NIRMA UNIVERSITY
NAAC ACCREDITED 'A' GRADE

NU/AC/4 (A)/18-69
Date: 05.05.2018

NOTIFICATION

Read:
1. **Regulation No. 44 of Academic Regulations for Admission to University, etc. published vide notification No. NU-442 dated 27.1.2004 – Empowering Academic Council to approve teaching & examination scheme, syllabus, etc.**
2. **Notifications mentioned in Handbook-IV, updated up to April, 2015**
3. **Noti. No. 246, Dt. 30.04.2016- Revision of Teaching & Examination Scheme of Semester – I to VIII and Syllabus of Semester – I & II of B.Pharm Programme, to be made effective for the students to be admitted in the Academic Year 2016-17 and onwards.**
4. **Noti. No. 38, Dt. 06.05.2017- Introduction of course- 2PH316- Titrimetric Methods of Pharmaceutical Analysis of Semester-III of B.Pharm. programme**
5. **Resolution Nos. 3(A), 5(I), 6(I), 7 and 8(I)- Faculty of Pharmacy Mtg.- 28.02.2018**
6. **Resolution No. 4(A) – Academic Council meeting – 20.04.2018**

Sub: **Introduction of Teaching & Examination Scheme and Syllabus of Semester-III & IV of B. Pharm. Programme**

It is, hereby, notified for information of all concerned that, the Academic Council in its meeting held on 20.04.2018 under resolution No. 4(A), in exercise of powers conferred upon it by the Board of Governors under regulation mentioned at serial 1 above, taking into consideration the recommendation of the Faculty of Pharmacy, has resolved to approve the *introduction* of Teaching & Examination Scheme and Syllabus of Semester-III & IV of **B. Pharm. Programme** in pursuance to new curriculum as prescribed by Pharmacy Council of India (PCI), to be made effective for the students to be registered in Semester-III & IV from academic year 2018-19 onwards as per ***Appendix-A*** attached herewith

Executive Registrar

Encl.: Appendix-A [Pages1 to 30]

To,
1. Dean, Faculty of Pharmacy
2. Coordinator of Exam, IP
3. Dy. Registrar: Examination

Copy to: OS-IP; Librarian-IP; P.A. to ER

c.f.w.cs. for information to: 1. Vice President
2. Director General

Nirma University
Institute of Pharmacy
Teaching & Examination Scheme *(B.Pharm)*

Semester - III

Sr. No.	Course Code	Course Title	Teaching Scheme				Examination Scheme				
			L	LPW/PW	T	C	Duration		Component Weightage		
							SEE	LPW/PW	CE	LPW/PW	SEE
1	BP301T	Pharmaceutical Organic Chemistry II – Theory	3	-	1	4	3.0	-	0.25	-	0.75
2	BP305P	Pharmaceutical Organic Chemistry II –Practical	-	4	-	2	-	4.0	0.30	0.70	-
3	BP302T	Physical Pharmaceutics I – Theory	3	-	1	4	3.0	-	0.25	-	0.75
4	BP306P	Physical Pharmaceutics I– Practical	-	4	-	2	-	4.0	0.30	0.70	-
5	BP303T	Pharmaceutical Microbiology – Theory	3	-	1	4	3.0	-	0.25	-	0.75
6	BP307P	Pharmaceutical Microbiology – Practical	-	4	-	2	-	4.0	0.30	0.70	-
7	BP304T	Pharmaceutical Engineering – Theory	3	-	1	4	3.0	-	0.25	-	0.75
8	BP308P	Pharmaceutical Engineering - Practical		4	-	2	-	4.0	0.30	0.70	-
		Total	**12**	**16**	**4**	**24**					
			32								

L: *Lectures*, P/T: *Practicals/Tutorial*, C: *Credits*
LPW: *Laboratory / Project Work*

SEE: *Semester End Examination*
CE: *Continuous Evaluation*

w.e.f. academic year 2018-2019 and onwards

Appendix - A
Noti. No. NU - 69
AC Mtg. 20.04.18

NIRMA UNIVERSITY
Institute of Pharmacy
(B. Pharm.)
(Semester - III)

L	T	P	C
3	1	-	4

Course Code	**BP301T**
Course Title	**Pharmaceutical Organic Chemistry II - Theory**

Scope:

This subject deals with general methods of preparation and reactions of some organic compounds. Reactivity of organic compounds are also studied here. The syllabus emphasizes on mechanisms and orientation of reactions. Chemistry of fats and oils are also included in the syllabus.

Objectives:

Upon completion of the course student shall be able to -

1. Write the structure, name and the type of isomerism of the organic compound.
2. Write the reaction, name the reaction and orientation of reactions.
3. Account for reactivity/stability of compounds.
4. Prepare organic compounds.

Course Learning Outcomes (CLO):

After successful completion of the course, student will be able to -

1. Remember properties, reactions and analysis of fats and oils.
2. Understand physical properties, preparations, reactions, structure and uses of various phenols.
3. Describe stability and reactions of cycloalkanes.
4. Discuss properties, preparation and reactions of aromatic amines and acids.
5. Explain aromaticity, properties, preparations, reactions and uses of benzene and its derivatives.
6. Draw synthesis, reaction with medicinal uses of polynuclear hydrocarbons.

Syllabus: **Teaching hours: 45 Hours**

General methods of preparation and reactions of compounds superscripted with asterisk (*) to be explained. To emphasize on definition, types, classification, principles/mechanisms, applications, examples and differences

UNIT I **10 Hours**

Benzene and its derivatives:

Analytical, synthetic and other evidences in the derivation of structure of benzene, Orbital picture, resonance in benzene, aromatic characters, Huckel's rule.

Reactions of benzene - nitration, sulphonation, halogenation- reactivity, Friedel crafts alkylation- reactivity, limitations, Friedel crafts acylation.

Substituents, effect of substituents on reactivity and orientation of mono substituted benzene compounds towards electrophilic substitution reaction.

Structure and uses of DDT, Saccharin, BHC and Chloramine.

UNIT II **10 Hours**

Phenols*:

Acidity of phenols, effect of substituents on acidity, qualitative tests, structure and uses of phenol, cresols, resorcinol, naphthols.

Aromatic Amines*:

Basicity of amines, effect of substituents on basicity, and synthetic uses of aryl diazonium salts.

Aromatic Acids*:

Acidity, effect of substituents on acidity and important reactions of benzoic acid.

UNIT III **10 Hours**

Fats and Oils:

Fatty acids – reactions.

Hydrolysis, hydrogenation, saponification and rancidity of oils, drying oils.

Analytical constants – Acid value, saponification value, ester value, iodine value, acetyl value, reichert meissl (RM) value – significance and principle involved in their determination.

UNIT IV **08 Hours**

Polynuclear hydrocarbons:

Synthesis, reactions.

Structure and medicinal uses of Naphthalene, Phenanthrene, Anthracene, Diphenylmethane, Triphenylmethane and their derivatives.

UNIT V **07 Hours**

Cyclo alkanes*:

Stabilities – Baeyer's strain theory, limitation of Baeyer's strain theory, Coulson and Moffitt's modification, Sachse Mohr's theory (Theory of strainless rings), reactions of cyclopropane and cyclobutane only.

Tutorials **Teaching Hours: 15 Hours**

Tutorials will be based on above syllabus.

Suggested Readings^:(Latest edition)

1. Morrison, R. T., Boyd, R. N. *Organic Chemistry*. Prentice Hall, Inc., USA.
2. Finar, I. L. Organic Chemistry, Vol. I, ELBS.
3. Bahl, B. S. *Text Book Of Organic Chemistry {For B. Sc. Students}*. S. Chand And Company Ltd Ram Nagar; New Delhi.
4. March, J. *Advanced organic chemistry: reactions, mechanisms, and structure*. John Wiley & Sons,.
5. Soni, P. L. *Fundamental organic chemistry*. New Delhi: S. Chand.
6. Mann, F. G., & Saunders, B. C. *Practical organic chemistry*. London: Longman.
7. Solomons, T. W., Fryhle, C. B., & Johnson, R. G. *Organic chemistry*. New York: Wiley.

8. Ahluwalia, V. K. *Organic Reaction Mechanism*. New Delhi: Ane Books India.
9. Mann, F. G. *Practical organic chemistry*. Pearson Education India.
10. Vishnoi, N. K. *Advanced practical organic chemistry*. Vikas Publishing House Pvt. Limited.
11. Pavia, D. L. *Introduction to organic laboratory techniques: a small scale approach*. Cengage Learning.
12. Gurudeep, C. R., & Gurudeep, C. R. *Reaction Mechanism and Reagents in Organic Chemistry*. Bombay: Himalaya Publsihing House.
13. Furniss, B. S. *Vogel's textbook of practical organic chemistry*. Pearson Education India.

L= Lecture, T= Tutorial, P= Practical, C= Credit
^ this is not an exhaustive list

(B. Pharm)
(Semester - III)

L	T	P	C
-	-	4	2

Course Code –	**BP305P**
Course Title	**Pharmaceutical Organic Chemistry II – Practical**

Syllabus: **Teaching hours: 60 Hours**

I. Experiments involving laboratory techniques:
- Recrystallization
- Steam distillation

II. Determination of following oil values (including standardization of reagents):
- Acid value
- Saponification value
- Iodine value

III. Preparation of compounds:
- Benzanilide/Phenyl benzoate/Acetanilide from Aniline/ Phenol /Aniline by acylation reaction.
- 2,4,6-Tribromo aniline/Para bromo acetanilide from Aniline.
- Acetanilide by halogenation (Bromination) reaction.
- 5-Nitro salicylic acid/Meta di nitro benzene from Salicylic acid / Nitro benzene by nitration reaction.
- Benzoic acid from Benzyl chloride by oxidation reaction.
- Benzoic acid/ Salicylic acid from alkyl benzoate/ alkyl salicylate by hydrolysis reaction.
- 1-Phenyl azo-2-napthol from Aniline by diazotization and coupling reactions.
- Benzil from Benzoin by oxidation reaction.
- Dibenzal acetone from Benzaldehyde by Claisen Schmidt reaction.
- Cinnamic acid from Benzaldehyde by Perkin reaction.
- *P*-Iodo benzoic acid from *P*-amino benzoic acid.

L= Lecture, T= Tutorial, P= Practical, C= Credit

(B. Pharm)
(Semester - III)

L	T	P	C
3	1	-	4

Course Code	**BP302T**
Course Title	**Physical Pharmaceutics I - Theory**

Scope:

The course deals with the various physical and physicochemical properties, and principles involved in dosage forms/formulations. Theory and practical components of the subject help the student to get a better insight into various areas of formulation research and development, and stability studies of pharmaceutical dosage forms.

Objectives:

After completion of course student is able to know

1. Understand various physicochemical properties of drug molecules in the designing the dosage forms.
2. Know the principles of chemical kinetics & to use them for stability testing and determination of expiry date of formulations.
3. Demonstrate use of physicochemical properties in the formulation development and evaluation of dosage forms.

Course Learning Outcomes (CLO):

At the end of the course, students will be able to –

1. Recognize basic concepts of physical and chemical properties of various materials
2. Describe principles and methodology related to above properties.
3. Determine properties of solid and liquid samples using various methods.
4. Discuss factors affecting properties of drug and excipients.
5. Explain particle properties and its impact on various parameters.
6. Solve calculations related to above topics.

Syllabus: **Teaching hours: 45 Hours**

UNIT I **10 Hours**

Solubility of drugs:

Solubility expressions, mechanisms of solute solvent interactions, ideal solubility parameters, solvation & association, quantitative approach to the factors influencing solubility of drugs, diffusion principles in biological systems. Solubility of gas in liquids, solubility of liquids in liquids, (Binary solutions, ideal solutions) Raoult's law, real solutions. Partially miscible liquids, Critical solution temperature and applications. Distribution law, its limitations and applications.

UNIT II **12 Hours**

States of Matter and properties of matter:

State of matter, changes in the state of matter, latent heats, vapour pressure, sublimation critical point,

eutectic mixtures, gases, aerosols-inhalers, relative humidity, liquid complexes, liquid crystals, glassy states, solid- crystalline, amorphous & polymorphism and its applications.

Physicochemical properties of drug molecules:
Refractive index, optical rotation, dielectric constant, dipole moment, dissociation constant, determinations and applications.

UNIT III **08 Hours**

Surface and interfacial phenomenon:
Liquid interface, surface & interfacial tensions, surface free energy, measurement of surface & interfacial tensions, spreading coefficient, adsorption at liquid interfaces, surface active agents, HLB Scale, solubilisation, detergency, adsorption at solid interface and its determination.

UNIT IV **08 Hours**

Complexation and protein binding:
Introduction, Classification of Complexation, Applications, methods of analysis, protein binding, Complexation and drug action, crystalline structures of complexes and thermodynamic treatment of stability constants.

UNIT V **07 Hours**

pH, buffers and Isotonic solutions:
Sorensen's pH scale, pH determination (electrometric and calorimetric), applications of buffers, buffer equation, buffer capacity, buffers in pharmaceutical and biological systems, buffered isotonic solutions.

TUTORIALS **Teaching hours: 15 Hours**

Tutorials will be based on above syllabus

Suggested Readings^: (Latest edition)

1. Martin, A. *Physical Pharmacy.* New York, Lippincott Williams & Wilkins
2. Eugene, P. *Experimental Pharmaceutics.* USA, Burgess Pub. Co.
3. Cooper and Gunn. *Tutorial Pharmacy.* Delhi. CBS Publishers & Distributors
4. Stocklosam, J. *Pharmaceutical Calculations.* Philadelphia, USA, Lea & Febiger
5. Liberman, H.A, Lachman, C. *Pharmaceutical Dosage forms, Tablets. Volume-1 to 3,* New York, USA, Marcel Dekker Inc
6. Liberman, H.A, Lachman, C. *Pharmaceutical Dosage forms, Disperse systems. Volume-1 to 3,* New York, USA, Marcel Dekker Inc
7. Ramasamy, C. Manavalan, R. *Physical Pharmaceutics.* Chennai, Vignesh Publisher.
8. Subramanyam, C.V.S, Thimmasettee, J. *Laboratory Manual of Physical Pharmaceutics.* Delhi, Vallabh Prakashan
9. Subramanyam, C.V.S. *Physical Pharmaceutics.* Delhi, Vallabh Prakashan
10. Jain, G. Khar, R.K. *Test book of Physical Pharmacy.* India, Elsevier

L= Lecture, T= Tutorial, P= Practical, C= Credit

^ this is not an exhaustive list

(B. Pharm.)
(Semester - III)

L	T	P	C
-	-	4	2

Course Code	**BP306P**
Course Title	**Physical Pharmaceutics I - Practical**

Syllabus: **Teaching hours: 60 Hours**

1. Determination the solubility of drug at room temperature
2. Determination of pKa value by Half Neutralization/ Henderson Hasselbalch equation.
3. Determination of Partition co- efficient of benzoic acid in benzene and water
4. Determination of Partition co- efficient of Iodine in CCl_4 and water
5. Determination of % composition of NaCl in a solution using phenol-water system by CST method
6. Determination of surface tension of given liquids by drop count and drop weight method
7. Determination of HLB number of a surfactant by saponification method
8. Determination of Freundlich and Langmuir constants using activated char coal
9. Determination of critical micellar concentration of surfactants
10. Determination of stability constant and donor acceptor ratio of PABA-Caffeine complex by solubility method
11. Determination of stability constant and donor acceptor ratio of Cupric-Glycine complex by pH titration method

L= Lecture, T= Tutorial, P= Practical, C= Credit

(B. Pharm.)
(Semester - III)

L	T	P	C
3	1	-	4

Course Code	**BP303T**
Course Title	**Pharmaceutical Microbiology - Theory**

Scope:
Study of all categories of microorganisms especially for the production of alcohol antibiotics, vaccines, vitamins, enzymes etc.

Objectives:
Upon completion of this course the student should be able to –

1. Understand methods of identification, cultivation and preservation of various microorganisms.

2. To understand the importance and implementation of sterilization in pharmaceutical processing and industry.
3. Learn sterility testing of pharmaceutical products.
4. Carried out microbiological standardization of Pharmaceuticals.
5. Understand the cell culture technology and its applications in pharmaceutical industries.

Course Learning Outcomes (CLO):

At the end of the course, students will be able to –

1. Understand fundamentals of pharmaceutical microbiology and cell culturing.
2. Identify various types of microorganisms.
3. Describe principle, operations and applications of various sterilization techniques.
4. Explain concept of disinfection, sterility testing, contamination and its prevention.
5. Practice aseptic processing for cultivation and isolation of microorganism.
6. Evaluate antibiotics, vitamins and amino acids by microbiological assay.

Syllabus: **Teaching hours: 45 Hours**

UNIT I **10 Hours**

Basics of Microbiology:

Introduction, history of microbiology, its branches, scope and its importance. Introduction to Prokaryotes and Eukaryotes. Study of ultra-structure and morphological classification of bacteria, nutritional requirements, raw materials used for culture media and physical parameters for growth, growth curve, isolation and preservation methods for pure cultures, cultivation of anaerobes, quantitative measurement of bacterial growth (total & viable count).

Types of Microscopy:

Study of different types of phase contrast microscopy, dark field microscopy and electron microscopy.

UNIT II **10 Hours**

Identification of Bacteria:

Identification of bacteria using staining techniques (simple, Gram's & Acid fast staining) and biochemical tests (IMViC).

Sterilization:

Study of principle, procedure, merits, demerits and applications of physical, chemical, gaseous, radiation and mechanical method of sterilization and concept of D, Z and F Value. Evaluation of the efficiency of sterilization methods. Equipment employed in large scale sterilization. Sterility indicators.

UNIT III **10 Hours**

Fungi and Viruses:

Study of morphology, classification, reproduction/replication and cultivation of Fungi and Viruses.

Disinfection:

Classification and mode of action of disinfectants, Factors influencing disinfection, antiseptics and their evaluation for bacteriostatic and bactericidal actions.

Sterility Testing:

Sterility testing of products (solids, liquids, ophthalmic and other sterile products) according to IP, BP and USP.

UNIT IV **08 Hours**

Aseptic Practice:

Designing of aseptic area, laminar flow equipment; study of different sources of contamination in an aseptic area and methods of prevention, clean area classification.

Microbiological Assay:

Principles and methods of different microbiological assay. Methods for standardization of antibiotics, vitamins and amino acids. Assessment of a new antibiotic.

UNIT V **07 Hours**

Contamination and Prevention:

Types of spoilage, factors affecting the microbial spoilage of pharmaceutical products, sources and types of microbial contaminants, assessment of microbial contamination and spoilage. Preservation of pharmaceutical products using antimicrobial agents, evaluation of microbial stability of formulations.

Cell Culture:

Growth of animal cells in culture, general procedure for cell culture, Primary, established and transformed cell cultures. Application of cell cultures in pharmaceutical industry and research.

Tutorials **Teaching hours: 15 Hours**

Tutorials will be based on above syllabus

Suggested Readings^: (Latest edition)

1. Denyer, Stephen P.; Hodges, Norman; Gorman, Sean P.; Gilmore, Brendan F. *Hugo and Russell's Pharmaceutical Microbiology.* Hoboken, NJ: Wiley-Blackwell
2. Prescott and Dunn's *Industrial Microbiology.* Delhi, India: CBS Publishers & Distributors.
3. Pelczar, Chan, Kreig. *Microbiology.* India: Tata McGraw-Hill Education
4. Malcolm, Harris. *Pharmaceutical Microbiology.* London, UK: Baillière, Tindall and Cox.
5. Rose Anthony H. *Industrial Microbiology.* London, UK: Butterworths
6. Frobisher, Hinsdill, Crabtree, Goodheart. *Fundamentals of Microbiology.* Japan: W.B. Saunders Company.
7. Carter, S.J. *Cooper and Gunn's Tutorial Pharmacy.* Delhi, India: CBS Publisher and Distribution.
8. Peppler, H. J.; Perlman, D. *Microbial Technology: Fermentation technology.* USA: Academic Press of University of Michigan.
9. Indian Pharmacopoeia, British Pharmacopoeia, United States Pharmacopoeia
10. Ananthnarayan, Paniker. *Text Book of Microbiology.* Chennai, India: Orient-Longman Publisher.
11. Edward, Alcamo. *The Fundamentals of Microbiology.* USA: Jones & Bartlett Publishers
12. Jain N. K. *Pharmaceutical Microbiology.* Delhi, India: Vallabh Prakashan
13. Holt J. G.. *Bergey's Manual of Systematic Bacteriology.* Baltimore, MD, USA: Williams and Wilkins

L= Lecture, T= Tutorial, P= Practical, C= Credit

^ this is not an exhaustive list

(B. Pharm.)
(Semester - III)

L	T	P	C
-	-	4	2

Course Code	**BP307P**
Course Title	**Pharmaceutical Microbiology - Practical**

Syllabus: **Teaching hours: 60 Hours**

1. Introduction and study of different equipment and processing, e.g., B.O.D. incubator, laminar flow, aseptic hood, autoclave, hot air sterilizer, deep freezer, refrigerator, microscopes used in experimental microbiology.
2. Sterilization of glassware, preparation and sterilization of media.
3. Sub culturing of bacteria and fungus. Nutrient stabs and slants preparations.
4. Staining methods- Simple, Grams staining and acid fast staining (Demonstration with practical).
5. Isolation of pure culture of micro-organisms by multiple streak plate technique and other techniques.
6. Microbiological assay of antibiotics by cup plate method and other methods
7. Motility determination by Hanging drop method.
8. Sterility testing of pharmaceuticals.
9. Bacteriological analysis of water
10. Biochemical test.

L= Lecture, T= Tutorial, P= Practical, C= Credit

(B. Pharm.)
(Semester - III)

L	T	P	C
3	1	-	4

Course Code	**BP304T**
Course Title	**Pharmaceutical Engineering - Theory**

Scope:

This course is designed to impart a fundamental knowledge on the art and science of various unit operations used in pharmaceutical industry.

Objectives:

After completion of course student is able to know,

1. To know various unit operations used in Pharmaceutical industries.
2. To understand the material handling techniques.
3. To perform various processes involved in pharmaceutical manufacturing process.

4. To carry out various test to prevent environmental pollution.
5. To appreciate and comprehend significance of plant lay out design for optimum use of resources.
6. To appreciate the various preventive methods used for corrosion control in pharmaceutical industries.

Course Learning Outcomes (CLO):

At the end of the course, students will be able to –

1. Understand theoretical principles of various unit operations.
2. Describe factors influencing various unit operations.
3. Discuss properties of materials used for pharmaceutical plant construction.
4. Explain pharmaceutical equipment of various unit operations.
5. Correlate various unit operations and its applications in formulation development.
6. Solve calculations involved in various pharmaceutical unit operations.

Syllabus: **Teaching hours: 45 Hours**

UNIT I **10 Hours**

Flow of fluids:

Types of manometers, Reynolds number and its significance, Bernoulli's theorem and its applications, Energy losses, Orifice meter, Venturimeter, Pitot tube and Rotometer.

Size Reduction:

Objectives, Mechanisms & Laws governing size reduction, factors affecting size reduction, principles, construction, working, uses, merits and demerits of Hammer mill, ball mill, fluid energy mill, Edge runner mill & end runner mill.

Size Separation:

Objectives, applications & mechanism of size separation, official standards of powders, sieves, size separation Principles, construction, working, uses, merits and demerits of Sieve shaker, cyclone separator, Air separator, Bag filter & elutriation tank.

UNIT II **12 Hours**

Heat Transfer:

Objectives, applications & Heat transfer mechanisms. Fourier's law, Heat transfer by conduction, convection & radiation. Heat interchangers & heat exchangers.

Evaporation:

Objectives, applications and factors influencing evaporation, differences between evaporation and other heat process. principles, construction, working, uses, merits and demerits of Steam jacketed kettle, horizontal tube evaporator, climbing film evaporator, forced circulation evaporator, multiple effect evaporator& Economy of multiple effect evaporator.

Distillation:

Basic Principles and methodology of simple distillation, flash distillation, fractional distillation, distillation under reduced pressure, steam distillation & molecular distillation.

UNIT III **08 Hours**

Drying:

Objectives, applications & mechanism of drying process, measurements & applications of Equilibrium Moisture content, rate of drying curve. principles, construction, working, uses,

merits and demerits of Tray dryer, drum dryer spray dryer, fluidized bed dryer, vacuum dryer, freeze dryer.

Mixing:

Objectives, applications & factors affecting mixing, Difference between solid and liquid mixing, mechanism of solid mixing, liquids mixing and semisolids mixing. Principles, Construction, Working, uses, Merits and Demerits of Double cone blender, twin shell blender, ribbon blender, Sigma blade mixer, planetary mixers, Propellers, Turbines, Paddles & Silverson Emulsifier.

UNIT IV **08 Hours**

Filtration:

Objectives, applications, Theories & Factors influencing filtration, filter aids, filter media. Principle, Construction, Working, Uses, Merits and demerits of plate & frame filter, filter leaf, rotary drum filter, Meta filter & Cartridge filter, membrane filters and Seidtz filter.

Centrifugation:

Objectives, principle & applications of Centrifugation, principles, construction, working, uses, merits and demerits of Perforated basket centrifuge, Non-perforated basket centrifuge, semi continuous centrifuge & super centrifuge.

UNIT V **07 Hours**

Materials of pharmaceutical plant construction, Corrosion and its prevention:

Factors affecting during materials selected for Pharmaceutical plant construction, Theories of corrosion, types of corrosion and there prevention. Ferrous and nonferrous metals, inorganic and organic non metals, basic of material handling systems.

TUTORIALS **Teaching hours: 15 Hours**

Tutorials will be based on above syllabus

Suggested Readings^: (Latest edition)

1. Walter L. B., Julius B. T. *Introduction to chemical engineering*. Tata McGraw-Hill Publishing Company Ltd. New Delhi.
2. Nigel J. K. S., *Solid phase extraction, Principles, techniques and applications*. Marcel Dekker Inc., USA.
3. Warren L. M., Julian C. S., Peter H. *Unit operation of chemical engineering*. McGraw-Hill Companies, Inc. USA.
4. Subrahmanyam C.V.S. Setty J. T., Suresh S., Devi V. K. *Pharmaceutical engineering principles and practices*. Vallabh Prakashan, New Delhi.
5. Gennaro A. R. *Remington the science and practice of pharmacy*. Lippincott Williams & Wilkins
6. Lachman l., Lieberman H. A., Kanig L. *Theory and practice of industrial pharmacy*. Varghese Publishing House, Mumbai.
7. Subrahmanyam C. V. S. *Essentials of Physical pharmaceutics*. Vallabh Prakashan, New Delhi.
8. Carter S. J. *Cooper and Gunn's Tutorial pharmacy*. C. B. S. Publishers & Distributors, Delhi.

L= Lecture, T= Tutorial, P= Practical, C= Credit

^ this is not an exhaustive list

(B. Pharm.)
(Semester - III)

L	T	P	C
-	-	4	2

Course Code	BP308P
Course Title	Pharmaceutical Engineering - Practical

Syllabus: **Teaching hours: 60 Hours**

1. Determination of radiation constant of brass, iron, unpainted and painted glass.
2. Steam distillation – To calculate the efficiency of steam distillation.
3. To determine the overall heat transfer coefficient by heat exchanger.
4. Construction of drying curves (for calcium carbonate and starch).
5. Determination of moisture content and loss on drying.
6. Determination of humidity of air – i) From wet and dry bulb temperatures – use of Dew point method.
7. Description of Construction working and application of Pharmaceutical Machinery such as rotary tablet machine, fluidized bed coater, fluid energy mill, dehumidifier.
8. Size analysis by sieving – To evaluate size distribution of tablet granulations – Construction of various size frequency curves including arithmetic and logarithmic probability plots.
9. Size reduction: To verify the laws of size reduction using ball mill and determining Kicks, Rittinger's, Bond's coefficients, power requirement and critical speed of Ball Mill.
10. Demonstration of colloid mill, planetary mixer, fluidized bed dryer, freeze dryer and such other major equipment.
11. Factors affecting Rate of Filtration and Evaporation (Surface area, Concentration and Thickness/ viscosity.
12. To study the effect of time on the Rate of Crystallization.
13. To calculate the uniformity Index for given sample by using Double Cone Blender.

L= Lecture, T= Tutorial, P= Practical, C= Credit

Nirma University
Institute of Pharmacy
Teaching & Examination Scheme *(B.Pharm)*

Semester - IV

Sr. No.	Course Code	Course Title	Teaching Scheme				Examination Scheme				
			L	LPW/PW	T	C	Duration		Component Weightage		
							SEE	LPW/PW	CE	LPW/PW	SEE
1	BP401T	Pharmaceutical Organic Chemistry III – Theory	3	-	1	4	3.0	-	0.25	-	0.75
2	BP402T	Medicinal Chemistry I – Theory	3	-	1	4	3.0	-	0.25	-	0.75
3	BP406P	Medicinal Chemistry I – Practical	-	4	-	2	-	4.0	0.30	0.70	-
4	BP403T	Physical Pharmaceutics II – Theory	3	-	1	4	3.0	-	0.25	-	0.75
5	BP407P	Physical Pharmaceutics II – Practical	-	4	-	2	-	4.0	0.30	0.70	-
6	BP404T	Pharmacology I – Theory	3	-	1	4	3.0	-	0.25	-	0.75
7	BP408P	Pharmacology I - Practical	-	4	-	2	-	4.0	0.30	0.70	-
8	BP405T	Pharmacognosy and Phytochemistry I - Theory	3	-	1	4	3.0	-	0.25	-	0.75
9	BP409P	Pharmacognosy and Phytochemistry I - Practical	-	4	-	2	-	4.0	0.30	0.70	-
		Total	**15**	**16**	**5**	**28**					
			36								

L: *Lectures*, P/T: *Practicals/Tutorial*, C: *Credits*
LPW: *Laboratory / Project Work*

SEE: *Semester End Examination*
CE: *Continuous Evaluation*

w.e.f. academic year 2018-2019 and onwards

NIRMA UNIVERSITY
Institute of Pharmacy
(B. Pharm)
(Semester - IV)

L	T	P	C
3	1	-	4

Course Code	**BP401T**
Course Title	**Pharmaceutical Organic Chemistry III - Theory**

Scope:
This subject imparts knowledge on stereo-chemical aspects of organic compounds and organic reactions, important named reactions, chemistry of important hetero cyclic compounds. It also emphasizes on medicinal and other uses of organic compounds.

Objective: At the end of the course, the student shall be able to
1. Understand the methods of preparation and properties of organic compounds.
2. Explain the stereo chemical aspects of organic compounds and stereo chemical reactions.
3. Know the medicinal uses and other applications of organic compounds.

Course Learning Outcomes (CLO):
After successful completion of the course, student will be able to -
1. Remember IUPAC rules for nomenclature and medicinal uses of heterocyclic compounds.
2. Understand basic aspects of stereochemistry including configuration and conformation.
3. Explain various reactions of synthetic importance.
4. Describe important chemical reactions and synthesis of heterocyclic rings.
5. Discuss optical & geometrical isomerism.

Syllabus: **Teaching hours: 45 Hours**
Note: To emphasize on definition, types, mechanisms, examples, uses/applications.

UNIT I **10 Hours**
Stereo isomerism
Optical isomerism:
Optical activity, enantiomerism, diastereoisomerism, meso compounds, elements of symmetry, chiral and achiral molecules.
DL system of nomenclature of optical isomers, sequence rules, RS system of nomenclature of optical isomers.
Reactions of chiral molecules.
Racemic modification and resolution of racemic mixture.
Asymmetric synthesis: partial and absolute.

UNIT II **10 Hours**
Stereo isomerism
Geometrical isomerism:
Nomenclature of geometrical isomers (Cis Trans, EZ, Syn, Anti systems), methods of determination

of configuration of geometrical isomers.
Conformational isomerism in Ethane, n-Butane and Cyclohexane.
Stereo isomerism in biphenyl compounds (Atropisomerism) and conditions for optical activity.
Stereospecific and stereoselective reactions.

10 Hours

UNIT III

Heterocyclic compounds:

Nomenclature and classification, synthesis, reactions and medicinal uses of following compounds/derivatives: Pyrrole, Furan, and Thiophene
Relative aromaticity and reactivity of Pyrrole, Furan and Thiophene.

08 Hours

UNIT IV

Heterocyclic compounds:

Synthesis, reactions and medicinal uses of following compounds/derivatives: Pyrazole, Imidazole, Oxazole and Thiazole, Pyridine, Quinoline, Isoquinoline, Acridine and Indole.
Basicity of Pyridine.
Synthesis and medicinal uses of Pyrimidine, Purine, Azepines and their derivatives.

07 Hours

UNIT V

Reactions of synthetic importance:

Metal hydride reduction ($NaBH_4$ and $LiAlH_4$), Clemmensen reduction, Birch reduction, Wolff Kishner reduction.
Oppenauer-oxidation and Dakin reaction.
Beckmann's rearrangement and Schmidt rearrangement.
Claisen-Schmidt condensation.

Teaching Hours: 15 Hours

Tutorials

Tutorials will be based on above syllabus.

Suggested Readings^:(Latest edition)

1. Morrison, R. T., Boyd, R. N. *Organic Chemistry*. Prentice Hall, Inc., USA.
2. Finar, I. L. Organic Chemistry, Vol. I & II, ELBS.
3. Gilchrist, T. L. *Heterocyclic chemistry*. New Delhi:Pearson.
4. Bahl, B. S. *Text Book Of Organic Chemistry*. S. Chand And Company Ltd Ram Nagar; New Delhi.
5. Bansal, R. K. *Heterocyclic chemistry*. New Age International.
6. March, J. *Advanced organic chemistry: reactions, mechanisms, and structure*. John Wiley & Sons,.
7. Solomons, T. W., Fryhle, C. B., & Johnson, R. G. *Organic chemistry*. New York: Wiley.
8. Vishnoi, N. K. *Advanced practical organic chemistry*. Vikas Publishing House Pvt. Limited.
9. Gurudeep, C. R., & Gurudeep, C. R. *Reaction Mechanism and Reagents in Organic Chemistry*. Bombay: Himalaya Publsihing House.

L= Lecture, T= Tutorial, P= Practical, C= Credit
^ this is not an exhaustive list

(B. Pharm)
(Semester - IV)

L	T	P	C
3	1	-	4

Course Code	BP402T
Course Title	Medicinal Chemistry I -Theory

Scope:

This subject is designed to impart fundamental knowledge on the structure, chemistry and therapeutic value of drugs. The subject emphasizes on structure activity relationships of drugs, importance of physicochemical properties and metabolism of drugs. The syllabus also emphasizes on chemical synthesis of important drugs under each class.

Objectives:

Upon completion of the course, the student shall be able to -

1. Understand the chemistry of drugs with respect to their pharmacological activity.
2. Understand the drug metabolic pathways, adverse effect and therapeutic value of drugs.
3. Know the Structural Activity Relationship (SAR) of different class of drugs.
4. Write the chemical synthesis of some drugs.

Course Learning Outcomes (CLO):

After successful completion of the course, student will be able to -

1. Understand the basic principles of medicinal chemistry.
2. Explain the fundamentals of drug metabolic pathways.
3. Describe classification, mechanism of action and uses of different class of drugs of ANS and CNS.
4. Discuss structure activity relationship studies of different class of drugs.
5. Report synthetic protocol of some drugs.

Syllabus: **Teaching hours: 45 Hours**

Study of the development of the following classes of drugs, Classification, mechanism of action, uses of drugs mentioned in the course, Structure activity relationship of selective class of drugs as specified in the course and synthesis of drugs superscripted (*)

UNIT I **10 Hours**

Introduction to medicinal chemistry.

History and development of medicinal chemistry.

Physicochemical properties in relation to biological action:

Ionization, Solubility, Partition Coefficient, Hydrogen bonding, Protein binding, Chelation, Bioisosterism, Optical and Geometrical isomerism.

Drug metabolism:

Drug metabolism principles - Phase I and Phase II.

Factors affecting drug metabolism including stereochemical aspects.

UNIT II **10 Hours**

Drugs acting on Autonomic Nervous System

Adrenergic Neurotransmitters:

Biosynthesis and catabolism of catecholamine.

Adrenergic receptors (Alpha & Beta) and their distribution.

Sympathomimetic agents: SAR of Sympathomimetic agents:

Direct acting agents:

Nor-epinephrine, Epinephrine, Phenylephrine*, Dopamine, Methyldopa, Clonidine, Dobutamine, Isoproterenol, Terbutaline, Salbutamol*, Bitolterol, Naphazoline, Oxymetazoline and Xylometazoline.

Indirect acting agents:

Hydroxyamphetamine, Pseudoephedrine, Propylhexedrine.

Agents with mixed mechanism:

Ephedrine, Metaraminol.

Adrenergic Antagonists:

Alpha adrenergic blockers:

Tolazoline*, Phentolamine, Phenoxybenzamine, Prazosin, Dihydroergotamine, Methysergide.

Beta adrenergic blockers:

SAR of beta blockers, Propranolol*, Metipranolol, Atenolol, Betaxolol, Bisoprolol, Esmolol, Metoprolol, Labetalol, Carvedilol.

UNIT III **10 Hours**

Drugs acting on Autonomic Nervous System

Cholinergic neurotransmitters:

Biosynthesis and catabolism of acetylcholine.

Cholinergic receptors (Muscarinic & Nicotinic) and their distribution.

Parasympathomimetic agents: SAR of Parasympathomimetic agents

Direct acting agents:

Acetylcholine, Carbachol*, Bethanechol, Methacholine, Pilocarpine.

Indirect acting/ Cholinesterase inhibitors (Reversible & Irreversible):

Physostigmine, Neostigmine*, Pyridostigmine, Edrophonium chloride, Tacrine hydrochloride, Ambenonium chloride, Isoflurophate, Echothiophate iodide, Parathion, Malathion.

Cholinesterase reactivator:

Pralidoxime chloride.

Cholinergic blocking agents: SAR of cholinolytic agents:

Solanaceous alkaloids and analogues:

Atropine sulphate, Hyoscyamine sulphate, Scopolamine hydrobromide, Homatropine hydrobromide, Ipratropium bromide*.

Synthetic cholinergic blocking agents:

Tropicamide, Cyclopentolate hydrochloride, Clidinium bromide, Dicyclomine hydrochloride*, Glycopyrrolate, Methantheline bromide, Propantheline bromide, Benztropine mesylate, Orphenadrine citrate, Biperiden hydrochloride, Procyclidine hydrochloride*, Tridihexethyl chloride, Isopropamide iodide, Ethopropazine hydrochloride.

UNIT IV **08 Hours**

Drugs acting on Central Nervous System

Sedatives and Hypnotics:

Benzodiazepines:

SAR of Benzodiazepines, Chlordiazepoxide, Diazepam*, Oxazepam, Clorazepate, Lorazepam, Alprazolam, Zolpidem

Barbiturates:

SAR of barbiturates, Barbital*, Phenobarbital, Mephobarbital, Amobarbital, Butabarbital, Pentobarbital, Secobarbital.

Miscellaneous:

Amides & imides: Glutethimide.

Alcohol & their carbamate derivatives: Meprobamate, Ethchlorvynol.

Aldehyde & their derivatives: Triclofos sodium, Paraldehyde.

Antipsychotics:

Phenothiazines:

SAR of Phenothiazines - Promazine hydrochloride, Chlorpromazine hydrochloride*, Triflupromazine, Thioridazine hydrochloride, Piperacetazine hydrochloride, Prochlorperazine maleate, Trifluoperazine hydrochloride.

Ring Analogues of Phenothiazines:

Chlorprothixene, Thiothixene, Loxapine succinate, Clozapine.

Fluoro butyrophenones:

Haloperidol, Droperidol, Risperidone.

Beta amino ketones:

Molindone hydrochloride.

Benzamides:

Sulpiride.

Anticonvulsants:

SAR of Anticonvulsants, mechanism of anticonvulsant action

Barbiturates:

Phenobarbitone, Metharbital.

Hydantoins:

Phenytoin*, Mephenytoin, Ethotoin

Oxazolidinediones:

Trimethadione, Paramethadione

Succinimides:

Phensuximide, Methsuximide, Ethosuximide*

Urea and monoacylureas:

Phenacemide, Carbamazepine*

Benzodiazepines:

Clonazepam

Miscellaneous:

Primidone, Valproic acid , Gabapentin, Felbamate

UNIT V **07 Hours**

Drugs acting on Central Nervous System

General anesthetics:

Inhalation anesthetics:

Halothane*, Methoxyflurane, Enflurane, Sevoflurane, Isoflurane, Desflurane.

Ultra short acting barbiturates:
Methohexital sodium*, Thiamylal sodium, Thiopental sodium.
Dissociative anesthetics:
Ketamine hydrochloride.*
Narcotic and non-narcotic analgesics:
Morphine and related drugs:
SAR of Morphine analogues, Morphine sulphate, Codeine, Meperidine hydrochloride, Anileridine hydrochloride, Diphenoxylate hydrochloride, Loperamide hydrochloride, Fentanyl citrate*, Methadone hydrochloride*, Propoxyphene hydrochloride, Pentazocine, Levorphanol tartrate.
Narcotic antagonists:
Nalorphine hydrochloride, Levallorphan tartrate, Naloxone hydrochloride.
Anti-inflammatory agents:
Sodium salicylate, Aspirin, Mefenamic acid*, Meclofenamate, Indomethacin, Sulindac, Tolmetin, Zomepirac, Diclofenac, Ketorolac, Ibuprofen*, Naproxen, Piroxicam, Phenacetin, Acetaminophen, Antipyrine, Phenylbutazone.

Tutorials **Teaching hours: 15 Hours**
Tutorials will be based on above syllabus.

Suggested Readings^: (Latest edition)

1. Wilson, C. O., Beale, J. M., & Block, J. H. *Wilson and Gisvold's textbook of organic medicinal and pharmaceutical chemistry*. Lippincott Williams & Wilkins.
2. Foye, W. O. *Foye's principles of medicinal chemistry*. Lippincott Williams & Wilkins.
3. Burger, A., & Abraham, D. J. *Burger's medicinal chemistry and drug discovery* (Vol. I–IV). Wiley.
4. Smith, H. J., & Williams, H. *Introduction to the principles of Drug design*. Elsevier.
5. Remington, J. P. *Remington: the science and practice of pharmacy* (Vol. 1 & 2). Lippincott Williams & Wilkins.
6. Reynolds, J. E. F., *Martindale: the extra pharmacopoeia*. Pharmaceutical Press, London.
7. Finar, I. L. *Organic Chemistry, Volume 2: Stereochemistry And The Chemistry Natural Product.*, Pearson Education India.
8. Lednicer, D. *The organic chemistry of drug synthesis* (Vol. 1-5). John Wiley & Sons.
9. Indian pharmacopoeia, Indian Pharmacopoeial Commission.
10. Furniss, B. S. *Vogel's textbook of practical organic chemistry*. Pearson Education India.

L= Lecture, T= Tutorial, P= Practical, C= Credit
^ this is not an exhaustive list

(B. Pharm)
(Semester - IV)

L	T	P	C
-	-	4	2

Course Code	**BP406P**
Course Title	**Medicinal Chemistry I - Practical**

Syllabus: **Teaching hours: 60 Hours**

I. Preparation of drugs/ intermediates:

1. 1,3-pyrazole
2. 1,3-oxazole
3. Benzimidazole
4. Benztriazole
5. 2,3- diphenyl quinoxaline
6. Benzocaine
7. Phenytoin
8. Phenothiazine
9. Barbiturate

II. Assay of drugs:

1. Chlorpromazine
2. Phenobarbitone
3. Atropine
4. Ibuprofen
5. Aspirin
6. Furosemide

III. Determination of Partition coefficient for any two drugs

L= Lecture, T= Tutorial, P= Practical, C= Credit

(B. Pharm.)
(Semester - IV)

L	T	P	C
3	1	-	4

Course Code	**BP403T**
Course Title	**Physical Pharmaceutics II – Theory**

Scope:

The course deals with the various physical and physicochemical properties, and principles involved in dosage forms/formulations. Theory and practical components of the subject help the student to get a better insight into various areas of formulation research and development, and stability studies of pharmaceutical dosage forms.

Objectives:

Upon completion of the course the student should be able to:

1. Understand various physicochemical properties of drug molecules in the designing the dosage forms.
2. Know the principles of chemical kinetics & to use them for stability testing and determination of expiry date of formulations.
3. Demonstrate use of physicochemical properties in the formulation development and evaluation of dosage forms.

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. Understand physicochemical properties of solids and dispersed systems.
2. Discuss colloidal dispersion systems in designing formulations.
3. Describe rheological behavior of various compounds and its measurement by viscometers.
4. Determine coarse dispersion systems, its properties and stability.
5. Explain particle properties and its impact on various parameters.
6. Identify various conditions for stability testing.

Syllabus: **Teaching hours: 45 Hours**

UNIT I **05 Hours**

Colloidal dispersions:

Classification of dispersed systems & their general characteristics, size & shapes of colloidal particles, classification of colloids & comparative account of their general properties. Optical, kinetic & electrical properties. Effect of electrolytes, coacervation, peptization & protective action.

UNIT II **10 Hours**

Rheology:

Newtonian systems, law of flow, kinematic viscosity, effect of temperature, non-Newtonian

systems, pseudoplastic, dilatant, plastic, thixotropy, thixotropy in formulation, determination of viscosity, capillary, falling Sphere, rotational viscometers.

Deformation of solids:

Plastic and elastic deformation, Heckel equation, Stress, Strain, Elastic Modulus.

UNIT – III **10 Hours**

Coarse dispersion:

Suspension, interfacial properties of suspended particles, settling in suspensions, formulation of flocculated and deflocculated suspensions. Emulsions and theories of emulsification, microemulsion and multiple emulsions; Stability of emulsions, preservation of emulsions, rheological properties of emulsions and emulsion formulation by HLB method.

UNIT – IV **10 Hours**

Micromeritics:

Particle size and distribution, mean particle size, number and weight distribution, particle number, methods for determining particle size by different methods, counting and separation method, particle shape, specific surface, methods for determining surface area, permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness & flow properties.

UNIV – V **10 Hours**

Drug stability:

Reaction kinetics: zero, pseudo-zero, first & second order, units of basic rate constants, determination of reaction order. Physical and chemical factors influencing the chemical degradation of pharmaceutical product: temperature, solvent, ionic strength, dielectric constant, specific & general acid base catalysis, Simple numerical problems. Stabilization of medicinal agents against common reactions like hydrolysis & oxidation. Accelerated stability testing in expiration dating of pharmaceutical dosage forms. Photolytic degradation and its prevention.

Tutorials **Teaching hours: 15 Hours**

Tutorials will be based on above syllabus

Suggested Readings^: (Latest edition)

1. Sinko, P. J., & Martin, A. N. *Martin's physical pharmacy and pharmaceutical sciences: Physical chemical and biopharmaceutical principles in the pharmaceutical sciences*. Philadelphia: Lippincott Williams & Wilkins.
2. Parrott, E.L. *Experimental Pharmaceutics*. Burgess Pub. Co
3. Cooper, J.W., Gunn, C., & Carter S.J. *Cooper and Gunn's tutorial pharmacy.* London: Pitman Medical.
4. Stocklosa, M.J., & Ansel, H.C. *Pharmaceutical calculations.* Philadelphia: Lea & Febiger.
5. Lieberman, H.A., Lachman, L., & Schwartz, J.B. *Pharmaceutical Dosage forms - Tablets*, volume 1 to 3. New York: Marcel Dekkar Inc.
6. Lieberman, H.A, Rieger, M.M., & Banker, G.S. *Pharmaceutical dosage forms - Disperse systems,* volume 1 to 3. New York: Marcel Dekkar Inc.
7. Ramasamy, C., & Manavalan, R. *Physical Pharmaceutics*. India: Vignesh Publisher

L= Lecture, T= Tutorial, P= Practical, C= Credit

^ this is not an exhaustive list

(B. Pharm.)
(Semester - IV)

L	T	P	C
-	-	4	2

Course Code	BP407P
Course Title	Physical Pharmaceutics II - Practical

Syllabus: **Total hours: 60 Hours**

1. Determination of particle size, particle size distribution using sieving method
2. Determination of particle size, particle size distribution using Microscopic method
3. Determination of bulk density, true density and porosity
4. Determine the angle of repose and influence of lubricant on angle of repose
5. Determination of viscosity of liquid using Ostwald's viscometer
6. Determination sedimentation volume with effect of different suspending agent
7. Determination sedimentation volume with effect of different concentration of single suspending agent
8. Determination of viscosity of semisolid by using Brookfield viscometer
9. Determination of reaction rate constant first order.
10. Determination of reaction rate constant second order
11. Accelerated stability studies

L= Lecture, T= Tutorial, P= Practical, C= Credit

(B. Pharm)
(Semester - IV)

L	T	P	C
3	1	-	4

Course Code	BP404T
Course Title	Pharmacology I – Theory

Scope:
The main purpose of the subject is to understand what drugs do to the living organisms and how their effects can be applied to therapeutics. The subject covers the information about the drugs like, mechanism of action, physiological and biochemical effects (pharmacodynamics) as well as absorption, distribution, metabolism and excretion (pharmacokinetics) along with the adverse effects, clinical uses, interactions, doses, contraindications and routes of administration of different classes of drugs.

Objectives:
Upon completion of this course the student should be able to -

1. Understand the pharmacological actions of different categories of drugs.
2. Explain the mechanism of drug action at organ system/sub cellular/ macromolecular levels.
3. Apply the basic pharmacological knowledge in the prevention and treatment of various diseases.
4. Observe the effect of drugs on animals by simulated experiments.
5. Appreciate correlation of pharmacology with other bio medical sciences.

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. Understand general concepts of pharmacology, adverse drug reactions, drug interactions, drug discovery and clinical evaluation of drugs.
2. Relate pharmacodynamics principles of drugs with mechanism of action.
3. Describe pharmacokinetics of drugs with respect to absorption, distribution, metabolism and elimination.
4. Discuss pharmacology of drugs acting on peripheral nervous system.
5. Explain pharmacology of drugs acting on central nervous system.
6. Apply their skills of handling of instruments, animals and softwares for studying pharmacological effects of the drugs.

Syllabus: **Teaching hours: 45 Hours**

UNIT I **08 Hours**

General Pharmacology:

Introduction to Pharmacology- Definition, historical landmarks and scope of pharmacology, nature and source of drugs, essential drugs concept and routes of drug administration, Agonists, antagonists (competitive and non-competitive), spare receptors, addiction, tolerance, dependence, tachyphylaxis, idiosyncrasy, allergy.

Pharmacokinetics- Membrane transport, absorption, distribution, metabolism and excretion of drugs. Enzyme induction, enzyme inhibition, kinetics of elimination.

UNIT II **12 Hours**

General Pharmacology:

Pharmacodynamics- Principles and mechanisms of drug action. Receptor theories and classification of receptors, regulation of receptors, drug receptors interactions, signal transduction mechanisms, G-protein–coupled receptors, ion channel receptor, transmembrane enzyme linked receptors, transmembrane JAK-STAT binding receptor and receptors that regulate transcription factors, dose response relationship, therapeutic index, combined effects of drugs and factors modifying drug action.

Adverse drug reactions.

Drug interactions (pharmacokinetic and pharmacodynamic).

Drug discovery and clinical evaluation of new drugs -Drug discovery phase, preclinical evaluation phase, clinical trial phase, phases of clinical trials and pharmacovigilance.

UNIT III **10 Hours**

Pharmacology of drugs acting on peripheral nervous system:

Organization and function of ANS.

Neurohumoral transmission, co-transmission and classification of neurotransmitters.

Parasympathomimetics, Parasympatholytics, Sympathomimetics, Sympatholytics.

Neuromuscular blocking agents and skeletal muscle relaxants (peripheral), ganglion stimulants and blockers.

Local anesthetic agents.

Drugs used in myasthenia gravis and glaucoma.

UNIT IV **08 Hours**

Pharmacology of drugs acting on central nervous system:

Neurohumoral transmission in the CNS. Special emphasis on importance of various neurotransmitters like with GABA, Glutamate, Glycine, serotonin, dopamine.

General anesthetics and pre-anesthetics.

Sedatives, hypnotics and centrally acting muscle relaxants.

Anti-epileptics.

Alcohol and disulfiram.

UNIT V **07 Hours**

Pharmacology of drugs acting on central nervous system:

Psychopharmacological agents: Antipsychotics, antidepressants, anti-anxiety agents, anti-manics and hallucinogens.

Drugs used in Parkinson's disease and Alzheimer's disease.

CNS stimulants and nootropics.

Opioid analgesics and antagonists.

Drug addiction, drug abuse, tolerance and dependence.

Tutorials **Teaching hours: 15 Hours**

Tutorials will be based on above syllabus

Suggested Readings^: (Latest Edition)

1. Rang H. P., Dale M. M., Ritter J. M., Flower R. J., Rang and Dale's Pharmacology. New York, Churchil Livingstone Elsevier
2. Katzung B. G., Masters S. B., Trevor A. J., Basic and Clinical Pharmacology. New Delhi, Tata Mc Graw-Hill
3. Brunton L., Chabner B.A., Knollman B. Goodman and Gillman's The Pharmacological Basis of Therapeutics. USA, McGraw Hill Education.
4. Marry Anne K. K., Lloyd Yee Y., Brian K. A., Robbin L.C., Joseph G. B., Wayne A. K., Bradley R.W., Applied Therapeutics, The Clinical Use of Drugs. USA, The Point Lippincott Williams & Wilkins
5. Harvey R.A., Clark M.A., Finkel R., Rey J.A., Whalen K. Pharmacology (Lippincott's Illustrated Reviews). New Jersey, Lippincott Williams and Wilkins
6. Tripathi K.D. Essentials of Medical Pharmacology. New Delhi, Jaypee Brothers Medical Publishers (P) Ltd.
7. Sharma H. L., Sharma K. K. Principles of Pharmacology. New Delhi, Paras Medical Publisher
8. Craig C.R. Stitzel R. E. Modern Pharmacology with Clinical Applications. Lippincott Williams & Wilkins

9. Ghosh MN. Fundamentals of Experimental Pharmacology. Kolkata. Hilton & Company.
10. Kulkarni SK. Handbook of Experimental Pharmacology. New Delhi. Vallabh Prakashan
11. Goyal R.K., Mehta A.A., Balaraman R., Burande M.D. Dearsari and Gandhi's Elements of Pharmacology. Ahmedabad, B.S. Shah Prakashan.

L= Lecture, T= Tutorial, P= Practical, C= Credit
^ this is not an exhaustive list

(B. Pharm)
(Semester - IV)

L	T	P	C
-	-	4	2

Course Code	**BP408P**
Course Title	**Pharmacology I – Practical**

Syllabus: **Total Hours: 60 Hours**

1. Introduction to experimental pharmacology.
2. Commonly used instruments in experimental pharmacology
3. Study of common laboratory animals
4. Maintenance of laboratory animals as per CPCSEA guidelines
5. Common laboratory techniques. Blood withdrawal, serum and plasma separation, anesthetics and euthanasia used for animal studies
6. Study of different routes of drugs administration in mice/rats
7. Study of effect of hepatic microsomal enzyme inducers on the phenobarbitone sleeping time in mice
8. Effect of drugs on ciliary motility of frog oesophagus
9. Effect of drugs on rabbit eye.
10. Effects of skeletal muscle relaxants using rota-rod apparatus
11. Effect of drugs on locomotor activity using actophotometer
12. Anticonvulsant effect of drugs by MES and PTZ method
13. Study of stereotype and anti-catatonic activity of drugs on rats/mice
14. Study of anxiolytic activity of drugs using rats/mice
15. Study of local anesthetics by different methods

Note: All laboratory techniques and animal experiments are demonstrated by simulated experiments by softwares and videos

L= Lecture, T= Tutorial, P= Practical, C= Credit

(B. Pharm)
(Semester - IV)

L	T	P	C
3	1	-	4

Course Code	**BP405T**
Course Title	**Pharmacognosy and Phytochemistry I - Theory**

Scope:

The subject involves the fundamentals of Pharmacognosy like scope, classification of crude drugs, their identification and evaluation, phytochemicals present in them and their medicinal properties.

Objectives:

Upon completion of the course the student shall be able to-

1. Know the techniques in the cultivation and production of crude drugs.
2. Know the crude drugs, their uses and chemical nature.
3. Know the evaluation techniques for the herbal drugs.
4. Carry out the microscopic and morphological evaluation of crude drugs.

Course Learning Outcomes (CLO):

At the end of the course, students will be able to -

1. Understand the history and scope of pharmacognosy, various sources of crude drugs and their classification.
2. Describe various aspects of cultivation, collection, processing and storage of herbal drugs.
3. Discuss the technique and applications of plant tissue culture.
4. Explain the role of pharmacognosy in various systems of traditional medicine and classify secondary metabolites.
5. Express the pharmacognostic study of some crude drugs belonging to category of carbohydrates, proteins, lipids, fibres and marine drugs.

Syllabus: **Teaching hours: 45 Hours**

UNIT I **10 Hours**

Introduction to Pharmacognosy:

Definition, history, scope and development of Pharmacognosy.

Sources of Drugs – Plants, Animals, Marine & Tissue culture.

Organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilages, oleoresins and oleo- gum -resins).

Classification of drugs:

Alphabetical, morphological, taxonomical, chemical, pharmacological, chemo and serotaxonomical classification of drugs.

Quality control of Drugs of Natural Origin:

Adulteration of drugs of natural origin. Evaluation by organoleptic, microscopic, physical, chemical and biological methods and properties.

Quantitative microscopy of crude drugs including lycopodium spore method, leaf constants, camera lucida and diagrams of microscopic objects to scale with camera lucida.

UNIT II **10 Hours**

Cultivation, Collection, Processing and storage of drugs of natural origin:

Cultivation and Collection of drugs of natural origin.

Factors influencing cultivation of medicinal plants.

Plant hormones and their applications.

Polyploidy, mutation and hybridization with reference to medicinal plants.

Conservation of medicinal plants.

UNIT III **07 Hours**

Plant tissue culture:

Historical development of plant tissue culture, types of cultures, nutritional requirements, growth and their maintenance.

Applications of plant tissue culture in pharmacognosy.

Edible vaccines.

UNIT IV **10 Hours**

Pharmacognosy in various systems of medicine:

Role of Pharmacognosy in allopathy and traditional systems of medicine namely, Ayurveda, Unani, Siddha, Homeopathy and Chinese systems of medicine.

Introduction to secondary metabolites:

Definition, classification, properties and test for identification of Alkaloids, Glycosides, Flavonoids, Tannins, Volatile oil and Resins.

UNIT V **08 Hours**

Study of biological source, chemical nature and uses of drugs of natural origin containing following drugs.

Plant Products:

Fibers - Cotton, Jute, Hemp

Hallucinogens, Teratogens, Natural allergens

Primary metabolites:

General introduction, detailed study with respect to chemistry, sources, preparation, evaluation, preservation, storage, therapeutic used and commercial utility as Pharmaceutical Aids and/or medicines for the following primary metabolites:

Carbohydrates:

Acacia, Agar, Tragacanth, Honey.

Proteins and Enzymes:

Gelatin, casein, proteolytic enzymes (Papain, bromelain, serratiopeptidase, urokinase, streptokinase, pepsin).

Lipids (Waxes, fats, fixed oils) :

Castor oil, Chaulmoogra oil, Wool Fat, Bees Wax.

Marine Drugs:

Novel medicinal agents from marine sources.

Tutorials **Teaching hours: 15 Hours**

Tutorials will be based on above syllabus

Suggested Readings^: (Latest Edition)

1. Evans, W.C. *Trease and Evans Pharmacognosy*. London, W.B. Saunders & Co.
2. Tyler, V.E., Brady, L.R. and Robbers, J.E. *Pharmacognosy*. Philadelphia, Lea and Febiger.
3. Wallis, T.E. *Text Book of Pharmacognosy*. London. J&A Churchill Ltd.
4. Ali, M. *Pharmacognosy and Phytochemistry*. New Delhi, CBS Publishers & Distribution.
5. Kokate, C.K. *Text Book of Pharmacognosy*. New Delhi, Nirali Prakashan.
6. Chaudhary, R..D. *Herbal Drug Industry*. New Delhi, Eastern Publisher.
7. Ansari, S.H. *Essentials of Pharmacognosy*. New Delhi. Birla Publications.
8. Kokate, C.K., Gokhale S.B. *Practical Pharmacognosy*. Pune, Nirali Prakashan.
9. Iyengar, M.A., Nayak, S.G. *Anatomy of Crude Drugs*. Career Publications.

L= Lecture, T= Tutorial, P= Practical, C= Credit

^ this is not an exhaustive list

(B. Pharm)
(Semester - IV)

L	T	P	C
-	-	4	2

Course Code	**BP409P**
Course Title	**Pharmacognosy and Phytochemistry I - Practical**

Syllabus: **Teaching hours: 60 Hours**

1. Analysis of crude drugs by chemical tests: (i) Tragacanth (ii) Acacia (iii) Agar (iv) Gelatin (v) Starch (vi) Honey (vii) Castor oil
2. Determination of stomatal number and index
3. Determination of vein islet number, vein islet termination and palisade ratio.
4. Determination of size of starch grains, calcium oxalate crystals by eye piece micrometer
5. Determination of Fiber length and width
6. Determination of number of starch grains by Lycopodium spore method
7. Determination of Ash value
8. Determination of Extractive values of crude drugs
9. Determination of moisture content of crude drugs
10. Determination of swelling index and foaming index

L= Lecture, T= Tutorial, P= Practical, C= Credit