**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-II Semester**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| S.No | Course code | Subject | Th | Tu/Drg/Lab | Credits |
| 1. | 15R00401 | Pharmaceutical Analysis – I | 3 | 1 - - | 3 |
| 2. | 15R00402 | Pharmacognosy – II | 3 | 1 - - | 3 |
| 3. | 15R00403 | Pharmaceutical Technology – I | 3 | 1 - - | 3 |
| 4. | 15R00404 | Physical Pharmacy –II | 3 | 1 - - | 3 |
| 5. | 15R00405 | Pathophysiology  | 2 | 1 - - | 2 |
| 6. | 15R00406 | Pharmaceutical Analysis – I Laboratory | - | - - 4 | 2 |
| 7. | 15R00407 | Pharmacognosy – II Laboratory | - | - - 4 | 2 |
| 8. | 15R00408 | Pharmaceutical Technology – I Laboratory |  |  - - 4 | 2 |
| 9. | 15R00409 | Physical Pharmacy –II Laboratory | - | - - 4 | 2 |
| 10. | 15R00410 | Comprehensive Online Exams-I | - | - - - | 1 |
|  14 5 16 | 23 |

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| ***Subject*** | **PHARMACEUTICAL ANALYSIS – I** | ***Course Code***  | 15R00401 |
| ***Course year***  | B. Pharmacy II year | ***Semester***  | II |
| ***Theory*** | 3 hrs/week | ***Tutorial***  | 1 hr/week |
| ***End exam***  | 70 marks | ***Internal exam***  | 30 marks |
| ***Credits***  | 3 |  |  |

**COURSEOBJECTIVE**

To aquire adequate scientific knowledge regarding basic principles of pharmaceutical analysis.

**UNIT I**

a) Definition of Analytical chemistry and role of pharmaceutical analysis in pharmaceutical industry.

 Significant figures, concept of error, precision, accuracy, rejection of doubtful values with special

reference to volumetric analysis. Calibration of glassware used in volumetric analysis-Burette, pipette and volumetric flask. Methods of expression of concentration(w/w,w/v,v/v).

b) **Theory of Neutralization Titrations**: Acid-base concept, Acidimetry, Alkalimetry, Common ion

effect and solubility product, indicators, Ostwald and quinonoid theories of Indicators

c) **Non-aqueous titration:** Theory, types, solvents used and application in pharmaceutical analysis.

***Application of the above methods in the analysis of drugs and formulations as under IP 2007and***

***2010.***

**UNIT II**

a) General principles, theory and examples of **oxidation-reduction methods,** permanganomerty**,**

ceriometry, iodometry, iodimetry indicators used in these titrations, self indicators.

b) General principles, theory and examples of **Precipitation methods:** Mohr’s method, volhard’s

method, account of the indicators used in these titrations, Adsorption indicators.

c) **Complexometric titration:** Theory, types and application in pharmaceutical analysis. Indicators

used, Masking and demasking and their applications.

***Application of the above methods in the analysis of drugs, as under IP 2007and 2010.***

**UNIT III**

a) Potentiometry: Introduction to EMF, electrochemical cells and half cells, Electrodes, measurement

of potential, pH curve, EMF curve, derivative curve in application to end point determination.

b) Conductometric titrations: Basic concepts, conductivity cell, different types of conductometric

titrations.

c) Polarography: Basic concepts, apparatus and principles, different currents, polarographic maxima,

general polarographic analysis, applications in identification and quantification of metals.

d) Amperometric titrations with one polarized electrode, general procedure, titration curves,

applications in pharmaceutical analysis.

**UNIT IV**

**Fluorimetry:** Theory, Fluorescence and chemical structure, stokes and anti-stokes, quantum efficiency,factors affecting the intensity of fluorescence, Instrumentation (double beam), Applications inPharmaceutical analysis.

**Flame Emission photometry Vs Atomic absorption spectroscopy:** Emission spectra, Absorptionspectra, line spectra, principle of absorption / emission of UV light by elements, instrumentation,applications in pharmaceutical analysis. Focus on interference.

**Nephelo-turbidimetry:** Introduction, principle, instrumentation of Nephelo-turbidimeter,pharmaceutical application as specified in IP, determination chlorides and sulphates.

**UNIT V**

a) Principle and applications of the following instruments and various grades of reagents a in QC laboratory.

 i) Refractometry ii) Polarimetry. iii) LR Grade iv) AR grade v) HPLC grade.

b). Role of moisture content determination in QC of pharmaceuticals (including Karl-Fisher method, LOD, IR balance).

***TEXT BOOKS:***

*1. A.H. Beckett & J.B Stanlake Vol. I & II., Practical Pharmaceutical Chemistry, Athlone Press of the Univ of London*

*2. B.K. Sharma, Instrumental Chemical Analysis, Goel Publishers.*

*3. Chatwal & Anand, Instrumental Methods of Analysis. Himalaya Publishing Home, 2009.*

***REFERENCE BOOKS:***

*1. A.I Vogel, Quantitative Chemical Analysis, VI edition, Pearson education Delhi.*

*2. Pharmacopoeia (IP, BP, USP).*

*3. D. A. Skoog, Principles of Instrumental Analysis, V edition, Thomson Brooks Banglore.*

*4. Connors, a Textbook of Pharmaceutical Analysis. Wiley India Pvt. Ltd*

**OUTCOME:**

Graduates will conduct analyze and interpret data of experiments in production, Analytical and clinical aspects

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| ***Subject*** | **PHARMACOGNOSY-II** | ***Course Code*** | 15R00402 |
| ***Course year*** | B. Pharmacy II year | ***Semester*** | II |
| ***Theory*** | 3 hrs/week | ***Tutorial*** | 1 hr/week |
| ***End exam*** | 70 marks | ***Internal exam*** | 30 marks |
| ***Credits***  | 3 |  |  |

**Objectives:** To make the student aware of Secondary metabolites production in plants and its medicinal significance, cosmeceuticals and nutraceuticals importance.

**UNIT I**

**Glycosides**

Definition, classification, properties and general tests of glycosides and detailed Pharmacognostic study of the following glycosides containing drugs:

1. **Saponin glycosides**- Glycyrrhiza, Ginseng, Dioscorea, Senega, Sarsaparilla
2. **Cardioactive glycosides**-Digitalis, Squill, Strophanthus, Thevetia
3. **Anthraquinone glycosides**-Aloe, Senna, Rhubarb, Cascara
4. **Bitter Glycosides**- Psoralea, Gentian, Chirata

**UNIT II**

1. General introduction to cosmeceuticals, role of herbs in cosmetics.
* Study of the following cosmeceuticals - Amla, Henna, Cyperus, Soap Nut, Aloe Vera, Turmeric, Sandal Wood and Bitter Orange Peel.
1. Definition and study of Neutraceuticals: Garlic, Spirulina, Soya and Royal jelly.

**UNIT III**

**Alkaloids:**

Definition, classification, properties and general tests and detailed pharmacognostic study of the following alkaloid containing drugs:

* 1. **Pyridine-Piperidine alkaloids**- Tobacco, Lobelia
	2. **Tropane**- Belladonna, Hyoscyamus, Datura, Coca.
	3. **Indole**-Ergot, Rauwolfia, Vinca, Nux Vomica
	4. **Imidazole**-Pilocarpus
1. **Steroid**- Kurchi, Veratrum, Aswagandha

**UNIT IV**

1. **Quinoline-Isoquinoline**-Cinchona, Ipecac, Opium

b**. Alkaloidal amine**- Ephedra, Colchicum

c. **Glycoalkaloid**-Solanum

d**. Purine**-Coffee, Tea, cola

e**. Quinazoline** -Vasaka

**UNIT V**

1. **Biogenesis:** General techniques of biosynthetic studies and basic metabolic pathways.
* Biogenesisof secondary metabolites of pharmaceutical importance.
1. **Extraction of herbal materials**: Definition of extraction, principle involved in extraction,different types of extraction.
* Factors affecting the process of extraction.
1. **Phytochemical Screening:** Preparation of extracts, identification and screening of alkaloids, saponins, cardiac glycosides, flavonoids, tannins and anthraquinones in plant extracts.

***Text Books:***

*1. Kokate CK, Purohit A.P. & Gokhale; Pharmacognosy Nirali Prakashan, New Delhi.*

*2. Text book of Pharmacognosy by Handa and Kapoor.*

*3. Peach K and Tracey MV, Modern methods of Plant analysis, Narose publishing house, New Delhi.*

*4. Pharmacognosy by Brady & Tyler.*

*5. Tutorial Pharmacy by Cooper and Gunn.*

*6. text book of pharmacognosy and phytochemistry by Vinod D Rangari, Vol I and II.*

***Reference Books:***

1. *Text book of Pharmacognosy by Wallis.*
2. *Herbal drug technology by Pulok Mukharjee*
3. *Pharmacognosy by Trease and Evans*
4. *Biosynthesis of natural products by Manitto P*
5. *Harbone JB, Phytochemical methods, Champman and Hall*

**OUTCOME**

a. know the scientific name, geographical distribution, chemical nature and uses of crude drugs.

b. know the role of glycosides, alkaloids in treating of various ailments of human beings.

c. know the significance of nutraceuticals and cosmeceuticals in maintaining the health conditions and appearance.

d. know various techniques used in biogenesis of secondary metabolites.

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| ***Subject***  | **PHARMACEUTICAL TECHNOLOGY – I** | ***Course Code***  | 15R00403 |
| ***Course year***  | B. Pharmacy II year | ***Semester***  | II |
| ***Theory***  | 3 hrs/week | ***Tutorial*** | 1hr/week |
| ***End exam***  | 70 marks | ***Internal*** | 30 marks |
| ***Credits***  | 3 |  |  |

**Scope and objectives:1.** This course is designed to understand the aspects of preformulation and formulation of liquid and semi solids

2. To gain the knowledge on stability associated ICH guidelines.

3. To gain basic knowledge on blood products.

**UNIT I**

**Preformulation**: Goals, Physicochemical properties like physical form, particle size, shape, density, wetting, dielectric constant, solubility, dissolution, partition coefficient, organoleptic additives, hydrolysis, oxidation-reduction, racemization, polymerization, etc and their effect on formulation, drug-excipient incompatability studies,. Introduction to Stability testing of finished products as per

ICH guidelines.

**UNIT II**

**Liquid dosage forms:** Introduction, types of additives used in formulations, vehicles, stabilizers,

preservatives, suspending agents, emulsifying agents, solubilizers, colors, flavours and others,

manufacturing packaging and evaluation of clear liquids, suspensions and emulsions official in

pharmacopoeia.

**Dry syrups:** Requirements, formulation, methods of preparation, containers, evaluation.

**UNIT III**

**Semisolid dosage forms:** Definitions, types, mechanisms of drug penetration, factors influencing

penetration, semisolid bases and their selection. General formulation of semi solids, clear gels

manufacturing procedure, evaluation and packaging.

**Suppositories:** Ideal requirements of bases, Different types of bases, displacement value, manufacturing procedure, packing and evaluation.

**UNIT IV**

**Pharmaceutical aerosols:** Definition, propellants general formulation, manufacturing and packaging

methods, pharmaceutical applications. Quality control tests for aerosols.

**UNIT V**

**Blood Products and Plasma Substitutes:** Collection, processing and storage of whole human blood, Concentrated human RBC’s, dried human plasma, human fibrinogen, human thrombin, human normal immunoglobulin, human fibrin, foam plasma substitutes, ideal requirements, PVP, Dextran etc. For control of blood pressure as per IP.

***Text Books:***

*1. L. Lachman, H.A, Lieberman and J.L. Kanig, Theory & Practice of industrial pharmacy, Lea &*

*Febieger, Philadelphia Latest Edn.*

*2. L. V. Allen Jr., N. G. Popovich, H. C. Ansel. Ansel‟s pharmaceutical dosage forms and drug*

*delivery systems. Lippincott Williams & Wilkins, 2005.*

*3. M. E. Aulton Pharmaceutics. The science of dosage form design. - 2nd ed. Churchill-Livingstone,*

*2002*

*4. B.M.Mithal. a text book of pharmaceutical formulations, 6thed., vallabh prakashan, 2010.*

***Reference Books:***

*1. Banker and Rhodes, Modern pharmaceutics, marcel dekker series.*

*2. James Swarbrick, Encyclopedia of pharmaceutical technology, 3 rd edi, informa healthcare.*

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

1. Acquire sufficient knowledge of preformulation and formulation of liquid and semi solids.
2. Understand the importance of blood products.
3. Describe what the pharmaceutical suspension and emulsion is and what roles they play in pharmaceutical science.

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| ***Subject***  | **PHYSICAL PHARMACY – II** | ***Course Code***  | 15R00404 |
| ***Course year***  | B. Pharmacy II year | ***Semester***  | II |
| ***Theory***  | 3 hrs/week | ***Tutorial*** | 1hr/week |
| ***End exam***  | 70 marks | ***Internal*** | 30 marks |
| ***Credits***  | 3 |  |  |

**Scope and objectives:** This course is designed to understand the physico-chemical fundamental aspects of solubility, distribution, flow of liquids & solids, complexation & interfacial phenomenon, andto gain knowledge on formulation & stability aspects of dispersion systems, drug decomposition & their kinetics.

**UNIT I**

**Solubility and distribution phenomena:** Solvent-solute interaction, solubility of gases in liquids,

solubility of liquids in liquids, solubility of solids in liquids, distribution of solutes in immiscible

solvents.

**Introduction to phenomena of diffusion:** Fick’s first law and second law.

**Complexation:** Classification of complexes, methods of preparation, analysis and applications.

**UNIT II**

**Interfacial Phenomena:** Liquid interfaces, spreading coefficient, measurement of surface and interfacial tensions,adsorption at liquid interfaces. Adsorption isotherms only (freundlich’s isotherms and Langmuir’sisotherm’s).Surface-active agents and HLB classification, solubilization, detergency.Parachor, Adsorption at solid interfaces. Solid gas and solid liquid interfaces, complex films, electrical propertiesof interfaces.

**UNIT III**

**Micromeritics and Powder Rheology:** Particle size and size distribution, number and weight distribution, particle number, methods for determining particle volume, methods of determining particle size: optical microscopy and sedimentation, measurement of particle shape, specific surface area: methods for determining surface area, permeability, adsorption, derived properties of powders, porosity, packing arrangement, densities, bulkiness and flow properties.

**UNIT IV**

**Rheology:** Newtons law of flow, kinematic viscosity, effect of temperature, Newtonian systems, non-Newtonian systems: pseudoplastic, dilatant, plastic, thixotropy, negative thixotropy Determination of viscosity, capillary, falling ball and rotational viscometers.

**UNIT V**

**Colloids:** Introduction, types of colloidal systems, protective colloids, applications of colloids in pharmacy.

**Coarse Dispersions:**

*Suspensions*: Types and theories of suspensions, effect of Brownian motion, interfacial properties of suspended particles, settling in suspensions. Sedimentation parameters, wetting of particles, controlled flocculation, flocculation in structured vehicles, rheological considerations.

*Emulsions:* Theories of emulsification, physical stability of emulsions.

***TEXT BOOKS:***

*1. Patrick J. Sinko, Martin's Physical Pharmacy and Pharmaceutical Sciences 5th Edition.Lippincolt*

*Williams.*

*2. CVSSubhramanyam, Physical Pharmaceutics, Vallabhprakashan.*

*3. Manavalan&Ramaswamy. Physical pharmaceutics. 2nd ed. Vignesh publisher, 2008.*

***REFERENCE BOOKS:***

*1. Lippincott Williams and Wilkins, Remington Pharmaceutical Sciences*

*2. 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:**

1. Acquire sufficient knowledge of surface and interfacial tension and its measurement.
2. Appreciate the role of surface active agents in controlling the solubility and stability of the liquids
3. Understand the different types of flow, thixotropic properties in order to identify and choice the suitable characters for each formulation
4. Describe what the pharmaceutical suspension and emulsion is and what roles they play in pharmaceutical science.

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| ***Subject*** | **PATHOPHYSIOLOGY** | ***Course Code*** | 15R00405 |
| ***Course year*** | B. Pharmacy II year  | ***Semester*** | II |
| ***Theory*** | 2 hrs/week | ***Tutorial*** | 1 hr/week |
| ***End exam*** | 70 marks | ***Internal exam*** | 30 marks |
| ***Credits*** | 2 |  |  |

**Objectives:** 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 of its application in other subject of pharmacy.

**UNIT I:**

**Basic Principles of Cell Injury, Adaptation:** Causes of cellular injury,pathogenesis and morphology of cell injury-autolysis, necrosis, apoptosis. Cellular adaptations-atrophy, hypertrophy.

**Inflammation:**Basic mechanism involved in inflammation and repair, alteration in vascular permeability and blood flow. Acute and chronic inflammation, mediators of inflammation.

**UNIT II:**

**Cancer:** Types of cancer, causes of cancer, cell cycle of normal & cancer cell. Apotosis and cell differentiation. Carcinogenesis and molecular mechanism of carcinogenesis. Markers involved in diagnosis of cancer.

**UNIT III:**

**Pathophysiology of common diseases** like hypertension, angina, congestive cardiac failure, atherosclerosis, myocardial infraction, diabetes and thyroid.

**UNIT IV:**

**Pathophysiology of common diseases** likeepilepsy, psychosis, depression, mania, parkinson’s disease, arthritis, gout, osteoporosis and peptic ulcer.

**UNIT V:**

**Pathophysiology of common diseases** likeasthma, tuberculosis, AIDS, acute & chronic renal failure and urinary tract infections, hepatitis and obesity.

**TEXT BOOKS:**

1. Harsh mohan, text book of pathology, latest edition.
2. Joseph Dipiro, Pathophysiology and applied therapeutics.

**REFERENCE BOOKS:**

1. Robbins, SL & Kumar, Basic Pathology. 8th Edition Elsewier.
2. Mary V. Buras, Pathophysiology: A self Instructional programme. Prentice Hall.
3. Mary Lou Mulvihill, Human Diseases: A Systemic approach. Prentice Hall 6th Edition.

**Outcomes:**

Upon completion of the subject student shall be able to

a. Describe the etiology and pathogenesis of the selected disease states;

b. Name the signs and symptoms of the diseases; and

c. Mention the complications of the diseases.

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| ***Subject*** | **PHARMACEUTICAL ANALYSIS – I LABORATORY** | ***Course Code***  | 15R00406 |
| ***Course year***  | B. Pharmacy II year | ***Semester***  | II |
| ***Theory*** | 4 hrs/week | ***Tutorial***  | -- |
| ***End exam***  | 70 marks | ***Internal exam***  | 30 marks |
| ***Credits***  | 2 |  |  |

**I. Experiments:**

1 Calibration of analytical glass ware.

2 Assay of Sodium carbonate by acid-base titration.

3 Assay of Ferrous sulfate (redox) ceric ammonium sulfate titration.

4 Assay of Sodium benzoate by non-aqueous titration.

5 Assay of Sodium chloride by precipitation titration.

6 Assay of Calcium gluconate by complexometry.

7 Potentiometric titration : Determination of strength of unknown solution HCl, HCl –Acetic acid mixture) against std. NaOH Solution.

8 Assay of any drug by potentiometry, (eg. Frusemide, metronidazole).

9 Conductometric titration – Determination of strength of unknown solution (HCl, HCl– Acetic Acid mixture) against std. NaOH Solution.

10 Determination of refractive index of any sample by Abbe’s refractometer.

11 Determination of sucrose concentration by Polarimetry.

12 Determination of moisture content by Karl-Fishcer reagent.

**II. Demo/work shop**

1. Demonstration on gel electrophoresis
2. Demonstration on Polarography

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

1. List out various drugs that can be assayed by acid-base titration, as perI.P.2007.

2. What is the need of determination of moisture content, what is the limit ofmoisture in various natural and synthetic drugs?

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| ***Subject*** | **PHARMACOGNOSY-II LABORATORY** | ***Course Code*** | 15R00407 |
| ***Course year*** | B. Pharmacy II year | ***Semester*** | II |
| ***Theory*** | 4 hrs/week | ***Tutorial*** | NIL |
| ***End exam*** | 70 marks | ***Internal exam*** | 30 marks |
| ***Credits***  | 2 |  |  |

**EXPERIMENTS:**

1. Study of various morphological characters of the drugs mentioned in theory under alkaloids
2. Study of various morphological characters of the drugs mentioned in theory under glycosides.
3. Microscopy (Transverse section & powder) of Datura and Vinca leaf
4. Microscopy (Transverse section & powder) of Cinchona and Ephedra
5. Microscopy (Transverse section & powder) of Nux vomica and Rauwolfia
6. Microscopy (Transverse section & powder) of Digitalis and Senna
7. Microscopy (Transverse section & powder) of Squill and Liquorice
8. Preparation and evaluation of any one herbal cosmeceutical preparation
9. Preliminary phytochemical screening of any one plant
10. Determination of crude fibre content for any one nutraceutical listed under theory.

**Seminar/ Assignment/Group discussion**

Seminar/assignment related to theory.

**Workshop/Demo**

Extraction of plant material using Soxhlet apparatus

**References**

* 1. Practical Pharmacognosy, C K Kokate, Nirali Prakashan
	2. Practical Pharmacognosy, Khandelwal, Nirali Prakashan
	3. Practical Pharmacognosy Iyengar, Manipal Press Ltd.
	4. Peach K and Tracey MV, Modern methods of Plant analysis, Narose publishing house, New Delhi.

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| ***Subject***  | **PHARMACEUTICAL TECHNOLOGY – I LABORATORY** | ***Course Code***  | 15R00408 |
| ***Course year***  | B. Pharmacy II year | ***Semester***  | II |
| ***Theory***  | 4 hrs/week | ***Tutorial*** | -- |
| ***End exam***  | 70 marks | ***Internal*** | 30 marks |
| ***Credits***  | 2 |  |  |

 **I. EXPERIMENTS:**

1. Preparation, evaluation and packaging of

a) Solutions: Paracetamol syrup, codeine phosphate linctus

b) Ferrous sulphate syrup

c) Suspensions: Milk of magnesia

d) Emulsions: o/w or w/o type

e) Benzyl benzoate lotion

f) Ointments: Benzoic acid ointment

g) Methyl salicylate ointment

h) Suppositories: Boric acid

i) Eye drops: Gentamycin.

j) Eye ointments: Chloramphenicol.

k) Sodiumchloride eye lotion

l) Cream: Cetrimide

m) Cold cream

n) Zincoxide jelly

o). Preparation of gel

**II. DEMO/ WORKSHOP**

Drug-excipient incompatibility studies, ointment filling machine.

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

1) Excipients and their concentrations in various dosage forms.

2) Seminar on blood products

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| ***Subject***  | **PHYSICAL PHARMACY – II LABORATORY** | ***Course Code***  | 15R00409 |
| ***Course year***  | B. Pharmacy II year | ***Semester***  | II |
| ***Theory***  | 4 hrs/week | ***Tutorial*** | NIL |
| ***End exam***  | 70 marks | ***Internal*** | 30 marks |
| ***Credits***  | 2 |  |  |

**I. EXPERIMENTS:**

1. Determination of bulk density, true density and percentage porosity.

2. Effect of particle size and effect of glidant on angle of repose.

3. Study of particle/globule size distribution by optical microscopy

4. Determination of CMC of a surfactant.

5. Determination of partition coefficient

Iodine between water and carbon tetrachloride

6. Determination of sedimentation volume and degree of flocculation.

7. Effect of addition of Salt/pH/co-solvent on the solubility

8. Surface tension using Stalagmometer.

9. HLB value estimation of surfactants.

10. Viscosity – by Ostwald Viscometer.

**II. DEMO/ WORKSHOP**

Determination of particle size by AndreasonPippette, Plotting of an adsorption isotherm

Brook field viscometer.

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

Viscoelasticity, solublisation techniques

***References***

*1.Physical Pharmaceutics, By Mohanta, and Guru Prasad B.S. Publications*

***List Of Minimum Equipments Required***

*1. Ostwald‟s viscometer*

*2. Stalgnometer*

*3. Digital pH meter*

*4. Microscopes*

*5. Stage and eyepiece micrometer*

*6. Digital electronic balance*

*7. Thermometer*

*8. Andreasonpipetter*

*9. Adequate glasswares*