MAULANA ABUL KALAM AZAD UNIVERSITY OF TECHNOLOGY,
KOLKATA (Formerly known as WBUT, Kolkata)

Syllabus for the Bachelor of Pharmacy (B. Pharm) Course

[Framed under Regulation 6, 7 & 8 of the Bachelor of Pharmacy (B. Pharm) course regulations 2014]
1. **Course of study (Presently it is for B.Pharm. 1st year only)**

The course of study for B. Pharm. 1st year shall include Semester Wise Theory & Practical as given in Table – I to II. The number of hours to be devoted to each theory, tutorial and practical course in any semester shall not be less than that shown in Table–I to II.

**Table-I: Course of study for semester I**

<table>
<thead>
<tr>
<th>Course code</th>
<th>Name of the course</th>
<th>No. of hours</th>
<th>Tutorial</th>
<th>Full Marks</th>
<th>Credit points</th>
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<td>PT105</td>
<td>Human Anatomy and Physiology I – Theory</td>
<td>3</td>
<td>1</td>
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<td>PT101</td>
<td>Pharmaceutical Analysis I – Theory</td>
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<td>1</td>
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<td>PT195</td>
<td>Human Anatomy and Physiology – Practical</td>
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<td>PT191</td>
<td>Pharmaceutical Analysis I – Practical</td>
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<td>Communication skills – Theory</td>
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<td>Communication skills – Practical</td>
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The students who have studied Mathematics / Physics / Chemistry at HSC will be appearing for Remedial Biology course.

The students who have studied Physics / Chemistry / Biology (Botany / Zoology) at HSC will be appearing for Remedial Mathematics course.

* Non University Examination (NUE)
Table-II: Course of study for semester II

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Name of the course</th>
<th>No. of hours</th>
<th>Tutorial</th>
<th>Full Marks</th>
<th>Credit points</th>
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<td>PT204</td>
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<td>Pathophysiology – Theory</td>
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<td>Environmental sciences – Theory</td>
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</table>

*Non University Examination (NUE)
PT105. HUMAN ANATOMY AND PHYSIOLOGY-I (Theory)
45 Hours

Scope: This subject is designed to impart fundamental knowledge on the structure and functions of the various systems of the human body. It also helps in understanding both homeostatic mechanisms. The subject provides the basic knowledge required to understand the various disciplines of pharmacy.

Objectives: Upon completion of this course the student should be able to
1. Explain the gross morphology, structure and functions of various organs of the human body.
2. Describe the various homeostatic mechanisms and their imbalances.
3. Identify the various tissues and organs of different systems of human body.
4. Perform the various experiments related to special senses and nervous system.
5. Appreciate coordinated working pattern of different organs of each system

Course Content:

Unit-I
• Introduction to human body
  Definition and scope of anatomy and physiology, levels of structural organization and body systems, basic life processes, homeostasis, basic anatomical terminology.
• Cellular level of organization
  Structure and functions of cell, transport across cell membrane, cell division, cell junctions. General principles of cell communication, intracellular signaling pathway activation by extracellular signal molecule, Forms of intracellular signaling: a) Contact-dependent b) Paracrine c) Synaptic d) Endocrine
• Tissue level of organization
  Classification of tissues, structure, location and functions of epithelial, muscular and nervous and connective tissues.

Unit II
• Integumentary system
  Structure and functions of skin

• Skeletal system
  Divisions of skeletal system, types of bone, salient features and functions of bones of axial and appendicular skeletal system
  Organization of skeletal muscle, physiology of muscle contraction, neuromuscular junction
• **Joints**  
  Structural and functional classification, types of joints movements and its articulation

**Unit III**  
10 hours

• **Body fluids and blood**  
  Body fluids, composition and functions of blood, hemopoeisis, formation of hemoglobin, anemia, mechanisms of coagulation, blood grouping, Rh factors, transfusion, its significance and disorders of blood, Reticuloendothelial system.

• **Lymphatic system**  
  Lymphatic organs and tissues, lymphatic vessels, lymph circulation and functions of lymphatic system

**Unit IV**  
08 hours

  **Peripheral nervous system:**  
  Classification of peripheral nervous system: Structure and functions of sympathetic and parasympathetic nervous system.  
  Origin and functions of spinal and cranial nerves.

• **Special senses**  
  Structure and functions of eye, ear, nose and tongue and their disorders.

**Unit V**  
07 hours

• **Cardiovascular system**  
  Heart – anatomy of heart, blood circulation, blood vessels, structure and functions of artery, vein and capillaries, elements of conduction system of heart and heart beat, its regulation by autonomic nervous system, cardiac output, cardiac cycle. Regulation of blood pressure, pulse, electrocardiogram and disorders of heart.
PT195. HUMAN ANATOMY AND PHYSIOLOGY (Practical)  

Practical physiology is complimentary to the theoretical discussions in physiology. Practicals allow the verification of physiological processes discussed in theory classes through experiments on living tissue, intact animals or normal human beings. This is helpful for developing an insight on the subject.

1. Study of compound microscope.
2. Microscopic study of epithelial and connective tissue
3. Microscopic study of muscular and nervous tissue
4. Identification of axial bones
5. Identification of appendicular bones
6. Introduction to hemocytometry.
7. Enumeration of white blood cell (WBC) count
8. Enumeration of total red blood corpuscles (RBC) count
9. Determination of bleeding time
10. Determination of clotting time
11. Estimation of hemoglobin content
12. Determination of blood group.
13. Determination of erythrocyte sedimentation rate (ESR).
15. Recording of blood pressure.

Recommended Books (Latest Editions)

3. Physiological basis of Medical Practice-Best and Tailor. Williams & Wilkins Co, Riverview, MIUSA
7. Textbook of Practical Physiology by C.L. Ghai, Jaypee brother’s medical publishers, NewDehi.
8. Practical workbook of Human Physiology by K. Srinageswari and Rajeev Sharma, Jaypee brother’s medical publishers, NewDehi.

Reference Books (Latest Editions)
1. Physiological basis of Medical Practice- Best and Tailor. Williams & Wilkins Co, Riverview, MIUSA
3. Human Physiology (vol 1 and 2) by Dr. C.C. Chatterjee, Academic Publishers Kolkata
PT101. PHARMACEUTICAL ANALYSIS (Theory)

Scope: This course deals with the fundamentals of analytical chemistry and principles of electrochemical analysis of drugs

Objectives: Upon completion of the course student shall be able to

- understand the principles of volumetric and electro chemical analysis
- carry out various volumetric and electrochemical titrations
- develop analytical skills

Course Content:

UNIT-I

(a) Pharmaceutical analysis- Definition and scope
   i) Different techniques of analysis
   ii) Methods of expressing concentration
   iii) Primary and secondary standards.
   iv) Preparation and standardization of various molar and normal solutions- Oxalic acid, sodium hydroxide, hydrochloric acid, sodium thiosulphate, sulphuric acid, potassium permanganate and cericammonium sulphate
(b) Errors: Sources of errors, types of errors, methods of minimizing errors, accuracy, precision and significant figures
(c) Pharmacopoeia, Sources of impurities in medicinal agents, limit tests.

UNIT-II

- Acid base titration: Theories of acid base indicators, classification of acid base titrations and theory involved in titrations of strong, weak, and very weak acids and bases, neutralization curves
- Non aqueous titration: Solvents, acidimetry and alkalimetry titration and estimation of Sodium benzoate and Ephedrine HCl

UNIT-III

- Precipitation titrations: Mohr’s method, Volhard’s, Modified Volhard’s, Fajans method, estimation of sodium chloride.
- Complexometric titration: Classification, metal ion indicators, masking and demasking reagents, estimation of Magnesium sulphate, and calcium gluconate.
- Basic Principles, methods and application of diazotization titration.
UNIT-IV

Redox titrations
(a) Concepts of oxidation and reduction
(b) Types of redox titrations (Principles and applications)
Cerimetry, Iodimetry, Iodometry, Bromatometry, Dichrometry, Titration with potassium iodate

UNIT-V

- Electrochemical methods of analysis
- **Conductometry** - Introduction, Conductivity cell, Conductometric titrations, applications.
- **Potentiometry** - Electrochemical cell, construction and working of reference (Standard hydrogen, silver chloride electrode and calomel electrode) and indicator electrodes (metal electrodes and glass electrode), methods to determine end point of potentiometric titration and applications.
- **Polarography** - Principle, Ilkovic equation, construction and working of dropping mercury electrode and rotating platinum electrode, applications
PT191. PHARMACEUTICAL ANALYSIS (Practical)

4 Hours / Week

I  Limit Test of the following
(1) Chloride
(2) Sulphate
(3) Iron
(4) Arsenic

II  Preparation and standardization of
(1) Sodium hydroxide
(2) Sulphuric acid
(3) Sodium thiosulfate
(4) Potassium permanganate
(5) Ceric ammoniumsulfate

III  Assay of the following compounds along with Standardization of Titrant
(1) Ammonium chloride by acid base titration
(2) Ferrous sulphate by Cerimetry
(3) Copper sulphate by Iodometry
(4) Calcium gluconate by complexometry
(5) Hydrogen peroxide by Permanganometry
(6) Sodium benzoate by non-aqueous titration
(7) Sodium Chloride by precipitation titration

IV  Determination of Normality by electro-analytical methods
(1) Conductometric titration of strong acid against strong
(2) base
(3) Conductometric titration of strong acid and weak acid against strongbase
(4) Potentiometric titration of strong acid against strongbase

Recommended Books: (Latest Editions)

2. A.I. Vogel, Text Book of Quantitative Inorganic analysis
4. Bentley and Driver's Textbook of Pharmaceutical Chemistry
5. John H. Kennedy, Analytical chemistry principles
6. Indian Pharmacopoeia.
PT106. PHARMACEUTICS- I (Theory)

45 Hours

Scope: This course is designed to impart a fundamental knowledge on the preparatory pharmacy with arts and science of preparing the different conventional dosage forms.

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

- Know the history of profession of pharmacy
- Understand the basics of different dosage forms, pharmaceutical incompatibilities and pharmaceutical calculations
- Understand the professional way of handling the prescription
- Preparation of various conventional dosage forms

Course Content:

UNIT–I

10Hours

- **Historical background and development of profession of pharmacy**: History of profession of Pharmacy in India in relation to pharmacy education, industry and organization, Pharmacy as a career, Pharmacopoeias: Introduction to IP, BP, USP and Extra Pharmacopoeia.
- **Dosage forms**: Introduction to dosage forms, classification and definitions
- **Prescription**: Definition, Parts of prescription, handling of Prescription and Errors in prescription.
- **Posology**: Definition, Factors affecting posology. Pediatric dose calculations based on age, body weight and body surface area.

UNIT–II

10Hours

- **Pharmaceutical calculations**: Weights and measures – Imperial & Metric system, Calculations involving percentage solutions, alligation, proof spirit and isotonic solutions based on freezing point depression and molecular weight method.
- **Powders**: Definition, classification, advantages and disadvantages, Simple & compound powders – official preparations, dusting powders, effervescent, efflorescent and hygroscopic powders, eutectic mixtures. Geometric dilutions.
- **Liquid dosage forms**: Advantages and disadvantages of liquid dosage forms. Excipients used in formulation of liquid dosage forms. Solubility enhancement techniques
UNIT–III 08Hours

- **Monophasic liquids:** Definitions and preparations of Gargles, Mouthwashes, Throat Paint, Eardrops, Nasal drops, Enemas, Syrups, Elixirs, Liniments and Lotions.
- **Biphasic liquids:**
- **Suspensions:** Definition, advantages and disadvantages, classifications, Preparation of suspensions; Flocculated and Deflocculated suspension & stability problems and methods to overcome, evaluation.
- **Emulsions:** Definition, classification, emulsifying agent, test for the identification of type of Emulsion, Methods of preparation & stability problems and methods to overcome, evaluation.

UNIT–IV 08Hours

- **Suppositories:** Definition, types, advantages and disadvantages, types of bases, methods of preparations. Displacement value & its calculations, evaluation of suppositories.
- **Pharmaceutical incompatibilities:** Definition, classification, physical, chemical and therapeutic incompatibilities with examples.

UNIV–V 07Hours

- **Semisolid dosage forms:** Definitions, classification, mechanisms and factors influencing dermal penetration of drugs. Preparation of ointments, pastes, creams and gels. Excipients used in semi solid dosage forms. Evaluation of semi solid dosage forms
1. Syrups
   a) Simple Syrup
   b) Compound syrup of Ferrous Phosphate

2. Elixirs
   a) Piperazine citrate elixir
   b) Paracetamol pediatric elixir

3. Linctus
   a) Terpin Hydrate Linctus
   b) Iodine Throat Paint (Mandles Paint)

4. Solutions
   a) Strong solution of ammonium acetate
   b) Cresol with soap solution
   c) Lugol’s solution

5. Suspensions
   a) Calamine lotion
   b) Magnesium Hydroxide mixture
   c) Aluminium Hydroxide gel

6. Emulsions
   a) Turpentine Liniment
   b) Liquid paraffin emulsion

7. Powders and Granules
   a) ORS powder (WHO)
   b) Effervescent granules
   c) Dusting powder
   d) Divided powders

8. Suppositories
   a) Glycero gelatin suppository
   b) Coca butter suppository
   c) Zinc Oxide suppository

8. Semisolids
   a) Sulphur ointment
   b) Non staining-iodine ointment with methylsalicylate
   c) Carbopalgel

9. Gargles and Mouthwashes
   a) Iodine gargle
   b) Chlorhexidine mouthwash

Recommended Books: (Latest Editions)
2. Carter S.J., Cooper and Gunn’s-Dispensing for Pharmaceutical Students, CBS publishers, New Delhi.
4. Indian pharmacopoeia.
5. British pharmacopoeia.
9. E.A. Rawlins, Bentley’s Text Book of Pharmaceutics, English Language Book Society, Elsevier Health Sciences, USA.
PT 103 PHARMACEUTICAL INORGANIC CHEMISTRY (Theory)  

Scope: This subject deals with the monographs of inorganic drugs and pharmaceuticals.

Objectives: Upon completion of course student shall be able to

- know the sources of impurities and methods to determine the impurities in inorganic drugs and pharmaceuticals
- understand the medicinal and pharmaceutical importance of inorganic compounds

Course Content:

UNIT I 10 Hours

- Impurities in pharmaceutical substances: History of Pharmacopoeia, Sources and types of impurities, principle involved in the limit test for Chloride, Sulphate, Iron, Arsenic, Lead and Heavy metals, modified limit test for Chloride and Sulphate

  General methods of preparation, assay for the compounds superscripted with asterisk (*), properties and medicinal uses of inorganic compounds belonging to the following classes

UNITII 10 Hours

- Acids, Bases and Buffers: Buffer equations and buffer capacity in general, buffers in pharmaceutical systems, preparation, stability, buffered isotonic solutions, measurements of tonicity, calculations and methods of adjusting isotoncity.

- Major extra and intracellular electrolytes: Functions of major physiological ions, Electrolytes used in the replacement therapy: Sodium chloride*, Potassium chloride, Calcium gluconate* and Oral Rehydration Salt (ORS), Physiological acid base balance.

- Dental products: Dentifrices, role of fluoride in the treatment of dental caries, Desensitizing agents, Calcium carbonate, Sodium fluoride, and Zinc eugenol cement.

UNITIII 10 Hours

- Gastrointestinal agents
  
  Acidifiers: Ammonium chloride* and Dil. HCl
  Antacid: Ideal properties of antacids, combinations of antacids, Sodium
Bicarbonate*, Aluminum hydroxide gel, Magnesium hydroxide mixture

**Cathartics:** Magnesium sulphate, Sodium orthophosphate, Kaolin and Bentonite

**Antimicrobials:** Mechanism, classification, Potassium permanganate, Boric acid, Hydrogen peroxide*, Chlorinated lime*, Iodine and its preparations

**UNITIV**

- **Miscellaneous compounds**
  - **Expectorants:** Potassium iodide, Ammonium chloride*.
  - **Emetics:** Copper sulphate*, Sodium potassium tartarate
  - **Haematinics:** Ferrous sulphate*, Ferrous gluconate
  - **Poison and Antidote:** Sodium thiosulphate*, Activated charcoal, Sodium nitrite333
  - **Astringents:** Zinc Sulphate, Potash Alum

**UNITV**

- **Radiopharmaceuticals:** Radio activity, Measurement of radioactivity, Properties of α, β, γ radiations, Half life, radio isotopes and study of radio isotopes - Sodium iodide I¹³¹, Storage conditions, precautions & pharmaceutical application of radioactive substances.
PT193 PHARMACEUTICAL INORGANIC CHEMISTRY (Practical)

I  Limit tests for following ions
    Limit test for Chlorides and Sulphates
    Modified limit test for Chlorides and Sulphates
    Limit test for Iron
    Limit test for Heavy metals
    Limit test for Lead
    Limit test for arsenic

II  Identification test
    Magnesium hydroxide
    Ferrous sulphate
    Sodium bicarbonate
    Calcium gluconate
    Copper sulphate

III  Test for purity
    Swelling power of Bentonite
    Neutralizing capacity of aluminium hydroxide gel
    Determination of potassium iodate and iodine in potassium Iodide

IV  Preparation of inorganic pharmaceuticals
    Boric acid
    Potash alum
    Ferrous sulphate

Recommended Books (Latest Editions)

2. A.I. Vogel, Text Book of Quantitative Inorganic Analysis
4. M.L Schroff, Inorganic Pharmaceutical Chemistry
5. Bentley and Driver's Textbook of Pharmaceutical Chemistry
7. Indian Pharmacopoeia
HU 181 COMMUNICATION SKILLS (Theory)  

30 Hours

Scope: This course will prepare the young pharmacy student to interact effectively with doctors, nurses, dentists, physiotherapists and other health workers. At the end of this course the student will get the soft skills set to work cohesively with the team as a team player and will add value to the pharmaceutical business.

Objectives:
Upon completion of the course the student shall be able to

1. Understand the behavioral needs for a Pharmacist to function effectively in the areas of pharmaceutical operation
2. Communicate effectively (Verbal and NonVerbal)
3. Effectively manage the team as a teamplayer
4. Develop interview skills
5. Develop Leadership qualities andessentials

Course content:

UNIT–I  07 Hours

- **Communication Skills:** Introduction, Definition, The Importance of Communication, The Communication Process – Source, Message, Encoding, Channel, Decoding, Receiver, Feedback, Context
- **Barriers to communication:** Physiological Barriers, Physical Barriers, Cultural Barriers, Language Barriers, Gender Barriers, Interpersonal Barriers, Psychological Barriers, Emotional barriers
- **Perspectives in Communication:** Introduction, Visual Perception, Language, Other factors affecting our perspective - Past Experiences, Prejudices, Feelings, Environment

UNIT–II  07 Hours

- **Elements of Communication:** Introduction, Face to Face Communication - Tone of Voice, Body Language (Non-verbal communication), Verbal Communication, Physical Communication
- **Communication Styles:** Introduction, The Communication Styles Matrix with example for each - Direct Communication Style, Spirited Communication Style, Systematic Communication Style, Considerate Communication Style
UNIT–III

- **Basic Listening Skills**: Introduction, Self-Awareness, Active Listening, Becoming an Active Listener, Listening in Difficult Situations

- **Effective Written Communication**: Introduction, When and When Not to Use Written Communication - Complexity of the Topic, Amount of Discussion’ Required, Shades of Meaning, Formal Communication

- **Writing Effectively**: Subject Lines, Put the Main Point First, Know Your Audience, Organization of the Message

UNIT–IV

- **Interview Skills**: Purpose of an interview, Do’s and Don’t’s of an interview

- **Giving Presentations**: Dealing with Fears, Planning your Presentation, Structuring Your Presentation, Delivering Your Presentation, Techniques of Delivery

UNIT–V

- **Group Discussion**: Introduction, Communication skills in group discussion, Do’s and Don’t’s of group discussion
HU182 COMMUNICATION SKILLS (Practical)

2 Hours / week

The following learning modules are to be conducted using Wordsworth® English language lab software

**Basic communication covering the following topics**

Meeting People
Asking Questions
Making Friends
What did you do?
Do’s and Don’t’s

**Pronunciations covering the following topics**

Pronunciation (Consonant Sounds)
Pronunciation and Nouns
Pronunciation (Vowel Sounds)

**Advanced Learning**

Listening Comprehension / Direct and Indirect Speech
Figures of Speech
Effective Communication
Writing Skills
Effective Writing
Interview Handling Skills
E-Mail etiquette
Presentation Skills
**Recommended Books: (Latest Edition)**

2. Communication skills, Sanjay Kumar, Pushpalata, 1\textsuperscript{st} Edition, Oxford Press, 2011
6. Developing your influencing skills, Deborah Dalley, Lois Burton, Margaret, Green hall, 1st Edition Universe of Learning LTD, 2010
11. Effective communication, John Adair, 4\textsuperscript{th} Edition, Pan MacMillan, 2009
PTB 184 REMEDIAL BIOLOGY (Theory)

30 Hours

Scope: To learn and understand the components of living world, structure and functional system of plant and animal kingdom.

Objectives: Upon completion of the course, the student shall be able to
- know the classification and salient features of five kingdoms of life
- understand the basic components of anatomy & physiology of plant
- know understand the basic components of anatomy & physiology animal with special reference to human

UNIT I

07 Hours

Living world:
- Definition and characters of living organisms
- Diversity in the living world
- Binomial nomenclature
- Five kingdoms of life and basis of classification. Salient features of Monera, Potista, Fungi, Animalia and Plantae, Virus,

Morphology of Flowering plants
- Morphology of different parts of flowering plants – Root, stem, inflorescence, flower, leaf, fruit, seed.
- General Anatomy of Root, stem, leaf of monocotyledons & Dicotylidones.

UNIT II

07 Hours

Body fluids and circulation
- Composition of blood, blood groups, coagulation of blood
- Composition and functions of lymph
- Human circulatory system
- Structure of human heart and blood vessels
- Cardiac cycle, cardiac output and ECG

Digestion and Absorption
- Human alimentary canal and digestive glands
- Role of digestive enzymes
- Digestion, absorption and assimilation of digested food

Breathing and respiration
- Human respiratory system
- Mechanism of breathing and its regulation
- Exchange of gases, transport of gases and regulation of respiration
- Respiratory volumes
UNIT III

Excretory products and their elimination
- Modes of excretion
- Human excretory system - structure and function
- Urine formation
- Rennin angiotensin system

Neural control and coordination
- Definition and classification of nervous system
- Structure of a neuron
- Generation and conduction of nerve impulse
- Structure of brain and spinal cord
- Functions of cerebrum, cerebellum, hypothalamus and medulla oblongata

Chemical coordination and regulation
- Endocrine glands and their secretions
- Functions of hormones secreted by endocrine glands

Human reproduction
- Parts of female reproductive system
- Parts of male reproductive system
- Spermatogenesis and Oogenesis
- Menstrual cycle

UNIT IV

Plants and mineral nutrition:
- Essential mineral, macro and micronutrients
- Nitrogen metabolism, Nitrogen cycle, biological nitrogen fixation

Photosynthesis
- Autotrophic nutrition, photosynthesis, Photosynthetic pigments, Factors affecting photosynthesis.

UNIT V

Plant respiration: Respiration, glycolysis, fermentation (anaerobic).

Plant growth and development
- Phases and rate of plant growth, Condition of growth, Introduction to plant growth regulators

Cell - The unit of life
- Structure and functions of cell and cell organelles. Cell division

Tissues
- Definition, types of tissues, location and functions.
Text Books
   a. Text book of Biology by S. B. Gokhale
   b. A Text book of Biology by Dr. Thulajappa and Dr. Seetaram.

Reference Books
   a. A Text book of Biology by B. V. Sreenivasa Naidu
   b. A Text book of Biology by Naidu and Murthy
   c. Botany for Degree students By A.C. Dutta.
   d. Outlines of Zoology by M. Ekambaranatha ayyer and T. N. Ananthakrishnan.
   e. A manual for pharmaceutical biology practical by S. B. Gokhale and C. K. Kokate
PTB 185 REMEDIAL BIOLOGY (Practical)

30 Hours

1. Introduction to experiments in biology
   a) Study of Microscope
   b) Section cutting techniques
   c) Mounting and staining
   d) Permanent slide preparation
2. Study of cell and its inclusions
3. Study of Stem, Root, Leaf, seed, fruit, flower and their modifications
4. Detailed study of frog by using computer models
5. Microscopic study and identification of tissues pertinent to Stem, Root, Leaf, seed, fruit and flower
6. Identification of bones
7. Determination of blood group
8. Determination of blood pressure
9. Determination of tidal volume

Reference Books
M 183 REMEDIAL MATHEMATICS (Theory)

30 Hours

Scope: This is an introductory course in mathematics. This subject deals with the introduction to Partial fraction, Logarithm, matrices and Determinant, Analytical geometry, Calculus, differential equation and Laplace transform.

Objectives: Upon completion of the course the student shall be able to:-
1. Know the theory and their application in Pharmacy
2. Solve the different types of problems by applying theory
3. Appreciate the important application of mathematics in Pharmacy

Course Content:

UNIT–I

- Partial fraction
  Introduction, Polynomial, Rational fractions, Proper and Improper fractions, Partial fraction, Resolving into Partial fraction, Application of Partial Fraction in Chemical Kinetics and Pharmacokinetics

- Logarithms
  Introduction, Definition, Theorems/Properties of logarithms, Common logarithms, Characteristic and Mantissa, worked examples, application of logarithm to solve pharmaceutical problems.

- Function:
  Real Valued function, Classification of real valued functions,

- Limits and continuity:
  Introduction, Limit of a function, Definition of limit of a function (ε-δ definition), \( \lim_{{x \to a}} \frac{x^n - a^n}{x - a} = na^{n-1} \), \( \lim_{{\theta \to 0}} \frac{\sin \theta}{\theta} = 1 \), \( \lim_{{x \to a}} x^n = a^n \)

UNIT–II

- Matrices and Determinant:
  Introduction matrices, Types of matrices, Operation on matrices, Transpose of a matrix, Matrix Multiplication, Determinants, Properties of determinants, Product of determinants, Minors and co-Factors, Adjoint or adjugate of a square matrix, Singular and non-singular matrices, Inverse of a matrix, Solution of system of linear of equations using matrix method, Cramer’s rule, Characteristic equation and roots of a square matrix, Cayley–Hamilton theorem, Application of Matrices insolving Pharmacokinetic equations
UNIT–III 06Hours

• Calculus

Differentiation: Introductions, Derivative of a function, Derivative of a constant, Derivative of a product of a constant and a function, Derivative of the sum or difference of two functions, Derivative of the product of two functions (product formula), Derivative of the quotient of two functions (Quotient formula) – Without Proof. Derivative of \(x^n\) w.r.t. \(x\), where \(n\) is any rational number, Derivative of \(e^x\), Derivative of \(\log x\), Derivative of \(a^x\). Derivative of trigonometric functions from first principles (without Proof), Successive Differentiation, Conditions for a function to be a maximum or a minimum at a point. Application

UNIT–IV 06Hours

• Analytical Geometry

Introduction: Signs of the Coordinates, Distance formula, Straight Line: Slope or gradient of a straight line, Conditions for parallelism and perpendicularity of two lines, Slope of a line joining two points, Slope – intercept form of a straight line

Integration:
Introduction, Definition, Standard formulae, Rules of integration, Method of substitution, Method of Partial fractions, Integration by parts, definite integrals, application

UNIT–V 06Hours

• Differential Equations: Some basic definitions, Order and degree, Equations in separable form, Homogeneous equations, Linear Differential equations, Exact equations, Application in solving Pharmacokinetic equations

• Laplace Transform: Introduction, Definition, Properties of Laplace transform, Laplace Transforms of elementary functions, Inverse Laplace transforms, Laplace transform of derivatives, Application to solve Linear differential equations, Application in solving Chemical kinetics and Pharmacokinetics equations

Recommended Books (Latest Edition)

1. Differential Calculus by Shanthinarayan
2. Pharmaceutical Mathematics with application to Pharmacy by Panchaksharappa Gowda D.H.
3. Integral Calculus by Shanthinarayan
4. Higher Engineering Mathematics by Dr. B.S. Grewal
Semester II
**PT 205 HUMAN ANATOMY AND PHYSIOLOGY-II (Theory)**

**Scope:** This subject is designed to impart fundamental knowledge on the structure and functions of the various systems of the human body. It also helps in understanding both homeostatic mechanisms. The subject provides the basic knowledge required to understand the various disciplines of pharmacy.

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

1. Explain the gross morphology, structure and functions of various organs of the human body.
2. Describe the various homeostatic mechanisms and their imbalances.
3. Identify the various tissues and organs of different systems of human body.
4. Perform the hematological tests like blood cell counts, haemoglobin estimation, bleeding/clotting time etc and also record blood pressure, heart rate, pulse and respiratory volume.
5. Appreciate coordinated working pattern of different organs of each system
6. Appreciate the interlinked mechanisms in the maintenance of normal functioning (homeostasis) of human body.

**Course Content:**

**Unit I**  
10 hours

- **Nervous system**
  
  Organization of nervous system, neuron, neuroglia, classification and properties of nerve fibre, electrophysiology, action potential, nerve impulse, receptors, synapse, neurotransmitters.
  
  Central nervous system: Meninges, ventricles of brain and cerebrospinal fluid. structure and functions of brain (cerebrum, brain stem, cerebellum), spinal cord (gross structure, functions of afferent and efferent nerve tracts, reflex activity)

**Unit II**  
6 hours

- **Digestive system**
  
  Anatomy of GI Tract with special reference to anatomy and functions of stomach, ( Acid production in the stomach, regulation of acid production through parasympathetic nervous system, pepsin role in protein digestion) small intestine

45 Hours
and large intestine, anatomy and functions of salivary glands, pancreas and liver, movements of GIT, digestion and absorption of nutrients and disorders of GIT.

- **Energetics**

  Formation and role of ATP, Creatinine Phosphate and BMR.

### Unit III

- **Respiratory system**

  Anatomy of respiratory system with special reference to anatomy of lungs, mechanism of respiration, regulation of respiration

  Lung Volumes and capacities transport of respiratory gases, artificial respiration, and resuscitation methods.

- **Urinary system**


### Unit IV

- **Endocrine system**

  Classification of hormones, mechanism of hormone action, structure and functions of pituitary gland, thyroid gland, parathyroid gland, adrenal gland, pancreas, pineal gland, thymus and their disorders.

### Unit V

- **Reproductive system**

  Anatomy of male and female reproductive system, Functions of male and female reproductive system, sex hormones, physiology of menstruation, fertilization, spermatogenesis, oogenesis, pregnancy and parturition

- **Introduction to genetics**

  Chromosomes, genes and DNA, protein synthesis, genetic pattern of inheritance
PT 193 HUMAN ANATOMY AND PHYSIOLOGY (Practical)

4 Hours/week

Practical physiology is complimentary to the theoretical discussions in physiology. Practicals allow the verification of physiological processes discussed in theory classes through experiments on living tissue, intact animals or normal human beings. This is helpful for developing an insight on the subject.

1. To study the integumentary and special senses using specimen, models, etc.,
2. To study the nervous system using specimen, models, etc.,
3. To study the endocrine system using specimen, models, etc
4. To demonstrate the general neurological examination
5. To demonstrate the function of olfactory nerve
6. To examine the different types of taste.
7. To demonstrate the visual acuity
8. To demonstrate the reflex activity
9. Recording of body temperature
10. To demonstrate positive and negative feed back mechanism.
11. Determination of tidal volume and vital capacity.
12. Study of digestive, respiratory, cardiovascular systems, urinary and reproductive systems with the help of models, charts and specimens.
13. Recording of basal mass index
15. Demonstration of total blood count by cell analyser
16. Permanent slides of vital organs and gonads.

Recommended Books (Latest Editions)
3. Physiological basis of Medical Practice-Best and Tailor. Williams & Wilkins Co, Riverview, MIUSA
8. Practical workbook of Human Physiology by K. Srinageswari and Rajeev Sharma, Jaypee brother’s medical publishers, New Delhi.

**Reference Books:**

1. Physiological basis of Medical Practice- Best and Tailor. Williams & Wilkins Co, Riverview, MI USA
3. Human Physiology (vol 1 and 2) by Dr. C.C. Chatterjee, Academic Publishers Kolkata
PT 203 PHARMACEUTICAL ORGANIC CHEMISTRY –I (Theory)

Scope: This subject deals with classification and nomenclature of simple organic compounds, structural isomerism, intermediates forming in reactions, important physical properties, reactions and methods of preparation of these compounds. The syllabus also emphasizes on mechanisms and orientation of reactions.

Objectives: Upon completion of the course the 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. identify/confirm the identification of organic compound

Course Content:

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

- Classification, nomenclature and isomerism
  Classification of Organic Compounds
  Common and IUPAC systems of nomenclature of organic compounds
  (up to 10 Carbons open chain and carbocyclic compounds)

Structural isomerisms in organic compounds

UNIT-II

- Alkanes*, Alkenes* and Conjugated dienes*
  SP$^3$ hybridization in alkanes, Halogenation of alkanes, uses of paraffins.
  Stabilities of alkenes, SP$^2$ hybridization in alkenes
  E$_1$ and E$_2$ reactions – kinetics, order of reactivity of alkyl halides, rearrangement of carbocations, Saytzeff’s orientation and evidences. E$_1$ versus E$_2$ reactions, Factors affecting E$_1$ and E$_2$ reactions. Ozonolysis, electrophilic addition reactions of alkenes, Markownikoff’s orientation, free radical addition reactions of alkenes, Anti Markownikoff’s orientation.
  Stability of conjugated dienes, Diel-Alder, electrophilic addition, free radical addition reactions of conjugated dienes, allylic rearrangement

UNIT-III

10 Hours
• **Alkyl halides***
  SN\textsubscript{1} and SN\textsubscript{2} reactions - kinetics, order of reactivity of alkyl halides, stereochemistry and rearrangement of carbocations.
  SN\textsubscript{1} versus SN\textsubscript{2} reactions, Factors affecting SN\textsubscript{1} and SN\textsubscript{2} reactions
  Structure and uses of ethylchloride, Chloroform, trichloroethylene, tetrachloroethylene, dichloromethane, tetrachloromethane and iodoform.

• **Alcohols*** - Qualitative tests, Structure and uses of Ethyl alcohol, Methyl alcohol, chlorobutanol, Cetosteryl alcohol, Benzyl alcohol, Glycerol, Propyleneglycol

UNIT-IV  
10 Hours

• **Carbonyl compounds*** (Aldehydes and ketones)
  Nucleophilic addition, Electromeric effect, aldol condensation, Crossed Aldol condensation, Cannizzaro reaction, Crossed Cannizzaro reaction, Benzoin condensation, Perkin condensation, qualitative tests, Structure and uses of Formaldehyde, Paraldehyde, Acetone, Chloral hydrate, Hexamine, Benzaldehyde, Vanilin, Cinnamaldehyde.

UNIT-V  
08 Hours

• **Carboxylic acids***
  Acidity of carboxylic acids, effect of substituents on acidity, inductive effect and qualitative tests for carboxylic acids, amide and ester
  Structure and Uses of Acetic acid, Lactic acid, Tartaric acid, Citric acid, Succinic acid. Oxalic acid, Salicylic acid, Benzoic acid, Benzyl benzoate, Dimethyl phthalate, Methyl salicylate and Acetyl salicylic acid

• **Aliphatic amines*** - Basicity, effect of substituent on Basicity. Qualitative test, Structure and uses of Ethanolamine, Ethylenediamine, Amphetamine
PT 293 PHARMACEUTICAL ORGANIC CHEMISTRY -I (Practical)

4 Hours / week

1. Systematic qualitative analysis of unknown organic compounds like
   1. Preliminary test: Color, odour, aliphatic/aromatic compounds, saturation and unsaturation, etc.
   2. Detection of elements like Nitrogen, Sulphur and Halogen by Lassaigne’s test
   3. Solubility test
   5. Melting point/Boiling point of organic compounds
   6. Identification of the unknown compound from the literature using melting point/boiling point.
   7. Preparation of the derivatives and confirmation of the unknown compound by melting point/boiling point.
   8. Minimum 5 unknown organic compounds to be analysed systematically.

2. Preparation of suitable solid derivatives from organic compounds

3. Construction of molecular models

Recommended Books (Latest Editions)
1. Organic Chemistry by Morrison and Boyd
2. Organic Chemistry by I.L. Finar, Volume-I
4. Organic Chemistry by P.L. Soni
5. Practical Organic Chemistry by Mann and Saunders.
8. Introduction to Organic Laboratory techniques by Pavia, Lampman and Kriz.
9. Reaction and reaction mechanism by Ahluwalia/Chatwal.

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PT 204 BIOCHEMISTRY (Theory)  

Scope: Biochemistry deals with complete understanding of the molecular levels of the chemical process associated with living cells. The scope of the subject is providing biochemical facts and the principles to understand metabolism of nutrient molecules in physiological and pathological conditions. It is also emphasizing on genetic organization of mammalian genome and hetero & autocatalytic functions of DNA.

Objectives: Upon completion of course student shall able to

1. Understand the catalytic role of enzymes, importance of enzyme inhibitors in design of new drugs, therapeutic and diagnostic applications of enzymes.
2. Understand the metabolism of nutrient molecules in physiological and pathological conditions.
3. Understand the genetic organization of mammalian genome and functions of DNA in the synthesis of RNAs and proteins.

Course Content:

UNITI 08Hours

- Biomolecules
  Introduction, classification, chemical nature and biological role of carbohydrate, lipids, nucleic acids, amino acids and proteins.

- Bioenergetics
  Concept of free energy, endergonic and exergonic reaction, Relationship between free energy, enthalpy and entropy; Redox potential.

  Energy rich compounds; classification; biological significances of ATP and cyclic AMP

UNITII 10Hours

- Carbohydrate metabolism
  Glycolysis – Pathway, energetics and significance
  Citric acid cycle- Pathway, energetics and significance
  HMP shunt and its significance; Glucose-6-Phosphate dehydrogenase (G6PD) deficiency
  Glycogen metabolism Pathways and glycogen storage diseases (GSD)
  Gluconeogenesis- Pathway and its significance
  Hormonal regulation of blood glucose level and Diabetes mellitus

- Biological oxidation
  Electron transport chain (ETC) and its mechanism.
Oxidative phosphorylation & its mechanism and substrate level phosphorylation
Inhibitors ETC and oxidative phosphorylation/Uncouplers

UNITIII

10 Hours

- **Lipid metabolism**
  - β-Oxidation of saturated fatty acid (Palmitic acid)
  - Formation and utilization of ketone bodies; ketoacidosis De novo synthesis of fatty acids (Palmitic acid)
  - Biological significance of cholesterol and conversion of cholesterol into bile acids, steroid hormone and vitamin D
  - Disorders of lipid metabolism: Hypercholesterolemia, atherosclerosis, fatty liver and obesity.

- **Amino acid metabolism**
  - General reactions of amino acid metabolism: Transamination, deamination & decarboxylation, urea cycle and its disorders
  - Catabolism of phenylalanine and tyrosine and their metabolic disorders (Phenyketonuria, Albinism, alkeptonuria, tyrosinemia)
  - Synthesis and significance of biological substances; 5-HT, melatonin, dopamine, noradrenaline, adrenaline
  - Catabolism of heme; hyperbilirubinemia and jaundice
• Nucleic acid metabolism and genetic information transfer
  Biosynthesis of purine and pyrimidine nucleotides
  Catabolism of purine nucleotides and Hyperuricemia and Gout disease
  Organization of mammalian genome
  Structure of DNA and RNA and their functions
  DNA replication (semi conservative model)
  Transcription or RNA synthesis
  Genetic code, Translation or Protein synthesis and inhibitors
UNITV

- **Enzymes**
  - Introduction, properties, nomenclature and IUB classification of enzymes
  - Enzyme kinetics (Michaelis plot, Line Weaver Burke plot)
  - Enzyme inhibitors with examples
  - Regulation of enzymes: enzyme induction and repression, allosteric enzymes regulation
  - Therapeutic and diagnostic applications of enzymes and isoenzymes
  - Coenzymes – Structure and biochemical functions

**PT 294 BIOCHEMISTRY (Practical)**

4 Hours / Week

1. Qualitative analysis of carbohydrates (Glucose, Fructose, Lactose, Maltose, Sucrose and starch)
2. Identification tests for Proteins (albumin and Casein)
3. Quantitative analysis of reducing sugars (DNSA method) and Proteins (Biuret method)
4. Qualitative analysis of urine for abnormal constituents
5. Determination of blood creatinine
6. Determination of blood sugar
7. Determination of serum total cholesterol
8. Preparation of buffer solution and measurement of pH
9. Study of enzymatic hydrolysis of starch
10. Determination of Salivary amylase activity
11. Study the effect of Temperature on Salivary amylase activity.
12. Study the effect of substrate concentration on salivary amylase activity.
Recommended Books (Latest Editions)
4. Biochemistry by D. Satyanarayan and U. Chakrapani
7. Outlines of Biochemistry by Conn and Stumpf
10. Practical Biochemistry for Medical students by Rajagopal and Ramakrishna.
11. Practical Biochemistry by Harold Varley.

PT 207 PATHOPHYSIOLOGY (THEORY)

Scope: Pathophysiology is the study of causes of diseases and reactions of the body to such disease producing causes. This course is designed to impart a thorough knowledge of the relevant aspects of pathology of various conditions with reference to its pharmacological applications, and understanding of basic pathophysiological mechanisms. Hence it will not only help to study the syllabus of pathology, but also to get baseline knowledge required to practice medicine safely, confidently, rationally and effectively.

Objectives: Upon completion of the subject student shall be able to –
1. Describe the etiology and pathogenesis of the selected disease states;
2. Name the signs and symptoms of the diseases; and
3. Mention the complications of the diseases.

Course content:

Unit I 10 Hours

Basic principles of Cell injury and Adaptation:
Basic mechanism involved in the process of inflammation and repair:
Introduction, Clinical signs of inflammation, Different types of Inflammation, Mechanism of Inflammation – Alteration in vascular permeability and blood flow, migration of WBC’s, Mediators of inflammation, Basic principles of wound healing in the skin, Pathophysiology of Atherosclerosis

Unit II

Cardiovascular System:
Hypertension, congestive heart failure, ischemic heart disease (angina, myocardial infarction, atherosclerosis and arteriosclerosis)

Respiratory system: Asthma, Chronic obstructive airways diseases.

Renal system: Acute and chronic renal failure

Unit II

Haematological Diseases:
Iron deficiency, megaloblastic anemia (Vit B12 and folic acid), sickle cell anemia, thalassemia, hereditary acquired anemia, hemophilia

Endocrine system: Diabetes, thyroid diseases, disorders of sex hormones

Nervous system: Epilepsy, Parkinson’s disease, stroke, psychiatric disorders: depression, schizophrenia and Alzheimer’s disease.

Gastrointestinal system: Peptic Ulcer

Unit IV

Inflammatory bowel diseases, jaundice, hepatitis (A, B, C, D, E, F) alcoholic liver disease.

Disease of bones and joints: Rheumatoid arthritis, osteoporosis and gout

Principles of cancer: Classification, etiology and pathogenesis of cancer

Diseases of bones and joints: Rheumatoid Arthritis, Osteoporosis, Gout

Principles of Cancer: Classification, etiology and pathogenesis of Cancer

Unit V

Infectious diseases: Meningitis, Typhoid, Leprosy, Tuberculosis

Recommended Books (Latest Editions)
1. Vinay Kumar, Abul K. Abas, Jon C. Aster; Robbins & Cotran Pathologic Basis of Disease; South Asia edition; India; Elsevier; 2014.
4. Best, Charles Herbert 1899-1978; Taylor, Norman Burke 1885-1972; West, John B (John Burnard); Best and Taylor’s Physiological basis of medical practice; 12th ed; unitedstates;
5. William and Wilkins, Baltimore; 1991 [1990 printing].
9. V. Kumar, R. S. Cotran and S. L. Robbins; Basic Pathology; 6th edition; Philadelphia; WB Saunders Company; 1997.

Recommended Journals
1. The Journal of Pathology. ISSN: 1096-9896(Online)
2. The American Journal of Pathology. ISSN: 0002-9440
3. Pathology. 1465-3931(Online)
4. International Journal of Physiology, Pathophysiology and Pharmacology. ISSN: 1944-8171 (Online)
5. Indian Journal of Pathology and Microbiology. ISSN: 0377-4929.
PT 202 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
1. to know the techniques in the cultivation and production of crude drugs
2. to know the crude drugs, their uses and chemical nature
3. to know the evaluation techniques for the herbal drugs
4. to carry out the microscopic and morphological evaluation of crude drugs

Course Content:

UNIT-I
Introduction to Pharmacognosy:
(a) Definition, history, scope and development of Pharmacognosy
(b) Sources of Drugs – Plants, Animals, Marine & Tissue culture
(c) 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 sero taxonomical 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
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
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

[Type text]
UNITIV
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

UNITV
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

PT 292 PHARMACOGNOSY AND PHYTOCHEMISTRY I (Practical) 4 Hours/Week
1. Analysis of crude drugs by chemical tests: (i)Tragacanth (ii) Acacia (iii)Agar (iv) Gelatin (v) starch (vi) Honey (vii) Castoroil
2. Determination of stomatal number and index
3. Determination of size of starch grains, calcium oxalate crystals by eye piece micrometer
4. Determination of Fiber length and width
5. Determination of Extractive values of crude drugs
6. Determination of moisture content of crude drugs
7. Determination of swelling index and foaming

Recommended Books: (Latest Editions)
3. Text Book of Pharmacognosy by T.E.Wallis
8. Practical Pharmacognosy: C.K. Kokate, Purohit, Gokhlae

HU 282 ENVIRONMENTAL SCIENCES (Theory)
30 hours

Scope: Environmental Sciences is the scientific study of the environmental system and the status of its inherent or induced changes on organisms. It includes not only the study of physical and biological characters of the environment but also the social and cultural factors and the impact of man on environment.

Objectives: Upon completion of the course the student shall be able to:
1. Create the awareness about environmental problems among learners.
2. Impart basic knowledge about the environment and its allied problems.
3. Develop an attitude of concern for the environment.
4. Motivate learner to participate in environment protection and environment improvement.
5. Acquire skills to help the concerned individuals in identifying and solving environmental problems.

Course content:

Unit-I
The Multidisciplinary nature of environmental studies
Natural Resources
Renewable and non-renewable resources:
Natural resources and associated problems
a) Forest resources; b) Water resources; c) Mineral resources; d) Food resources; e) Energy resources; f) Land resources: Role of an individual in conservation of natural resources.

Unit-II
Ecosystems
- Concept of an ecosystem.
- Structure and function of an ecosystem.
- Introduction, types, characteristic features, structure and function of
the ecosystems: Forest ecosystem; Grassland ecosystem; Desert ecosystem; Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit-III

Environmental Pollution: Air pollution; Water pollution; Soil pollution

Recommended Books (Latest edition):
1. Y.K. Sing, Environmental Science, New Age International Pvt, Publishers, Bangalore
5. Clark R.S., Marine Pollution, Clanderson Press Oxford
8. Down of Earth, Centre for Science and Environment