



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR**  
(Established by Govt. of A.P., Act. No. 30 of 2008)  
ANANTHAPURAMU – 515 002 (A.P) INDIA

**Course Structure for B. Pharmacy. - R15 Regulations**  
**B. Pharmacy**

**II-I Semester**

| S.No | Course code | Subject   | Th | Tu/Drg/Lab | Credits |
|------|-------------|---|----|------------|---------|
| 1.   | 15R00301    | Pharmaceutical Engineering                        | 3  | 1 - -      | 3       |
| 2.   | 15R00302    | Physical Pharmacy –I                              | 3  | 1 - -      | 3       |
| 3.   | 15R00303    | Pharmaceutical Organic Chemistry – III            | 3  | 1 - -      | 3       |
| 4.   | 15R00304    | Pharmaceutical Microbiology                       | 3  | 1 - -      | 3       |
| 5.   | 15A01101    | Environmental Studies                             | 2  | 1 - -      | 2       |
| 6.   | 15R00305    | Pharmaceutical Engineering Laboratory             | -  | - - 4      | 2       |
| 7.   | 15R00306    | Physical Pharmacy –I Laboratory                   | -  | - - 4      | 2       |
| 8.   | 15R00307    | Pharmaceutical Organic Chemistry – III Laboratory | -  | - - 4      | 2       |
| 9.   | 15R00308    | Pharmaceutical Microbiology Laboratory            | -  | - - 4      | 2       |
|      |             |   | 14 | 5 16       | 22      |

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|--------------------|-----------------------------------|--------------------|----------|
| <b>Subject</b>     | <b>PHARMACEUTICAL ENGINEERING</b> | <b>Course Code</b> | 15R00301 |
| <b>Course year</b> | B. Pharmacy II year               | <b>Semester</b>    | I        |
| <b>Theory</b>      | 3 hrs/week                        | <b>Tutorial</b>    | 1hr/week |
| <b>End exam</b>    | 70 marks                          | <b>Internal</b>    | 30 marks |
| <b>Credits</b>     | 3                                 |                    |          |

**Scope and objectives:**

This course is dealing with the various unit operations i.e. drying, evaporation and working principles of different machinery like hammer mill, cyclone separator.

**Unit I**

**Introductory concepts:** Unit operation / Unit processes, material and energy balance, equilibrium state, rate process.

**Fluid Flow:** Types of flow, Reynold's number, Bernoulli's equation, viscosity, concept of boundary layer, basic equations of fluid flow, valves, flow meters, manometers and principles of measuring instruments.

**Material handling systems**

a. Liquid and Gas handling - Study of different types of pumps such as Reciprocating pumps, Turbine pumps and centrifugal pumps, fans, blowers and compressors.

b. Solid handling – Conveyor.

**Corrosion:**

Classification, mechanism of corrosion, factors effecting, prevention and control.

**Unit II**

**Dehumidification and Humidity control**

Basic concepts and definition, wet bulb and adiabatic saturation temperature. Psychrometric chart and

measurement of humidity, application of humidity measurement, Equipments for dehumidification

operations.

**Refrigeration and air-conditioning:** Principles and applications.

**Evaporation and drying:** Basic concept of phase equilibria. Definition and theory of evaporation, factors affecting evaporation, evaporators-film evaporators.

Moisture content and theory of drying, rate of drying and time of drying calculations, drying curves. Concept of loss on drying and its importance. Classification and types of dryers, dryers used

in pharmaceutical industries- tray dryer, Fluid bed dryer, spray dryer, freeze-dryer, tunnel dryer and vacuum dryer.

**UNIT III**

**Crystallization:**

Miers supersaturation theory, crystals growth, size, shape, geometry. Material and heat balances around Swenson walker crystallizer. Nucleation mechanisms, steady of various types of crystallizers, tanks, agitated batch, single vacuum, circulating magma and krystal crystallizer.

**Filtration and Centrifugation:** Theory of filtration, Factors affecting filtration, filter aids, filter media, industrial filters including filter press, rotary filter, edge filter, Air filtration. Principles of centrifugation, industrial centrifugal filters and centrifugal sedimenters.

#### UNIT IV

**Size Reduction:** Definition, theory and objectives of size reduction, factors affecting size reduction,

laws governing energy and power requirements of a mill. A brief study of ball mill, hammer mill, fluid energy mill.

**Size Separation:** Different techniques of size separation, sieves, sieve shakers, sedimentation tank, cyclone separators, bag fillers.

**Mixing:** Theory of mixing, solid-solid, solid-liquid and liquid-liquid mixing equipments-double cone,

twin-shell, silverson mixer, colloid mill, sigma blade mixer, planetary mixer, propeller mixer and

turbine mixer. Homogenizer, triple roller mill.

#### UNIT V

##### **Automated process control systems:**

Process variables, temperature, pressure, flow, level and vacuum and their measurements. Elements of automatic process control and introduction to automatic process control systems, elements of computer aided manufacturing. Reactors and fundamentals of reactors design for chemical reactions.

##### **TEXT BOOKS:**

1. S.J. Carter, Cooper and Gunn's *Tutorial Pharmacy*, 6<sup>th</sup> ed., CBS publisher, Delhi.
2. CVS Subramanyam, *Pharmaceutical Engineering*. Vallabh Prakasham New Delhi.
3. K. Samba Murthy, *Pharmaceutical Engineering new Age International Publishers Ltd*. 1998.
4. L. Lachman, H. Lieberman & J.B.Schwartz. *Pharmaceutical dosage forms volume-II*, 2<sup>nd</sup> ed., marcel dekker Inc.

##### **REFERENCE BOOKS:**

1. E.A. Rawlin's, *Bentley's Text Book of Pharmaceutics*, 8<sup>th</sup> ed ELBS.
2. Badzer & Banchoro, *Introduction to Chemical Engineering*. Tata – Mc Graw Hill.

#### OUTCOME

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

- a. Graduate understands the basic fundamentals of various unit operations required for drug development.  
Apply the operating skills of pharmaceutical machinery required to work in the pharmaceutical field viz. drug manufacturing & production.

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|--------------------|------------------------------|--------------------|----------|
| <b>Subject</b>     | <b>PHYSICAL PHARMACY – I</b> | <b>Course Code</b> | 15R00302 |
| <b>Course year</b> | B. Pharmacy II year          | <b>Semester</b>    | I        |
| <b>Theory</b>      | 3 hrs/week                   | <b>Tutorial</b>    | 1hr/week |
| <b>End exam</b>    | 70 marks                     | <b>Internal</b>    | 30 marks |
| <b>Credits</b>     | 3                            |                    |          |

**Scope and objectives:**

This course is designed to provide the basis for understanding the chemical and physical phenomena that govern the *in vivo* and *in vitro* actions of pharmaceutical products.

**UNIT I**

**Intermolecular forces and states of matter:** Binding forces between molecules, the states of matter, change in the state of matter, latent heat and vapour pressure, sublimation critical point, eutectic mixtures, relative humidity, the liquid state, liquid crystalline state, Glossy state and solid state, amorphous and polymorphism.

**Phase rule:** Definition and explanation. One component (water system), two compartment system (phenol - water system & TEA (Tri Ethyl Amine) and Water system).

**UNIT II**

**Thermodynamics:** The zeroth, first, second and third law of thermodynamics, Free energy functions and applications.

**Physical properties of drug molecules:** Dielectric constant induced polarization, dipole moment, refractive index and molar refraction and optical rotatory dispersion.

**UNIT III**

**Solutions of Non electrolytes:** Concentration expressions, ideal and real solutions, colligative properties (lowering of vapour pressure, depression in freezing point, elevation of boiling point and Osmotic pressure), molecular weight determinations.

**Solutions of Electrolytes:** Properties of solutions of electrolytes. The Arrhenius theory of electrolyte dissociation. The modern theory of strong electrolytes (Activity co-efficient and ionic strength).

**UNIT IV**

**Ionic equilibria:** Modern theories of acids, bases and salts, Sorensen's pH scale, concentration as a function of pH, calculation of pH and acidity constants.

**Buffers and isotonic systems:** The buffer equation, buffer capacity, buffers in pharmaceutical and biological systems, isotonic solutions, methods of adjusting tonicity and pH (relevant numerical problems).

**UNIT V**

**Kinetics and drug stability:** General consideration and concepts, half life period ( $t_{1/2}$ ) determination, influence of temperature and Arrhenius theory, light, solvent, catalytic species and other factors. Accelerated stability studies, expiration dating.

**TEXT BOOKS:**

1. Patrick J. Sinko, *Martin's Physical Pharmacy and Pharmaceutical Sciences Fifth Edition*. Lippin  
Cott Williams and Wilkins.
2. C.V.S.Subramanyam, *Essentials of Physical Pharmacy*, VallabhPrakashan.
3. Manavalan & Ramaswamy. *Physical pharmaceutics*. 2<sup>nd</sup> ed. Vignesh publisher, 2008.

**REFERENCE BOOKS:**

1. *Pharmacopoeia*, (I.P., B.P., U.S.P. and European)
2. Martindale, *The Extra Pharmacopoeia*; latest edition, the Royal Pharmaceutical Society.
3. Lippincott Williams and Wilkins, *Remington Pharmaceutical Sciences*.
4. L. Lachman, H. Lieberman *The Theory And Practice Of Industrial Pharmacy* J. L Kaniz  
Lee &  
Febiger Philadelphia, USA.

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

- a. Understand the chemical & physical fundamental aspects of intermolecular forces,
- b. Relevant with laws of thermodynamics,
- c. Know the importance of solubilization of electrolytes & non-electrolytes,
- d. Recognize the significance of pH & tonicity that govern the *In vivo* & *In vitro* actions of pharmaceutical products.
- e. Define reaction kinetics, reaction order, and discuss factors affecting the rate of the reaction, degradation and stabilization of medicinal agents as well as accelerated stability testing.

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|--------------------|---|----------------------|-----------|
| <b>Subject</b>     | <b>PHARMACEUTICAL ORGANIC CHEMISTRY – III</b> | <b>Course Code</b>   | 15R00303  |
| <b>Course year</b> | B. Pharmacy II year                           | <b>Semester</b>      | I         |
| <b>Theory</b>      | 3 hrs/week                                    | <b>Tutorial</b>      | 1 hr/week |
| <b>End exam</b>    | 70 marks                                      | <b>Internal exam</b> | 30 marks  |
| <b>Credits</b>     | 3   |                      |           |

**Objectives:**

1. To fulfil the knowledge on basics of hetero cyclic chemistry and stereo chemistry of organic molecules.
2. To understand the knowledge of organic chemistry in relation to natural compounds such as carbohydrates, proteins and lipids etc..
3. To impart the knowledge on fundamentals of named reactions and rearrangements.

**UNIT I: Heterocyclic chemistry**

Definition, nomenclature, structure, aromaticity, reactivity, synthesis, acidity-basicity and characteristic reactions of the following heterocyclic compounds. Few examples of drugs which contain the cited ring system.

**Five membered ring systems:** Furan, pyrrole, thiophene, Pyrazole, imidazole, oxazole, isoxazole, thiazole. **Six membered ring systems:** pyridine, pyrazine, pyrimidine and pyridazine. **Fused ring systems:** Indole, quinoline, iso-quinoline, acridine, Benzimidazole, phenothiazine, purines.

**UNIT II: Stereochemistry of Carbon compounds -** Optical rotation, plane polarized light, optical activity, chirality, notations (assignment of configuration), relative configuration (Fischer DL configuration), absolute configuration (R & S), sequence rules (with examples), enantiomers, meso compounds, racemic mixture and resolution of racemic mixture.

Concept of E & Z, Cis & Trans, Syn & Anti configurations. Elements of symmetry. Stereo selective & stereo specific reactions. Optical activity of biphenyl compounds.

**UNIT III**

**Carbohydrates:** Definition, classification, nomenclature, study of glucose structure, mutarotation, ring structure, oxidation-reduction reactions, osazone formation, epimerization, Lobry De Bruyn – Van Ekenstein reaction, structure of the sucrose, starch and cellulose. non-reducing nature; A brief account on pharmaceutical importance of various carbohydrates. **Glycosides:** Definition, classification,  $\alpha$ ,  $\beta$  – glycosidic linkages, enzymatic hydrolysis, structure and physiological importance of Anthraquinone glycosides.

**UNIT IV**

**Amino acids and Proteins:** Definition, classification, configuration, methods of preparation of amino acids, physical, chemical properties, Zwitter ionic nature and isoelectric point. peptide synthesis, CTAA and NTAA concept and determination. Structure and chemistry of Insulin, Oxytocin, Heparin. Pharmaceutical importance of polypeptides and proteins.

**Lipids (oils and fats):** Definition, classification of fatty acids, trans and cis fatty acids, fat analysis including Saponification value, acid value, peroxide value and Iodine value etc.), hydrogenation and rancidity of oils and fats. Comparison of fat, oil, wax based on their properties.

## **UNIT V: Reaction mechanisms and applications in Drug synthesis**

Beckmann rearrangement, Birch reduction, Mannich reaction, Michael addition reaction, Wittig reaction, MPV reduction, Oppenauer oxidation, Curtius rearrangement, Schmidt reaction. Neighbouring group effects and reduction by transition metal complexes.

### **TEXT BOOKS:**

1. *Heterocyclic chemistry by Bansal, 5<sup>th</sup> edition.*
2. *Arun Bahl & S.S Bahl, Advanced Organic Chemistry-S.Chand.*
3. *R Morrison and R. Boyd, organic chemistry, Pub by Printice Hall of India, New Delhi.*
4. *I L Finar, Organic Chemistry, Vol. I. & II, 6<sup>th</sup> Pearson education*
5. *O.P Agarwal, A Textbook of Organic Chemistry*
6. *Eliel, Stereochemistry of Organic compounds.*
7. *Oraganic reactions, Stereo chemistry & mechanizam by PS Kalsi*

### **REFERENCE BOOKS:**

1. *Jerry March, Advanced Organic Chemistry 4<sup>th</sup> Edition Wiley Publication. 2 Cram & Hammond. Organic Chemistry Mc Graw-Hill.*
3. *A.I. Vogel's, A textbook of practical organic chemistry Mc Graw Hill. 6<sup>th</sup> Edition.*
4. *Solomons, Organic Chemistry 9<sup>th</sup> Edition Wiley Publication.*

### **Course outcomes:**

1. Graduate will Understand and apply the nomenclature, basic chemistry, stereochemistry, rearrangement reaction, mechanisms of heterocyclic & other organic compounds.
2. Graduates will able to synthesize basic heterocyclic molecules, analyze, estimate organic compounds and understand the recent methods of organic synthesis.

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|--------------------|--|--------------------|----------|
| <i>Subject</i>     | <b>PHARMACEUTICAL<br/>MICROBIOLOGY</b> | <i>Course Code</i> | 15R00304 |
| <i>Course year</i> | B. Pharmacy II year                    | <i>Semester</i>    | I        |
| <i>Theory</i>      | 3 hrs/week                             | <i>Tutorial</i>    | 1hr/week |
| <i>End exam</i>    | 70 marks                               | <i>Internal</i>    | 30 marks |
| <i>Credits</i>     | 3                                      |                    |          |

**OBJECTIVE :**

To know the anatomy, identification, growth factors and sterilization of microorganisms. To know the mode of transmission of diseases and applications of microorganisms in pharmaceutical field.

**UNIT I Introduction to Microbiology:** Origin, scope and discovery of spontaneous generations  
theory, contributions of Antonie Van Leeuwenhoek, Pasteur, Koch and Lister.  
Diversity of  
Microorganisms: Prokaryotes versus eukaryotes – eukaryotic and prokaryotic cell structure, threedomains of life (bacteria, archaea and eukaryotes).  
Pharmaceutical significance of protozoa, algae, fungi, bacteria and viruses.  
Characterization and identification of microorganisms.

**UNIT II Nutrition and Growth of Microbes:** Nutritional requirements, Types of Nutrient  
media and growth conditions and Nutritional types based on energy source. Isolation, cultivation (aerobic & anaerobic) and preservation of microorganisms, physiology of  
growth, bacterial growth curve, methods for determining bacterial numbers, mass and cell  
constituents. Exponential growth and generation time. Bacterial growth in batch and continuous culture (chemostat and turbidostat) synchronous growth.

**UNIT III Control of Microorganisms:** General Concepts, Inhibition of growth and killing,  
sterilization and disinfection, antisepsis and sanitation, mode of action application & limitation of physical agents (moist and dry heat, radiation and filtration), chemical agents. Various types of disinfectants, factors affecting sterilization and disinfection, evaluation of antimicrobial activity. Chemotherapeutic agents, mode of action and applications, drug resistance. Official methods of sterility testing of pharmaceuticals and biosafety measures.



## UNIT IV

**Epidemiology of Diseases:** Study of etiology, diagnosis, source of infection, mode of transmission, immunization methods, prevention and control of the following diseases. Bacillary dysentery, diphtheria, tuberculosis, leprosy, cholera, typhoid, syphilis, gonorrhoea, tetanus, food poisoning and infective hepatitis. Diagnostic tests of Malaria, Typhoid, Cholera, TB, Leprosy.

## UNIT V Application of Microbes in Pharmaceutical Industry

a. **Microbiological Assays:** Principles and Methods involved in Assay of Antibiotics (penicillins, tetracyclines and streptomycins only) Vitamins (cyanocobalamin and riboflavin only), Amino acids (lysine and glutamic acid only) & Bio-Sensors in Analysis.

b. **Microbial Source & applications of various pharmaproducts** like Antibiotics, vitamins, Amino acids, solvents, enzymes & genetic engineered products etc.

### **Text Books:**

1. Pelczar and Reid, *Text Book of Microbiology* Lippincott Williams & Wilkins, 2nd Edition.
2. Anantha Narayan and Jayram Panikar, *Text Book of Microbiology*, Orient Longman, Delhi, Hyderabad.
3. R.C. Dubey, *A textbook of Microbiology* S.Chand.

### **Reference Books:**

1. *Pharmaceutical microbiology* by Kishore Gujar, Himalaya publishing house.
2. Nester, Anderson, Roberts, Pearsall, *Microbiology*, McGraw-Hill.
3. Hugo. W B, *Pharmaceutical Microbiology*. PA Publishing Pvt. Ltd.
4. Tortora, Gerard, *Text Book of Microbiology*. Benjamin Cummings.
5. Prescott and Dunn, "*Industrial Microbiology*" 2nd Ed, Mc Graw Hill Book Company Inc.

## OUTCOMES :

1. Students can understand the importance of microbiology in industry & pharmacy
2. Students can learn the microbiological significance disease and its treatment.

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|--------------------|------------------------------|--------------------|----------|
| <b>Subject</b>     | <b>ENVIRONMENTAL STUDIES</b> | <b>Course Code</b> | 15A01101 |
| <b>Course year</b> | B. Pharmacy II year          | <b>Semester</b>    | I        |
| <b>Theory</b>      | 3 hrs/week                   | <b>Tutorial</b>    | 1hr/week |
| <b>End exam</b>    | 70 marks                     | <b>Internal</b>    | 30 marks |
| <b>Credits</b>     | 3                            |                    |          |

**Objectives:**

To make the students to get awareness on environment, to understand the importance of protecting natural resources, ecosystems for future generations and pollution causes due to the day to day activities of human life to save earth from the inventions by the engineers.

**UNIT – I**

**MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES:** – Definition, Scope and Importance – Need for Public Awareness.

**NATURAL RESOURCES :** Renewable and non-renewable resources – Natural resources and associated problems – Forest resources – Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people – Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. – Energy resources:

**UNIT – II**

**ECOSYSTEMS:** Concept of an ecosystem. – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem:

- a. Forest ecosystem.
- b. Grassland ecosystem
- c. Desert ecosystem
- d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

**BIODIVERSITY AND ITS CONSERVATION :** Introduction 0 Definition: genetic, species and ecosystem diversity – Bio-geographical classification of India – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

**UNIT – III**

**ENVIRONMENTAL POLLUTION:** Definition, Cause, effects and control measures of :

- a. Air Pollution.
- b. Water pollution
- c. Soil pollution
- d. Marine pollution
- e. Noise pollution
- f. Thermal pollution
- g. Nuclear hazards

**SOLID WASTE MANAGEMENT:** Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

**UNIT – IV**

**SOCIAL ISSUES AND THE ENVIRONMENT:** From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns. Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies – Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness.

#### **UNIT – V**

**HUMAN POPULATION AND THE ENVIRONMENT:** Population growth, variation among nations. Population explosion – Family Welfare Programmed. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of information Technology in Environment and human health – Case studies.

**FIELD WORK:** Visit to a local area to document environmental assets River/forest grassland/hill/mountain – Visit to a local polluted site-Urban/Rural/Industrial/Agricultural Study of common plants, insects, and birds – river, hill slopes, etc..

#### **Text Books:**

1. Text Book of Environmental Studies for Undergraduate Courses, Erach Bharucha, Universities Press Pvt Ltd, Hyderabad. 2<sup>nd</sup> Edition 2013.
2. Environmental Studies by Kaushik, New Age PUBLISHERS.

#### **References:**

1. Environmental Studies by Rajagopalan, Oxford Publishers.
2. Comprehensive Environmental studies by J.P.Sharma, Laxmi publications.
3. Introduction to Environmental engineering and science by Gilbert M. Masters and Wendell P. Ela - Printice hall of India Private limited.

#### **Outcomes:**

- Students will get the sufficient information that will clarify modern environmental concepts like equitable use of natural resources, more sustainable life styles etc.
- Students will realize the need to change their approach so as to perceive our own environmental issues correctly, using practical approach based on observation and self learning.
- Students become conversant with the fact that there is a need to create a concern for our environment that will trigger pro-environmental action; including simple activities we can do in our daily life to protect it.
- By studying environmental sciences, students is exposed to the environment that enables one to find out solution of various environmental problems encountered on and often.
- At the end of the course, it is expected that students will be able to identify and analyze environmental problems as well as the risks associated with these problems and efforts to be taken to protect the environment from getting polluted. This will enable every human being to live in a more sustainable manner.

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|--------------------|---|--------------------|----------|
| <b>Subject</b>     | <b>PHARMACEUTICAL ENGINEERING<br/>-LABORATORY</b> | <b>Course Code</b> | 15R00305 |
| <b>Course year</b> | B. Pharmacy II year                               | <b>Semester</b>    | I        |
| <b>Theory</b>      | 4 hrs/week  | <b>Tutorial</b>    | NIL      |
| <b>End exam</b>    | 50 marks  | <b>Internal</b>    | 25 marks |
| <b>Credits</b>     | 2   |                    |          |

**I. EXPERIMENTS:**

1. Evaluation of filter media, determination of rate of filtration and study of factors affecting filtration  
Including filter aids.
2. Particle size measurement by sieve shaker.
3. Determination of Humidity-using Dry Bulb and Wet Bulb thermometers and Psychometric charts.
4. Determination of overall Heat Transfer Coefficient.
5. Determination of rate of evaporation.
6. Determination of rate of drying, free moisture content and bound moisture content.
7. Experiments to illustrate the influence of various parameters on construction of drying curves.
8. Experiments to illustrate principles of size reduction, Laws governing energy and power requirements of a size reduction (Ball mill).
9. Experiments to illustrate solid-solid mixing, determination of mixing efficiency using different types of mixers.
10. Analysis of pharmaceutical packaging materials-leaching of contents from packaging materials.

**II. DEMO/ WORKSHOP**

Determination of type of flow (Reynolds experiment)  
Double cone blender, homogenizer, tray dryer.

**III. SEMINAR/ASSIGNMENT/GROUP DISCUSSION**

Advances in packaging technology.

**LIST OF MINIMUM EQUIPMENTS REQUIRED**

1. Tray dryer
2. Ball mill
3. Seive shaker with set of sieves as per IP
4. Double cone blender
5. Propeller type mechanical agitator
6. Homogeniser
7. Buchner filtration apparatus
8. Vaccum pump
9. Desiccators'
10. Energy meter
11. Autoclave

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| <i>Subject</i>     | <b>PHYSICAL PHARMACY – I<br/>LABORATORY</b> | <i>Course Code</i> | 15R00306 |
| <i>Course year</i> | B. Pharmacy II year                         | <i>Semester</i>    | I        |
| <i>Theory</i>      | 4hrs/week                                   | <i>Tutorial</i>    | NIL      |
| <i>End exam</i>    | 50 marks                                    | <i>Internal</i>    | 25 marks |
| <i>Credits</i>     | 2   |                    |          |

**I. EXPERIMENTS:**

1. Percent composition – Capillary Flow method.
2. Percent composition –refractometer.
3. Molecular weight – Rast camphor method.
4. Calibration of pH Meter using standard buffers pH Estimation – pH meter.
5. pKa Estimation by Half Neutralization Method.
6. Refractive index of liquids.
7. Phenol water system – CST.
8. Lower consolute temperature – TEA (Tri Ethyl Amine) and Water.
9. Ternary phase diagram.
10. Preparation of phosphate Buffers and their Buffer Capacity Determination.
11. Effect of temperature on first order kinetics and to find the energy of activation.

**II. Demo/ Workshop**

Demo on polarimeter (To prove that the hydrolysis of sucrose follows first order kinetics).

**III. SEMINAR/ASSIGNMENT/GROUP DISCUSSION**

Thermodynamics of solutions and polymers, Types of electrodes.

**LIST OF MINIMUM EQUIPMENTS REQUIRED**

1. Ostwald's viscometer
2. Stalgnometer
3. Polarimeter
4. Abbe's refractometer
5. CST apparatus
6. pH meter
7. Colorimeter
8. Digital balances

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|--------------------|--|--------------------|----------|
| <b>Subject</b>     | <b>PHARMACEUTICAL ORGANIC CHEMISTRY-III LABORATORY</b> | <b>Course Code</b> | 15R00307 |
| <b>Course year</b> | B. Pharmacy II year                                    | <b>Semester</b>    | I        |
| <b>Theory</b>      | 4 hrs/week   | <b>Tutorial</b>    | NIL      |
| <b>End exam</b>    | 50 marks   | <b>Internal</b>    | 25 marks |
| <b>Credits</b>     | 2  |                    |          |

**I. Experiments:**

**A. Quantitative determination of organic compounds via functional groups**

1. Phenolic groups by bromination method.
2. Alcoholic group by acetylation method.
3. Carbonyl group by hydroxylamine hydrochloride-pyridine method.
4. Aldehyde group by sodium sulphite-sulphuric acid procedure.
5. Carboxyl group by acid-base method.
6. Amino group by bromination method.
7. Amino acid formal titration method.

**B. Synthesis/preparation involving more than one step (Any five).**

8. Synthesis of acetophenone oxime and its conversion to acetamide.
9. Phenothiazine from diphenyl amine
10. Benzimidazole from o-phenylene diamine
11. Knorr quinoline synthesis (4-methyl 2- quinoline) from aceto acetanilide
12. Synthesis of Imidazole -4,5-dicarboxylic acid from tartaric acid
13. Benzilic acid from benzene.
14. Preparation of 2-phenylindole from Phenylhydrazine by Fischer's method.

**C. Systematic analysis of organic binary mixtures**

**D. Analysis of oils & fats**

- a. Determination of Acid value of fixed oils.
- b. Determination of Saponification value of a fixed oils.
- c. Determination of Iodine value of a fixed oils.
- d. Determination of peroxide value of a fixed oils.

**II. Demo/Workshop:**

Synthesis of some asymmetric organic molecules, identification of synthesized compounds by TLC, Catalyst and solvent effect in synthesis.

**III. Seminar/Assignment/Group discussion:**

Principles of green chemistry, solvent free synthesis, sonication as the green chemical method for organic synthesis.

**References:**

1. *Indian Pharmacopoeia*. – 1996.
2. *A.I. Vogel's – Practical Organic Chemistry – Prentice Hall*.
3. *Text Book of Practical Organic Chemistry, Vogel's, 5<sup>th</sup> Edition Pearson*.
4. *Laboratory Manual of Organic Chemistry, R.K. Bansal, New Age International 5<sup>th</sup> Edition 2007*.
5. *Advanced Practical Organic Chemistry, O.P. Agarwal, 3<sup>rd</sup> Edition Goel Publication*.
6. *Practical Organic Chemistry, F.G.Mann & B.C. Saunders, Pearson 4<sup>th</sup> Edition*.

***LIST OF MINIMUM EQUIPMENTS REQUIRED***

1. *Triple beam balances*
2. *Physical balances and analytical balances*
3. *Melting point apparatus*
4. *Suction pumps*
5. *Oven*
  
6. *Hot plates*
7. *Water baths*
8. *Distillation unit*
9. *Refrigerator*
10. *Mechanical stirrer*
11. *Reflex flask with condenser*
12. *Magnetic stirrer with thermostat*
13. *Adequate glassware's*

**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR  
ANANTHAPURAMU**

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|--------------------|---|--------------------|----------|
| <i>Subject</i>     | <b>PHARMACEUTICAL<br/>MICROBIOLOGY<br/>LABORATORY</b> | <i>Course Code</i> | 15R00308 |
| <i>Course year</i> | B. Pharmacy II year                                   | <i>Semester</i>    | I        |
| <i>Theory</i>      | 4 hrs/week  | <i>Tutorial</i>    | --       |
| <i>End exam</i>    | 50 marks  | <i>Internal</i>    | 25 marks |
| <i>Credits</i>     | 2   |                    |          |

**I. EXPERIMENTS:**

- 1 Introduction to equipment and glassware used in microbiology laboratory.
- 2 Preparation of various culture media.
- 3 Sterilization techniques and their validations.
- 4 Aseptic transfer of culture into different types of media.
- 5 Characterization of microbes by staining methods (simple gram's, acid fast and negative staining and spore staining) and motility testing by hanging drop method.
- 6 Enumeration of bacteria by pour plate/spread plate technique
- 7 Enumeration of bacteria by direct microscopic count.(Neubauer's chamber)
- 8 Isolation of pure cultures by streak plate, spread plate and pour plate.
- 9 Evaluation of antiseptics and disinfectants by phenol coefficient method(R/w),
- 10 Sterility test for bulk powders and water for injection (IP).
- 11 Observation of colony/culture characters
- 12 Bio chemical reactions:
  - i) Indole test.
  - ii) Methyl red test.
  - iii) Voges proskauer test.
  - iv) Starch hydrolysis test.
  - v) Fermentation of carbohydrates and gelatin liquefaction.
- 13 Anti-microbial assay by cup and plate method and turbidometric method

**II. Demonstration/Workshop:** Construction of Bacterial growth curve by different methods, Rapid Diagnostic tests by kits

**III. Assignment/Seminar/Group discussion:**

Recent trends in Identification, Cultivation, Handling of Microorganisms.  
Polymer Chain Reaction (PCR).