. Mermet, M. Otto, M. Valcarceland, H. M. Widmer, Analytical Chemistry: A modern approach to analytical science, Wiley-VCH, USA.
16 J. W. Munson, Pharmaceutical Analysis: Modern methods (in two parts), Marcel Dekker Inc., USA.
17 W. Kemp, Organic Spectroscopy, Reprinted, Palgrave Publishers Ltd., New York, USA.
18 R. M. Silverstein, F. X. Webster and D. J. Kiemle, Spectrometric identification of organic compounds, John Wiley & Sons, Inc. (Indian edition), New Delhi.
19 D.B. Troy and P. Beringer, Remington-The Science and Practice of Pharmacy, Vol. I & II, Walters Kluwer/ Lippincott Williams & Wilkins (Indian edition), New Delhi.
20 J.W. Robinson, E. M. S. Frame and G. M. Frame II, Undergraduate Instrumental Analysis, 6th Ed., Marcel Dekker, New York, USA.
21 J.R. Dyer, Applications Of Absorption Spectroscopy Of Organic Compounds, Prentice- Hall of India Pvt. Ltd, New Delhi, India.
22 D. L. Pavia, G. M. Lampman, G.S. Kriz and J. R. Vyvyan, Introduction to Spectroscopy, Brooks / Cole Cengage Learning, Australia.
23 S. Bolton and C. Bon, Pharmaceutical statistics: Practical and clinical applications, Drugs and Pharmaceutical Sciences Series, Vol. 203, Informa Healthcare, USA.

Pharmaceutics – III **3 Hrs/week**

Unit	Topic	Hours
1	**TABLETS**	**19**
1.1	Definition, advantages and limitations, preformulation aspects.	3
1.2	Tablet formulation and design, additives, excipients with examples.	3
1.3	Large scale manufacturing. Drying as a unit operation. Equipments for mixing. Direct compression, wet Granulation, dry Granulation (Slugging and roller compaction).	5
1.4	Compression – (Single station tablet press and Rotary press), physics of tablet compression (brief).	3
1.5	Processing problems in tableting. Quality control of tablets.	3
1.6	***Self Study*** *-Types of tablets-Effervescent, succal, lozenges, chewable, sublingual, dispersible, soluble, orodispersible. layered tablets.Layout of tablet section.*	2
2.	**CAPSULES**	9
2.1	Definition, types of capsules, advantages and limitations, and raw materials including gelatin and other materials. ***Self Study-****Manufacture of gelatin.*	1 1
2.2	Hard gelatin capsule: Manufacturing of hard gelatin capsule shells, size, size selection, sealing, storage, defects of shells.	1
2.3	Hard capsule fill formulation aspects: Large scale manufacturing. Filling of hard capsule shells, types of fills and excipients. Filling equipments: classification-volumetric, dosator type and tamping type (one example of each type of equipment). Humidity control in capsule manufacturing and filling area. Problems in capsule filling & remedies	3
2.4	Soft gelatin capsules: Properties, nature of shell and contents, Formulation aspects-concepts(minim/gm) Large scale manufacturing- Rotary Die Process	2
2.5	***Self study*** -Quality Control of empty capsule shell and hard and soft gel capsules. Layout of capsule section.	1
3	**PACKAGING**	3
3.1	Blister and strip Packing, manufacturing defects, QC	2
3.2	***Self study*** -Packing materials	1
4	**AEROSOL**	6
4.1	Definition, advantages & disadvantages, desirable features. Components – Prepellants-types, selection, two phase & three phase systems	2
4.2	Containers – Tin Plate, Aluminum, Glass, Plastics, Valve, & Actuator Standard valve (detail) & specialized valves (in brief).	2
4.3	Product concentrate Different formulation systems- solution, Dispersions, Foams Powders.	1
4.4	Manufacturing and Quality Control testing.	1
5	**COATING OF TABLETS**	8
5.1	Need for tablet coating, types of coating, tablet core properties.	1
5.2	Sugar coating – Raw materials, Steps in detail, Sugar coating defects/problems.	2
5.3	Film coating including Enteric coating. Raw materials, Aqueous film coating, film coating defects/problems.	2
5.4	Coating Equipments – Conventional & modified pans, coating columns (fluidized bed coating), Spray equipment & other accessories..	2
5.5	***Self study*** –Quality control of coated tablets.	1
	TOTAL	45 hrs

Latest editions of the following books to be adopted

1. Aulton Michael E., Pharmaceutics: The Science of Dosage Form Design, Churchill Livingstone Publishers.
2. Lachman Leon, Liberman Herbert A., Kanig Joseph I., The Theory and Practice of Industrial Pharmacy, Varghese Publishing House, Mumbai.
3. Liberman Herbert A., Lachman Leon, Schwartz Joseph B., Pharmaceutical Dosage Forms – Tablets, Volume 1/2/3, Marcel Dekker Inc., New York.
4. Larry L. Augsburger and Stephen W. Hoag., Pharmaceutical Dosage Forms – Tablets Volume 1/2/3, Informa healthcare, New York, London.
5. Cole G., Pharmaceutical Coating Technology" Taylor and Francis Ltd., Bristol, PA.
6. S.J. Carter Ed., Tutorial Pharmacy, Cooper and Gunn, CBS Publishers & Distributors, India.

Pharmacognosy and Phytochemistry – I **4 Hrs/week**

Unit	Topic	Hours
1	**Introduction to Pharmacognosy**	**7**
1.1	Historical development, modern concept and scope of Pharmacognosy and Phytochemistry. Sources of drugs of natural origin (**DONO**) including plants, animals, minerals, marines and plant tissue culture products with examples of each source. Significance of pharmacognosy in various systems of medicine practised in India *viz.* Ayurveda, Unani, Homeopathy and Siddha. Introduction to the concept of phytomedicines. *Self study: (4 or 5 examples of each of the following)* • *Examples of sources of DONO* • *Examples of drugs used in different traditional systems of medicine.*	2 2
1.2	Introduction to organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilages, oleoresins and oleo- gum -resins), unofficial and official drugs as per the Indian Pharmacopoeia with suitable examples. Classification of DONO based on alphabetical, morphological, pharmacological, chemical, taxonomical and chemotaxonomical methods along with the significance of each method	3
2.	**Commercial production, Collection & Preparation of Crude Drugs**	**7**
2.1	Overview of cultivation, collection, preparation, drying and storage (Pest control, moisture control) of crude drugs. *Self study:* *Commerce of crude drugs and 4-5 examples of plants from different geographical sources and climatic zones.*	3 1
2.2	Factors affecting quality of crude drugs – Exogenous Factors, Environmental Factors and Endogenous factors: Mutation, Polyploidy and Hybridization. Introduction to plant tissue culture and its applications to pharmacognosy. Plant growth regulators and their application to tissue culture, propagation of plants and production of secondary metabolites.	3
3.	**Morphological and histological characteristics of crude drugs**	**12**
3.1	Study of ergastic cell contents including calcium oxalate crystals, starch grains and aleurone grains and idioblasts	2
3.2	Study of morphology and histology of monocot and dicot roots, rhizomes, stems, barks, woods, leaves, flowers, fruits and seeds. Details of mountants, clearing agents and microchemical reagents. *Self study:* • *Classification of roots, stems, fruits* • *Salient features of monocot, dicot root and stem* • *Different types of inflorescence*	6 3
3.3	Identification and significance of morphological & microscopic differences between plants of allied species as exemplified by digitalis, brahmi, cinnamon &tinospora.	1
4	**Introduction to Phytoconstituents**	**6**
4.1	Brief introduction to Primary and secondary metabolites in plants with structures. *Self Study:* • *Any two examples of each class of phytoconstituents and significance of phytoconstituents for therapeutic application*	2 2
4.2	Study of their biosynthetic pathways with structures (Including shikimic acid pathway and acetate hypothesis, polyketides and terpenoids)	2
5	**Extraction of phytochemicals**	**5**
5.1	Introduction to general methods of extraction of different classes of phytochemicals from crude drugs *viz.*maceration , percolation, soxhlet extraction, Dien Stark assembly for moisture content determination and extraction of volatile oil. Introduction to newer	2

	techniques of extraction like microwave assisted extraction, countercurrent extraction and supercritical fluid extraction. *Self Study:* • *Commercial applications of recent methods of extraction techniques with any two examples.*	 2
5.2	General methods of extraction for following classes of phytoconstituents : alkaloids, glycosides & tannins	1
6	**Evaluation & Quality Control of drugs of natural origin (DONO)**	**8**
6.1	Introduction & significance of evaluation of DONO. Study of organoleptic, microscopic, physical, chemical and biological methods of evaluation of crude drugs with respect to pharmacopoeias. Introduction to WHO guidelines and monographs of drugs of natural origin.	4
6.2	Quantitative microscopy of crude drugs including lycopodium spore method, leaf constants, camera lucida and diagrams of microscopic objects to scale with camera lucida. Study of adulteration and substitution of crude drugs. *Self Study:* • *Examples of adulteration and substitution of crude drugs*	2 2
7	**Study of Fibres**	**3**
7.1	Study of plant, animal & mineral fibres with respect to their classification, sources, production, chemistry, commercial utility and significance in Pharmaceutical Industry for the following: Absorbent & nonabsorbent cotton, jute, flax, hemp, asbestos, glass wool, silk, wool, rayon, viscose	3
8	**Study of carbohydrate containing drugs of natural origin**	**8**
8.1	Detailed study of Carbohydrates with respect to chemistry, sources, preparation, evaluation and commercial utility as Pharmaceutical Aids and Medicines for the following: Cellulose and cellulose derivatives, starches, honey, inulin, alginic acid, malt and malt extract, dextran, pectin, chitin, tamarind kernel powder (TKP).	3
8.2	Plants as sources of gums including tragacanth, acacia, sterculia, xanthan, guar gum, galactomannans. Plants as sources of mucilages including agar, Isapghol and linseed. *Self Study:* *Study of monograph of any two carbohydrate containing drugs as per IP*	3 2
9	**Proteins and Enzymes**	**4**
9.1	Study of Proteins and Enzymes with respect to sources, preparation and uses - protein hydrolysates, gelatin, casein, thyroid hormones, proteolytic enzymes (Papain, bromelain, serratiopeptidase, urokinase, streptokinase, pepsin). Study of plant lectins with respect to sources, composition and applications for Abrin, ricin. *Self study:* • *Marketed formulations containing serratiopeptidase and their applications.*	3 1
	Total	**60**

Latest editions of the following books to be adopted

1. Trease D. & Evans W. C.: Text Book of Pharmacognosy: W. B. Saunders.
2. Tyler V.E., Brady L.R. & Robbers J. E.: Pharmacognosy; LeaFeibger, USA.
3. Wallis T. E.;Text Book of Pharmacognosy; CBS Publishers, Delhi.
4. Kokate C.K., Purohit A. P. & Gokhale S. B.: Pharmacognosy; Nirali Publications, Pune.
5. Harbone J. B.: Phytochemical Methods: A guide to modern techniques Analysis: Chapman& Hall, London.
6. Bruneton J.: Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
7. Vasudevan T.N. & Laddha K.S.: A Textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
8. The Indian Pharmacopeia: The Controller of Publication; Delhi.
9. Brain K.R. & Turner T. D.: ThePractical Evaluation of Phytopharmaceuticals: Wright, Scientica, Bristol.
10. Iyengar M. A. & Nayak S. G.: Anatomy of Crude Drugs: Manipal Power Press Manipal.

11. Iyengar M. A.: Pharmacognosy of Powdered Drugs; Manipal Power Press, Manipal.
12. Kokate C. K.: Practical Pharmacognosy;Vallabh Prakashan.
13. Wagner, Bladt & Zgainski; Plant Drug Analysis; Springer Verlag.
14. Khandelwal K. R.: Practical Pharmacognosy Techniques and Experiments; Nirali Prakashan, Pune.
15. Vasudevan T. N. and Laddha K. S.:Practical Pharmacognosy; New Vrinda Publishing House, Jalgaon.

Hospital Pharmacy and Drug Store Management **3 Hrs/week**

Unit	Topic	Hours
1.	**Introduction to Hospitals and Hospital Pharmacy**	**5**
1.1	Definition, Classification, Organizational structure of Hospital, administration and functions of hospitals	2
1.2	Definition, History, Development and Current status of Hospital Pharmacy Duties and Responsibilities of Hospital Pharmacist	2
1.3	Layout, space and facilities, Concept of Pharmaceutical care. (self study)	1
2.	**Pharmacy and Therapeutics Committee**	**5**
2.1	Objective, Composition and Functions of P and T Committee, Drug Utilization	2
2.2	Review Hospital Formulary: Definition, advantages, limitations, preparation, content, with few	2
2.3	examples, selection of drugs, publication and format 2.3. Hospital Pharmacy procedural manual (self study)	1
3.	**Purchasing procedure in hospitals (self study)**	**3**
3.1	Purchasing procedure and storage	1
3.2	Inventory control in hospitals	2
4.	**Drug Distribution systems in Hospitals**	**4**
4.1	Dispensing to In – patients, Outpatients, Unit dose dispensing, Prepackaging	2
4.2	Dispensing of controlled substances	2
5.	**Central Sterile Supply Services**	**6**
5.1	Advantages, Plan, Location, Layout	1
5.2	Sterilization of surgical dressings – methods of packing, loading and prevention of wetting of dressings. Sterilization of rubber gloves, syringes, needles, catheters, tubings, surgical instruments, mattresses, utensils and bedpans and other accessories	3
5.3	Manufacturing and Bulk compounding of large volume parenterals, Total Parenteral Nutrition and Intravenous additives.	2
6.	**Safe use of medication in hospitals (self study)**	**2**
6.1	Medication errors and ASHP Guidelines to prevent errors, Infection control in hospitals	2
7.	**Health Accessories (self study)**	**2**
7.1	Wheel chairs, canes, crutches, bedpans, vapourizers, syringes, needles, clinical thermometers, first aid supplies	2
8.	**Introduction to Pharmacy Practice**	**3**
8.1	Pharmacy Trade or Profession, Community Pharmacy, Code of Ethics for a pharmacist.	3
9.	**Channels of distribution and Forms of Business Organization**	**5**
9.1	Wholesalers and Retailers and their professional role.	2
9.2	Hindu undivided family, Sole Proprietorship, Partnership, Co – operative society and Company	2
9.3	Planning of retail pharmacy and Entrepreneurship.	1
10.	**Drug Store Management**	**5**
10.1	Legal aspects, Licenses and Registrations.	1
10.2	Location analysis and layout design.	2
10.3	Sales promotion and Window display.	2
11.	**Purchasing and Inventory control in retail trade**	**3**
11.1	Purchasing procedure in retail trade	1
11.2	Inventory control (Want Book, Systematic Want Book, Open to Buy budgeting, ABC, VED, EOQ analysis), Use of computers for Inventory control	2
12.	**Risk Management and Frauds in retail practice**	**2**
12.1	Risk management, Insurance policies and Frauds in retail practice	2
	Total	**45**

Latest editions of the following books to be adopted

1. Hospital Pharmacy, W. E. Hassan, Edition, Lea and Febiger, Philadelphia.
2. A text – book of Hospital Pharmacy, S.H. Merchant and Dr. J.S. Quadry, B.S. Shah Prakashan, Ahmedabad.
3. Hospital Pharmacy, Dr. H. P. Tipnis and Dr. Amrita Bajaj, Career Publication, Maharashtra.
4. Gennaro Alfonso R, Remington – The Science and Practice of Pharmacy", Lippincott Williams and Wilkins.
5. Principles and methods of Pharmacy Management, Smith, Lea and Febiger, Philadelphia.
6. Drug store management, Nolen and Maynard. McGraw Hill.
7. Drug Store and Business Management, A. P. Battasse, Unique Publication.
8. Text book of Forensic Pharmacy, N. K. Jain, Vallabh Prakashan.

Pharmaceutical Chemistry Lab. – II **4 Hrs/week**

Traditional methods of synthesis to be followed for each of the Unit Operations in addition to specific methods as indicated.

1. Acetylation - Synthesis of aspirin using Microwave Procedure Ref: Green Chemistry V. K. Ahluwalia, pg. no. 7.3. Synthesis of Acetanilide as per Green Chemistry DST Monograph
2. Halogenation – Synthesis of p-bromoacetanilide as per Green Chemistry, DST Monograph
3. Esterification of Ibuprofen using DCC coupling.
4. Oxidation - Synthesis of benzoic by oxidation of toluene **or** benzyl alcohol with alkaline potassium permanganate.
5. Hydrolysis of methyl benzoate.
6. Reduction - ketones: Synthesis of benzhydrol by reduction of benzophenone with zinc and sodium hydroxide) **or** synthesis of m-nitroaniline by partial reduction of m- dinitrobenzene with sodium polysulfide.
7. Nitration: Synthesis of 5-nitrosalicylic acid as per Green Chemistry, DST Monograph.
8. Synthesis of benzimidazole.

Books

1. Vogel's A Text book of Practical Organic Chemistry by Vogel, Longman group limited, London.
2. Practical Organic Chemistry by Mann FC & Saunders BC, Longman Group Limited, London.
3. Laboratory Techniques in Organic Chemistry, Ahluwalia V.K. I.K. Publishers.
4. Green Chemistry, V. K. Ahluwalia.
5. New Trends in Green Chemistry, V K Ahluwalia and M Kidwai, KluwerAcademic Publishers
6. Monograph on Green laboratory Experiments, Grenn Chemistry Task Force Committee, DST.
7. Practical Organic Synthesis: A Student's Guide - Reinhart Keese, Martin Brändle, Trevor Toube.
8. Advanced practical Medicinal Chemistry by Ashutosh Kar, New Age International Publications.

Pharmaceutical Analysis Lab. – II **4 Hrs/week**

1. Assay of finished products by **UV spectroscopy, using A (1%, 1 cm)**-minimum assay of 5 formulations to be done.
    - Paracetamol tablets
    - Propranolol tablets
    - Atenolol tablets
    - Hydrochlorthiazide tablets
    - Frusemide tablets
    - Albendazole tablets
    - Rifampicin capsules
2. Assay of drugs using **single point and double point standardization** method by UV spectroscopy. *e.g*. Paracetamol
3. **Colorimetric assays (Construction of calibration curve using linear regression analysis)**
    - Assay of streptomycin injection.
    - Assay of salicylic acid.
4. **Fluorimetric analysis**
    - Assay of quinine sulphate.
    - Effect of different concentrations of iodide ions on fluorescence of quinine sulphate.
5. **Potentiometric titrations using pH meter**
    - Determination of pK_a and normality of phosphoric acid (Second end-point).
    - Determination of normalities of individual acids in a mixture of acids. (*e.g*: HCl and H_3PO_4- Second end point).
6. **Demonstration experiments:**
    - Determination of Na^+/ K^+ by Flame photometry.
    - Working of FTIR and Interpretation of IR spectra of any one drug.

Latest editions of books to be adopted

1 Indian Pharmacopoeia, The Indian Pharmacopoeia Commission, Ghaziabad, Government of India.
2 G. D. Christian, Analytical Chemistry, John Wiley & Sons, Singapore, reprint by Wiley India Pvt. Ltd.
3 A. H. Beckett and J. B. Stenlake, Practical Pharmaceutical Chemistry, Part I and II, CBS Publishers and Distributors, India.
4 United States Pharmacopoeia.
5 J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education Ltd.
6 D. G. Watson, Pharmaceutical Analysis –A textbook for pharmacy students and pharmaceutical chemists, Churchill Livingstone Elsevier.
7 R. M. Silverstein, F. X. Webster and D. J. Kiemle, Spectrometric identification of organic compounds, John Wiley & Sons, Inc. (Indian edition), New Delhi**.**

Pharmaceutics Lab - III 4 Hrs/week

1. A) Evaluation of Excipients-Bulking agents- At least one excipient in Conventional and Directly Compressible form for : Flow properties , Bulk density, Compressibility and Particle size and Discussion of Observations.
1. B) Evaluation Of Excipients-Disintegrating Agents for their swelling Index and Discussion of Observations.
1. C) Evaluation Of Excipients of tablets-Lubricants and Glidants-Influence on flow properties of granules, Results and discussion.
2. Granulation for Soluble Aspirin Tablets IP and Evaluation.
3. Granulation, Compression and evaluation of Riboflavin Tablets IP 96.
4. Granulation, Compression and evaluation of Chewable Antacid Tablets.
5. Granulation Compression and evaluation of Paracetamol Tablets IP 96.
6. Preparation and evaluation of orodispersible tablet for low dose drug.
7. Dissolution Test of Paracetamol Tablet IP
8. Evaluation of Capsule shells, filling of Ampicillin trihydrate capsule and their evaluation.
9. Introduction to different devices for inhalation and demo of evaluation of a suitable commercial product for simple test related to spray and weight / drug content per discharge

Books

All books listed in the theory syllabus as well as current editions of IP, BP and USP.

Pharmacognosy & Phytochemistry Lab. – I **4 Hrs/week**

1. Quantitative microscopy (Estimation of Leaf constants *i.e.* Stomatal Index, Vein islet number and Vein termination number, Palisade ratio)
2. Evaluation of Cinnamon powder or Nux vomica powder by Lycopodium Spore method.
3. Determination of alcohol soluble and water soluble extractives, Total ash value and acid insoluble ash and water soluble ash value for any one crude drug as per IP.
4. Microscopical Studies of basic tissues both monocot and dicot stem, leaves, roots, bark, seed, fruits.
5. Study of different types of starch grains, calcium oxalate crystals, Trichomes and stomata
6 Identification of Fibres and Minerals based on chemical tests as covered in theory. Tests for detection of honey, starch, tragacanth, acacia, guar gum, agar.
7 Extraction and detection of starch/pectin from any one source.
8 Morphological identification of any twenty crude drugs and their salient morphological features: Acacia tears, Agar strips, Sterculia lumps, Cinnamon, Cassia, Tinospora, Isapghul, Senna, Potato, Pyrethrum, Tragacanth ribbons, Bael, Tamarind, Rhubarb, Squill, Colchicum corm, Senna pod, Any one inflorescence, Hibiscus, Red sandalwood.

Latest Editions of the following books to be adopted

1. Trease D. & Evans W.C.: Text Book of Pharmacognosy:W. B. Saunders.
2. Tyler V. E., Brady L. R. & Robbers J. E.: Pharmacognosy; LeaFeibger, USA.
3. Wallis T. E.;Text Book of Pharmacognosy; CBS Publishers, Delhi.
4. Kokate C. K., PurohitA.P. & Gokhale S. B.: Pharmacognosy; Nirali Publications, Pune.
5. Harbone J. B.: Phytochemical Methods:A guide to modern techniques Analysis: Chapman& Hall, London.
6. Bruneton J.: Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
7. Vasudevan T. N. & Laddha K. S.: A Textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
8. The Indian Pharmacopeia: TheController of Publication; Delhi.
9. Brain K. R. & Turner T. D.: The Practical Evaluation of Phytopharmaceuticals: Wright, Scientica, Bristol.
10. Iyengar M. A.& Nayak S. G.: Anatomy of Crude Drugs: Manipal Power Press Manipal.
11. Iyengar M. A.: Pharmacognosy of Powdered Drugs; Manipal Power Press, Manipal.
12. Kokate C. K.: Practical Pharmacognosy; Vallabh Prakashan.
13. Wagner, Bladt & Zgainski; Plant Drug Analysis; Springer Verlag.
14. Khandelwal K. R.: Practical Pharmacognosy Techniques and Experiments; Nirali Prakashan, Pune.
15. Vasudevan T. N. and Laddha K. S.: Practical Pharmacognosy; New Vrinda Publishing House, Jalgaon.

Framework for the Final Year B. Pharm. (Credit Based System)

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No	Semester- VII	Credits	Contact hrs/week	Weightage		Marks
	Subject			**Continuous internal assessment**	**End Semester Examination**	
1	Pharmaceutical Chemistry - III	3	3	30	70	100
2	Pharmaceutical Analysis- III	3	3	30	70	100
3	Pharmacology-III	3	3	30	70	100
4	Pharmaceutics - IV	3	3	30	70	100
5	Pharmacognosy & Phytochemistry -II	3	3	30	70	100
6	Pharmaceutical Jurisprudence	3	3	30	70	100
	Total	**18**	**18**	**180**	**420**	**600**
	Practicals					
7	Pharmaceutical Analysis Lab - III	2	4	15	35	50
8	Pharmaceutics Lab - IV	2	4	15	35	50
9	Pharmacology Lab - II	2	4	15	35	50
10	Pharmacognosy & Phytochemistry Lab - II	2	4	15	35	50
	Total	**8**	**16**	**60**	**140**	**200**
	Total Teaching Hours~~rs~~.		**34**			
	Total Credits	**26**				
	Total Marks			**240**	**560**	**800**

No.	Semester -VIII					
1	Pharmaceutical Chemistry-IV	4	4	30	70	100
2	Pharmaceutics-V	4	4	30	70	100
3	Biopharmaceutics & Pharmacokinetics	4	4	30	70	100
4	Pharmacognosy & Phytochemistry-III	4	4	30	70	100
5	Clinical Pharmacy	2	2	15	35	50
	Total	**18**	**18**	**135**	**315**	**450**
	Practicals					
6	Pharmaceutical Chemistry Lab - III	2	4	15	35	50
7	Pharmaceutics Lab - V	2	4	15	35	50
8	Pharmacognosy & Phytochemistry Lab - III	2	4	15	35	50
	Total	**6**	**12**	**45**	**105**	**150**
	Total Teaching Hours.		**30**			
	Total Credits	**24**				
	Total Marks			**180**	**420**	**600**

The revised total number of credits for the B. Pharm. Course from Semester I to Semester VIII is 198

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Scheme of Examination

No	Semester-VII	No of papers	End Semester Examination			Internal Assessment			Maximum marks	Minimum marks for passing the subject
						Periodic Test		Continuous Evaluation		
	Subject - Theory		**Duration (hrs)**	**Maximum marks**	**Minimum for passing**	**Duration (hrs)**	**Maximum marks**	**Maximum marks**		
1	Pharmaceutical Chemistry - III	1	3	70	28	1	15	15	100	40
2	Pharmaceutical Analysis - III	1	3	70	28	1	15	15	100	40
3	Pharmacology - III	1	3	70	28	1	15	15	100	40
4	Pharmaceutics - IV	1	3	70	28	1	15	15	100	40
5	Pharmacognosy & Phytochemistry - II	1	3	70	28	1	15	15	100	40
6	Pharmaceutical Jurisprudence	1	3	70	28	1	15	15	100	40
	Practicals									
7	Pharmaceutical Analysis Lab - III	1	4	35	14	4	8	7	50	20
8	Pharmaceutics Lab - IV	1	4	35	14	4	8	7	50	20
9	Pharmacology Lab -II	1	4	35	14	4	8	7	50	20
10	Pharmacognosy & Phytochemistry Lab - II	1	4	35	14	4	8	7	50	20

No	Semester-VIII	No of papers	End Semester Examination			Internal Assessment			Maximum marks	Minimum marks for passing the subject
						Periodic Test		Continuous Evaluation		
	Subject - Theory		Duration (hrs)	Maximum marks	Minimum for passing	Duration (hrs)	Maximum marks	Maximum marks		
1	Pharmaceutical Chemistry-IV	1	3	70	28	1	15	15	100	40
2	Pharmaceutics- V	1	3	70	28	1	15	15	100	40
3	Biopharmaceutics and Pharmacokinetics	1	3	70	28	1	15	15	100	40
4	Pharmacognosy & Phytochemistry - III	1	3	70	28	1	15	15	100	40
5	Clinical Pharmacy	1	2	35	14	1	8	7	50	20
	Practicals									
6	Pharmaceutical Chemistry Lab-III	1	4	35	14	4	8	7	50	20
7	Pharmaceutics Lab- V	1	4	35	14	4	8	7	50	20
8	Pharmacognosy & Phytochemistry Lab- III	1	4	35	14	4	8	7	50	20

Syllabus

Final Year B.Pharm. Sem. VII

Pharmaceutical Chemistry – III **3 Hrs/Week**

~~Sr. No.~~Unit	TOPIC~~opic~~	Hours
	Discussion of the following classes of drugs including classification, chemical nomenclature, structure including stereochemistry, generic names, SAR and metabolism, molecular mechanism of action, synthesis(*) and rational development if any	
1	**Anti-Cancer agents:** • Alkylating agents like mechlorethamine , chlorambucil* (self study), melphalan*, cyclophosphamide*~~, mitomycin C~~, busulfan, carmustine, lomustine, streptozocin, dacarbazine and procarbazine, timozolomide • Antimetabolites like azaserine , methotrexate*, pralatrexate, azacytidine, 5-fluorouracil, cytarabine (Ara–C), 6-MP and 6-TG. • Antibiotics like dactinomycin, daunorubicin, doxorubicin , bleomycin and other natural products like vincristine, vinblastine, paclitaxel, docetaxel, topotecan, irinotecan (only highlights of structure to be discussed for bleomycin and natural products) • Platinum compounds like cisplatin and oxaliplatin • Histone Deacetylase Inhibitors: romidepsin, vorinostat • Tyrosine Kinase Inhibitors: imatinib, dasatinib, lapatinib • Combination therapy for breast cancer, leukemia **(Self study)**	7 1
2.	**Antivirals agents including anti-HIV agents:** A~~a~~mantadine*, rimantadine, oseltamivir, zanamivir, acyclovir and its prodrugs, ganciclovir, famciclovir, penciclovir, idoxuridine, vidarabine~~, azidothymidine*, stavudine~~ Reverse transcriptase inhibitors: , azidothymidine*, stavudine, lamivudine, zalcitabine, didanosine, abacavir, Non-nucleosides reverse-transcriptase inhibi~~e~~tors: delaviridine, nevirapine, efavirenz, Enfuviritide. HIV-protease inhibitors: raltegravir, saquinavir, ritonavir, (only highlights of structure of protease inhibitors). Drugs like nelfinavir, lopinavir, atazanavir, amprenavir, telaprevir and Combination anti-therapy **(Self Study)**	3 2
3.	**Cardiovascular Drugs**	**21**
3.1	Cardiac Glycosides Digitalis glycosides (digitoxin, digoxin, lanatoside C)	1
3.2	**Antianginal Agents** Antianginal agents: Amyl nitrite, isosorbide dinitrate, pentaerythritol tetranitrate, verapamil, bepridil, diltiazem, nifedipine*, amlodipine, nimodipine, nicardipine, dipyridamole*	2
3.3	**Antiarrythmic Agents** Antiarrhythmic agents: quinidine, procainamide*, disopyramide, lidocaine, tocainide, mexilitine, encainide, amiodarone, propafenone, verapamil, diltiazem, propranolol, sotalol*	2
3.4	**Diuretics** • Site 1. Carbonic anyhydrase inhibitors: acetazolamide*, methazolamide, brinzolamide, ethoxzolamide • Site 2. High celing or loop diuretics: Sulphamoyl anthranilic acids like furosemide*,	4

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	azosemide and ~~and~~ bumetanide and phenoxyacetic acids ethacrynic acid* • Site 3. Thiazide and Thia~~a~~izide like diureties, chlorthiazide***(self study)** hydrochlorthiazide, benzthiazide, methyclothiazide, trichlormethiazide, chlorthalidone, metolazone, quinethazone, indapamide • Site 4. Potassium sparing diureties such as spironoloactone, eplerenone **(self study)** triamterene and amiloride. • Osmotic diuretics- mannitol, isosorbide.	1
3.5	**Agents affecting Renin-Angiotensin Pathway and Calcium Blockers** • ACE Inhibitors- captopril* enalapril, benazepril, ramipril, Lisinopril • Angiotensin II receptor blockers- losartan, valsartan, candesartan, telmisartan, • Calcium channel blockers- verapamil bepridil, diltiazem, nifedipine, amlodipine, nimodipine, nicardipine, • Renin Inhibitors- aliskiren **(self study)** • Aldosterone antagonists: spironolacone, eplerenone **(self study)**	2 1 1
3.6	**Vasodilators/Sympatholytics** • Vasodilators- Hydralazine* diazoxide • Non-selective beta blockers- propranolol, nadolol • Selective beta-1 blockers- acebutalol, atenolol, esmolol • Selective alpha-2 blockers- prazosin* terazosin • Mixed alpha-beta blockers- carvedilol, labetalol • K-channel agonists- Minoxidil	2
3.7	**Antihyperlipoproteinemics** Clofibrate*, gemfibrozil, ciprofibrate, HMG-CoA reductase inhibitors: lovastatin, atorvastatin, simvastatin, rosuvastatin, niacin, ezetimibe.	2
3.8	**Thrombolytics, Anticoagulants, Antiplatelets** W~~w~~arfarin* dicoumarol, anisidione, phenindione, aspirin, triflusal, indobufen **(self study)**, dipyridamole, cilostazol, ticlopidine clopidogrel, abciximab **(self study)**	2 1
4	**Antihistaminics** Antihistaminies:H_1 and H_2 receptors Emphasis to be on the second generation H_1 antagonists such as fexofenidine, astemazole, loratidine, cetrizine, mizolastine, and acrivastine, H_2 receptor antagonists like cimetidine **(self study)** ranitidine*, famotidine, nizatidine, proton pump inhibitors like omeprazole, rabeprazole, pantoprazole and lansoprazole.	3 1
5	**Hypoglycemics and Insulin Analogues** Hypoglycemics (Insulin not to be discussed) • Biguanides e.g. metformin • Sulfonylureas: 1st Generation like tolbutamide, chloropropamide, tolazamide and acetohexamide***(self study);** 2nd Generation like glyburide* glypizide and glimepride,glyclazide and meglitinides like repaglinide, nateglinide. • Thiazolidinediones such as troglitazone, ciglitazone, rosiglitazone and pioglitazone. • GLP-1 agonists and DPP-IV inhibitors- exenatide and liraglutide (no structures), saxagliptin, vildagliptin, sitagliptin, linagliptin • β – Glucosidase inhibitors like ~~acarbose,~~ voglibose, and miglitol. • Insulin analgoues: Lispro insulin, glargine insulin	3 1
6	**Anaesthetics**	3
6.1	**General:** Halothane, isoflurane*, enflurane, sevoflurane, ketamine, propofol, thiopental.	
6.2	**Local:** • Amino esters – procaine, tetracaine, benzocaine* • Amino amides – lidocaine*, mepivacaine, bupivacaine, ropivacaine	

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	• Amino ethers – pramoxine • Amino ketones – dyclonine • Alcohols – benzyl alcohol, eugenol	
	Total	**45**

*Synthesis to be taught

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Latest ~~e~~Editions of the following books to be adopted.

1. An Introduction to Medicinal Chemistry, Graham L. Patrick, Oxford University Press.
2. Fundamentals of Medicinal Chemistry, Gareth Thomas, Wiley, New York.
3. The Organic Chemistry of Drug Design and Drug Action, Richard B.Silverman, Academic Press.
4. Foye's Principles of Medicinal Chemistry, Thomas L. Lemke, David A Williams, Lippincott Williams & Wilkins.
5. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, John M. Beale, John H. Block, Lippincott Williams & Wilkins.
6. Medicinal Chemistry, Ashutosh Kar, New Age International Publishers.
7. Introduction to Medicinal Chemistry, Alex Gringauz, Wiley.
8. The Organic Chemistry of Drug Synthesis, Daniel Lednicer, Lester A. Mitscher, John Wiley and Sons.
9. Pharmaceutical Chemistry, Volume 1, Organic Synthesis, H. J. Roth & A. Kleemann, Ellis Horwood Series in Pharmaceutical Technology, Halsted Series.
10. Synthesis of Essential Drugs, Ruben Vardanyan and Victor Hruby, Elsevier.
11. Pharmaceutical Substances: Syntheses, Patents, Applications, Kleemann & Engel, Thieme Publications.

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Pharmaceutical Analysis – III **3 Hrs/week**

Unit	TOPIC	~~Hrs~~Hours
1.0	**Multicomponent analysis by UV Spectroscopy**	**2**
1.1	• Assay as a single component sample • Corrected interference • Assay after solvent extraction • Simultaneous Equation method • Absorbance Ratio method • Difference Spectroscopy method • Derivative Spectroscopy	2
2.0	**Concepts of Chromatography**	**6**
2.1	*Terminologies:* stationary phase, mobile phase, retention time, gradient and isocratic elution, normal and reverse phase chromatography, planar chromatography, retention factor, chromatogram, internal standard, reference standard, working standard, tailing factor (symmetry factor), asymmetry factor, resolution, signal to noise ratio, column chromatography, preparative chromatography, adsorption chromatography and partition chromatography.	3
2.2	• Classification of chromatographic methods ***(Self study-0.5 hr)*** • Quantitative analysis (Peak height, peak areas, calibration curve, internal standard, and area normalization) • Optimization of column performance (Column efficiency and band broadening, shape of peak-Gaussian, Plate height, Number of theoretical plates, van Deemter equation, Capacity factor, Selectivity factor, Tailing factor, peak width, and Resolution) • Numericals related to column performance.	3
3.0	**High Performance Liquid chromatography (HPLC)**	**4**
3.1	**Instrumentation:** • Mobile phase reservoir • Pumps (reciprocating, displacement, pneumatic) ***(Self study-~~30 min~~0.5 hr)*** • Sample injection systems (Rheodyne injector and autosampler) • Column types (analytical, guard and preparative columns) and column packing (porous, pellicular and monolithic), • Detectors (Concept of solute and bulk property detector-Refractive index ,UV-Vis, Photototodiode array, fluorescence, , Electrochemical, Evaporative Light Scattering), • Difference between UPLC and HPLC ***(Self study-0.5 hr)*** • Applications, Advantages and Limitations of HPLC ***(Self study-0.5 hr)***	4
4.0	**Gas chromatography (GC)**	**3**
4.1	• Introduction **Instrumentation** • Carrier gas supply • Sample injection system including Head space analysis • Columns (Packed, Open tubular columns, Capillary columns) and column ovens ***(Self study-0.5 hr)*** • Detectors (Thermal conductivity, Electron capture, Flame ionization) • Applications, Advantages and Limitations of GC ***(Self study-0.5 hr)***	3
5.0	**Planar chromatography**	**3**
5.1	• **Paper chromatography**-Principle, Developmental techniques (Ascending, Descending, Radial and Two-dimensional), Spray reagents and Pharmaceutical applications ***(Self study-0.5 hr)*** • **TLC**-Principle, types of adsorbents, Developmental techniques ***(Self study-0.5 hr),***	3

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	Visualisation techniques, factors affecting resolution, Pharmaceutical applications of TLC and Preparative TLC. • **HPTLC**-Advantages of HPTLC over TLC and HPLC ***(Self study-0.5 hr)*** • Instrumentation-Applicator, photodensitometry, photodocumentation.	
6.0	**Ion exchange chromatography, Ion Pair and Size Exclusion chromatography**	**3**
6.1	• Principle, Stationary phases, Mobile phases and Applications ***(Self study-0.5 hr)***	
7.0	**Nuclear Magnetic Resonance Spectroscopy (^{1}H-NMR)**	**8**
7.1	**^{1}H-NMR phenomenon-** spinning nucleus, precessional motion, precessional frequency, gyromagnetic ratio, energy transitions and relaxation processes, NMR Spectra, Chemical shift, shielding and deshielding, Vanderwaal's deshielding, Deuterium exchange, Chemical and magnetic equivalence , anisotropic effect (eg. Alkanes, alkenes, alkynes, carbonyl, aromatic and cyclohexane), Solvents, Reference compounds and internal standards.	2
7.2	**Measurement of chemical shift:** • Scales used. • Factors affecting chemical shift (Electronegativity-Shielding and Deshielding, Vanderwaal's deshielding, anisotropic effect) • Instrumentation of NMR Spectrometer (including schematic representation) ***(Self study-0.5 hr)*** • Principle of FT NMR (including representation of conversion of time domain spectra to frequency domain spectra)	3
7.3	**Spin-spin coupling-Spin-Spin splitting:** • N+1 rule (Pascal's triangle), theory of spin-spin splitting, formation of doublet, triplet and quartet due to possible spin orientations, inverted tree diagram, Coupling constants & values for alkyl, alkenyl , aromatic). • Information obtained from proton NMR-Chemical shift, splitting, coupling constant, integration. ***(Self study-0.5 hr)***	3
8.0	**Mass Spectrometry**	**4**
8.1	• Principle & basic theory- Mass spectrum, relative abundance, mass to charge ratio, molecular ion, fragment ion (daughter ion), metastable ion, base peak, isotope peak, mass to charge ratio.	1
8.2	**Instrumentation:** • Basic components of mass spectrometer (including block diagram). • Ionisation methods: Electron Ionisation, Chemical Ionisation, Desorption Ionisation (MALDI), Fast Atomic Bombardment, Atmospheric Pressure Ionisation (Electrospray, APCI, APPI). • Analysers: Quadrupole, Ion Trap and Time of Flight.	3
9.0	**Hyphenated techniques**	**2**
	Significance, interfaces and applications of • LC-MS • GC-MS ***(Self study-1 hr)***	2
10.0	**Structure Elucidation by spectral techniques using UV, IR, 1H-NMR and Mass spectrometry**	**8**
10.1	UV-Woodward Fieser rules for predicting λ_{max} (acyclic & cyclic dienes, and α, β unsaturated ketones (acyclic and 6 membered ring). (**Note**-only alkyl substituents to be studied). ***(Practice problems-Self study-0.5 hr)***	2
10.2	Elucidation of structure of a compound using IR and ^{1}H NMR data- Problems for simple organic compounds with molecular formula given ***(Practice problems-Self study-0.5 hr)***	3
10.3	Mass spectrometry: **Fragmentation:** Representation of fragmentation process, Basic types of fragmentation: • Fissions (homolytic and heterolytic, α and β fission). • Rearrangement (McLafferty, Retro Diel-Alders, 4-membered cyclic rearrangement) • Nitrogen rule and Even electron rule. ***(Practice problems-Self study-0.5 hr min)***	3

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11	**Analytical method Validation as per ICH guidelines. *(Self study- 0.5 hr)***	**2**
	Total	**45**

Latest ~~e~~Editions of the following books to be adopted.

1 D. A. Skoog, F. J. Holler and S. R. Crouch, Principles of Instrumental Analysis, Saunders College Publishing, USA.

~~1~~2 K. A. Connors, A Textbook of Pharmaceutical Analysis, John Wiley and Sons, Canada.

~~1~~3 A. H. Beckett and J. B. Stenlake, Practical Pharmaceutical Chemistry~~,~~ Vol. 6, Part I and II, CBS Publishers and Distributors, India.

~~1~~4 D. A. Skoog, D. M. West, F. J. Holler and S. R. Crouch, Fundamentals of Analytical Chemistry, Saunders College Publishing, USA.

~~1~~5 G. D. Christian, Analytical Chemistry, John Wiley & Sons, Singapore, reprint by Wiley India Pvt. Ltd.

~~1~~6 H.H. Willard, L. L. Merrit and J. A. Dean, Instrumental Method of Analysis, CBS Publishers & Distributors, New Delhi.

~~1~~7 Ashutosh. Kar, Pharmaceutical Drug Analysis, New Age International (P) Ltd. Publishers, India.

~~1~~8 S. S. Mahajan, Instrumental Methods of Analysis, Popular Prakashan Pvt Ltd., India.

~~1~~9 G. R. Chatwal and S. K. Anand, Instrumental methods of chemical analysis, Himalaya Publishing House Pvt. Ltd.

10 Indian Pharmacopoeia, The Indian Pharmacopoeia Commission, Ghaziabad, Government of India.

11 United States Pharmacopeia

12 J. Mendham, R. C. Denney, J. D. Barnes, M. J. K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, Pearson Education Ltd.

13 D. G. Watson, Pharmaceutical Analysis –A textbook for pharmacy students and pharmaceutical chemists. Churchill Livingstone Elsevier.

14 J. W. Robinson, E. M. S. Frame and G. M. Frame II, Undergraduate Instrumental Analysis, Marcel Dekker, New York, USA.

15 R. Kellnar, J. M. Mermet, M. Otto, M. Valcarceland, H. M. Widmer, Analytical Chemistry: A modern approach to analytical science, Wiley-VCH, USA.

16 J. W. Munson, Pharmaceutical Analysis: Modern methods (in two parts), Marcel Dekker Inc., USA.

17 W. Kemp, Organic Spectroscopy, Palgrave Publishers Ltd., New York, USA.

18 R. M. Silverstein, F. X. Webster and D. J. Kiemle, Spectrometric identification of organic compounds, John Wiley & Sons, Inc. (Indian edition), New Delhi.

19 D. B. Troy and P. Beringer, Remington-The Science and Practice of Pharmacy, Vol-I & II, Wolters Kluwer/ Lippincott Williams & Wilkins (Indian edition), New Delhi.

~~1~~20 J. W. Robinson, E. M. S. Frame and G. M. Frame II, Undergraduate Instrumental Analysis, Marcel Dekker, New York, USA.

~~1~~21 J. R. Dyer, Applications Of Absorption Spectroscopy Of Organic Compounds, Prentice- Hall of India Pvt Ltd, New Delhi, India.

~~1~~22 D. L. Pavia, G. M. Lampman, G. S. Kriz and J. R. Vyvyan, Introduction to Spectroscopy, Brooks/Cole Cengage Learning, Australia.

~~1~~23 Y. R. Sharma, Elementary organic spectroscopy-Principles and Chemical Applications, S. Chand & Company Ltd, New Delhi, India.

~~1~~24 L. R. Snyder, J. J. Kirkland, J. L. Glajch, Practical HPLC Method Development, Wiley-Interscience publication, John Wiley & Sons, Inc., Canada.

~~1~~25 S. Ahuja and M. W. Dong, Handbook of Pharmaceutical Analysis by HPLC, Volume 6 of Separation Science and Technology, Elsevier Academic Press, Indian edition.

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Pharmacology – III **3 Hrs/Week**

Unit~~Sr.No.~~	TOPIC~~opic~~	Hours
1	**Drugs acting on Central Nervous System**	23
1.1	Aliphatic alcohols	1
1.2	General and Local anesthetics	3
1.3	Sedatives, Hypnotic and anxiolytic agents	2
1.4	Antiepileptic drugs	2
1.5	Drugs Used in Parkinson's disease	2
1.6	Drugs used in Alzheimer's disease	2
1.7	Antipsychotic, antidepressant, anti-mania drugs	3
1.8	Opioid analgesics	2
1.9	CNS stimulants	2
1.10	SELF STUDY: Physiology of CNS and central neurotransmitters	4
2	Autacoids; Drug therapy of inflammation	10
2.1	Histamine, bradykinin and their antagonists	2
2.2	Serotonin, agonists and antagonists	1
2.3	Lipid derived autacoids, Eicosanoids and platelet activating factor	1
2.4	NSAIDs	2
2.5	Pharmacotherapy of Asthma	2
2.6	SELF STUDY: Pharmacotherapy of Gout	2
3	**Drugs acting on gastrointestinal tract**	9
3.1	Antacids and Drugs for peptic ulcers	2
3.2	Emetics, antiemetics and Prokinetics	2
3.3	Drugs for constipation and diarrhoea	2
3.4	Drugs for Inflammatory Bowel Diseases	1
3.5	SELF STUDY: Innervations and hormones of GIT: Neuronal control and hormonal control	2
4	**Principles of Toxicology**	3
4.1	Heavy metals (Lead, Mercury, Arsenic)Poisoning,	1
4.2	Pesticide and Opioid Poisoning and treatment	1
4.3	SELF STUDY: Environmental toxicants	1
	Total	45

Latest editions of the following books to be adopted

1. Goodman & Gilman's Pharmacological Basis of Therapeutics, McGraw Hill Companies Inc.
2. Satoskar R.S. Bhandarkar S.D. &Rege N.N. Pharmacology & Therapeutics, Popular Prakashan.
3. Rang & Dale Pharmacology, Churchill Livingstone.
4. Lippincott's Illustrated Reviews: Pharmacology- Lippincott-Raven Howland &Nyeets Publishers NY.
5. Laurence D.R. & Bennett Clinical Pharmacology, Elsevier NY.
6. Kulkarni S.K. Handbook of Experimental Pharmacology, VallabhPrakashan, New Delhi.
7. B.G.Katzung-Basic and Clinical Pharmacology, Appleton and Lange publications.
8. Ghosh M.N. Fundamentals of Experimental Pharmacology Hilton & Company, Kolkata.

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Pharmaceutics – IV **3 Hrs/Week**

Unit~~No.~~	TOPIC~~opic~~	Hour
1	**Introduction to sterile dosage forms - Parenteral products**	**16**
1.1	Various routes of parenteral administration, pyrogens, vehicle,- WFI preparation, purity, storage and distribution, vehicles other than WFI, additives in parentertal products	4
1.2	*Self study* *Containers - glass and plastics- types and evaluation, , rubber closures and testing*	2
1.3	Personnel, facilities- layout, environmental control cleanliness classes, air handling (HVAC systems), HEPA filters, laminar flow	3
1.4	SVP – formulation considerations, types, product procedures, freeze drying	3
1.5	LVP – types, formulation aspects, packaging	2
1.6	QA & QC- sterility test, pyrogen/ endotoxin test, particulate evaluation, leaker test	2
2	**Ophthalmic Products**	**9**
2.1	*Self study-Anatomy and physiology of eye (1h)* lachrymal system, tears, precorneal tear film, cornea, ocular bioavailability	2
2.2	Formulation and packaging of various ophthalmic products - solutions, suspension, ophthalmic ointments and gels, preservatives and efficacy test, additives	3
2.3	QA and QC sterility test, clarity, particle size for suspension, tests on ointments and collapsible tubes	2
2.4	Contact lens solutions: types of lenses, cleaning solution, disinfection solution, lubricants, multipurpose solutions and packages	2
3	**Oral sustained and controlled release systems**	**110**
3.1	Advantages of SR systems, biopharmaceutical consideration and dose calculation of drug *Self study-Calculation for dose–loading, ~~maintainance~~maintenance-(2h)*	3
3.2	Properties of drug with reference to the design of oral SR systems	2
3.3	Matrix and reservoir type of systems, dissolution controlled systems, diffusion controlled systems, ion exchange controlled systems	4
3.4	Evaluation of sustain release systems	~~1~~ 2
4	**Stability Studies**	**9**
4.1	Importance of stability studies, kinetic principles, Arrhenius equation and derivation of shelf life based on Arrhenius equation, limitations and advantages of Arrhenius equation Self study-Problems –(2h)	4
4.2	Degradation pathways- hydrolysis, oxidation, photolytic degradation, methods to enhance stability of drugs	2
4.3	Accelerated stability studies, introduction to ICH guidelines	2
4.4	*Self studies-Interactions with containers and closures (1h)*	1
	Total	45

Latest e~~E~~ditions of the following books to be adopted

1. Pharmaceutical Dosage forms, Parenteral Medications. Vol I.II.III, Ed. By Kenneth A. Avis, Leon Lachman, and H .A. Liberman. Marcel ~~dekker~~ Dekker INC.

~~1.~~2. Pharmaceutics. The science of dosage form design, Ed. M. E. Aulton, Churchill livingstone.

~~1.~~3. Modern Pharmaceutics, Ed. By Gilbert S. Banker and Christopher T. Rhodes. Marcel Dekker INC.

~~1.~~4. The theory and practice of Industrial Pharmacy, Ed. By Leon Lachman, H. A. Liberman, J. L. Kanig; Varghese Publishing House.

~~1.~~5. Remington, The science and practice of Pharmacy, Vols. I and II, B.L. Publications Pvt. Ltd.

~~1.~~6. Ophthalmic drug delivery systems, ~~ed~~ Ed by Ashim K. Mitra, Volume 58, Marcel Dekker INC.

~~1.~~7. Turco and Kings, Sterile Dosage Forms, Lea and Febiger, Philadelphia.

~~1.~~8. Michel J. Akers, Quality Control of Parenterals, Marcel Dekker

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~~1.~~9. Controlled Drug Delivery-Fundamentals and Applications, Robinson Joseph R., Lee Vincent H, Vol 29, Marcel Dekker INC.
~~1.~~10. Pharmacetuical Technology, Vols. I, II, RSR Murthy, Ashutosh Kar, New Age Int. Ltd.

Pharmacognosy & Phytochemistry – II **3 Hrs/Week**

~~Sr. No.~~Unit	TOPIC~~opics~~	Hours
	Drugs indicated in bold font are to be studied for detailed pharmacognostic scheme	
1	**Lipids (Waxes, fats, fixed oils)**	**10**
1.1	General introduction to lipids. Study of the following drugs with respect to sources, classification,general properties, methods of extraction, preservation, storage, composition, evaluation,therapeutic uses and general applications. – Arachis**, castor**, sesame**, linseed**, jojoba, olive, **almond**, mustard, cottonseed, coconut, safflower, sunflower, croton, neem, rice bran, wheatgerm, hydnocarpus, cod-liver oil. *Self study* • *Methods of storage and preservation of oils and fats.*	5 1
1.2	Detailed study of following lipids with respect to chemistry, sources, extraction & / or preparation, preservation, evaluation and therapeutic use - Kokum butter, coca butter, Shea butter, woolfat, spermaceti wax, **beeswax,** carnauba wax, lecithin and introduction to glycolipids. *Self study –* • *Spermaceti and its substitutes* • *Uses and examples of glycolipids*	2 2
2	**Tannins**	**4**
2.1	Introduction to the structures of simple phenolics and their occurrence. Introduction to tannins and their definition, classification, occurrence, chemistry, detection, estimation and therapeutic applications.	1
2.2	Study of sources, composition, extraction and applications of **Galls, catechu (pale & black**) & Kino. Study of following tannin containing members with respect to their sources, properties, and therapeutic applications - arjuna, ashoka, harda, behra, green tea, pomegranate peel. Study of urushiol from poison ivy. *Self study-* • *Role of tannins in healthcare with suitable examples*	2 1
3	**Alkaloids**:	**15**
3.1	Introduction to alkaloids- Definition, classification, properties, general methods of extraction, detection and estimation. Study of following drugs containing alkaloids with respect to their chemistry (structures), sources, salient features of extraction and specific tests for detection (if any) and biopotenial : Alkaloidal Amines – **Ephedra,** colchicum Tropane – belladonna, **datura**, stramonium, hyoscyamus, coca, **Ashwagandha** Indole – **Rauwolfia,** vinca, **nux vomica, ergot** Steroidal – **kurchi** Terpene – Aconite Quinazoline – **Vasaka**	6
3.2	Study of following drugs containing alkaloids with respect to their chemistry (structures), sources, salient features of extraction and specific tests for detection (if any) and biopotenial : Benzyl isoquinoline – **opium** Isoquinoline - Ipecac, hydrastine, berberine, curare alkaloids Quinoline - **cinchona** Pyridine-Piperidine – Tobacco, Lobelia, pepper Purine - cocoa, tea, coffee, cola Glycoalkaloids – Solanum	5

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	Imidazole – Pilocarpus	
3.3	Biosynthesis of lysergic acid, opium alkaloids, tropane alkaloids, colchicines, emetine, quinine. *Self study –* • *Pharmacopoeial status of any five alkaloidal drugs*	2 2
4	**Miscellaneous phytochemicals**	**3**
4.1	**Polyacetylenes** Introduction to composition & properties of polyacetylenes from matricaria **Sulphur containing compounds** Thiophenes from tagetes. Study of sources, structure and properties of sulphur containing compounds from Allium species (*A. cepa and A. sativum*). **Napthoquinones** Study of alkana, henna, and plumbago with respect to active constituents and uses. **Benzoquinone** Study of *Embelia ribes.*	3
5	**Glycosides**	**8**
5.1	Introduction to glycosides their occurrence, chemistry, extraction and uses a) Anthroquinone - Rubia, cochineal, **aloes**, hypericum, cascara, andira**, senna**, rhubarb. Biosynthesis of Aloe emodin *Self study –* • *Commercial uses and preparation of aloes*	5 1
5.2	Chemistry, extraction & uses of following classes of glycosides : b) Isothiocyanate - Brassica c) Cyanogenetic - bitter almond, wildcherry Biosynthesis of amygdaline	2
	Pesticides of natural origin	**3**
6.1	Detailed study of following pesticides of natural origin with respect to their merits demerits, sources, active constituents and applications - Neem, Pyrethrum & Tobacco *Self Study* • *Commercially available pesticides and their composition*	2 1
7.	**Nutraceuticals**	**2**
7.1	Introduction to nutraceuticals. Study of the following drugs as nutraceuticals with respect to biological source, probable active constituents and uses – Alfalfa, Arnica, Apricot pits, bran, Chamomile, Chicory, Cucumber, Fenugreek, Onion, Garlic, Hydrocotyle, Hibiscus, Hops, Honey, Marigold, Amla, Ginseng, Ashwagandha, Gingko biloba, Spirulina, Gymnema, Momordica, Tinospora. *Self study:* • *Study of marketed nutraceutical preparations (any 2)*	1 1
	Total	**45**

Latest ~~e~~Editions of the following books to be adopted.

1. Trease D. & Evans W.C.: Text Book of Pharmacognosy: W.B. Saunders.
~~1.~~2. Tyler V. E. Brady L. R. & Robbers J. E.: Pharmacognosy; Lea Feibger, USA.
~~1.~~3. Wallis T. E.; Text Book of Pharmacognosy; CBS Publishers, Delhi.
~~1.~~4. Kokate C. K., Purohit A. P. & Gokhale S. B.: Pharmacognosy; Nirali Publications, Pune.
~~1.~~5. Harbone J. B.: Phytochemical Methods: A guide to modern techniques Analysis: Chapman & Hall, London.
~~1.~~6. Bruneton J.: Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
~~1.~~7. Vasudevan T. N. & Laddha K. S.: A Textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
~~1.~~8. The Indian Pharmacopeia: The Controller of Publication; Delhi.
~~1.~~9. Brain K. R. & Turner T. D.: The Practical Evaluation of Phytopharmaceuticals: Wright, Scientica, Bristol.
~~1.~~10. Iyengar M. A. & Nayak S. G.: Anatomy of Crude Drugs: Manipal Power Press, Manipal.
~~1.~~11. Iyengar M. A.: Pharmacognosy of Powdered Drugs; Manipal Power Press, Manipal.

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~~1.~~12. Kokate C. K. : Practical Pharmacognosy; Vallabh Prakashan.
~~1.~~13. Wagner, Bladt & Zgainski; ~~plant~~ Plant Drug Analysis; Springer Verlag.
~~1.~~14. Khandelwal K. R.: Practical Pharmacognosy Techniques and Experiments; Nirali Prakashan, Pune.
~~1.~~15. Vasudevan T. N. Laddha K. S.: Practical Pharmacognosy; New Vrinda Publishing House, Jalgaon.

Pharmaceutical Jurisprudence **3 Hrs/Week**

~~Topic No.~~Unit	~~Content~~TOPIC	Hours
1	**Historical perspectives including details of Chopra Committee and Hathi Committee**	1
2	**PHARMACY ACT 1948**	5
2.1	Definitions	~~1~~2
2.2	Pharmacy Council of India and State Councils : Composition and Functions	
2.3	Preparation of registers and qualifications for entry into registers	~~2~~3
2.4	Educational Regulations and Approval of Courses and Institutions	
2.5	Offences and Penalities	
3	**DRUGS AND COSMETICS ACT 1940 AND RULES 1945**	18
3.1	Definitions	2
3.2	Advisory Bodies : DTAB and DCC : Composition and Function	2
3.3	Analytical Bodies : Drug control Laboratories and Government Analyst	
3.4	Executive Bodies : Licensing Authorities, Controlling Authorities, Drug Inspectors and Customs Collectors	
3.5	Provisions regarding Import of Drugs	~~4~~6
3.6	Provisions regarding Manufacture of Drugs	
3.7	Provisions regarding Sale of Drugs	
3.8	Labeling and Packing of Drugs	1
3.9	Provisions applicable to Manufacture, Sale, labeling and Packing of Ayurvedic Drugs	1
3.10	Provisions applicable to Import, Manufacture, Sale, labeling and Packing of Homeopathic Drugs	1
3.11	Provisions applicable to Import, Manufacture, Sale, labeling and Packing of Cosmetics	1
3.12	Offences and corresponding penalties	~~2~~3
3.13	Broad Content of various Schedules of the Drugs and Cosmetics Act; Schedule M and Schedule Y in moderate details	
3.14	Self-study : Case Studies	1
4.0	**DRUGS AND MAGIC REMEDIES (OBJECTIONABLE ADVERTISEMENTS) ACT 1954**	3
4.1	Definitions	2
4.2	Prohibited Advertisements, Savings	
4.3	Self-study : Case studies	1
5	**NARCOTIC DRUGS AND PSYCHOTROPIC SUBSTANCES ACT 1985**	3
5.1	Definitions	1
5.2	Narcotics Commissioner and other Officers	
5.3	Illicit Traffic and measures to prevent illicit traffic of opium	~~1~~2
5.4	Offences and corresponding penalties	
6	**DRUGS PRICES CONTROL ORDER ~~1995~~2013**	3
6.1	Background of DPCO 1995~~Definitions~~	3
6.2	Definitions ~~Calculation of prices for scheduled and non scheduled bulk drugs and formulations~~	
6.3	~~Drug Price Equalization Account~~ Calculation of prices for drug products	
6.4	~~Drug Price Equalization Account~~Current National Pricing Policy ~~-~~Micellaneous heads under the order	

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7	**MEDICINAL AND TOILET PREPARATION (EXCISE DUTIES ACT) 1955**	2
7.1	Definitions, restricted and unrestricted preparations	2
7.2	Manufacturing in bond and outside bond	
8	**FOOD SAFETY AND STANDARDS ACT 2006 AND RULES 2011**	2
8.1	Definitions : Food, Adulterant and Food additive	2
8.2	Authorities and bodies : Food Safety and Standards Authority of India, Central Advisory Committee, Food safety Officer, Commissioner of Food Safety in the State, Analytical Laboratories and Food Analysts	
8.3	Packaging and Labeling of Foods	
9	**INDIAN PATENTS ACT 2005**	3
9.1	Background : Intellectual Property and its types	2
9.2	Definitions, features of a patent	
9.3	Criteria for patentability and inventions not patentable in India	
9.4	Process of patenting in India	
9.5	Self-study : Case studies	1
10	**BOMBAY SHOPS AND ESTABLISHMENTS ACT**	1
10.1	Definitions of Shops and Commercial Establishments and Provisions under the Act in Brief	1
11	**FACTORIES ACT 1954**	1
11.1	Definitions	1
11.2	Provisions under the Act in Brief	
12	**INDIAN PENAL CODE AND CODE OF CRIMINAL PROCEDURES**	1
12.1	Provisions pertaining to different courts, jurisdiction and power	1
12.2	Provisions governing entry, search, arrest, bailable and non-bailable offences, cognizable and non-cognizable offences	
13	**INTRODUCTION TO DRUG REGULATORY AFFAIRS**	2
13.1	Brief overview of Drug Regulatory Agencies of US, Australia, Europe, UK, Japan and Australia.	2
13.2	Introduction to USFDA, European, ICH and WHO guidelines	
	Total	~~36~~45

Latest e~~E~~ditions of the following books to be adopted.

1. Govt. Of India Publications of above Acts and Rules.
2. Kuchekar B. S., Khadtare A. M., Itkar S. C., Forensic Pharmacy, Nirali Prakashan.
3. N. K. Jain, Textbook of Forensic Pharmacy, Vallabh Prakashan.
~~3.~~4. Mittal B. M.- A Textbook of Forensic Pharmacy, Vallabh Prakashan.
~~3.~~5. Deshpande S. W. -Drugs & Cosmetics Act.
~~3.~~6. Guarino Rechard A. – New Drug Approval Process, Marcel Decker.

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Pharmaceutical Analysis Lab. – III **4 Hrs/week**

1. UV spectrophotometric estimation of two components formulation by simultaneous equation method, Eg- Caffeine and Sodium benzoate injection.
2. UV spectrophotometric estimation of two components formulation by absorbance ratio method, Eg- Caffeine and Sodium benzoate injection.
3. UV spectrophotometric estimation of formulation by Difference spectroscopy: Eg: Phenylephrine HCl ophthalmic solution.
4. Assay of Trimethoprim in cotrimoxazole tablets.
5. Determination of concentration of sample by UV spectroscopy (Construction of calibration curve using linear regression analysis). e.g-Ibuprofen.
6. Determination of validation parameters by UV spectroscopy: e.g Ibuprofen, Paracetamol.
   Linearity
   Precision
   Accuracy
7. Separation and identification of compounds by TLC
8. Determination of pK_a by UV spectroscopy e.g. Phenylephrine HCl
9. Demonstration experiments:
   1. -Separation and identification of amino acids by paper chromatography.
10. -Development of mobile phase for TLC
11. -Working of HPLC, GC and HPTLC.
12. -Separation of compounds by column chromatography

Note: Examples of drugs are provided for reference purpose only. Any other suitable drug can also be used.

Books Latest editions of the following books to be adopted.

1. A.H. Beckett and J.B. Stenlake, *Practical Pharmaceutical Chemistry*, 4th Edn., Part I and II, CBS Publishers and Distributors, India, 2005.
2. G. D. Christian, *Analytical Chemistry*, 6th Edn., John Wiley & Sons, Singapore, reprint by Wiley India Pvt. Ltd., 2008.
3. *Indian Pharmacopoeia*, The Indian Pharmacopeia Commission, Ghaziabad, Government of India, 2010.
4. United States Pharmacopeia
5. J. Mendham, R. C. Denney, J. D. Barnes, M.J. K. Thomas, *Vogel's Textbook of Quantitative Chemical Analysis*, 6th Edn., Pearson Education Ltd, 2002. (Seventh impression 2008)
6. D.G. Watson, *Pharmaceutical Analysis –A textbook for pharmacy students and pharmaceutical chemists*. 3rd Edn., Churchill Livingstone Elsevier, 2012.
7. L. R. Snyder, J. J. Kirkland, J. L. Glajch, *Practical HPLC Method Development*, 2nd Edn., Wiley-Interscience pPublication, John Wiley & Sons, Inc., Canada, 1997.
8. S. Ahuja and M. W. Dong, *Handbook of Pharmaceutical Analysis by HPLC*, Volume 6 of Separation Science and Technology, 1st Edn., Elsevier Academic Press, Indian edition, 2009.

Reference books and textbooks (Please refer latest editions if available)

1. A.H. Beckett and J.B. Stenlake, *Practical Pharmaceutical Chemistry*, 4th Edn., Part I and II, CBS Publishers and Distributors, India, 2005.
2. G. D. Christian, *Analytical Chemistry*, 6th Edn., John Wiley & Sons, Singapore, reprint by Wiley India Pvt. Ltd., 2008.
3. *Indian Pharmacopoeia*, The Indian Pharmacopeia Commission, Ghaziabad, Government of India, 2010.
4. United States Pharmacopeia
5. J. Mendham, R. C. Denney, J. D. Barnes, M.J. K. Thomas, *Vogel's Textbook of*

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Quantitative Chemical Analysis, 6th Edn., Pearson Education Ltd, 2002. (Seventh impression 2008)

6 D.G. Watson, *Pharmaceutical Analysis –A textbook for pharmacy students and pharmaceutical chemists*. 3rd Edn., Churchill Livingstone Elsevier, 2012.

7 L. R. Snyder, J. J. Kirkland, J. L. Glajch, *Practical HPLC Method Development*, 2nd Edn., Wiley-Interscience publication, John Wiley & Sons, Inc., Canada, 1997.

8 S. Ahuja and M. W. Dong, *Handbook of Pharmaceutical Analysis by HPLC*, Volume 6 of Separation Science and Technology, 1st Edn., Elsevier Academic Press, Indian edition, 2009.

Pharmaceutics Lab. – IV **4 Hrs/Week**

1. Preparation and monographic testing of Water for Injection IP.
~~1.~~2. Processing and monographic testing of Glass containers and rubber closures as per IP.
~~1.~~3. Product –Package interaction- quantitative estimation of preservative absorption by rubber closures.
~~1.~~4. Preparation and documentation of the following injections:
    a. Sodium chloride and Dextrose injection IP.
    ~~a.~~b. Calcium gluconate injection IP
    ~~a.~~c. Ascorbic acid injection IP.
    ~~a.~~d. Official injection using an oily vehicle
    ~~a.~~e. Official parenteral suspension
5. Preparation and documentation of following ophthalmic products:
    a. Sulphacetamide eye drops, BPC.
    ~~a.~~b. Official antibiotic eye ointment
    ~~a.~~c. Contact lens solution
6. Accelerated stability testing of Aspirin
7. Sterility test and environmental control(Demonstration)

Latest editions of the following books to be adopted.

~~Books~~

All books listed in the theory syllabus as well as current editions of IP, BP and USP.

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Pharmacology Lab. – II **4 Hrs/Week**

Experiments:

1. Bioassay of Acetylcholine using suitable isolated tissue preparation e.g. Cock ileum
2. Bioassay of Atropine using suitable isolated tissue preparation e.g. Cock ileum

Demonstrations: (with kymograph recordings or audio-visual aids)

1. Bioassay of oxytocin
2. Behavioral Pharmacology Demonstrations/ Simulated experiments (CDs).
    - To study effect of drugs on locomotor activity in rodents using actophotometer.
    - To study the muscle relaxant property of drug using Rota-rod.
    - To study analgesic activity of drug using an analgesiometer.
    - To study anticonvulsant activity of drugs using maximal electroshock/ chemically induced seizures.
    - To study phenothiazines induced catalepsy using suitable animal model.

Toxicity studies

- Introduction to CPCSEA, OECD guidelines
- Introduction to acute, sub-acute and chronic toxicity studies

Latest editions of the following books to be adopted

1. Kulkarni S. K. Handbook of Experimental Pharmacology, VallabhPrakashan, New Delhi.
2. Ghosh M.N. Fundamentals of Experimental Pharmacology Hilton & Company, Kolkata.
3. S. B. Kasture. A handbook of Experiments in Pre-Clinical Pharmacology, Career Publications.
4. W. L. M. Perry, Pharmacological Experiments on isolated preparations, E & S Livingstone, Edinburg & London.
5. Patil C. R. X-cology (Software), Pragati Book Co. Pvt. Ltd, Pune.

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Pharmacognosy & Phytochemistry – Lab. – II **4 Hrs/Week**

1 Study of morphology, histology and powder characteristics of cinchona bark and, extraction, chemical tests and TLC of quinoline alkaloids from Cinchona. ~~1 Practical~~

2 Study of morphology, histology and powder characteristics and tests for alkaloids of Rauwolfia. ~~1 Practical~~

3 Study of morphology, histology and powder characteristics of leaflets of senna. Extraction, chemical test and TLC of anthraquinone glycosides from senna. ~~1 Practical~~

4 Study of morphology , histology and powder characteristics of seeds of nuxvomica and extraction, chemical test and TLC of alkaloids of nux vomica ~~1 Practical~~

5 Study of morphology and histology of Datura, Ephedra, Vasaka, Kurchi, Ashwagandha, Arjuna, linseed ~~7 Practicals~~

6 Microscopical examination of powder mixtures of drugs mentioned above. ~~2 Practicals~~

7 Extraction and quantification of any one alkaloid by U.V and Demonstration of HPTLC. ~~1 Practical~~

8 Morphological identification of twenty crude drugs and their salient morphological features
Arachis, Castor, Sesame, Almond, Mustard, Ashoka, Galls, Pale and black catechu, Colchicum, Coffee beans, Vinca leaf, Ergot/ long pepper, Rhubarb, Wild cherry bark, Neem seeds and leaves, Pyrethrum, Henna, Aconite, Pepper black, kokum. ~~1 Practical~~

~~Total~~ ~~15 Practicals~~

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Latest Editions of the following books to be adopted.

1. Trease D. & Evans W.C.: Text Book of Pharmacognosy: W.B. Saunders.
~~1.~~2. Tyler V. E. Brady L. R. & Robbers J. E.: Pharmacognosy; Lea Feibger, USA.
~~1.~~3. Wallis T. E.; Text Book of Pharmacognosy; CBS Publishers, Delhi.
~~1.~~4. Kokate C. K., Purohit A. P. & Gokhale S. B.: Pharmacognosy; Nirali Publications, Pune.
~~1.~~5. Harbone J. B.: Phytochemical Methods: A guide to modern techniques Analysis: Chapman & Hall, London.
~~1.~~6. Bruneton J.: Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
~~1.~~7. Vasudevan T. N. & Laddha K.S.: A Textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
~~1.~~8. The Indian Pharmacopeia: The Controller of Publication; Delhi.
~~1.~~9. Brain K. R. & Turner T. D.: The Practical Evaluation of Phytopharmaceuticals: Wright, Scientica, Bristol.
~~1.~~10. Iyengar M. A. & Nayak S. G.: Anatomy of Crude Drugs: Manipal Power Press Manipal.
~~1.~~11. Iyengar M. A.: Pharmacognosy of Powdered Drugs; Manipal Power Press, Manipal.
~~1.~~12. Kokate C.K.: Practical Pharmacognosy; Vallabh Prakashan.
~~1.~~13. Wagner, Bladt & Zgainski; plant Drug Analysis; Springer Verlag.
~~1.~~14. Khandelwal K. R.: Practical Pharmacognosy Techniques and Experiments; Nirali Prakashan, Pune.
~~1.~~15. Vasudevan T. N. Laddha K. S.: Practical Pharmacognosy; New Vrinda Publishing House, Jalgaon.

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Final Year B. Pharm. Sem. VIII

Pharmaceutical Chemistry – IV **4 Hrs/Week**

~~Sr. No.~~Unit	~~Topic~~TOPIC	Hours
	Discussion of the following classes of drugs including classification, chemical nomenclature, structure including stereochemistry, generic names, SAR and metabolism, molecular mechanism of action, synthesis(*) and rational development if any	
1	**CNS Drugs**	**20**
1.1	Sedatives – Hypnotics Barbiturates: phenobarbital, butabarbital, amobarbital, secobarbital, pentobarbital; benzodiadepines: chlordiazepoxide, diazepam, nitrazepam*, temazepam, alprazolam, estazolam; zolpidem, eszopiclone, ramelteon (last 3 for self study – 1 hr).	3 ~~+1~~
1.2	Anticonvulsants Types of seizures (Self study- 1 hr) phenobarbital, mephobarbital, phenytoin, mephenytoin, ethotoin, trimethadione, ethosuximide, methsuximide, phensuximide, diazepam, clonazepam, carbamazepine*, valproic acid, vigabatrine, progabide, lamotrigine, tiagabine	3 ~~+1~~
1.3	Antidepressants MAO Inhibitors (self study – 1 hr) Iproniazide, moclobemide, phenelzine, tranylcypromine; imipramine*, chlorimipramine, amitriptyline, nortriptyline, doxepine* fluoxetine*, paroxetine, sertraline, escitalopram, amoxapine	3 ~~+1~~
1.4	Anxiolytics Oxazepam, buspirone, meprobamate, tybamate (last two for self study- 1 hr)	1 ~~+1~~
1.5	Antipsychotics chlorpromazine*, triflupromazine, thioridazine, fluphenazine, trifluperazine, chlorprothixen(self study), haloperidol* (synthesis for self study- 1 hr), droperidol , pimozide, risperidone, loxapine, clozapine, sulpiride	3 ~~+1~~
1.6	Antiparkinson's carbidopa, levodopa, selegiline, amantadine, benztropine, procyclidine, orphenadrine (last 3 for self study- 1 hr)	1~~+1~~
2	**ANS Drugs**	**17**
2.1	Adrenergic Drugs Alpha adrenergic agonists: phenylephrine*, naphazoline, xylometazoline, oxymetazoline, methyldopa, clonidine, guanabenz, guanafacine Beta agonists : Isoproterenol, colterol, metaproterenol, terbutaline*, albuterol, isoxsuprine, ritodrine Alpha antagonist : tolazoline, phentolamine, phenoxybenzamine, prazosin, doxazosin Beta Antagonists : pronethalol, propranolol*, pindolol, sotalol, timolol, atenolol, metoprolol, esmolol, acebutolol, carvedilol, labetalol* (last two for self study, including synthesis of labetalol) Other adrenergic agents (Self study-2 hrs) : amphetamine, pseudoephedrine, ephedrine, guanethidine, propylhexedrine, reserpine	7~~+2~~
2.2	Cholinergic Drugs Muscarinic agonists : methacholine, carbachol, bethanechol, pilocarpine Acetylcholineesterase inhibitors : physostigmine, neostigmine*, pyridostigmine, edrophonium, echothiophate, malathion, parathion, paraoxonC, sarin, pralidoxime AntiAlzheimer's : Tacrine*, donepezil, rivastigmine Cholinergic antagonists : Atropine, scopolamine, homatropine, ipratropium cyclopentolate*, dicyclomine*, benztropine, procyclidine, isopropamide, tropicamide	7~~+1~~

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	Ganglion blockers : (Self study- 1 hr) trimethaphan, mecamylamine, hexamethonium Neuromuscular blockers :(Self study) tubocurarine, gallamine, succinylcholine, decamethonium	
3.	**Analgesic Drugs**	12
3.1	Opioid peptides(Self study) Different types of opioid receptors, agonists, partial agonists and antagonists of these receptors Morphine, codeine, levorphanol, buprenorphine, phenazocine, pentazocine, meperidine*, alpha and beta prodine, pheniridine, anileridine, fentanyl, methadone, dextropropoxyphene*, tramadol, nalorphine, naloxone, naltrexone Antidiarrhoeals (Self study-1 hr) : loperamide, diphenoxylate	5~~+1~~
3.2	NSAIDS paracetamol, aspirin, indomethacin, sulindac, mefenamic acid, ibuprofen, naproxen*, flurbiprofen, nabumetone, diclofenac*, piroxicam*, nimesulide, celecoxib, rofecoxib Cytokine inhibitors :(Self study-1 hr) infliximab, rituximab, anakinra, abatacept Drugs in Gout : colchicine, probenecid, sulfinpyrazole, allopurinol, febuxostat	5~~+1~~
4	**Drugs affecting Male and Female Health (Steroids)**	**5**
4.1~~4.~~	~~Drugs affecting Male and Female Health (Steroids)~~ Testosterone, 17-alphamethyltestosterone, oxymesterone, fluoxymesterone, stanazolol, danazol (Self study) estradiol, ethinyl estradiol, mestranol, medroxyprogesterone acetate, megestrol acetate, norethindrone, norgestrel, diethylstilbestrol*(Synthesis for self study), clomiphene (Self study), tamoxifen, anastrozole, letrozole, exemestane (Self study-1 hr) medroxy progesterone acetate, megesterol acetate, norethindrone and norgestrel	4~~+ 1~~
5	**Drugs affecting Hormonal Systems**	~~6~~**2 ~~+ 3~~**
5.1	Thyroid Hormones (Self study- 1 hr) levothyroxine, propylthiouracil, methimazole, carbimazole	
5.2	Adrenocorticosteroids cortisone, hydrocortisone, prednisone, prednisolone, dexamethasone and betamethasone, flurometholone, fluocinolone, triamcinolone, aldosterone, fludrocortisone	4
5.3	Calcium Homeostasis (Self study-1 hr) raloxiphene, alendronate, teriparatide	
	TOTAL	60

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Books

As prescribed for Pharm. Chem. – III

Pharmaceutics – V **4 Hrs/Week**

Unit~~No.~~	TOPIC~~opic~~	Hours
1	**Introduction to NDDS**	**8**
1.1	Limitations of conventional dosage forms, need of NDDS, concept of targeting, advantages of targeting DDS	2
1.2	Advantages, limitations, concept, design and one suitable application of a typical system – oral multiparticulate (microspheres and pellets), floating gastro-retentive systems, transdermal DDS (membrane permeation systems), ocular insert, colloidal DDS (liposomes, nanoparticles, microemulsions), implantable systems (intrauterine device) Introduction to concept of iontophoresis, sonophoresis	6
2	**Mucoadhesive drug delivery systems**	**6**
2.1	Mucoadhesion and theories, factors influencing mucoadhesion	2
2.2	*In vitro-in vivo* methods to study mucoadhesion	2
2.3	Bioadhesive polymers, systems with reference to various routes of administration (oral, buccal, nasal, pulmonary, rectal)	2
3	**Colonic targeting**	**4**
3.1	Physiology of colon, difficulties in colonic drug delivery	1
3.2	Approaches - prodrug, pH sensitive polymers, polysaccharides, time release systems, osmotic systems, azo polymers and evaluation	3
4	**Osmotic Systems**	**3**
4.1	Basic principles (osmosis)	1
4.2	Classification, design and release kinetics of oral osmotic pumps, osmotic implants, applications and evaluation	2
5	**Microencapsulation**	**5~~6~~**
5.1	Definition, need/ reasons, concepts of core and coat	1
5.2	Methods of microencapsulation - phase separation coacervation (various techniques), wurster process, spray drying and related processes, interfacial polymerization, multiorifice centrifugal process, pan coating, solvent evaporation	4~~5~~
6	**Quality Assurance** (discuss specimen documents)	**8**
6.1	Raw material control, actives and inactive, in process control, sanitization, environmental and microbiological control, packaging and labeling control, finished product control	2
6.2	cGMP	2
6.3	Q. C. standards of identity, purity, quality and potency	2
6.4	Statistical Quality Control - Q. C. Charts, sampling and sampling plans	2
7	**Documentation**	**5**
7.1	Need and importance of documentation, maintenance and retrieval of documents	3
7.2	*Self study-SOP and BMR of various formulations*	2
8	**Pilot plant scale up techniques**	**5**
8.1	Group's responsibilities, facilities, example of scaling up of manufacturing of tablets, liquids (suspension, solutions, emulsions) and semisolids	5
9	**Validation**	**5~~6~~**
9.1	Definition, Types, Qualification, Validation of raw materials Process Validation – steps and documentation ~~e.g.:~~ mixing and wet granulation Equipment validation – ~~e.g.:~~ mixer and granulator	3~~4~~
9.2	Validation of sterilization process and equipment – microbial death kinetic terms,	2

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	F value applications, steps for validating steam sterilization method	
10	**Production Management**	**7**
10.1	Pharma industry - current scenario, Site selection and development – factors to be considered in designing a facility	2
10.2	*Self study-Personnel – qualifications, selection, responsibilities and training*	1
10.3	Material management - vendor audit, warehousing, sales forecasting, inventory control, production planning, elements of cost and cost controls	4
11	**Factory Layout**	**4**
11.1	As per schedule M - general considerations/ steps,	1
11.2	Examples of Typical layout schemes for Tablets, capsule, liquids, sterile formulations manufacturing areas	3
	TOTAL	**60**

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Latest ~~e~~Editions of the following books to be adopted

1. The theory and practice of Industrial Pharmacy, Ed. Leon Lachman, H. A. Liberman, J. L. Kanig; Varghese Publishing House.
~~1.~~2. Remington, The science and practice of Pharmacy, Vols. I and II, B. L. Publications Pvt. Ltd.
~~1.~~3. Cole Graham, Pharmaceutical Production Facilities, Design and Applications.
~~1.~~4. Pharmaceutical Process Validation, Nash Robert A., Berry Ira R., Volume 57, Marcell Dekker INC, New York.
~~1.~~5. Pharmaceutical dosage forms: Parenteral medications. Vols. I, II, III, Ed Kenneth A. Avis, Leon Lachman and H. A. Liberman, Marcel Dekker INC.
~~1.~~6. Pharmacetuical Technology, Vols. I, II, R S R Murthy, Ashutosh Kar, New Age Int. Ltd.
~~1.~~7. Advances in controlled and novel drug delivery, Ed. N. K. Jain, CBS publishers and distributors.
~~1.~~8. Modern Pharmaceutics, Ed. Gilbert S. Bankerand Christopher T. Rhodes. Marcel Dekker INC.
~~1.~~9. Targeted and controlled drug delivery, Novel carrier systems, S. P. Vyas and R. K. Khar., CBS publishers and Distributors.
~~1.~~10. Controlled and novel drug delivery, Ed N. K. Jain, CBS publishers and distributors.
~~1.~~11. Controlled drug delivery, concepts and advances; S. P. Vyas and R. K. Khar, Vallabh Publishers.
~~1.~~12. Bioadhesive Drug Delivery Systems – Fundamentals, Novel Approaches and Development, Mathiowitz Edith. Chickering III, Donald E., Lehr Claus – Michael, Volume 98, Marcel Dekker Inc. New York.
~~1.~~13. Nanoparticulate Drug Delivery Systems, Thasu Deepak, Dellers Michael, Pathak Yashwant, Volume 166, Marcel Dekker INC., New York.
~~1.~~14. Microencapsulation., Methods and Industrial Applications., D. Benita Simon, Marcel Dekker, INC, New York.
~~1.~~15. Controlled and Novel Drug Delivery, Jain N. K., CBS publishers and Distributors, New Delhi.
~~1.~~16. Ophthalmic drug delivery systems, Ed. Ashim K. Mitra, Volume 58, Marcel Dekker INC.

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Biopharmaceutics & Pharmacokinetics **4 Hrs/Week**

Unit~~No.~~	~~Topic~~TOPIC	Hrs
1	**INTRODUCTION**	5
~~1~~	~~**INTRODUCTION**~~	
1.1	Introduction to the subject of biopharmaceutics and p~~P~~harmacokinetics. Emphasis on the importance in drug discovery, development and clinical pharmacy and applications. Definitions: ADME, Bioavailability, Bioequivalence	2
1.2	Drug Transport: Different mechanisms of drug transport, physiology of cell membrane and passage of drugs across cell membrane.	3
2	**ABSORPTION**	10
~~2~~	~~**ABSORPTION**~~	
2.1	Routes of drug administration: Emphasis on Oral, parenteral and Extravascular routes (Self study)	2
2.2	Factors affecting drug absorption: Physicochemical factors (Emphasis on pH partition theory and solubility)	3
2.3	Factors affecting drug absorption: Physiological factors (Emphasis on physiology of GIT)	3
2.4	Factors affecting drug absorption: Formulation and Dosage form factors (Self study)	2
3	**DISTRIBUTION**	5
~~3~~	~~**DISTRIBUTION**~~	
3.1	Factors affecting distribution: Physiological barriers, Tissue permeability and perfusion limited distribution	2
3.2	Volume of Distribution – Concept, dependence on site/fluid of measurement, limits of values of volume of distribution	1
3.3	Protein Binding of drugs and its significance	2
4	**METABOLISM/Biotransformation**	8
~~4~~	~~**METABOLISM/Biotransformation**~~	
4.1	Phase I and Phase II reactions (self study)	3
4.2	Factors affecting drug metabolism: Age, species difference, genetic difference, induction and inhibition, drug- drug interaction	2
4.3	First pass metabolism, concept of clearance , hepatic clearance and factors affecting hepatic clearance, Hepatic extraction ratio, limits of values of organ clearance	3
5.	**EXCRETION**	4
5.1	Renal excretion, Renal clearance and factors affecting renal clearance, Excretion ratio	2
5.2	Non hepatic and non-renal routes of elimination	2
6	**DISSOLUTION**	7
6.1	Introduction to Biopharmaceutical Classification System of drugs	2
6.2	Theories of dissolution, Dissolution rate and methods of enhancing dissolution rate.	~~2~~3
6.3	Official and unofficial methods of dissolution rate testing. Application to different dosage forms (self study)	~~3~~2
7	**PHARMACOKINETICS**	16
7.1	Pharmacokinetics: Introduction to compartmental and physiological models. Introduction to the one compartmental open model and its assumptions. Concept	3

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	of zero order and first order rate kinetics	
7.2	Mathematical treatment of pPharmacokinetics upon (One compartment open model) IV bolus dosing: Importance of volume of distribution. Clearance, elimination rate constant, half life, area under the curve (trapezoidal rule)	2
7.3	Mathematical treatment of pharmacokinetics upon (One compartment open model) extravascular dosing. Absorption rate constant, absorption half life, bioavailability. ~~Introduction of the concept of a~~Area under the curve~~, the trapezoidal rule~~ and the method of residuals. Concept of Cmax and tmax.	3
7.4	Introduction to the R~~r~~ate of excretion method and Sigma minus method for urine analysis after IV administration	2
7.5	Discussion of linear and nonlinear kinetics and description of factors resulting in non linear kinetics.	2
7.6	Application of PK principles through simple problems. (3 hours self study)	4
8	**BIOAVAILABILITY AND BIOEQUIVALENCE**	5
8.1	Concept of absolute and relative bioavailability	1
8.2	Methods of assessment and enhancement of bioavailability (1 hour self study)	2
8.3	Bioequivalence: Study designs, Introduction to the concept of biowaiver (1 hour self study)	2
	TOTAL	**60**

Latest e~~E~~ditions of the following books to be adopted

1. Leon Shargel, Susanna Wu – Pong, Andrew B.C, Applied Biopharmaceutics and Pharmacokinetics, Singapore.
~~1.~~2. Brahmankar D.M and Jaiswal Sunil B, Biopharmaceutics and Pharmacokinetics – A Treatise, Vallabh Prakashan.
~~1.~~3. Robert E. Notari, Biopharmaceutics and Pharmacokinetics – An Introduction, Marcel Dekker Inc., New York.
~~1.~~4. Milo Gibaldi, Biopharmaceutics and Clinical Pharmacokinetics~~"~~, ~~1991,~~ USA.
~~1.~~5. Malcom Roland, Thomas Tozer, Clinical Pharmacokinetics: Concept and Application, A Lea – Febiger book, USA
~~1.~~6. Banakar~~,~~ Umesh, Pharmaceutical Dissolution Testing, Volume 49, Marcel Dekker Inc, New York.

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Pharmacognosy & Phytochemistry – III **4 Hrs/Week**

~~Sr.No~~ Unit~~:~~	TOPIC~~epic~~	Hours
	Drugs highlighted in bold font are to be studied for detailed pharmacognostic scheme	
1	**Volatile Oils**	**11**
1.1	General introduction, composition, chemistry, general methods of extraction, therapeutic uses and commercial applications of volatile oils. Introduction to terpeneless volatile oils. Study of sources, composition of volatile oils, salient features of extraction (if any) and applications of the following : a. Umbelliferous fruits (Anise, Caraway, **Dill**, Ajowan, **Fennel**, **Coriander,** Cumin). Biosynthesis of mono and sesquiterpenoid derivatives occurring in volatile oils. *Self study* *Comparative study of morphology and microscopy of Umbelliferous fruits*	4 1
1.2	Study of sources, composition of volatile oils, salient features of extraction (if any) and applications of the following : b. Hydrocarbon volatile oil – Turpentine oil c. Alcohol – Peppermint, **Cardamom,** Rose oil, Peppermint d. Aldehyde volatile oil - Lemon and Orange peel oil, Lemongrass e. Ketone volatile oil - Camphor, spearmint (mint oils) f. Ester volatile oil - Oil of Wintergreen g. Ether volatile oil - **Eucalyptus oil** h. Miscellaneous - Sandalwood, Sassurea, Star anise, Jatamansi, Valerian, Vetiver, Phenyl propanoids - **Cinnamon, Cassia cinnamon, clove**, nutmeg. *Self study* • *Oils used in perfume industry any 2 examples* • *Marketed formulations containing the volatile oils mentioned above (any 5)*	4 2
2.	**Steriodal and Triterpenoidal drugs**	**9**
2.1	Introduction to steroidal and saponin glycosides with respect to their chemistry, general chemical tests. Detailed study of drugs with respect source, chemistry & biopotential of the following drugs - **Liquorice**, Quillaia, **Asparagus**, Ginseng, **Dioscorea**, Agave, Fenugreek, Bacopa, Hydrocotyle, Smilax, Sapindus, *Acacia concinna.*	5
2.2	Introduction to cardiac glycosides with respect to their classification, chemistry & general chemical tests. Detailed study of drugs with respect source, chemistry & biopotential of the following drugs – ***Digitalis lanata, Digitalis purpurea***, Strophanthus, Squill, Nerium, Thevetia. *Self Study:* • *Morphological and histological differences between different species of Diascorea, Digitalis, Brahmi*	2 2
3.	**Resins and resin combinations**	**5**
3.1	Introduction of resins as pathological products, definition, general properties, composition and applications. Study of occurrence, composition, uses and specific tests for identification of the following natural resins - Colophony, Myrrh, Benzoin, Balsams of Tolu and Balsam of Peru, Guggul, Asafoetida.	3
3.2	Introduction of metabolic resins and their methods of extractions. Study of details of chemistry (structures of principal components), sources and uses of the following resins - Cannabis, Turmeric, Ginger, Capsicum, Shellac. *Self Study:* • *Morphology and microscopy of Ginger* • *Preparation of Ginger and Turmeric for market*	1 1
4	**Phenyl propanoids and related compounds**	**6**

4.1	Biosynthesis of phenyl propanoids. Examples of monomeric , dimeric and related phenylpropanoid derivatives e.g., lignans, lignins and flavonoids.	1
4. 2	Flavonoids: Introduction to flavonoids, classification, chemical tests occurrence & their biopotential as exemplified by orange peel , garcinia, soyabean, liquorice, cranberry, buckwheat.	3
4.3	Study of following drugs with respect to sources, constituents and uses – Podophyllum, Psoralea, Ammi majus, Phyllanthus *Self study:* • *Differences between two species of Podophyllum* • *Differences between two species of Tinospora* • *Herbal photosensitizer and photoprotective agents*	1 1
5.	**Iridoids & Miscellaneous phytochemicals**	**5**
5.1	**Iridoids** General introduction to iridoids. Study of Gentian, piccrohiza. **Modified Triterpenoids** Quassia, tinospora, Artemisia, Taxus, , Andrographis. **Tetraterpenoids** General introduction to tetraterpenoids. Study of carotenoids- lutein, crocin, zeaxanthin, and lycopene with respect to sources, chemistry, and biopotential. *Self study:* • *All sources and applications of lycopene*	4 1
6	**Traditional drugs**	**6**
6.1	Study of following traditional drugs with respect to common names, sources, and traditional uses & observed pharmacological activities of the following drugs - punarnava (*Boerhavia diffusa*), shankpusphi (*Convolvulus microphylla*), Leshun (*Allium sativum*), Guggul (*Commiphora mukul*), Kalmegh (*Andrographis paniculata*), Tulsi (*Ocimum sanctum*), valerian(*Valerian officinalis*), Artemisia(*Artemisia annua*), Chirata (*Swertia chirata*), Ashoka (*Saraca indica*)	3
6.2	Study of all traditional drugs listed in Sec. 6.1, with respect to phytoconstituents. *Self study:* • *Study of marketed formulations containing traditional drugs (any two)*	2 1
7	**Study of Herbal Excipients & Cosmetics**	**6**
7.1	Herbal Excipients – Significance of substances of natural origin as excipients – colorants, sweeteners, binders, diluents, viscosity builders, disintegrants, flavors & perfumes.	3
7.2	Herbal Cosmetics - Importance of herbals as surfactants (soapnut), hair conditioners and hair colorants (henna, hibiscus, tea), herbals for skin care (aloe vera gel, turmeric, lemon peel, vetiver). *Self study:* • *Study of two examples of each type of excipient from natural sources*	2 1
8.	**Study of herbal formulations & Ayurvedic formulations**	**5**
8.1	Formulations based on substances of natural origin – Challenges and salient features of preparation of herbal formulations	2
8.2	**Ayurvedic Formulations –**Introduction to Ayurvedic formulations like aristas, asava, gutika, taila, churna, avaleha, ghrita. Introduction to the concept of detoxification in Ayurveda. *Self study:* • *Examples of Ayurvedic formulations (any two)*	2 1
9	**Standardization, Regulations & Intellectual Property Rights of Herbal and Ayurvedic, Siddha & Unani (ASU) drugs**	**7**
9.1	Standardisation : Detailed study of Quality control of herbal drugs as per WHO guidelines. Safety parameters, toxicity concerns and herb- drug interactions. *Self study:*	2 1

	• *Examples of Herbal drug interactions* • *Study of five examples of markers from each class of phytoconstituents for standardization*	
9.2	Regulatory Issues - Regulations in India (ASU DTAB, ASU DCC), Regulation of manufacture of ASU drugs - Schedule T & Y of Drugs & Cosmetics Act for ASU drugs. Overview of Global regulatory issues. Indian and International patent laws, proposed amendments as applicable to herbal /natural products and processes, Intellectual Property Rights with special reference to phytoconstituents. *Self study:* • *Search on one case study of patent related to herb*	3 1
	Total	**60**

Latest ~~e~~Editions of the following books to be adopted.

1. Trease D. & Evans W.C.: Text Book of Pharmacognosy: W. B. Saunders.
~~1.~~2. Tyler V. E. Brady L. R. & Robbers J. E.: Pharmacognosy; Lea & Feibger, USA.
~~1.~~3. Wallis T. E.; Text Book of Pharmacognosy; CBS Publishers, Delhi.
~~1.~~4. Kokate C. K., Purohit A. P. & Gokhale S. B.: Pharmacognosy; Nirali Publications, Pune.
~~1.~~5. Harbone J. B.: Phytochemical Methods: A guide to modern techniques Analysis: Chapman & Hall, London.
~~1.~~6. Bruneton J.: Pharmacognosy, Phytochemistry, Medicinal Plants: Intercept Limited.
~~1.~~7. Vasudevan T. N. & Laddha K. S.: A Textbook of Pharmacognosy, Vrinda Publication House, Jalgaon.
~~1.~~8. The Indian Pharmacopeia: The Controller of Publication; Delhi.
~~1.~~9. Brain K. R. & Turner T. D.: The Practical Evaluation of Phytopharmaceuticals: Wright, Scientica, Bristol.
~~1.~~10. Iyengar M. A. & Nayak S. G.: Anatomy of Crude Drugs: Manipal Power Press, Manipal.
~~1.~~11. Iyengar M. A.: Pharmacognosy of Powdered Drugs; Manipal Power Press, Manipal.
~~1.~~12. Kokate C. K.:Practical Pharmacognosy; Vallabh Prakashan.
~~1.~~13. Wagner, Bladt & Zgainski; Plant Drug Analysis; Springer Verlag.
~~1.~~14. Khandelwal K. R.: Practical Pharmacognosy Techniques and Experiments; Nirali Prakashan, Pune.
~~1.~~15. Vasudevan T. N. Laddha K. S.: Practical Pharmacognosy; New Vrinda Publishing House, Jalgaon.
~~16.~~ Pulok ~~k~~K. Mukherjee , GMP for botanicals (Regulatory and Quality Issues on Phytomedicines).
16. Editor Robert Verpoorte, Business Horizons New Delhi.
17. Pulok K Mukherjee, Quality control of herbal drugs, an approach to evaluation of botanicals, Business Horizons, New Delhi.

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Clinical Pharmacy **2 Hrs/Week**

Unit~~Sr. No.~~	TOPIC~~epic~~	Hours
1	Concept of Clinical Pharmacy, Community pharmacy and hospital pharmacy (Definition, scope and objectives), Patient Counselling: Role of Pharmacist in patient counselling	3
2	Patient Compliance, Methods of assessment of compliance, Reason for patient noncompliance, Strategies to improve compliance, Precaution and directions for medication, Administration instructions	2
3	Adverse Drug reactions: Epidemiology, Classification, Risk factors, Monitoring, Detecting and reporting of ADR	3
4	Drug interactions: Types, General Considerations and Mechanisms	3
5	**Drug use in special population**	
5.1	Drugs used in Geriatrics	2
5.2	Drugs used in Paediatrics	1
5.3	Drugs used in Pregnancy	1
6	Therapeutic Drug Monitoring: Definition, indications and strategies	2
7	**Drug discovery & development:**	
7.1	Preclinical development	1
7.2	Clinical development History, terminologies, types of clinical research, phases of clinical trials, role of clinical trial in new drug developments. Ethical issues in clinical trials: Principle of regulatory requirements, responsible conduct, supervision of ethics, (Informed Consent, Independent Ethics Committee, Institutional Review Board)	4
7.3	Good Clinical Practice (GCP): Concept and importance	1
7.4	Definitions of essential documents; SOP, protocol, Investigator's brochure, informed consent forms and case report forms	1
7.5	Introduction to BA/BE studies	2
7.6	SELF STUDY: - Pharmacovigilance: Definition, scope and aims of Pharmacovigilance	4
~~7.7~~	~~SELF STUDY: Pharmacovigilance: Definition, scope and aims of Pharmacovigilance~~	~~4~~
	Total	30

Latest editions of the following books to be adopted

1. Clinical Pharmacy and Therapeutics, Roger Walker, Clive Edwards, Churchill Livingstone.
2. Clinical Pharmacy, Dr.Tipnis, Dr. Bajaj, Career Publications.
3. Clinical Pharmacology, P.N. Benett, M. J. Brown, Churchill Livingstone.
4. Text Book of Clinical Pharmacy Practice, G. Parthisarathi, Karin Nyfort Hansen, Milap C. Nahata, Orient Longman.

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Pharmaceutical Chemistry Lab. – III **4 Hrs/Week**

Synthesis of the following Drugs and Drug Intermediates

1. Diels – Alder Reaction using Maleic Acid + Furan
2. Synthesis of Benzilic Acid: Conventional Method and Green Modification as in Green Chemistry DST Monograph
3. Synthesis of Benzoin from Benzaldehyde using Thiamine, Ref: Green Chemistry – V. K. Ahluwalia, pg. no. 2.5
4. Three Component Synthesis of Pyrimidone using Ethylacetoacetate, Benzaldehyde and Urea as per Green Chemistry DST Monograph
5. Synthesis of Dibenzylidene Acetone using LiOH as per Green Chemistry DST Monograph
6. Synthesis of Benzoic Acid using Cannizaro Reaction of Benzaldehyde, Ref: Green Chemistry, V. K. Ahluwalia pg. No. 65.
7. Hofmann rearrangement: Anthranilic acid from Phthalimide.
8. Reduction reaction: PABA from *p*-nitrobenzoic acid.
9. Synthesis of Benzocaine from PABA

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Pharmaceutics Lab. – V **4 Hrs/Week**

1. Preparation and *in vitro* release evaluation of sustained release oral granules/tablets-using hydrophobic and hydrophilic matrix materials.
2. Dissolution testing of marketed formulations of conventional tablets containing freely soluble and poorly soluble drug(selection of medium).
3. Calculations of pharmacokinetic parameters (plasma samples provided).
4. Preparation and evaluation of mucoadhesive buccal films (including mucoadhesive strength).
5. Preparation and evaluation of film coated modified release/colon specific dosage form.
6. Microencapsulation of solid and liquid core using phase separation coacervation technique and evaluation of microcapsules.
7. Validation of process-dissolution/mixing.
8. Assignment on SOP's of dissolution apparatus/tablet press/coating equipment.
9. Assignment on excipient/API specifications.

Books

All books listed in the theory syllabus as well as current editions of IP, BP and USP

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Pharmacognosy & Phytochemistry Lab. – III **4 Hrs/Week**

1 Study of morphology, histology, powder characteristics of Fennel and Coriander
Extraction and detection of volatile oil from fennel. 1 Practical
2 Study of morphology, histology, powder characteristics of Liquorice
Extraction and detection of saponin glycosides and flavonoids from Liquorice 1 Practical
3 Study of morphology, histology, powder characteristics of Clove. Extraction of clove oil and detection of Eugenol by TLC and potassium euginate test. 1 Practical
4 Study of morphology, histology, powder characteristics of, Ginger, Quassia, Kalmegh, Eucalyptus, Cinnamon 5 Practicals
5 Microscopical examination of powder mixtures of drugs mentioned above. 3 Practicals
6 Extraction and detection by TLC of curcumin from turmeric. 1 Practical
8 Morphological identification any twenty samples and their salient morphological features
Anise and Star anise, Caraway, Dill, Ajowan, Cumin, Citrus peel, Sandalwood, Sassurea, Jatamansi, Valerian, Nutmeg and mace, Vetiver, Dioscorea, Fenugreek, Brahmi, Shikakai, Soapnut, Squill, Digitalis, Turmeric, Soyabean, Capsicum, Podophyllum, Picrorhiza, Punarnava, Apricot, Amla, Karela 1 Practical
9 Qualitative evaluation of phytoconstituents from herbal formulation with respect to volatile oils, saponin glycosides, cardiac glycosides, flavanoids. 2 Practicals
Total 15 Practicals

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1. Trease D. & Evans W.C.: Text Book of Pharmacognosy: W.B. Saunders.
2. Tyler V. E. Brady L. R. & Robbers J. E.: Pharmacognosy; Lea Feibger, USA.
3. Wallis T. E.; Text Book of Pharmacognosy; CBS Publishers, Delhi.
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