

196

21.07.10  
22/07/10  
30.07.14  
22.07.14  
30.07.14

Proposed Course Structure

&

Detailed Syllabus for Bachelor of Technology

In

***Leather Technology***

## ***Theory & Practices of preservation and pre-tanning operations***

### **Preservation of Hides and Skins :**

Principles and practice involved in long and short term preservation techniques for hides and skin, Preservation, defects.

### **PRETANNING PROCESSES :**

**Soaking** :- Physico-chemical explanation of wetting, objectives materials, methods and different controls in soaking operation

**Liming** :- Chemistry of Unhairing, Unhairing by different methods, Objectives of liming, Effects of liming in collagen, controls in liming operation to achieve different physical properties of leather.

**Deliming and Drenching** :- Objectives, Principles and controls of deliming and drenching.

**Bating** :- Chemistry of proteolytic enzymes used for bating, Necessity of bating, its necessity and controls for desired properties of leather.

**Pickling** :- Acid binding capacity of collagen, use of organic acids or salts in pickling, its necessity and controls, concept of De-pickling.

**Degreasing** :- Objectives and necessity of Degreasing, different degreasing systems and methods.

### **CLEANER PROCESSING PRACTICES IN BEAM HOUSE**

Salt free curing option, Sulfide free unhairing system, ammonia free deliming, salt free pickling system, eco friendly degreasing system, strategies to bring down BOD, COD and TDS of tannery effluents

## ***Introduction to Leather Technology***

Live stock population, animal mortality and availability of hides and skins in India.

Statistical analysis of leather Industries, Leather, Leather products ( National & International Scenario).

Chemical constituents of hides and skins.

General principles involved in raw hide and skin preservation, assortment and their processing, pre tanning, tanning and post tanning operations.

Defects in leather, Microscopy & Bacteriology

### ***Bio-Chemistry of Proteins***

#### **Fundamentals of Biochemistry :-**

The molecular logic of life, strong and weak interactions, introductory concept of cell, bio-molecules and water.

Histology and fibre packing in commercially viable hides/skins.

#### **Amino acids, peptides and proteins :-**

Chemistry, Classification determination of amino acids, Qualitative and Quantitative determinations, Structure of Various amino acids, formation of peptides, polypeptides and separation of proteins, covalent structure of proteins, Reaction of Proteins with acid, bases and salts.

Polarity of amino acids and ionization of proteins, electro-phoresis, hydration, solubility of proteins, dielectric properties, intermolecular forces of proteins cross linking in collagen, Iso-electric point of collagen and its manipulation in various stages of leather manufacture. Acid and base binding capacity of collagen, reversible and irreversible acid and base binding capacity of collagen, Effects of anions, swelling (osmotic and lyotropic) and phase transition in collagen, helix-coil transition, Denaturation and melting of collagen. Glass transition of collagen, Shrinkage denaturation and optical birefringence of collagen.

Structure, function and chemical features of collagen reactive groups and Cross linking, Tropo collagen molecules, Sub-units of collagen, Types of collagen, Structure and function, Fibril formation, Precipitated forms of collagen, Electron microscopy of the collagen fibre, Bio-Synthesis.

Structure and functional role of other skin proteins like keratin, Reticulin and Elastic, albumin, globulin and mucine etc.

### ***CHEMICAL ENGINEERING -I***

1. **Fluid Mechanics :-** Properties of fluids, Compressible, Incompressible fluid, Viscosity, Elasticity, Vapour pressure, Surface tension, Buoyancy and floatation.
2. **Flow Measurement :-** Pitot tube, Venturi meter, Orifice meter, Pumps, Manometers.
3. **Fluid Dynamics :-** Bernoulli's theorem, Continuity equation, Euler's equation, Energy and momentum equation, Basic concept of Newtonian and Non-Newtonian fluid.

4. **Heat transfer** :- Heat transfer by conduction, convection and radiation, Conduction through plain and cylindrical surfaces, Natural and forced convection, Heat transfer coefficient. Log mean temp. difference.
5. **Evaporation** :- Types of Evaporators, Operation of Evaporation unit, Different methods of feedings.
6. **Size Separation** :- Screening, Mixing and agitation, floatation,

## ***CHEMICAL ENGINEERING –II***

1. Nitration, Alkylation, Halogenation, Sulfonation.
2. **Crystallization** :- Theory of crystallization, crystallization equipment for chemical processing.
3. **Adsorption** :- Theory of adsorption, Industrial adsorbents adsorption equipments Decolourization of chemicals.
4. **Diffusion** :- Binary diffusion Concept of mass transfer coefficients and interface mass transfer and stage wise contact.
5. **Absorption** :- Theory of gas absorption, Design and operation of absorption towers, Humidity and its measurements. Adiabatic Saturation temp. Dry and wet bulb temp, Humidity chart.

## ***Principles of Inorganic Tanning***

**Tanning** :- Theory, Chemistry, Factors and objectives of following inorganic tanning operations :- (a) Chrome Tanning (b) Aluminum Tanning (c) Iron Tanning (d) Zirconium Tanning (e) Titanium Tanning (f) Poly Phosphate Tanning and (g) Silica Tanning.

### **Introduction to Co-ordination Chemistry, metal ion in tanning :-**

Historical introduction to mineral tanning, Introduction of factors controlling molecular stability of transition metal complexes, Werner's theory of Co-ordination, Role of d and f orbitals, Definition of ligands, Ligand Bond in Collage, Chelation, Masking agent :- Their requirement for use in chrome tanning, Effect of masking on chrome tanned leather & as chrome liquor.

### **Aqueous Chemistry of Chromium :-**

Electric configuration, common oxidation states of chromium, stabilities of Chromium (IV) and Chromium (III) salt, Basicity, Olation, Oxolation and polymerization, complexity of chrome complexes.

**Factor Controlling Chrome tanning :-**

Single and double bath chrome tannage and their relative merits and demerits, preparation of Basic chromium sulphate salt, Effects of float Volume, PH, basicity, Masking temperature, drum speed, ageing chrome tanned substrate.

**Mechanism of chrome tanning :-**

Theories of chrome tanning, Absorption, Coating, Electrostatic and hydrogen bond interaction and co-ordinative forces involved in chrome tanning, hydro thermal stability of chrome-collagen compound.

***Principles of Organic Tannage*****Vegetable Tannins -**

Classification of Vegetable tannins – Structural aspects, Analysis of Chemistry of Hydrolysable & Condensed tannins, Manufacture of vegetable tannin extract use of additive for product notification, Reactions of vegetable tannins with collagen, Principle of vegetable tanning, Factors affecting tannin diffusion & factors affecting tannin fixation with collagen, Principle of Rapid tanning methods.

**Synthetic tannins -**

Chemistry & Multifunctional properties of syntans, Nontans in synthetic tannins, General Manufacturing methods of Phenol, Formaldehyde Naphthalene, Formaldehyde and Naphthol, Formaldehyde condensates, Supra Syntans, Use of Syntans for the Manufacture of various Leathers & for chemical modifications for specific objectives, use of Lignosulfonic acids in Leather processing.

**Resin Syntans -**

Urea, Formaldehyde & Melamine, Formaldehyde condensates as tanning agents for leather, their chemistry & structure, Property, Relationship, Polyacrylates & Polyurethanes as Resin tanning agent Principles of their use.

**Aldehydes as tannins -**

Formaldehyde and other mono, difunctional aldehydes their chemistry, Structure and general properties, Reaction of aldehydes with different functional groups of protein. Tanning faculty at different pH reactions, oil, sulphony/chloride quinone tannage.

**Combination tannages -**

Deficiencies of single tannage, Mechanistic classification of tannages. All chrome based combination tannages, semi-chrome & semi – alum tannages.

## ***Practices of Leather Manufacturing - I***

General Practices in vegetable and chrome tanning with quality control in manufacture of the following Industrial and heavy leathers.

Traditional and Rapid methods of vegetable tannage of sole (Pit and Drum tanning). Chrome tanned sole and waxed chromed soles. Improvement of water resistance of vegetable tanned sole leathers.

Bag tanning of cattle and buffalo hides, different types of finished leather from bag tanned leathers, Belting harness, Saddlery and honing leathers.

Picking band leathers, Apron leathers, Hydraulic pneumatic leathers such as water and air pump leathers for turbines, Oil seals, Gas meters etc.

Sports goods leathers like Foot ball, Hokey ball, Volley ball, Cricket ball, Glove for wicket keepers and Boxing. Taxidermi.

Manufacture of Kattai, Banwar and case hides from Buff cattles.

## ***Analytical Chemistry of Leather***

### **1. Analysis of Lime**

Principles underlying determination of following in lime

- (a) Available lime
- (b) Total based by titration method
- (c) Iron by colorimetric method

### **2. Analysis of Na<sub>2</sub>S**

Principles underlying analysis of Na<sub>2</sub>S by official international method.

### **3. Analysis of lime liquors (Fresh & used)**

Principles underlying determination of following in lime liquor :-

- (a) Total Alkalinity
- (b) Total lime
- (c) Total nitrogen
- (d) Hide substance
- (e) Amino acids

### **4. Analysis of limed pelt**

Principles underlying determination of following in limed pelt

- (a) Total Alkalinity
- (b) Total Ammonia
- (c) Hide Substance

### **5. Analysis of Boric acid**

6. Analysis of deliming agent (Ammonium chloride and Ammonium sulfate)

7. Analysis of enzyme bates

8. Analysis of used pickle liquors for following :-

- (a) Determination of acid

(b) Determination of salt

9. Analysis of Sodium formate

10. Analysis of Chrome liquor to determine

(a) Basic chromium

(b) Basicity of chrome liquor

(c) Degree of Olation.

11. Analysis of basic chromium sulfate for following :-

(Power of Crystal)

(a) Moisture

(b) Chromium

12. Analysis of acids & salts in vegetable tannin extracts by different methods.

13. Analysis of Zirconium and Alum. Tanning agents.

14. Analysis of Formaldehyde.

15. Analysis of chrome tanned leather for following :-

Moisture, ash, Chromic oxide content, Solvent extractable substances, Water soluble matter and difference figure.

16. Analysis of followings of Veg. tanned leather :-

Moisture, ash, Water soluble matter, Solvent extractable substances and difference figure, Degree of tannage.

17. Analysis of followings of Alum. Tanned leather moisture, total ash, Solvent extractable substances, Aluminium as Alumina.

18. Analysis of followings of Zirconium tanned leather :-

Moisture, Ash, Solvent extractable substances, Zirconium content.

19. Analysis of followings of combined tanned leather :-

Moisture, Ash, Solvent Extractable substances, Water soluble matter and difference figure, Chromic oxide content, Degree of tannage.

20. Analytical Chemistry of Post tanning and Finishing agent

Analysis of lipids for following :

(a) Acid value

(b) Saponification value by reflux method.

(c) Iodine value by Hanus method.

(d) Unsaponifiables by extraction method.

(e) Analysis of sulfated oils and ready made fat liquors.

21. Principles underlying examination and analysis of dyes used in leather manufacture

22. Principles underlying examination and analysis of readymade finishes and finishing materials used in leather manufacture.

### ***Principles of Post-Tanning Operation***

**NEUTRALISATION :-** Its objectives, necessities and control to achieve desired uptake of dyes and fat liquors.

**BLEACHING :-** Definition, Theory, Mechanism of chemical bleaching, classification and application of different methods of bleaching to leathers.

**DYEING :-** Classification of dyes based on their chemical nature and also according to their application, Theory of colour, Manual colour matching, Theory and mechanism of dyeing, Chemistry and application of dyeing auxiliaries such as levelling agents, wetting agents, dispersing agents and dye fixative, Metal complex dye.

**FAT LIQUORING :-** Theory of stability of Emulsion (Surface tension theories and Electrical theories), Fatliquor based on natural oils, their chemistry and preparation, Oxidation, Sulphation, Sulphonation, Bisulphitation and their properties, Synthetic Fat liquor :- Preparation and Properties, Principles and objectives of fatliquoring, Differences between synthetic and natural fat & oils concept of curring.

**RETANNING SYNTANS AND RETANNING :-** Classification of retanning syntans, Tanning power of retanning syntan, Dipole theory of syntan tanning, General method of manufacture of aromatic syntans their general properties, Objective of retanage, Effect of different retanning agents on properties of leather principle of bondage of retanning material.

**THEORY OF LEATHER DRYING :-** principles of energy and mass transfer, Physio-Chemical aspect of leather drying, Different methods of drying followed in leather Industry

### ***Leather Bio-Technology***

**Microbiology (Bacteria) :-**

Morphology & fine structure of bacteria :- The size shape & arrangement of bacterial cells, Bacterial structures, Structure external to the cell wall, Flagella and motility, pili, capsules, sheaths & stalks.

The Cultivation reproduction & Growth :- Nutritional requirement, nutritional types of bacteria, Prototroph Chemotrophs autotrophs & hetrotrophs, obligate parasites.

**Bacteriological media :-** Types of media, preperation of media, Physical conditions required for growth.

**Reproduction :-** Modes of cell devision, new cell formation .

**Methods of isolating pure culture :-** The streak plate technique, the power plate and spread techniques, micro manipulator techniques, the maintence and preservation of pure culture,

culture collection cultural characteristics colony characteristics, Characteristics of broth culture.

Characteristics, Classification of mold, Role of bacteria and mold in leather, uses of Bactericides and Fungicides in leather.

**Enzyme, their Physico-chemical concept regulation of enzyme synthesis in microbes, classification, function methodology, Enzyme reaction mechanism :** - Enzyme kinetics isolation and purification of enzymes. Immobilization of enzymes in whole cell and enzyme reactors.

**Cleaner Leather processing :-** use of enzyme option in beam house operations – Soaking, Unhairing, Bating Degreasing, offal treatment, Types of enzymes – Proteases, Lipases, Properties and Production.

**Fermentation :-** Mechanism of alcoholic fermentation of carbohydrate, bacterial fermentation, fermentation by coliform organisms, fermentation of nitrogenous compound, vinegar.

**Bacterial Genetics :-** Biosynthesis of deoxyribonucleic acid (DNA)- Structure of DNA, Biosynthesis of nucleotides in DNA strands, Replication of the DNA molecule, Transcription & translation of genetic information in protein synthesis.

**Bacterial mutation :-** Types of mutation, How mutation occur, How mutation are repaired, Bacterial recombination, Bacterial conjugation, Bacterial transduction, Bacterial transformation, Recombinant DNA Technology, DNA Cloning.

**Lisation of collagenous tissues for Biomedical and other application :-** Collagen and its application in food, cosmetic and medical fields.

## ***Leather Product Technology – I***

### **1. Introduction**

History of Footwear industry, Functions of footwear, Different parts of Footwear (Upper, Bottom and hidden components)

### **2. Anatomy of Human foot**

Bones, Joints, Muscles, Ligaments, arches of skin of human foot, Internal and external changes of human foot from infant to adult stage, Analysis of human locomotion, Common foot abnormalities and their remedies. Foot comfort and foot care.

### **3. Last**

Definition, Classification of last, Different parts of last, Seasoning of wood for wooden last, Last measurement, Comparison of last with human foot.

#### **4. Shoe Sizes and Fittings**

Relation between foot sizes and fittings and shoe, sizes and fittings, English, American, French, Continental and mondopoint shoe sizes and fittings system.

#### **5. Designing**

Introduction, Classification of Basic design, Elements of Design, Elements of Fashion design procedure, Concept of inside form, outside form and mean form, Making a basic shoe standard, pattern making allowances, Grading (Grading m/c)

#### **6. Footwear materials**

- (a) Upper and Lining materials – Different natural and synthetic materials.
- (b) Adhesive – Definition, Different types of adhesives use in footwear industry and their relative advantages and disadvantages.
- (c) Sole, Insole, Toe, PUA, Shonic, Stiffner, Itec, Thread, Required properties of these materials, Different types of these materials.

#### **7. Footwear Costing**

Material, Labour and Overhead cost, Determining the material consumption, Leather consumption – One pair tracing insole consumption, Adhesive and thread consumption etc.

### ***Principles of Material Testing***

#### **1. Introduction**

Thumb tests, Necessity of Physical Testing, Classification, Sampling positions, Conditioning of test samples

#### **2. Different Strengths of Leather**

Determination of Tensile strength and percent elongation of break, Stitch tear strength, Tearing strength, Tongue tearing strength, Buckle tear strength, Split tear strength, Distension and strength of grain by Boll Burst test – (i) The Lastometer (ii) The Tensometer.

#### **3. Few more tests for upper and light leather**

Flexing endurance test, air and water vapour permeability, Dynamic water proofness test, Dry and wet rub fastness test, Measurement of shrinkage temperature.

#### **4. Tests for Sole leather**

Measurement of apparent and real density, Determination of Abrasive resistance of sole leather, Dynamic water proofness of sole leather (Kubelka method), Grain cracking in sole leather (Mandrel test)

#### **5. Tests for Finish -film**

Determination of bond strength between the leather surface and finish film, cold, crack resistance, Light fastness test.

### 6. Specification

Shoe upper, Sole, Lining Leather, Clothing, Glove, Technical leathers, Upholstery and fancy leather.

## ***CHEMICAL ENGINEERING - III***

1. **Distillation** :- Vapour-liquid, Equilibria, Theory of distillation of Binary liquid mixture, Fraction, Design and operation of distillation column for separation of binary mixture by McCabe-Thiele method.
2. **Filtration** :- Theory and Mechanism of filtration, continuous and batch type filtration equipment.
3. **Drying** :- Drying characteristics of material, Theory and Mechanism of drying, estimation of drying rate. Type of dryers.
4. **Extraction**:- Extraction, Types of extraction, liquid-liquid extraction liquid-solid extraction, operation of stagewise and differential contact extractors.
5. **Chemical Process** :- Manufacture of Bleaching powder, Alkali Industries Sodium sulfide, Sodium dichromate Basic Chromium sulphate.

## ***Leather Finishing Materials and Auxiliaries***

### 1. Pigments :-

Inorganic and Organic Pigments, Preparation of Pigments, Methods of Preparation of Pigments, Aqueous Pigment Paste, Properties required in Pigments.

### 2. Principles of Finishing, Finish Formulation and their Application:-

Definition, Aim, Film- Formulation mechanism, Properties of films such as transparency, Gloss and resistance to heat, light and solvent, Role of dispersion and stability – Requirement in multiple coat technique- Single coat, Composition and methods of application like spraying, Curtain coating, Roller coating etc, Cationic finishes and their relative merits.

3. Chemistry and Preparation of Nitrocellulose, lacquers, lacquer emulsion, Coloured lacquers, Wax emulsions, Silicone emulsion.
4. Chemistry and Properties required of Synthetic Polymers, Impregnating agents, Binders, Chemistry of Polyurethane lacquers.
5. Chemistry and Mechanism of Plasticization, Internal and External Plasticizers.
6. Definition of Water proofing, Theory of water Proofing, Chemistry & Mechanism involved in water proofing.

#### 7. Upgradation technologies in finishing.

General introduction to addition, condensation, Natural polymer, Caesin, Cellulose

### ***Practices of Leather Manufacturing - II***

Manufacture of different types of wet blue/wet white from raw Cow/Goat/Sheep/Buffalo hides/skins.

Modern practices in E.I. tanning, E.I. Kips and their dressing into upper, lining and leather for goods.

Semi chrome/Full chrome/Chrome retain hunting suede, Safety uppers burnishable upper leathers from cattle hides. Printed and shrunken grain leathers, Chrome tanned Buff uppers, Upholdstry and printed leathers. Vegetable and chrome tanned lining leathers.

Morocco leathers, Chamois leathers, book binding leathers and pleated leathers.

### ***Theory of Leather supplements & Synthetics***

1. Chemistry of the most common Polymeric materials used in leather industry as supplements.
2. Concept of a macromolecule, natural & synthetics polymer, modes of polymerization, radical, condensation, stereo regular polymerization, polymerization kinetics, mechanism, anionic and cationic polymerization.
3. Manufacture of industrially important polymer for plastics, fibres and elastomer, polyethylene, polypropylene, polyvinyl, chloride, polyvinyl, alcohol, polyacrylonitrile, polyurethane, fluoro – carbon polymer, epoxy resins, polyamides, polyesters, alkyd resin, silicon polymers, cellulosics, polyacrylates, polyurethanes and their common applications.
4. Testing of Polymers, Mechanical and thermal testing.
5. Polymer and Rubber industries in India.
6. Manufacture of Rubber and Synthetic rubber, Natural rubber processing and vulcanizing synthetic elastomers, butadiene copolymer, Polyisoprene, Polybutadiene, Thermosetting, Thermoplastic.

## ***Instrumentation & Process control***

### **AIM**

To know the principle and importance of various analytical instruments used for the characterization of various materials.

### **OBJECTIVES**

To have thorough understanding of theory, instrumentation and applications of analytical equipments used in Industries for testing quality of raw materials, intermediates and finished products.

### **Introduction to spectroscopical methods of Analysis**

**Electromagnetic Radiation :-** Various ranges, Dual properties, Various energy levels, Interaction of photons with matter, absorbance & transmittance and their relationship, Permitted energy levels for the electrons of an atom and simple molecules, Classification of instrumental methods based on physical properties.

**Quantitative Spectroscopy :-** Beer-Lambert's law, Limitations, Deviations (Real, Chemical, Instrumental), Estimation of inorganic ions such as Fe, Ni and estimation of Nitrate using Beer-Lambert's Law.

**UV – Vis Spectrophotometry :-** Determination of spectra of some known organic compounds and identification of molecular transitions and functional groups in single beam spectrophotometer, quantitative estimation of various compounds in single beam spectrophotometers, estimation of  $\text{Cr}^{6+}$ ,  $\text{Fe}^{3+}$ ,  $\text{NO}_3$ ,  $\text{PO}_4^{3-}$ , COD in spectrophotometer.

**Atomic Absorption Spectrophotometry :-** Determination of some heavy metal concentrations (like total Cr, Fe, Zn, Pb, Zr etc.) from solution, leather, effluent, soil/sludge, plant and fish tissues.

### **IR, RAMAN AND ATOMIC SPECTROSCOPY :-**

Theory of IR spectroscopy, Various stretching and vibration modes for diatomic and triatomic molecules both linear and nonlinear, various ranges of IR (Near, Mid, Finger print and Far) and their usefulness, Instrumentation (Only the sources and detectors used in different regions), sample preparation techniques, Applications.

**Raman spectroscopy :** Theory, Differences Between IR and Raman.

**Atomic Absorption spectrophotometry :-** Principle, Instrumentation (Types of burners, Types of fuels, Hollow cathode lamp, Chopper only) and Applications, various interferences observed in AAS (Chemical, radiation and excitation).

**Flame photometry :-** Principle, Instrumentation, quantitative analysis (Standard addition method and internal standard method) and applications.

**CHROMATOGRAPHIC METHODS :-**

Classification of chromatographic methods, Column, Thin layer, Paper, Gas, High Performance Liquid Chromatographical methods (Principle, mode of separation and Technique). Separation of organic compounds by column and Thin layer, mixture of Cu, Co and Ni by Paper, separation of amino acids by paper, estimation of organic compounds by GC and HPLC.

**Controls in leather processing :-**

Concept continuous processes, material and energy optimization, conventional and computer assisted control strategies, case studies.

***Leather Product Technology – II*****1. Clicking**

Characteristics and variations in leather, Material selection, Clicking of upper linings, Socks and fabrics.

**2. Preparation (Pre – Closing )**

- (a) Identification making, stitch making, Punching, Perforating and embossing.
- (b) Skiving – Objectives, different types skiving.
- (c) Reinforcements.
- (d) Topline and edge treatments.

**3. Closing operations**

- (a) Stitching – Types of stitching m/c, Types of stitch, Different types of seam.
- (b) Eyeleting , lasting, etc

**4. Construction**

Assembly, Definition of construction, Types of Construction, Flowchart of different construction., Details of cemented construction – Methods, Details of moulded construction – DVP construction, Direct PVC moulded construction, Direct PU moulded construction, Veldtschoen construction, Machine welted construction. Slip – lasted construction, string lasted shoes.

**5. Treeing Department (Shoe-room operations)**

Shoe-room operations for grain, leather and suede leather uppers.

6. Quality control in footwear industry, Marketing of footwear, Hand tools and fittings for footwear industry.

### ***Tannery Waste Management***

#### **Water Pollution in General Perspectives: -**

Leather industry attributed for water pollution. Types of water pollution – Physical, Chemical and Biological pollution. Hazardous effects of water pollution on land, Ground water, Surface water, Aquatic life and sea. Ecological system and water pollution.

#### **Tannery Effluent :-**

Types of tannery effluent, Characteristics of effluent from beam house processes, Tan yard processes and finishing processes their nature and pretreatment before disposal, Most toxic ingredients- Hazards of tannery effluent, Principles involved in removing their toxic effect from tannery effluent, Principles for estimation of TDS, SS, DO, COD, BOD, Sulphides, Chromium and non bio-degradable aromatic substances in waste water.

#### **Primary Treatment :-**

Main object of primary treatment – Primary treatment units, Collection system of discharged waste water in tanneries, Screening, Equalisation of waste water.

#### **Secondary Treatment :-**

Principles of secondary treatment – Different processes involved in secondary treatment system, Lagoon treatment, Aeration Treatment, Trickling filter, Systematic design of these systems.

#### **Tertiary Treatment :-**

Unit operation in controlling pollutant at tertiary stage.

#### **Standards and Specifications :-**

Indian standards, International standards specifications for Industrial effluent discharge, Types of effluent disposal.

#### **Recovery of Waste Water and Materials :-**

Different processes in recovery and reuse of waste water & material in tanning industry, Economic feasibility of different processes.

### ***Practices of Leather Manufacturing – III***

General practices and techniques involved in manufacture of different types of light leathers. Glove kin, Resin upper, Glazed uppers, Lining leathers, Shoe suedes, Garment Swedes, Grain garment leathers, Gloving leathers. Sheep nappa, Suede garments, Uppers and safety uppers, Lining and diaphragm leathers.

Nubuck, Oil pull up leathers, Dressing of for skins and processing of reptiles.  
Combination tanning, Embossing, Grain correction, Special effects by spray, Screen printing,  
Roller coating, Gravure printing, tie and dye leathers, imitation leathers.

### ***Leather Product Technology - III***

Historical evolution of Garment and Goods styling, Seasonal cultural and geographical influences on fashion, Friends in fashion concept, Colour and human psychology.

Classification of Leather Goods and Garments, Selection of materials, Grading and assortment of Leathers for leather goods and garments. Property requirement for leather and lining materials. Accessories for leather goods and garments comparison between manual and machine cutting, Maintenance of knives and tools, clicking machines mechanical, Hydraulic/Pneumatic pattern interlocking/nesting for material optimization Assembly and sticking (Closing).

Different types of sewing machines (Flat bed, inclined bed, special type machines), Feed mechanisms, Various types of assembly techniques for leather goods and garments.

#### **Pattern Designing**

Basic design development, Measurements/Sizing chart for Man, Women and Children, Adaptation of stages to basic blocks. Pattern development, grading. Application of CAD for leather goods and garments design and production. Feasibility reports for leather goods and garments production. Machinery requirement/plant layout, process scheduling and line balancing, Quality control measures. Packaging methods and practices. Costing, pricing and marketing procedures for domestic and international markets.

## ELECTIVE – I

(One Elective paper will be taken up out of the following four options with the consultation of H.O.D)

### 1. Animals & Tannery Byproducts Utilization

2. An Overview :- Types of tannery available in India. Their nature and composition. Present methods of collection and utilization. Recovery of salt from the same. Its treatment and re-use. Theoretical and practical aspects of recovery of chrome, Protein and biogas from the tannery waste.
3. Beam-house Products :- Recovery of fat, proteins, chemicals and glue and their use. Pet Treats, finished split, gloves, washers etc.
4. Leather shavings and Trimmings :- Chemistry and Processing into hydrolysates, glue gelatin, syntans, fertilizers, processing into leather and acoustic boards.
5. Nature of Tannery Hair :- Chemistry and processing into protein meal hydrolysates and their uses – Conversion into felts and other utility products.
6. Process Studies :- Glue and protein meal from tannery fleshing, Quality evaluation of glue and protein meal, pet treats limited stock recovery of salt from used salt – Analytical procedures of protein meals.

### 2. Polymer Science and Technology

01. Science of Macromolecules: Basic concepts, molecular forces and chemical bonding in polymers, molecular weight and its distribution.
02. Step Reaction Polymerisation: Classification of polymers and polymerization mechanisms, mechanisms of step growth polymerisation, kinetics, polyfunctional step growth polymerisation.
03. Radical Chain polymerisation: Mechanism of vinyl polymerisation, kinetics of chain growth polymerisation, molecular weight and its distribution,
04. Ionic and Co-ordination Chain Polymerisation: Similarity and contrasts in ionic polymerisation, mechanisms and kinetics of anionic, cationic and co-ordination polymerisations.
05. Copolymerisation: Kinetics of copolymerisation, composition of copolymers, mechanism of copolymerisation, blocks and graft polymers.
06. Polymerisation Conditions and polymer Reactions: Polymerisation in homogeneous and heterogeneous systems, polymerisation engineering, chemical reaction of polymers.
07. Polymer Solutions: Criteria for polymer solution, conformation of dissolved polymer chains, thermodynamics of polymer solution.
08. Measurement of Molecular Weight and Size: End group analysis, colligative properties measurement.
09. Structure-Property Relationship: Polymer folding, thermodynamic and kinetic flexibility, Crystallisation and melting of polymers and the factors responsible, glass transition and phase transition of polymers.



10. Determination of Thermal Behaviour of Polymers: Principles of DSC, DTA, TGA analyses.
11. Plasticization and Crosslinking of polymers: Theory and mechanisms of plasticization, kinds of plasticizers, crosslinking of polymers and its effect in the physical property of polymer network.

### 3. Co-ordination Chemistry.

General characteristics of d block elements, Metallic character, Colour, Magnetic properties, Double salts, Tendency to form complexes, Coordination compounds, Coordination complexes and complex ions, Isomerism coordination number, important ligands, chelating ligands and chelates,

Postulates of werner's co-ordination theory, to explain the different oxidation states of Cr, Al, Zr, Pt, Ti, P As, Sb, Bi, Co etc. Explain the structure of Cr, Al, and Zr Ammines on the basis of Werner's Coordination theory, Experimental evidence in favour of Werner's theory, complex co-ordination, Molecular orbital and ligand field theories, Sidgwick's electronic concept of Co-ordination bond, limitations of sidgwick's electronic concept of Co-ordination bond, sidgwick's effective atomic number (EAN) Rule, Calculation of EAN of the central Metal atom in complex ions, Application of EAN Rule, Some typical Problems with Solutions, Metallurgy of Cr, Ti, Al, V, Co, Mn, Mo and Zr.

Chemistry of chromium salts and chrome tanning, factors affecting the formation and stability of different complexes like Al, Cr, Zr etc.

### 4. Organic Chemistry

#### 1. Carbohydrates :-

Introduction – Mono and Diaccharides, Trisacchrides , Polysacchrides, Strach and Cellulose, Derivatives of cellulose, Carboxy Methyl cellulose, Structural aspects of cellulose and starch.

#### 2. Amino acids and Proteins :-

Classification of Proteins, Test of Proteins, Denaturation, Structural aspects of wool.

#### 3. Oils, Fats and Waxes :-

Analysis of Oils, Fats and Waxes, Natural sources, General properties and reactions.

#### 4. Dyes and Dyeing :-

Chemical classification of dyes, Synthesis of some important dyes, Synthesis of triphenyl methane dyes, Anthraquinone dyes, Phthalein dyes, Introduction to Natural and reactive dyes, Metal complex dyes.

#### 5. Reaction of mechanism :-

Homolytic bond fission, free radicals, heterolytic bond fission, electrophiles, Carbonium ion, Nucleophiles, Acids and bases, Bronsted lowry concept lewis concept, Strength of acids and bases, substitutions reactions –  $S_N1$ ,  $S_N2$ ,  $S_Ni$ , Addition reactions, Elimination reactions, condensation, redox reactions.

## **ELECTIVE – II**

**(One Elective paper will be taken up out of the following four options with the consultation of H.O.D)**

### **1. Fashion styling and Computer added design of leather product**

International Fashion Trends :

Historical evolution of footwear and garment styling, seasonal, cultural and geographical influences on foot wear and leather garments fashion, trends in fashion, concepts, colour and human psychology.

Colour characteristics :

Primary colours and colour scheming for aesthetics, colour blending and techniques for colour matching.

Decorative styling Techniques :

Decorative components, decorative techniques like batik, stitching, punching, printing, embossing, knitting etc.

CAD of Leather Product :

Introduction to general CAD, Input and output devices required for CAD and their working principles. Capabilities of CAD for styling purpose- colour, basic primitives etc. Design methods using CAD for leather products, Pattern assessment methods for inter locking and economic cutting.

Introduction to CAM :

Tools required in CAM, Possible application of CAM in leather products, Introduction of the commercial CAM systems for leather products.

### **2. Advance Leather Process Technology**

Anatomical structures of hides and skins, Retanning, dyeing and fat liquoring in light and heavy leathers composition of finishes, formulation and application of Leather auxiliaries like protein and resin binders, pigments, wax emulsions, lacquer and lacquer emulsions coloured

lacquers, silicones and slip agents, pretanning and neutralizing syntans etc. in manufacture of above leathers.

Function of different finishing ingredients – Newer approaches in finishing, problems encountered in finishing and their solutions.

#### **Novel finishing techniques :**

Role of newer equipments like auto spray, roller coats, continuous embossing machines, finiflex etc., Methods such as oil-pull-up, Waxy burnishable, antique, grain sueded, screen printing, roller coating, pearl finishing easy care and petent finishing.

#### **Light leathers from heavy hides and skins :**

Resin upper, glazed uppers, lining leathers shoe-suedes, garment suedes- sheep nappa, glove leathers, E.I.- Wet-blue, wet – white, etc – details of processing techniques split processing for shoe suede, garment sued, grain finished and specialty finishes.

Upgradation through processing technologies and finishing techniques specially suited for the purpose like selection and use of retannage systems, Embossing-special effects by screen and block printing, roller coating, gravure printing, Tie and Dye leather.

### **3. Applied Statistics and Quality Control**

#### **Definition of Probability and Related basic concept :**

Discrete and continuous probability distributions (Binomial, Poisson, uniform, normal, Gamma and exponential), Basic concept of statistical population and sampling, Sampling design, random sampling, Mean variance and co-variance, correlation coefficient, Moments. Basic concepts of testing of hypothesis, Analysis of variance and Co-variance.

#### **Basic concept of statistical Quality control (S & C) :**

Development of various quality control and quality assurance concepts, Concept of product quality, Concept of quality control system, Nature of control limits, purposes of control charts, control charts for variables, control charts for attributes, cusum control chart.

Application of computers to quality systems.

Introduction to ISO 9000 and TQM :

ISO 9000 genesis, advantages, documentation, procedures. ISO 9000 VS classical quality control concepts.

System evaluation, system development, system implementation, and maintenance, ISO 9000 and ISO 14000 standards

### **4. Surface and colloid chemistry**

#### **Colloidal State :**

Introduction to colloidal state, Distinction among true solutions, colloids, Suspensions classification of colloids based on (physical state, Nature of interaction, Type of particles)

Study of different phases (micellar, liquid crystalline and microemulsions) as well as aggregates such as vesicles, Purification of colloidal solutions, General physical properties of Colloidal solutions (colligative, Mechanical and electrical properties of colloidal solutions), Protective colloids and Gold number.

Application of colloids, stability of emulsions, electrophoresis, dialysis, coagulation and flocculation and their characteristics summary of surface chemistry.

Adsorption Physisorption and chemisorption and their characteristics, factors affecting adsorption of gases on solids – Freundlich and Langmuir adsorption, Isotherms, Adsorption from solutions.

### ***ELECTIVE – III***

**(One Elective paper will be taken up out of the following four options with the consultation of H.O.D)**

#### **1. Computer application for Leather Technology**

1. Computer Programming Languages Operating System :- An overview of operating systems – DOS, UNIX, OS/2, MS-WINDOWS Review of Programming Languages – Basic, C & Fortran.
2. Data Processing :- Introduction to spread sheets, Analysis of data, Graphical representation.
3. Office Automation & Presentation Softwares :- Word Processing, Presentation Softwares, Professional Report generation using the above., Audio visual presentations using Multimedia.
4. Database and its Application :- Basic structures Retrieval of data for Reports, query and other formats and their export to other applications.
5. Cad Systems for Leather & Leather Products :-  
Pattern Grading & Cutting for Footwear and Garments.  
Design & Development of Leather Products.  
Computerised colour matching system –its Principle & application.

#### **2. Profession Ethics**

1. **Engineering Ethics** :- Senses of Engineering Ethics Variety of moral issue- types of inquiry – moral dilemmas- moral autonomy kolberg's theory – consensus and controversy professions and professionalism – professional ideals and virtues –

theories about right action – self – interest – customs and religion – uses of ethical theories.

2. **Engineering as social experimentation :-** Engineering as experimentation – engineers as responsible experimenters-codes of ethics-a balanced outlook on law-the challenger case study.
3. **Engineer's responsibility for safety :-** Safety and risk – assessment of stability and risk benefit analysis-reducing risk-the three mile island and chernobyl case studies.
4. **Responsibilities and rights :-** Collegiality and loyalty – respect for authority – collective bargaining- confidentiality – conflicts of interest – occupational crime-professional right – employee rights – intellectual property rights (ipr) – discrimination.
5. **Global issues :-** Multination corporations –environmental ethics-computer ethics-weapons development-engineers as managers-consulting engineers as expert witnesses and advisors-moral leadership-sample code of conduct.

### 3. Entrepreneurship

#### 1. Introduction :

Productivity in India, Resources, Availability and mobilization, Land Labour and capital, Industrial Growth in five year plan period, Human resources development.

#### 2. Technology and Investment :

Industrial climate in India, Technological investment, Transfer of Technology, Factors influencing technical investment, NRI, Capital market in India.

#### 3. Technocrats :

Development of Technocrats, Role of educational institutions, Psychology of India technocrats, Technocrats as entrepreneur, Characteristics of an entrepreneur.

#### 4. Leadership :

Attitudes and aptitudes, Qualities and development, Risk taking and decision making, Personal involvement.

#### 5. Value Engineering Techniques :

Value added products, Value adding techniques, cost reduction techniques, Waste control, Alternate product application, Functional value of the product, Improvement and expansion.

#### 6. Marketing :

Indian and International markets, Market surveys, Strategies and development of market, Need based marketing techniques.

#### 7. Business Laws and Regulations :

Company law of India, Taxation Laws, Labour Laws, Factories Act., ESI Act., Workmen Compensation act., Licencing procedures of State and the Central Governments, Industrial subsidies.

8. Entrepreneurship Development and Government: Role of Central Government and State Government in promoting Entrepreneurship - Introduction to various incentives, subsidies and grants - Export Oriented Units - Fiscal and Tax concessions available. Women Entrepreneurs Reasons for low / no women Entrepreneurs their Role, Problems and Prospects.

## **4. Total Quality Management**

### **1. Introduction**

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – Analysis Techniques for Quality Costs, Basic Concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Demin Philosophy, Barriers to TQM Implementation.

### **2. TQM Principles**

customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDCA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, Sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

### **3. Statistical Process Control (SPC)**

the seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

### **4. Total Quality Management Tools**

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

### **5. Quality System**

Need for ISO 9000 and other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

173

## B. PHARM.

### REMEDIAL BIOLOGY

1. Cytology:
  - Plant cell & its structure,
  - Mitosis & meiosis,
  - Different types of plant tissues & their functions.
2. Genetics:
  - Mendalism,
  - Chromosomal aberration,
  - Polyploidy.
3. Morphology & Histology of different parts of the plants: root, stem, bark, leaf, flower, fruit, and seed.
4. Classification of plants: in brief.
5. General survey of Animal Kingdom:  
Structure and life history of parasites as illustrated by amoeba, entamoeba, trypanosoma, plasmodium, taenia, and ascaris.
6. General Structure and Life History of Insects (in relation to humans & medicinal crops):
  - Insects,
  - Mosquito,
  - Housefly,
  - Mites,
  - Silkworm, and
  - Cockroach

### PHARMACEUTICAL CHEMISTRY-I

The treatment should be on the basis of modern physico-chemical aspects-

Structure & Properties:

Atomic and Molecular orbitals, Molecular Orbital theory, Wave equation, Bonding and Antibonding orbitals

Modern aspects of covalent bonds Hybrid Orbitals-sp, sp<sup>2</sup>, sp<sup>3</sup> hybridizations Intramolecular forces, Bond dissociation energy

Polarity of bonds, Polarity of Molecules & Intermolecular forces.

Alkanes:

- Energy of Activation
- Transition states & Free-radical substitution.

Stereo-chemistry:

- Definition, Chirality, & Chiral reagents
- Configuration- Enantiomers, Specification of Configuration by Sequence Rules
- Diastereoisomerism, Meso-structure & Conformational isomers.

Alkenes:

- Preparation and Reactions of Carbon-Carbon double bonds
- Carbonium ions, Mechanism of Electrophilic and Free-Radical Addition. Reactions.

Alkynes and Diene:

- Preparation and Properties of Alkynes Stability of Conjugated Dienes
- Isoprene Rule.

Cycloparaffins:

Modern interpretation of Baeyer's strain theory with special reference to conformation of cyclohexane stereoisomers. Benzene:

- Resonance, Aromatic character
- Electrophilic Aromatic substitution

- Orientation, Arenes stability and ease of formation of benzyl Carbonium - ion and benzyl free radical. Alkyl Halides:
  - Preparation
  - Substitution- and Elimination- Reactions.
- Alcohol, Ethers & Epoxides:
  - Preparation
  - Properties
  - Hydrogen Bonding in alcohols.
- Aldehyde and Ketones:
  - Preparation
  - Nucleophilic-addition reactions
  - Cannizzaro's reaction, Carbanions, Aldol condensation
  - Wittig's- and Reformatsky- reactions.

### PHARMACEUTICAL ANALYSIS – I

1. Quantitative Analysis:
    - Significance of quantitative analysis in Quality Control
    - Preliminaries and definitions
    - Precision and accuracy
    - Different techniques of analysis
    - Analytical balance and its reliability of measurements.
  2. Titrimetric Methods :
    - Fundamentals of titrimetric analysis
    - Calculations of titrimetric analysis
    - Neutralization theory & Neutralization methods
    - Theory of Indicators.
  3. Redox Titrations:
    - i). Titrations involving oxidation with -
      - Potassium permanganate,
      - Potassium dichromate, Ceric sulphate.
    - ii). Iodimetry and Iodometry.
- weights. Preparation and Standardization of 0.1 N Sodium Hydroxide Solution.  
 Preparation and Standardization of 0.1 N Hydrochloric Acid Solution. Assay of Sodium Hydroxide I.P.  
 Assay of Acetic Acid Glacial I.P. Assay of Sodium carbonate I.P. Assay of Sodium bicarbonate I.P. Assay of Phosphoric acid .P.  
 Estimation of Carbonate and Hydroxides in the given sample solution. Estimation of Carbonate and Bicarbonate in the given sample solution.

### ENVIRONMENTAL SCIENCE

1. Introduction:
  - The Multidisciplinary nature of environmental studies: Definition, scope and importance
  - Need for public awareness.
2. Ecosystems:
  - i. Concept of an Ecosystems- Structure and function of an ecosystem. Producers, consumers and decomposers, Energy & nutrient flow in the ecosystem
  - ii. Ecological Succession- Food chains, food webs and ecological pyramids
  - iii. Types of Ecosystems - Characteristic features, structure and function of the various ecosystems.
- 3 Biodiversity:
  - Ecosystem diversity, threats to biodiversity

- Biodiversity at global, national & local levels
  - Conservation of biodiversity.
4. Natural Resources (Renewable and non renewable):
- Role of an individual in conservation of natural resources
  - Equitable use of resources for sustainable lifestyle.
5. Environmental Pollution:
- Segments of environment
- i. Environmental Pollutants: classification, sources, pathway & fate of environmental pollutants, causes of environmental pollution, population explosion, Environment and human health, Human Rights, Value Education, Women and child welfare.
  - ii. Air Pollution : segments of atmosphere, its significance, classification of air pollutants, toxic effects, sampling & analysis, stationary and mobile emissions, various control measures, vehicular emission norms photo chemical smog, sulphurous smog, green-house effect, global warming, ozone depletion. Air (Prevention & Control of Pollution) Act.[10]
  - iii. Water Pollution: water Resources, sources of water pollution, various pollutants & their detrimental effects, potability of water, various control measures, rain-water harvesting, water-shed management, Water.
  - iv. (Prevention & Control of Pollution) Act.  
Other Pollutants: A brief introduction to noise pollution, soil pollution, thermal pollution and nuclear hazards.  
Solid - Waste Management: Cause, effect & control, measurement of urban & industrial waste.

## PHARMACEUTICS

- I. HISTORICAL BACKGROUND : (6 hrs)
  1. Indian Pharmacy-
    - Origin & Development: with special reference to Charaka Samhita, Sushruta Samhita & Bower's Manuscript,
    - Literature of Iatro –chemical period from the Pharmaceutical Development viewpoint.
  2. European & American Pharmacy- Origin and Development in brief.
  3. Official Compendia-
    - Historical Background & Developments,
    - Importance with special reference to IP/BP/USP.
- II. PHARMACEUTICAL CALCULATIONS:(12 hrs)
  - Avoirdupois & Apothecaries' Systems of Weights & Measures, Calculations of Doses in Pediatrics & Geriatrics,
  - Percentage Calculations (including parts per million – ppm),
  - Proportions & Alligations,
  - Proof strengths & Electrolyte solutions ( mEq, mM, mOsM),
  - Calculations on Extracts.
- III. PHARMACEUTICAL DOSAGE FORMS:(12 hrs)
  1. Classification & Definitions (Covering Pharmacopoeial & Marketed Products).
  2. Principles involved in the Preparation of the followings-
    - i) Aromatic Waters,
    - ii) Spirits,
    - iii) Solutions (including Mouthwashes, Gargles, Douches, Enema, and Collodions),
    - iv) Syrups,
    - v) Elixirs,
    - vi) Mucilages,
    - vii) Magmas,
    - viii) Glycerites,

- ix) Lotions,
  - x) Liniments,
  - xi) Extractives.
- IV. **GALENICALS:** (10 hrs)
1. Extraction of Active Constituents from Vegetable Drugs-
    - i) Principles & Theory of Extraction.
    - ii) Size Reduction ( in the light of Extraction Requirements)-
      - Objectives,
        - Factors influencing Size Reduction,
        - Mechanisms of Size Reduction & Methods used,
        - Selection of Size Reduction Technique,
        - Choice of Degree of Size Reduction.
    - iii) Size Separation –
      - Powder Grades / Standards,
      - Standardization of Powders (Sieves, Sieve Standards & Sieving Methods).
    - iv) Choice of Solvents for Extraction
    - v) Extraction Processes -
      - Infusion,
      - Decoction,
      - Digestion,
      - Maceration,
      - Percolation, etc.
  2. Finishing, Packaging & Storage of Extractives
  3. Compendial Products (covering a few examples of each extractive type)

### PHARMACEUTICAL MICROBIOLOGY

1. Introduction to the Scope of Microbiology.
2. Structure of Bacterial Cell.
3. Classification of Microbes and their Taxonomy-  
Actinomycetes, bacteria, rickettsia, spirochetes and virus.
4. Growth and Nutrition of Bacteria:  
Growth curve, generation time Bacterial nutrition, culture media and their common ingredients  
Physical factors affecting growth of bacteria.
5. Identification of Microbes:  
Staining Techniques-simple and differential techniques Bacterial reproduction and spores.
6. Identification of Bacteria.
7. Maintenance of Laboratory Organisms :
  - Isolation of pure culture
  - Permanent and working stock preparations.
8. Microbial Genetics and Variations.
9. Control of Microbes by Physical and Chemical Methods :  
Disinfection -
  - Disinfectants, factors influencing activity of disinfectants, dynamics of disinfection
  - Antiseptics & their evaluation (Chick Martin test, Rideal Walker test) Sterilization -  
Sterilization methods  
Validation of sterilization methods and equipments.
10. Sterility Testing of Pharmaceuticals.
11. Microbial Assays :  
Antibiotics, Vitamins and Amino acids.

### PHARMACEUTICAL CHEMISTRY-II

The treatment should be done on the basis of modern physico-chemical aspects including

nomenclature, methods of preparation and properties-

Carboxylic Acids and their Derivative: Nomenclature, structure and physical properties Acidity, effect of substituents on acidity preparation oxidation methods Grignard's synthesis, properties, alpha halogenations of acids.

Carboxylic Acid Derivatives : Acid chlorides, amides, esters & anhydrides Nomenclature, synthesis Nucleophilic substitution. comparison of nucleophilic reaction of aldehydes and ketones with that of acid derivatives

Nucleophilic substitution - alkyl vs. acyl

Kinetics of hydrolysis of esters by alkali and acids. Transesterification, reactions of ester with Grignard's reagent.

Amines:

General- Nomenclature, classification, industrial sources, Physical properties, Stereochemistry of nitrogen preparation of aliphatic and aromatic amines-amination, reductive amination, Hoffmann's Bromamide reaction, 1, 2-shifts, reductive methods of preparation of amines.

Basicity of aliphatic and aromatic amines - effect of substituents on basicity of amines, conversion to amides. Hinsberg's method of separation of amines and ring substitution of aromatic amines, reaction with nitrous acids. Hoffmann's elimination and its usefulness.

Diazonium salts - reaction of Diazonium salts, Sandmeyer's reaction, synthesis using diazonium salts, coupling, azo compounds, reduction & oxidation products of azo compounds. Benzedine rearrangement reaction.

Phenols:

Structure, nomenclature, physical properties Industrial sources and methods of preparation

Reactions-acidity of phenols, ether formation, ester formation, sulfonation, halogenation, Friedel-Crafts alkylation Friedel-Craft acylation, Fries rearrangement, nitrosation, Carbonation, Reimer-Tiemann reaction, reaction with formaldehyde.

Aryl Halides:

Structure, Nomenclature, physical properties

Industrial sources, preparation from diazonium salts, halogenation reaction, formation of Grignard's reagent

Electrophilic substitution, nucleophilic substitution, lower reactivity of aryl halides

Bimolecular displacement reaction mechanism

Elimination addition mechanism in aromatic halides involving BENZYNE transition intermediate.

Alpha- and Beta- Unsaturated Carbonyl containing Compounds: Interactions of functional groups

Electrophilic and nucleophilic addition with special reference to the mechanism of Michael's addition

Introduction to Diel Alder's reaction.

Malonic Esters and Acetoacetic Esters:

Synthesis and Properties Applications in organic synthesis.

Conservation of Orbital Symmetry and Rules:

Electrocyclic, Cycloaddition and sigmatropic reactions; Neighbouring group effects

Catalysis by transition metal complexes Stereoselective and Stereospecific reactions New organic reagents used in drug synthesis.

## PHARMACEUTICAL ANALYSIS – II

Theoretical considerations and applications (in drug analysis and quality control) of the following analytical techniques-

Gravimetric Analysis:

- Precipitation methods involving gravimetry
- Purity of the precipitate, co-precipitation, post precipitation
- Washing and ignition of precipitates, fractional precipitation, organic

precipitation.

Non-aqueous Titrations :

- Titrations of acidic and basic substances in Non-aqueous solvents
- Acidimetry and Alkalimetry in non-aqueous solvents with special reference to

Pharmacopoeial compounds.

Quantitative Organic Analysis:

Determination of Nitrogen, Halogen and Sulphur

Determination of alcoholic and phenolic hydroxyl-, amino-, carboxylic-, aldehyde- & ketone- groups

Estimation of sugars.

Oils and Fats Analysis :

Introduction to Oils and Fats

Acid value, acetyl value, saponification value, ester value and iodine value. Determination of unsaponifiable matter.

Moisture Analysis :

Preparation, standardization and application of Karl-Fischer's reagent.

Chromatography:

Introduction and classification

TLC, Paper and Column Chromatography.

### HUMAN ANATOMY,PHYSIOLOGY & HEALTH EDUCATION – I

1. Scope of Anatomy & Physiology.
2. Cell & Tissue :
  - Structure of cell, its components and their functions,
  - Mechanism of Transport through the Cell membrane,
  - Epithelial, Connective, Muscular and Nervous tissues, their sub-types & characteristics.
3. Osseous and Muscular System:
  - Structure, composition and functions of Skeleton,
  - Classification of joints, types of movements of joints, disorders of joints, Gross anatomy & physiology of muscle contraction,
  - Properties of skeletal muscles and their disorders.
4. Haemopoietic System:
  - Composition and functions of Blood and its elements & their disorders, Blood groups and their significance, Mechanism of coagulation, disorders of platelets and coagulation.
5. Lymph and Lymphatic System:Composition, formation and circulation of Lymph, disorders of Lymph and Lymphatic system, Basic physiology and functions of spleen.
6. Cardiovascular System:Physiology of Heart, blood vessels and circulation, Cardiac cycle, heartsounds, ECG,Blood pressure and its regulation,Brief outline of Cardiovascular disorders like Hypertension,Hypotension, Arteriosclerosis, Angina, Myocardial Infarction, Congestive heart failure and Cardiac arrhythmias.
7. Digestive System: Gross anatomy of GIT, Functions of Liver, Pancreas and Gall bladder, GI-secretions and their role in the absorption and digestion of food, Disorders of Digestive system.
8. Respiratory System:
  - Anatomy of Respiratory organs and their functions,
  - Mechanism and regulation of Respiration, Respiratory volumes and vital capacity,
  - Various disorders of Respiratory system.

### PHYSICAL PHARMACEUTICS

- I. STATES OF MATTER
  1. Intermolecular Forces
  2. Gaseous State:
    - i. Kinetic Molecular Theory &Molecular Weight
    - ii. Ideal Gas Law & vander Waals equation for Real Gases.
  3. Liquid State:

- i. Liquefaction of Gases- Theory & Methods
  - ii. Aerosols
  - iii. Vapour Pressure of liquids-
    - Clausius Clapeyron equation & Heat of Vaporization
    - Boiling Point.
4. Solid State:
  - i. Melting & Heat of Fusion
  - ii. Polymorphism
  - iii. Amorphous Solids.
5. Liquid-Crystalline State:
  - i. Structure & Properties
  - ii. Pharmaceutical Significance.
- II. PHASE EQUILIBRIA
  1. Phase Rule in the light of Condensed Isothermal Systems.
  2. Two-Component Systems:
    - i. Liquid-Liquid Systems & Critical Solution Temperatures (CST)
    - ii. Solid-Solid Systems:
      - Eutectics
      - Molecular Compounds
      - Solid Solutions.
  3. Three-Component Systems:
    - i. Ternary Phase Diagram (TDP)
    - ii. One-, Two-, & Three- Pairs of Partially- Miscible liquids
    - iii. Interpretation of TPDs of Cosolvent- & Surfactant-based Pharmaceutical Products & their Importance.
- III. BUFFERSYSTEMS
  1. Buffer Equations: pH of Buffer Solution as influenced by Ionic Strength (including Common-ion Effect)
  - ii. Factors Influencing pH of Buffer Systems
  - iii. Drugs as Buffers.
  2. Buffer Capacity:
    - i. Approximate & Actual Calculations
    - ii. Influence of Concentration
    - iii. Maximum Buffer Capacity
    - iv. Universal Buffer in the light of Titration Curves.
  3. Buffers in Pharmaceutical & Biological Systems:
    - i. In-Vitro Biological Buffer Systems
    - ii. Pharmaceutical Buffers & their Preparation
    - iii. Influence of pH & Buffer Capacity on:
      - Tissue irritation
      - Solubility
      - Stability
      - Optimum Therapeutic Response.
- IV. ISOTONIC SOLUTIONS
  1. Isotonicity value
  2. Methods of adjusting Tonicity and pH:
    - i. Class I Methods -
      - Cryoscopic Method
      - Sodium Chloride - Equivalent Method.
    - ii. Class II Methods -
      - White- Vincent Method
      - Sprowls Method.
    - iii. Measurement of Tonicity.

## V. INTERFACIAL PHENOMENA

1. Surface & Interfacial Tensions:
  - i. Theoretical Background
  - ii. Significance in Pharmacy
  - iii. Experimental Evaluation.
2. Adsorption:
  - i. Adsorption Isotherms -
    - Freundlich
    - Langmuir
    - Brunauer, Emmett & Teller (BET).
  - ii. Pharmaceutical Significance.

## VI. RED- OX PROCESSES:

1. Reduction / Oxidation Potential & Choice of Antioxidant
2. Effect of pH on Red- Ox Potential
3. Measurement of Oxidation/Reduction Potential.

## VII. CHEMICAL KINETICS

1. Molecularity & Order of Chemical Reaction
2. Basic Units of Rate Constants
3. Reaction – Orders' Expressions:  
Zero order Pseudo- Zero order (Suspensions) First order Pseudo  
first order Second order.
4. Measurement of Reaction Order:  
Substitution Method  
Graphical Method  
Half-life Method.  
(NB: Covering numerical wherever involved).

## PRESCRIPTION PHARMACY

### I. PRESCRIPTION :

1. Definition, Parts, Processing (including compounding accuracy), Pricing & Refilling
2. Latin Terms in Common use
3. Prescription Containers and Closures
4. Labeling & Packaging.

### II. DISPENSING

Principles involved & Procedures adopted in Compounding of the following classes of extemporaneous pharmaceutical Preparations:

1. Solid Dosage Forms -
  - Powders
  - Hard Gelatin Capsules
  - Tablet Triturates.
2. Liquid Dosage Forms-
  - Mixtures
  - Emulsions (no details of emulsifiers & stability)
  - Lotions
  - Liniments
  - Applications
  - Throat Paints
  - Eye Drops & Lotions
  - Ear Drops
  - Gargles & Mouthwashes.
3. Semi- Solid Dosage Forms-
  - i. Ointments & Creams--
    - Ointment Bases, their Ingredients & Compositions

- Methods of Preparation & Evaluation
- Compendial Examples.
- ii. Pastes & Jellies.
- iii. Suppositories & Pessaries.

### III. INCOMPATIBILITIES:

(12hrs)

1. Definition & Classification
2. Identification & Handling of the following of types of incompatibilities:
  - i. Inorganic Incompatibilities-
    - Metals & their Salts
    - Nonmetals, Acids & Alkalies
  - ii. Organic Incompatibilities-

Alkaloids, Purine bases, and Pyrazolone derivative- active agents including Quaternaries  
Carbohydrates, Glycosides & Amino acids Liquid Extracts, Anesthetics & Dyes.

### IV COMMUNITY PHARMACY:(6hrs)

1. Drug Stores (Retail as well as Wholesale):
  - Organization, Structure, Design & Maintenance
  - Legal Requirements for Establishment including Categorization & Storage of

Pharmaceuticals Product based on Legal Aspects of  
Labeling & Storage ( to be covered in Pharmaceutical-  
Jurisprudence)

- Dispensing of Proprietary Products
- Maintenance of Records.
2. Patients' Counseling on:
  - Rational Use of Drugs
  - Health Care Aspects.
3. Role of Pharmacist in Community Health -Care & Education.

### V. REVIEWS:

(4hrs)

- Prescription / Non -Prescription Products
- Medical & Surgical Accessories
- Diagnostic Aids
- Appliances available in Market.

## PHARMACEUTICAL CHEMISTRY – III

1. Polynuclear Hydrocarbons:  
Naphthalene, Anthracene, and Phenanthrene.
2. Heterocyclic Compounds:  
General discussion with regard to-
  - five membered rings with one hetero-atom (Pyrrole, Thiophene, and Furan)
  - five membered rings with two hetero-atoms (Imidazole, Pyrazole, Thiazole, and Oxazole)
  - six membered rings with one hetero-atom (Pyrimidine and others)
  - fused ring system (Quinoline, Isoquinoline, and Indole).
3. Carbohydrates:
  - i. Monosaccharides-
    - Structure elucidation of glucose & Fischer's proof
    - Killiani-Fischer's synthesis for lengthening the chain
    - Ruff's degradation for shortening the chain
    - Cyclic structure of glucose
    - Anomers, epimers and muta-rotation.
  - ii. Disaccharides-

General method of structure elucidation with specific examples (Lactose, Maltose, and Sucrose)

- iii. Polysaccharides-Starch and Glycogen.
4. Glycosides:
  - Introduction
  - Synthesis of glycosides
  - Structure elucidation of Ruberythric acid, Amygdalin and salicin.
5. Lipids :
  - Oils and Fats
  - Synthesis of glycerides
  - Classification of lipids and their uses.

### HUMAN ANATOMY, PHYSIOLOGY & HEALTH EDUCATION– II

1. Autonomic Nervous System (ANS) :
  - Physiology and functions of the ANS
  - Mechanism of Neurohumoral transmission in the ANS.
2. Central Nervous System:
  - Functions of different parts of the brain and spinal cord
  - Neurohumoral transmission in central nervous system, Reflex action, EEG
  - Cranial nerves and their functions.
3. Urinary System:
  - Structure and functions of kidney and urinary tract
  - Physiology of urine formation and acid-base balance
  - Diseases of the urinary system.
4. Reproductive System:
  - Male and Female reproductive organs and their hormones
  - Physiology of menstruation, coitus and fertilization.
  - Sex differentiation, spermatogenesis & oogenesis
  - Pregnancy and its maintenance and parturition.
5. Endocrine System:

Basic anatomy and physiology of pituitary, thyroid, parathyroid, adrenals, pancreas, testis and ovary, their hormones and functions.

#### 6. Sense Organs:

Basic anatomy and physiology of the eye (vision), ear (hearing), taste buds, nose (smell) and skin (superficial receptors).

#### 7. Concepts of Health & Disease:

- Nutritional deficiency disorders, their treatment and preventions.
- Brief outline, their Causative agents, modes of transmission and prevention of communicable diseases (like chicken pox, measles, influenza, diphtheria, tuberculosis, poliomyelitis, malaria, leprosy, AIDS etc.).

### PHYSIOLOGICAL CHEMISTRY

1. Enzymes & Co-enzymes :  
Classification, Kinetics, Michaelis – Menton equation, and determination of Km value, Mechanism of enzymes action, Inhibitors & Activators.
2. Bioenergetics:  
Concept of free energy, Redox potential, Electron transport system, High energy Phosphates, Oxidative phosphorylation.
3. Carbohydrate Metabolism:  
Glycolysis, TCA cycle, HMP Shunt, Gluconeogenesis, Glycogenesis & Uronic acid pathway, Regulation of blood sugar level, Carbohydrate metabolic disorders.

4. **Nucleic acid Proteins & Nitrogen Metabolism:**  
Purines and Pyrimidines biosynthesis & degradation, Structure of DNA and its replication, Genetic code, Transcription and processing of mRNA, Translation, Urea cycle, Creatine and Creatinine, Nitrogen balance,  
Diseases related with purines, pyrimidines and urea metabolism.
5. **Mineral & Water Metabolism:** Ca, P, Mg, Fe, Na<sup>+</sup>, K<sup>+</sup>, Cl<sup>-</sup> & H<sub>2</sub>O Metabolism.
6. **Hormones :**  
Mode of action of different Hormones.
7. **Nitrogen & Sulfur Cycle:**  
Nitrogen fixation, Ammonia assimilation, Nitrification and Nitrate assimilation, Sulphate activation, Sulphate reduction, Incorporation and Release of sulphate.

### PHARMACEUTICAL SYSTEMS – I

1. **Solubility of Drugs:**  
Solubility expressions, Mechanisms of solute-solvent interactions, Ideal solubility and Scatchard-Hildebrand equation, solubility parameter, solvation and association, Quantitative approach to the factors influencing solubility of drugs.
2. **Distribution Phenomena:**  
Introduction, Effect of ionic dissociation and molecular association on partition, Application of distribution phenomenon in important pharmaceutical processes like extraction, preservation of emulsions, drug action etc.
3. **Interfacial Phenomena:**
  - A. Classification of interfaces
  - B. Liquid interface: Surface, interfacial tensions and their measurements, adhesion, Cohesion and spreading.
  - C. Adsorption at solid interfaces: Adsorption isotherms.
  - D. Adsorption in medicine and pharmacy.
  - E. Electrical properties of interface. Origin of charge, Electrical double layer and concept of Beta potential, Measurement of Beta potential, bulk stress effect.
4. **Micromeritics:**
  - A. Introduction: Definition, Applications, and Classification of properties of powders.
  - B. Fundamental Properties of Powders:
    - (i). Particle size and size distribution-Equivalent spherical diameters, Average particle size, size- frequency distribution, Number and weight distribution, Number and weight distribution, Particle number, Determination of particle size.
    - (ii). Particle shape, surface area and its measurement.
  - C. Derived Properties of Powders: Packing arrangements, Densities and Porosities, Bulkness, Flow properties and their influence on processing of solid dosage forms.
5. **Rheology:**
  - A. Types of flow: Newtonian flow, Viscosity Coefficients, Effect of temperature on viscosity, Non-Newtonian flows and their mechanisms.
  - B. Rheological structures (Time dependant flow properties): Thixotropy, Bulges and spurs, Antithixotropy, Rheopexy.
  - C. Determination of Flow Properties:  
Choice of Viscometer, Principle and Theory underlying capillary Falling sphere, Cup and Bob (with operational details of Brooke field Viscometer) and Cone and Plate Viscometers.
  - D. Plug Flow.
  - E. Applications of Rheology in the formulation of dispersed systems.

### HOSPITAL PHARMACY & PHARMACEUTICAL ADMINISTRATION

#### I. FUNDAMENTALS

Definition, Goals & Advantages, and Detailed Study with respects to:

- i) Hospital Pharmacy Organization-
  - Organizational Structure of Hospital Pharmacy, and
  - Responsibilities of various Divisions of Hospital Pharmacy.
- ii) Hospital Pharmacy Policies.
- iii) Hospital Pharmacy Personnels-
  - Determination of Requirements of Hospital Pharmacy Personnel,
  - Abilities Required of Hospital Pharmacists, and
  - Responsibilities of Personnel.
- iv) Hospital Pharmacy Facilities.
- v) Hospital Formulary.
- vi) Pharmacy & Therapeutic Committee.
- II. PURCHASE & INVENTORY CONTROL
  1. Modes of Drug Purchases.
  2. Procedures of Drug Purchases by Hospital Pharmacy.
  3. Control of Purchases :
    - Calculations of Reorder Quantity Level,
    - Economic Order Quantity, and
    - Inventory Turnover & Inventory Control ( Annual and Perpetual).
- III. DISPENSING OF MEDICATIONS & Their Distribution w.r.t. :
  1. In – patients,
  2. Ambulatory,
  3. Out – Patients, and
  4. Controlled Drugs.
- IV. BULK MANUFACTURE :
  1. Advantages,
  2. Policy Making, and
  3. Good Manufacturing Regulations (GMR)
- V. PRE – PACKAGING IN HOSPITALS
  1. Pre – packaging policy,
  2. Pre-packaging Operations, and
  3. Labeling of Pre-packaged Products.
- VI. CENTRAL STERILE UNIT & IT'S MANAGEMENT :(4 hrs)
  1. Types of Materials for Sterilization.
  2. Packaging of Materials prior to Sterilization.
  3. Sterilization Facilities, Equipments & Methods.
  4. Distribution of Sterile Materials.
- VII. HOSPITAL PHARMACY LAY-OUT
- VIII. RADIO –PHARMACY
  1. Introduction to Radio-pharmaceuticals
  2. Production of Radio-pharmaceuticals (including Units of Radioactivity & Radioactive Half-life):
    - i) Methods of Isotopic Tagging.
    - ii) Preparation of Radio-Isotopes in laboratory using Radiation Dosimetry.
    - iii) Radio – Isotope Generators.
    - iv) Quality Control of Radio – pharmaceuticals.
  3. Radiation Detection Instruments
  4. Permissible Radiation Dose, Hazards of Radiations & Prevention of Exposure to Radiations
  5. Specifications for Radio- active Laboratory.

#### PHARMACEUTICAL ENGINEERING –I

1. Unit Operations: Introduction and Basic concepts.
2. Size Reduction:

- Definition, objectives of size reduction, factors affecting size reduction,
  - Mechanism of size reduction. Choice of degree of size reduction (from the view point of extraction), Laws of size reduction,
  - Classification of size reduction equipments, operation and energy aspects of various types of crushing and grinding machinery used in pharmaceutical industry, Selection of equipment, and
    - Mathematical problems.
3. Size Separation:
    - a. Screen, standard screen, screen analysis, material balances, over all screen effectiveness,
    - b. Types of screening equipments, selection of screening equipments,
    - c. Classifiers - Laws of settling, sedimentation, principles of centrifugal sedimentation, centrifugal settling process, and
    - d. Equipments used in solid-gas, solid-liquid and liquid-liquid systems.
  4. Filtration:
    - a. Theory of filtration, filter aid, filter media,
    - b. Types of industrial filters and their operation,
    - c. Factors affecting filtration,
    - d. Industrial centrifugal filters, and
    - e. Mathematical problems.
  5. Mixing :
    - a. Theory of mixing,
    - b. Solid-solid, solid-liquid and liquid-liquid mixing equipments.
  6. Evaporation:
    - a. Basic concept of phase equilibria,
    - b. Types of evaporators, operation of evaporation units, factors affecting evaporation, single effect and multiple effect evaporators, and
    - c. Mathematical problems on evaporation.
  7. Solid Handling:
    - a. Handling of solids in pharmaceutical plants,
    - b. Storage and weighing of solids,
    - c. Types of conveyors, their operation, and uses.

## INORGANIC MEDICINALS

- I. Impurities in pharmacopoeial substances, importance of limit test, general principles and procedures for limit test for chloride, sulphate, iron, arsenic, lead and heavy metals, special procedures for limit tests.
- II. General methods of preparation properties tests for purity storage condition, assay inorganic compounds listed in I.P. belonging to the following classes:
  1. Compounds of oxygen, nitrous oxide, carbon dioxide, hydrogen peroxide, oxygen therapy, an aesthetic gases.
  2. Gastrointestinal agents
    - Acidifiers : dil HCl
    - Antacids : Aluminium hydroxide gel, dried aluminium hydroxide gel, tablets, calcium carbonate, Sod. Bi carbonate, Magnesium trisilicate, Magnesium carbonate (light and heavy), Magnesium oxide (light and heavy), magnesium hydroxide mixture. Protective and adsorbents: Kaolin, talc, Bismuth sub carbonate. Saline cathartics: Magnesium sulphate, Sodium orthophosphate, Sod. Sulphate.
  3. Major intra and extra cellular electrolytes, major physiological ions, electrolytes used for the replacement therapy, physiological acid base balance, electrolyte combination therapy. Sodium chloride and Sod. Chloride injection, Tablets, Dextrose and sodium chloride injection, Potassium chloride tablets, injection, Cal chloride, Cal Gluconate, Tablets and Injection, Cal lactate, Sod. Acetate, Pot. Acetate, Sodium bi carbonate, tablets, injection. Sod. Citrate, Sod.

Lactate, Lactated Ringer's injection, Compound sod. Lactate injection, ORS.

4. Essential trace elements, their compounds and application, Iron salts as haematinics and mineral supplements. Trace elements like copper, Cobalt, Iron, Zinc, Manganese, Chromium, Iodine, Sulphur. Haematinics : Ferrous sulphate, Ferrous gluconate, Ferrous fumarate, Iron dextran injection, Iron and ammonium citrate.

5. Topical agents and dermatological preparations :

Protectives : Talc, Zinc oxide, Zinc stearate, Titanium dioxide, silicone polymers.

Antimicrobials : Pot Permanganate, chlorinated lime, Iodine, its preparations, Silver nitrate, Boric acid, Borax.

Astringents : Aluminium sulphate, Alum, Zinc sulphate.

6. Dental products : Dentifrices, Anticaries agents, desensitizing agents, calcium carbonate, Sodium fluoride, Stannous fluoride, Zinc chloride, Zinc Eugenol oint.

7. Miscellaneous agents: Buffers and Colorants. Antioxidants and complexing /chelating agents.

Sclerosing : Sodium Morrhuate injection Expectorants: Ammonium chloride, Potassium iodide.

Emetics : Copper sulphate, antimony pot. Tartrate.

Sedatives : Sodium bromide

Poisons and antidotes : Sodium nitrite, Sodium thiosulphate, Charcoal. ( Activated)

Respiratory stimulants : Ammonium carbonate.

Pharmaceutical aids : Bentonite, Kaolin, Talc, Magnesium stearate, Sodium metabi.Sulphate, Borate and phosphate buffers.

8. Radio-pharmaceuticals : Introduction, units of radioactivity, measurement of activity, Diagnostic and therapeutic applications, dosage, hazards and precautions, Sod. Chromate, Iron citrate, gold injection, Sod. Iodide, Sod. Phosphate, Strontium chloride, barium meal.

### PHARMACOLOGY - I (General Pharmacology, Toxicology & Bioassay)

1. General Pharmacology:

- (i) Introduction to Pharmacology, Sources of Drugs,
- (ii) Dosage forms and Routes of administration,
- (iii) Mechanism of action & Combined effect of Drugs,
- (iv) Factors modifying drug action, Tolerance and Dependence, Pharmacogenetics,
- (v) Absorption, Distribution, Metabolism and Excretion of Drugs,
- (vi) Principles of Basic and Clinical Pharmacokinetics,
- (vii) Adverse Drug Reactions.

2. Bioassay:

- (i) Principles of Bioassay and Biological Standardization,
- (ii) Bioassay of Acetylcholine, Histamine, Oxytocin, Digitalis and Insulin.

4. Clinical Evaluation:

- (i) Discovery and Development of New Drugs,
- (ii) Evaluation of Drugs in Man.

5. Principles of Toxicology:

- (i) Definition of Poison,
- (ii) Mechanisms of the Antidotal Treatment,
- (iii) General principles of treatment of Poisoning with particular reference to Barbiturates, Opioids, Organophosphorus and Atropine Poisoning,
- (iv) Heavy Metals (e.g. Leads, Arsenic, Antimony) Poisoning and their Antagonists.

### PHARMACOGNOSY - I

1. Pharmacognosy:

Definition, History, Scope and Development

2. Sources of Drugs:

Biological, marine, mineral and plant tissue culture .

3. **Classification of Drugs:**  
Alphabetical, morphological, taxonomical, chemical and pharmacological.
4. **Plant Taxonomy:**  
Study, of the following families (with special reference to medicinally important plants)-  
Apocynaceae, Solanaceae, Rutaceae, Umbelliferae, Leguminosae, Gramineae and Labiatae.
5. **Cultivation, Collection, Processing and Storage of Crude Drugs:**  
Factors influencing cultivation of medicinal plants Types of soils and fertilizers of common use Pest management and natural pest - control agents Plant hormones and their applications  
Polyploids, mutation and hybridization with reference to medicinal plants.
6. **Quality Control of Crude Drugs:**
  - Adulteration of crude drugs
  - Their detection by organoleptic, microscopic, physical, chemical and biological methods of evaluation.
7. **An Introduction to Active Constituents of Plants:**
  - Isolation
  - Classification
  - Properties.
8. **Systematic Pharmacognostic Study of the Followings:** i. Carbohydrates & derived products –  
Agar, Guar gum, Acacia, Honey, Isabgol, Pectin, Sterculia and Tragacanth.  
ii. **Lipids-**  
Bees wax, Castor oil, Cocoa butter, Cod-liver oil, Hydnocarpus oil, Kokum butter, Lard, Linseed oil, Rice-bran oil, Shark - liver oil and Wool fat.

## PHARMACEUTICAL SYSTEMS – II

1. **Surface – active agents:**
  - A. **Classification based on chemical nature and HLB scale, Determination of HLB, Surface activity and Mechanism of formation of micelles, Structure of micelle and Liquid crystal, Factors influencing CMC and Aggregation number, Life of micelle, Bulk properties of surface solution.**
  - B. **Miceller solubilization: Mechanism of solubilization, Factors influencing the choice of solubilizing agents, Ternary phasediagram in the formulation of solubilized systems.**
2. **Colloidal dispersions:**
  - A. **Classification of dispersed systems and their general characteristics, size and shapes of colloidal particles, Classification of colloids and comparative account of their general properties.**
  - B. **Properties of Colloids:**
    - (i) **Optical and Kinetic properties and their applications in determining molecular weight of polymers.**
    - (ii) **Electrical properties: Electrokinetic phenomena, Donnan membrane equilibrium.**
  - C. **Stability of Colloidal Systems:**  
**Mechanism, Effect of electrolytes, Coacervation, Peptization and protective action.**
3. **Emulsions:**
  - A. **Definition, thermodynamic consideration, Classification, Transparent emulsions, Pharmaceutical applications.**
  - B. **Emulsion types: Empirical rules governing emulsion types, Methods for determination of type of emulsions (only principle) and their limitations.**
  - C. **Mechanisms of Emulsion (droplet) stabilization: Monomolecular and particulate orientation, Mixed emulsifiers, Critical HLB concept.**
  - D. **Theories of Emulsifications: Non-electrical and electrical theories, Detailed account of non-electrical theories and advanced electrical theories like Schulman and Cockbain molecular complex formation, DLVO and Davies theories.**
  - E. **Stability of Emulsions, Factors influencing stability of emulsions.**
  - F. **Factors influencing rheological properties of emulsions.**
4. **Suspensions:**
  - A. **Definition, Application & solid content.**
  - B. **Theoretical concepts in the formulation of suspensions: Wetting and Dispersion,**

Particle-particle interaction and particle behaviour, Controlled flocculation, sedimentation concepts, Rheological considerations, and Formulation in structure vehicle.

5. Drug Stability:

- A. Reaction Kinetics: Zero, Pseudo-Zero, First & Second order, Units of basic rate constants, Determination of Reaction order.
- B. Physical and Chemical factors influencing the chemical degradation of pharmaceutical product: temperature, solvent, ionic strength, Dielectric constant, specific & general acid base Catalysis light.
- C. Stabilization of medicinal agents against common reactions like hydrolysis & Oxidation.
- D. Accelerated stability testing in dating of Pharmaceutical dosage forms.

### PHARMACEUTICAL BIOTECHNOLOGY AND BIOINFORMATICS

1. Biotechnology: Scope and Future
2. Recombinants DNA Technology:
  - Restrictions, Enzymes, Vectors, Gel electrophoresis, Molecular probes, Blotting techniques,
  - Construction and Screening of DNA libraries, PCR,
  - Isolation of gene, Sequencing of gene, DNA finger printing,
  - Transformation of bacterial cell,
  - Products from recombinant DNA technology such as Hepatitis B, Insulin, Interferons and Growth Hormones.
3. Monoclonal Antibodies & Hybridoma Technology.
4. Plant Tissue Culture:
  - Principles of tissue & cell culture,
  - Tissue culture techniques, nutrient media, culture techniques,
  - Cytology of cultured cells, protoplast fusion & culture.
5. Bioinformatics:
  - Meaning, scope and areas of Bioinformatics,
  - Biological information recourses on internet and their retrieval systems,
  - Common Bioinformatics softwares and their applications: FASTA, BLAST, Rasmol, Tree View, Oligo, etc,
  - Human Genome projects and their applications in Drug Design.

### PHARMACEUTICAL ENGINEERING – II

1. Mass Transfer:

Gas Absorption:

Gases in liquid, Henry's law, gas - absorption equipments, Numerical problems.

Liquid-Liquid Extraction:

Distribution law, principles of extraction, extraction equipments, selection of solvents for extraction, and Numerical problems.

2. Drying:

Moisture content and mechanism of drying,

Calculation of rate of drying and time of drying,

Classification and types of dryers, dryers used in pharmaceutical industries and special drying methods, and Mathematical problems.

3. Crystallization:

Characteristics of crystals like-purity, size, shape, geometry, habit, form size and factors affecting them,

Solubility curves and calculation of yield,

Material and heat balances around Swenson-Walker crystallizer, Super-saturation theory, nucleation mechanism, crystal growth, Study of various types of crystallizers - tank, agitated batch, Swenson – Walker, Vacuum crystallizer, crystal crystallizer, Caking of crystal and its prevention, and Numerical problems on yield.

#### 4. Distillation:

Binary liquid mixture, Raoult's law, phase diagram, volatility, simple steam and flash distillation, principles of rectification,

McCabe Thiele method for calculation of number of theoretical plates, Azeotropic and extractive distillation, and Mathematical problems on distillation.

5. Fluid Flow: Types of flow, Reynold's number, viscosity, concept of boundary layer, basic equation of fluid flow, Valves, flow meters, manometers and measurement of flow and pressure, and Related problems.

#### 6. Material Handling Systems:

- i. Liquid Handling - Different types of pumps.
- ii. Gas Handling - Various types of fans, blowers and compressors.

### NATURAL MEDICINALS – I

#### I. Amino acids & Proteins:

Amino acid synthesis & properties, Structure and synthesis of peptides, End group analysis of proteins.

#### II Terpenes:

Introduction, Classification, Isolation, general methods of determining structure, Chemistry of monoterpenoids (Citral), Monocyclic monoterpenoids (alpha-terpineol Menthol) Bicyclic monoterpenoids (alpha-pinene, Camphor) Wagner – Mearwin rearrangement, Sesquiterpenoids (Farnesol) Diterpenoids (Phytol)

#### III. Alkaloids:

Definition, extraction of alkaloids, general properties, general method of structure determination, classification of alkaloids, Phenylethylamine group- Ephedrine, Pyridine & Piperidine group – Piperine, Pyrrolidine – Pyridine group – Nicotine, Atropine, Stereochemistry of tropines, Quinoline group – Cinchona alkaloids with special reference to Cinchonine and Quinine, Quinidine, Cinchonidine & their stereochemistry. An elementary treatment of the alkaloids of isoquinoline, Phenanthrene & indole group.

#### IV. Purines:

Uric acid, Caffeine, Theophylline & theobromine.

### PHARMACOLOGY – II (Neuropharmacology)

#### 1. Autonomic Nervous System:

- i. Neurohumoral transmission (Autonomic and Somatic),
- ii. Parasympathetics-Parasympathomimetics, Parasympatholytics, Cholinesterase & Anticholinesterases, Cholino receptors,
- iii. Neuromuscular blocking agents,
- iv. Ganglionic stimulants and blocking agents,
- v. Sympathetics - Sympathomimetic & Sympatholytic agents,
- vi. Adrenergic receptors,
- vii. Alpha- Adrenergic and Beta- Adrenergic blocking agents.

#### 2. Central Nervous System:

- i. Neurotransmitter Systems,
- ii. General Anesthetics,
- iii. Alcohol and Antabuse,
- iv. Sedatives, Hypnotics and Tranquillizers,
- v. Analgesics, Antipyretics, Anti-inflammatory and Antigout drugs,

- vi. Convulsants and Anticonvulsants,
- vii. Motor disorder,
- viii. Psychopharmacological agents (Antidepressant & Antimaniacs).
- 3. Local Anaesthetics:
  - 1. Classification on the basis of site of action and chemical nature,
  - 2. Mechanism of action.
- 4. Autacoids:
  - i. Histamine and Serotonine,
  - ii. Prostaglandins, thromboxanes and leukotriens,
  - iii. Pentagastrin, Cholecystokinin, Angiotensin, Bradykinin and Substance P.

### PHARMACOGNOSY – II

#### 1. Resins:

Study of Drugs Containing Resins and Resin Combinations like -

Colophony, Podophyllum, Jalap, Cannabis, Capsicum, Myrrh, Asafoetida, Balsam of Tolu, Balsam of Peru, Benzoin, Turmeric and Ginger.

#### 2. Tannins:

Study of Tannins and Tannin- containing Drugs like –

Gambir, Black Catechu, Gall and Myrobalan.

#### 3. Volatile Oils:

- General methods of obtaining volatile oils from plants, and
- Study of volatile oils of –

Mentha, Cinnamon, Cassia, Lemon peel, Orange peel, Lemon grass, Citronella, Caraway, Dill, Spearmint, Clove, Fennel, Nutmeg, Eucalyptus, Chenopodium, Cardamom, Valerian, Musk, Palmarosa, Gaultheria, Sandal wood.

#### 4. Phytochemical Screening:

- Preparation of extracts, and
- Screening of alkaloids, saponins, cardenolides and bufadienolides, flavonoids and leucoanthocyanidins, tannins and polyphenols, anthraquinones, cynogenetic glycosides, amino acids in plant extracts.

#### 5. Fibers:

Study of fibers used in pharmacy such as cotton, silk, wool, nylon, glass wool, polyester and asbestos.

#### 6. Pharmaceutical Aids:

Study of pharmaceutical aids like –

Talc, Diatomite, Kaolin, Bentonite, Gelatin and natural Colours.

- The holistic concept of drug administration in traditional systems of medicine, and
- Introduction to Ayurvedic preparations like Arishtas, Asvas, Gutikas, Tailas, Churnas, Lehyas and Bhasmas.

### INDUSTRIAL PHARMACY-I

#### 1. Preformulation:

Dosage form Design, Methodology, Physico-chemical considerations of a new medicinal agent involved in formulation of dosage form.

#### 2. Tablets:

##### I. Oral Tablets:

- A. Product Development – Formulation Additives, Methods of preparation (wet granulation, Dry granulation, Direct compression, Sheronization, Spray drying, Spray congealing).
- B. production – Tablet machines, processing problems.

- II. Product development aspects of other forms of compressed tablets including Chewable, soluble, effervescent, Buccal & Sublingual, Implants, Compression coated tablets,

(155)

multiplayer tablets etc.

III. Evaluation (including official procedures).

IV. Critical study of selected pharmacopoeial (IP/BP) monograph in the light of Forms of tablets (uncoated), and Deviation from normal official limits.

3. Tablet Coating:

A. Sugar, Film, Enteric, Fluid bed coating, Coating Materials, solvents, processing problems.

B. Evaluation of coated tablets (including official procedures).

C. A critical study of selected Pharmacopoeial (IP/BP) monographs based on  
(i) coating types, and  
(ii) Deviations from normal official limits.

4. Capsules:

Hard and soft gelatin capsules, Capsule filling equipments and operation, Finishing & Formulation, Quality control (including official tests). A critical study of selected Pharmacopoeial (IP/BP) monographs based on

(i) Capsule types

(ii) Equivalence considerations

(iii) Deviations from normal official limits.

5. Microencapsulation:

A. Fundamental Considerations: Core material, Coating material, Selected stability and release properties, Equipment & processing.

B. Preparation of Microcapsules: Air suspension, Coacervation-phase separation, Mechanical and insitu methods.

6. Sustained Release Dosage Forms:

Terminologies, Factors in design and Efficiency-Drug elimination rate, Estimation of initial and maintainance dose. Formulation, in-vivo and in-vitro evaluation.

7. Medicated Applications:

A. Dermatological Preparations: Percutaneous absorpction, ointment bases, production and preservation.

B. Ophthalmic Preparation: i) Ophthalmic Solution: Desirable properties, preparation, sterilization & preservation (ii) Ophthalmic Ointments: Bases industrial processing, Sterilization and preservation.

### PHARMACEUTICAL ENGINEERING – III

1. Heat Transfer :

- Sources of heat, heat transfer processes, Fourier's law, prediction of surface coefficients,
- Different laws of conduction, convection and radiation,
- Different types of heat- transfer process equipments, heating medium and their selection, insulating materials, and
- Mathematical problems on heat transfer.

2. Dehumidification and Humidity Control :

- a. Basic concepts and definition, wet bulb and adiabatic saturation temperature,
- b. Psychometric chart and measurement of humidity, application of humidity measurement in pharmacy,
- c. Equipments for dehumidification operation, and
- d. Related mathematical problems.

3. Refrigeration and Air Conditioning:

Principles and applications of –

- a. Refrigeration, and
- b. Air conditioning.

4. Materials of Construction:

- a. General study of corrosion, measures to avoid corrosion, surface preparation, surface coatings- metallic and organic,

- b. Selection of lining material for pharmaceutical plant and equipment, and
- c. Properties and applications of different materials of construction with special reference to stainless steel, glass and different alloys.
- 5. Automated Process - Control System:
  - a. Process variables, temperature, pressure, flow level and their measurements, and
  - b. Elements of automatic process control and introduction to automatic process control system, process control computer.
- 6. Bioreactors:
  - Fundamentals of bioreactor design for pharmaceutical operation.
- 7. Stoichiometry:
  - a. Unit processes material and energy balance, molecular units, mole fraction, gas laws, molar volume,
  - b. Primary and secondary quantities, equilibrium state, rate process, steady and unsteady states, Dimensionless equation, dimensionless groups, dimensionless formulae, and
  - c. Mathematical problems.

### NATURAL MEDICINALS-II

- I. Steroids:
  - Introduction, nomenclature, classification, Structure elucidation of cholesterol excepting the stereochemistry and involving ring systems, position of hydroxyl group, double bond, Side chain and angular methyl groups. Steroidal hormones – Adrenocortcoids, classification and structure elucidation of some important corticoids. Estrogens – Estradiol, Estrone, Estriol their synthesis and structure elucidation. Androgens – Androsterone, Testosterone, their synthesis and structure elucidation. Synthetic analogs official in IP/BP.
- II. Non-steroidal Hormones:
  - Adrenaline, Noradrenaline, Thyroxine. An elementary treatment of oxytocin and Insuline.
- III. Vitamins:
  - Structure elucidation, Synthesis and medicinal uses of following vitamins – Vit. A,D,E & K, Vit.B1, B2, B6, and Vit. C.
- IV. Glycosides:
  - Chemistry of digitoxin, diosgenin and sarsasapogenin.

### Chemotherapeutic Agents

Synthesis, SAR (Structure Activity Relationship), mode of action and uses in general shall be discussed:

- 1. Sulfonamides
- 2. Antibiotics
- 3. Anti Tubercular Drugs
- 4. Immunosuppresants and Immunostimulants
- 5. Anti Malarials
- 6. Anti Protozoal Drugs
- 7. Anthelmintics
- 8. Antifungal Agents
- 9. Antivirals Agents including anti HIV Agents
- 10. Antineoplastic Agents

### PHARMACOLOGY - III (Systemic Pharmacology)

- 1. Drugs acting on Cardiovascular System:
  - i. Digitalis and Cardiac Glycosides,
  - ii. Antihypertensive agents,
  - iii. Antianginal and Vasodilator agents,
  - iv. Antiarrythmic agents,

- v. Antihyperlipedemic drugs,
- vi. Drugs used in the therapy of shock.
- 2. Drugs acting on Hemopoietic System :
  - i. Coagulants and Anticoagulants,
  - ii. Fibrinolytic and Anti-platelet drugs,
  - iii. Hematinics,
  - iv. Blood and Plasma volume expanders.
- 3. Drugs acting on Urinary System:
  - i. Fluid & electrolyte balance,
  - ii. Diuretics.
- 5. Drugs acting on Respiratory System :
  - i. Anti-asthmatic drugs including bronchodilators,
  - ii. Anti-tussive and expectorants,
  - iii. Respiratory stimulants.
- 5. Drugs acting on GIT:
  - i. Antacid, Antisecretory and Anti-ulcer drugs,
  - ii. Emetics and Antiemetics,
  - iii. Laxatives and Antidiarrhoeal drugs.

### PHARMACOGNOSY – III

1. Study of the biological sources, cultivation, collection, commercial varieties, chemical constituents, substitutes, adulterants, uses, diagnostic-macroscopic and microscopic features and specific chemical tests of the following groups of drugs containing glycosides:
  - i. Saponins: Liquorice, ginseng, dioscorea, sarsaparilla and senega.
  - ii. Cardioactive sterols: Digitalis, squill, strophanthus and thevetia.
  - iii. Anthraquinone cathartics: Aloe, senna, rhubarb and cascara.
  - iv. Others: Psoralea, Ammi majus, Ammi visnaga, gentian, saffron, chirata and quassia.
2. Systemic study of source, cultivation, collection, processing, commercial varieties, chemical constituents, substitutes, adulterants, uses, diagnostic-macroscopic and microscopic features and specific chemical tests of the following alkaloid containing drugs:
  - i. Pyridine-piperidine: Tobacco, Areca and Lobella.
  - ii. Tropane: Belladonna, Hyoscyamine, Datura, Duboisia, Coca and Withania.
  - iii. Quinolone and isoquinoline: Cinchona, Ipecac, Opium.
  - iv. Indole: Ergot, Rauwolfia, Catharanthus, Nux Vomica and Physostigma.
  - v. Imidazole: Pilocarpus.
  - vi. Steroidal: Veratrum and Kurchi.
  - vii. Alkaloidal amines: Ephedra and Colchicum.
  - viii. Glycoalkaloids : Solanum.
  - ix. Purines : Coffee, Tea and Cola.
3. Study of traditional drugs, common vernacular names, botanical sources, morphology, chemical nature of chief constituents, pharmacology, categories, common uses and marketed formulations of following indigenous drugs: Amla, Kantkari, Satavari, Tylophora, Bhilawa, Kalijiri, Vajach, Rasna, Punarnava, Chitrack, Apamarg, Gokhur, Shankpushpi, Brahmi, Adusa, Arjuna, Ashoka, Methi, Lahsun, Palas, Guggul, Gymnema, Shilajit, Nagarmotha and Neem.

### INDUSTRIAL PHARMACY – II

1. Liquid Orals:
  - A. Formulation Considerations: Solubility, stability and Organoleptic properties.
  - B. Manufacturing Considerations: Raw materials, Equipments, Compounding & Packaging.
2. Emulsions:
  - A. Product Development:

- i). Formulation Factors: Choice of lipid phase, surface-active agents, auxiliary emulsifiers, antimicrobial preservatives, antioxidants, Special formulation considerations with respect to consistency.
- ii). Processing Factors: Temperature, Agitation, Placement of emulgents, Mode of blending the phases, Rate of Cooling etc.
- B. Mechanical Equipments and Production Aspects.
- C. Processing of Emulsions.
- D. Illustrative examples with a reference to official products.
- 3. Suspensions:
  - A. Preparation of Insoluble Phase: Preparative methods, Crystal structure factors in relation to physical stability and bioavailability.
  - B. Formulation of suspensions: Deflocculated and Flocculated systems, Formulation adjuvants, preparative techniques.
  - C. Illustrative examples with a reference to official products.
- 4. Parenteral Products:
  - i). Small Volume Parenterals:
    - A. Product Development: Classification, General and specific formulation requirements, selection of parenteral components like vehicles, solutes (active ingredients) additives, containers and closures.
    - B. Formulations: Solutions, suspensions, Emulsions, Freezedried products, Sustained release formulations.
    - C. Production: Production facilities and production procedures.
    - D. Quality control (inclusive of official tests & their limits).
    - E. A Critical study of selected official (IP/BP) monographs based on physical; nature of formulation, Route of administration etc.
  - ii). Large Volume Parenterals (LVPS):
    - A. Specific Formulation Aspects.
    - B. Packaging systems.
    - C. Administration procedures.
    - D. Quality control.
    - E. A Critical study of selected official (IP/BP) monographs.
- 5. Aerosols:
  - A. Introduction: Definition, Historical developments, Relative merits/demerits.
  - B. Components of Aerosol package: Propellants, Containers, Valves & Actuators.
  - C. Formulation of Pharmaceutical Aerosols, Classification, Formulation details, Selection of components.
  - D. Testing of Pharmaceutical Aerosols.
- 6. Packaging:
  - Function of package, classification of packaging materials and their composition, Factors governing the selection of packaging materials, Unit dose packing, Evaluation of packaging materials (including methods).

## BIOPHARMACEUTICS & PHARMACOKINETICS

- I. BIOPHARMACEUTICS : 1. INTRODUCTION
  - i) Biopharmaceutics & Pharmacokinetics : Definitions, and Role in Product Development
  - ii) Explanation of the Terms:
    - Bioavailability, and
    - Bioequivalence
  - iii) Equivalence Types :
    - Chemical,
    - Clinical,
    - Therapeutic,
    - Generic, and
    - Pharmaceutical Alternatives

## 2. PRINCIPLES OF DRUGS DISSOLUTION RELATED TO BIOAVAILABILITY

- i) Tablets & Capsules.
- ii) Disintegration & Factors affecting DT
- iii) Dissolution of solids:
  - Mechanisms & Models of Dissolution
  - Factors influencing Dissolution Rate (in vitro Release)
  - Quantitative Study of Dissolution- Methods
  - In-vitro Dissolution & Interpretation of Dissolution Data.

## DRUG ABSORPTION RELATED TO BIO-AVAILABILITY

(15 hrs)

- i) Biological Factors:
    - Passage of Drugs through Natural Membranes.
    - Gastric Emptying & Intestinal Transition.
    - Blood Flow, G.I. –Metabolism & -Degradation.
    - Interactions with Food & Co-administered Drugs.
    - Disease State, and
    - Route of Administration.
  - ii) Physico – Chemical Factors :
    - Lipid Solubility,
    - Dissociation & pH,
    - Complexation & Surface –active agents, and
    - Donnan Membrane Equilibrium.
  - iii) Pharmaceutical Factors :
    - Dosage Form Types, and
    - Formulation Variables
- II. PHARMACOKINETICS :
1. Principles of Pharmacokinetics,
  2. Concepts of Compartmental Model,
  3. Characteristics of One Compartment Model, and
4. One Compartment Model – based Pharmacokinetic Derivations (involving the concepts of
- (a.) Experimentally Determined Rates,
  - (b.) Methods of Residuals, and
  - (c.) Trapezoidal Rule
- for the following modes of Drug Administration :
- i) Intra-Venous Administration (Plasma Level & Urinary Excretion Data)-
    - Single Dose
    - Repeated / Multiple Dosing (Plasma Data)
    - Continuous /Constant Rate Administration (Infusion).
  - ii) Absorption – Related /Based Administration (Single Dose) -
    - Absorption Rate Constant ( $k_a$ )
    - Elimination Rate Constant ( $K$ ) & Elimination Half - life ( $t_{1/2}$ ).
    - AUC,  $C_{max}$ , and  $t_p$ .
  - iii) Apparent Volume of Distribution ( $V_d$ ) & Renal Clearance ( $Q$ )-
    - Pharmacokinetic expressions for the above Administration situations.

## SYNTHETIC MEDICINALS I

Structure, nomenclature, classification, synthesis, SAR, Uses of the following categories of drugs including the synthesis and assay of I.P. & B.P. compounds.

1. Analgesics: Opioid analgetics including Enkephalins & Endorphins.
2. NSAIDs and non steroidal anti-inflammatory analgesics.
3. Anti-inflammatory Steroids
4. Antihistaminics – H<sub>1</sub>, H<sub>2</sub>, receptor antagonist antiallergenic drugs.
5. Local Anaesthetics
6. General Anaesthetics

7. Hypnotics & Sedatives
8. Psychotropic drugs – Antipsychotic drugs, anxiolytics, Antidepressants, Neuro Leptics & Psychosomatic agents.
9. Antiemetics
10. Expectorant & Antitussives
11. Antifertility agents

### INSTRUMENTAL DRUG ANALYSIS

- I. Theoretical aspects, basic instrumentation, elements of interpretation of spectra and applications of following analytical techniques:  
UV, Visible and IR spectroscopy, Fluorimetry, Flame Photometry, Potentiometry, Conductometry and Polarography.
- II. Introduction to Mass Spectroscopy, NMR-Spectroscopy, Atomic Absorption Spectroscopy and Instrumental Chromatography (HPLC, GC & HPTLC)

### PHARMACOLOGY – IV (Chemotherapeutic & Endocrine Pharmacology)

1. Chemotherapeutic Pharmacology:
  - i. General Principles of chemotherapy,
  - ii. Sulphonamides and Cotrimoxazole,
  - iii. Antibiotics - Penicillins, Cephalosporins, Chloramphenicol, Macrolides, Quinolones & miscellaneous antibiotics,
  - iv. Chemotherapy of Tuberculosis and Leprosy,
  - v. Fungal diseases,
  - vi. Viral infections,
  - vii. Protozoal Parasites (Malaria, Amoebiasis, Anthelmintics),
  - viii. Urinary-tract infections,
  - ix. Sexually-transmitted diseases,
  - x. Chemotherapy of Malignancy and Immunosuppressive agents.
2. Pharmacology of Endocrine System:
  - i. Hypothalamic & Pituitary hormones,
  - ii. Thyroid hormones & Antithyroid drugs- Parathormone, Calcitonin and Vit.D,
  - iii. Insulin, Oral Hypoglycemic agents and Glucagon,
  - iv. ACTH & Corticosteroids,
  - v. Androgens & Anabolic steroids,
  - vi. Estrogen, Progesterone and Oral Contraceptives,
  - vii. Drugs acting on the Uterus.

### PHARMACEUTICAL ENTERPRISE MANAGEMENT

1. Fundamental Concepts of Management:
  - Definition and different concepts of Management
  - Evolution of management, Scope of management
  - Administrative management and various functions of a manager including planning, staffing, controlling and directing
  - Pharmaceutical Entrepreneurship development.
2. Principles of Management:
  - Coordination, Communication, Motivation
  - Decision making, Leadership, Innovation, Creativity
  - Delegation of authority / responsibility, Record keeping
  - Identification of key areas to give maximum thrust for

- development & perfection.
3. Economics:
    - Principles of economics with special reference to laws of demand & supply
    - Demand schedule, demand curve
    - General principles of insurance.
  4. Business Organization:
 

Forms of Business organization-Sole trading, Partnership, Joint Stock Company, Cooperatives.
  5. Marketing Management:
    - i. Functions- buying, selling, transportation, storage, finance.
    - ii. Channels of Distribution- wholesale, retail, departmental store, multiple shop and mail order business.
    - iii. Market Research- brief introduction to market research with respect to pharmaceutical industries.
  6. Human Resource Management:
    - Recruitment and selection of employees
    - Motivation
    - Compensation
    - Training & Development of employees in a pharmaceutical industry
    - Pharmacist-patient relationship and pharmacist – wholesaler relationship
    - Labour welfare schemes.
  7. Materials' Management:
    - i. A brief exposure on the basic principles of management – major areas, scope, purchase.
    - ii. Stores Management - Inventory Control (ABC & VED) and evaluation of material management with reference to drugs and pharmaceuticals.
  8. Accountancy:
    - Basic principles of accountancy
    - Ledger posting and book entries, columns of a cashbook
    - Bills of exchanges
    - Preparation of trial balance, Profit & Loss account, Balance sheet.

### BIOLOGICAL & FERMENTATION PRODUCTS

1. Surgical Products:
  - a. Definition, primary wound dressing, absorbents, surgical cotton, surgical gauzes etc., bandages, adhesive tape, official dressings
  - b. Medical prosthetics and organ replacement materials.
2. Ligatures and Sutures:
 

Preparation, preservation & standardization of ligatures and sutures with special reference to catgut.
3. Immunity and Immunological products:
  - i. Introduction to antigen and antibody, Different types of antigen- antibody reactions, Defensive mechanisms of our body, Interferon.
  - ii. Manufacturing, preservation and standardization of vaccines and sera (official in IP/BP ) with special reference to:
    - a. Cholera vaccine, Pertusis vaccine, TAB vaccine, BCG vaccine, Small Pox vaccine, Rabies vaccine, Yellow fever vaccine, Influenza vaccine, Polio vaccine, Typhus vaccine
    - b. Diphtheria toxoid, Tetanus toxoid, Staphylococcal toxoid
    - c. Diphtheria antitoxin, Gas gangrene antitoxin, Botulinum antitoxin, Tetanus antitoxin
    - d. Rabies antisera, Normal immunoglobulin etc.
4. Diagnostic Agents:
 

Preparation and application of various diagnostic agents with special reference to detection of diseases like diphtheria and tuberculosis.
5. Blood and Blood - Related Products :
  - a. Whole Human Blood, Concentrated RBC

- b. Dried Human Plasma, Dried Human Serum
- c. Human Fibrinogen, Human Thrombin, Human Fibrin Foam
- d. Human Normal Immunoglobulin
- e. Any other product with reference to compendial standards.
- 6. General Processes in Microbial Production:
  - a. Alcohol,
  - b. Acetic acid, and
  - c. Antibiotics like Penicillin, Tetracycline, Streptomycin.

### PHARMACEUTICAL JURISPRUDENCE

- I. INTRODUCTION:
  - 1. Pharmaceutical Legislations
  - 2. Drugs & Pharmaceutical Industry
  - 3. Pharmaceutical Education
- II. DETAILED STUDY OF THE FOLLOWING ACTS & RULES  
(as amended up-to-date while citing relevant cases' Judgments of various High Courts):
  - 1. Drugs & Cosmetics Act & Rules
  - 2. Pharmacy Act
  - 3. Pharmaceutical Ethics
  - 4. Medicinal & Toilet Preparation (Excise Duties) Act & Rules
  - 5. Drugs & Magic Remedies (Objectionable Advertisement) Act
  - 6. Narcotic Drugs & Psychotropic Substances Act & Rules
  - 7. Drugs price Control order.
- III. BRIEF STUDY OF THE FOLLOWINGS WITH REFERENCE TO THE MAIN PROVISIONS: (10 hrs)
  - 1. AICTE Act
  - 2. Factories Act
  - 3. States Shops & Establishment Act & Rules
  - 4. Poison Act
  - 5. Insecticide Act
  - 6. Prevention of Cruelty to Animals Act
  - 7. Patent Act
  - 8. GATT Agreement
  - 9. Trade & Merchandise Marks Act.

### SYNTHETIC MEDICINALS II

Structure, nomenclature, SAR of the following category of drugs including synthesis, uses as assay of I.P. / B.P. compounds.

- 1. Adrenergic drugs
- 2. Cholinergic and anticholinesterases
- 3. Hypoglycemic agents – NIDDM, IDDM based drugs.
- 4. Coagulants and anticoagulants
- 5. Cardiovascular drugs – Antianginal agents vasodilator Antiarrhythmic drugs antiplatelet agents.
- 6. Antihypertensives
- 7. Diuretics
- 8. Antiparkinsonism drugs, drugs used in Alzheimers' disease.
- 9. Antithyroid agents
- 10. Diagnostic agents

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

## Mechanical Engineering

- 1. Thermodynamics, Cycles and IC Engines:** Basic concepts, Open and Closed systems. Heat and work. Zeroth, First and Second Law, Application to non-Flow and Flow processors. Entropy, Availability, Irreversibility and Tds relations. Claperyron and real gas equations, Properties of ideal gases and vapours. Standard vapour, Gas power and Refrigeration cycles. Two stage compressor. C-I and S.I. Engines. Pre-ignition, Detonation and Diesel-knock, Fuel injection and Carburation, Supercharging. Turboprop and Rocket engines, Engine Cooling, Emission & Control, Flue gas analysis, Measurement of Calorific values. Conventional and Nuclear fuels, Elements of Nuclear power production.
- 2. Heat Transfer and Refrigeration and Airconditioning:** Modes of heat transfer. One dimensional steady and unsteady conduction. Composite slab and Equivalent Resistance. Heat dissipation from extended surfaces, Heat exchangers, Overall heat transfer coefficient, Empirical correlations for heat transfer in laminar and turbulent flows and for free and forced Convection, thermal boundary layer over a flat plate. Fundamentals of diffusive and connective mass transfer, Black body and basic concepts in Radiation, Enclosure theory, Shape factor, Net work analysis. Heat pump and Refrigeration cycles and systems, Refrigerants. Condensers, Evaporates and Expansion devices, Psychrometry, Charts and application to air conditioning, Sensible heating and cooling, Effective temperature, comfort indices, Load calculations, Solar refrigerations, controls, Duct design.
- 3. Fluid Mechanics:** Properties and classification of fluids, Manometry, forces on immersed surfaces, Center of pressure, Buoyancy, Elements of stability of floating bodies. Kinematics and Dynamics. Irrotational and incompressible. Inviscid flow. Velocity potential, Pressure field and Forces on immersed bodies. Bernoulli's equation, Fully developed flow through pipes, Pressure drop calculations, Measurement of flow rate and Pressure drop. Elements of boundary layer theory, Integral approach, Laminar and turbulent flows, Separations. Flow over weirs and notches. Open channel flow, Hydraulic jump. Dimensionless numbers, Dimensional analysis, Similitude and modelling. One-dimensional isentropic flow, Normal shock wave, Flow through convergent - divergent ducts, Oblique shock-wave, Rayleigh and Fanno lines.
- 4. Fluid Machinery and Steam Generators :** Performance, Operation and control of hydraulic Pump and impulse an reaction Turbines, Specific speed, Classification. Energy transfer, Coupling, Power transmission, Steam generators Fire-tube and water-tube boilers. Flow of steam through Nozzles and Diffusers, Wetness and condensation. Various types of steam and gas Turbines, Velocity diagrams. Partial admission. Reciprocating, Centrifugal and axial flow Compressors, Multistage compression, role of Mach Number, Reheat, Regeneration, Efficiency, Governance.

296

**5. THEORY OF MACHINES:** Kinematic and dynamic analysis of planer mechanisms. Cams. Gears and gear trains. Flywheels. Governors. Balancing of rigid rotors and field balancing. Balancing of single and multicylinder engines, Linear vibration analysis of mechanical systems. Critical speeds and whirling of shafts Automatic controls.

**6. MACHINE DESIGN:** Design of Joints: cotters, keys, splines, welded joints, threaded fasteners, joints formed by interference fits. Design of friction drives: couplings and clutches, belt and chain drives, power screws. Design of Power transmission systems: gears and gear drives shaft and axle, wire ropes. Design of bearings: hydrodynamics bearings and rolling element bearings.

**7. STRENGTH OF MATERIALS:** Stress and strain in two dimensions, Principal stresses and strains, Mohr's construction, linear elastic materials, isotropy and anisotropy, stress-strain relations, uniaxial loading, thermal stresses. Beams: Bending moment and shear force diagram, bending stresses and deflection of beams. Shear stress distribution. Torsion of shafts, helical springs. Combined stresses, thick-and think-walled pressure vessels. Struts and columns. Strain energy concepts and theories of failure.

**8. ENGINEERING MATERIALS:** Basic concepts on structure of solids. Crystalline materials. Defects in crystalline materials. Alloys and binary phase diagrams. Structure and properties of common engineering materials. Heat treatment of steels. Plastics, Ceramics and composite materials. Common applications of various materials.

**9. PRODUCTION ENGINEERING:** Metal Forming: Basic Principles of forging, drawing and extrusion; High energy rate forming; Powder metallurgy. Metal Casting: Die casting, investment casting, Shell Moulding, Centrifugal Casting, Gating & Riser design; melting furnaces. Fabrication Processes: Principles of Gas, Arc, Shielded arc Welding; Advanced Welding Processes, Weldability: Metallurgy of Welding. Metal Cutting: Turning, Methods of Screw Production, Drilling, Boring, Milling, Gear Manufacturing, Production of flat surfaces, Grinding & Finishing Processes. Computer Controlled Manufacturing Systems- CNC, DNC, FMS, Automation and Robotics. Cutting Tools Materials, Tool Geometry, Mechanism of Tool Wear, Tool Life & Machinability; Measurement of cutting forces. Economics of Machining. Unconventional Machining Processes. Jigs and Fixtures. Fits and tolerances, Measurement of surface texture, Comparators Alignment tests and reconditioning of Machine Tools.

**10. INDUSTRIAL ENGINEERING:** Production Planning and Control: Forecasting - Moving average, exponential smoothing, Operations, scheduling; assembly line balancing, Product development, Break-even analysis, Capacity planning, PERT and CPM. Control Operations: Inventory control ABC analysis, EOQ model, Materials requirement planning. Job design, Job standards, Work measurement, Quality Management - Quality analysis and control. Operations Research: Linear Programming - Graphical and Simplex methods, Transportation and assignment models. Single server queueing model. Value Engineering: Value analysis for cost/value.

**11. ELEMENTS OF COMPUTATION:** Computer Organisation, Flow charting, Features of Common computer Languages - FORTRAN, d Base III, Lotus 1-2-3, C and elementary Programming.

(854)

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

## 1. ELECTRICAL ENGINEERING:

Gauss's Law and Amperes Law. Fields in dielectrics, conductors and magnetic materials. Maxwell's equations. Time varying fields. Plane-Wave propagating in dielectric and conducting media. Transmission lines.

## 2. Electrical Materials

Band Theory. Conductors, Semi-conductors and Insulators. Super-conductivity. Insulators for electrical and electronic applications. Magnetic materials. Ferro and ferri magnetism. Ceramics, Properties and applications. Hall effect and its applications. Special semi conductors.

## 3. Electrical Circuits

Circuits elements. Kirchoff's Laws. Mesh and nodal analysis. Network Theorems and applications. Natural response and forced response. Transient response and steady state response for arbitrary inputs. Properties of networks in terms of poles and zeros. Transfer function. Resonant circuits. Threephase circuits. Two-port networks. Elements of two-element network synthesis.

## 4. Measurements and Instrumentation

Units and Standards. Error analysis, measurement of current, Voltage, power, Power-factor and energy. Indicating instruments. Measurement of resistance, inductance, Capacitance and frequency. Bridge measurements. Electronic measuring instruments. Digital Voltmeter and frequency counter. Transducers and their applications to the measurement of nonelectrical quantities like temperature, pressure, flow-rate displacement, acceleration, noise level etc. Data acquisition systems. A/D and D/A converters.

## 5. Control Systems

Mathematical modelling of physical systems. Block diagrams and signal flow graphs and their reduction. Time domain and frequency domain analysis of linear dynamical system. Errors for different type of inputs and stability criteria for feedback systems. Stability analysis using Routh-Hurwitz array, Nyquist plot and Bode plot. Root locus and Nicols chart and the estimation of gain and phase margin. Basic concepts of compensator design. State variable matrix design. Sampled data system and performance of such a system with the samples in the error channel. Stability of sampled data system. Elements of non-linear control analysis. Control system components. electromechanical, hydraulic, pneumatic components.

## 6. Electrical Machines and Power Transformers

Magnetic Circuits - Analysis and Design of Power transformers. Construction and testing. Equivalent circuits. Losses and efficiency. Regulation. Auto-transformer, 3-phase transformer. Parallel operation. Basic concepts in rotating machines. EMF, torque, basic machine types. Construction and operation, leakage losses and efficiency. D.C. Machines. Construction, Excitation methods. Circuit models. Armature reaction and commutation. Characteristics and performance analysis. Generators and motors. Starting and speed control. Testing, Losses and efficiency. Synchronous Machines. Construction. Circuit model. Operating characteristics and performance analysis. Synchronous reactance. Efficiency. Voltage regulation. Salient-pole machine. Parallel operation. Hunting. Short circuit transients. Induction Machines. Construction. Principle of operation. Rotating fields. Characteristics and performance analysis. Determination of circuit model. Circle diagram. Starting and speed control. Fractional KW motors. Single-phase synchronous and induction motors.

## 7. Power systems

Types of Power Stations, Hydro, Thermal and Nuclear Stations. Pumped storage plants. Economics and operating factors. Power transmission lines. Modeling and performance characteristics. Voltage control. Load flow studies. Optimal power system operation. Load frequency control. Symmetrical short circuit analysis. Z-Bus formulation. Symmetrical Components. Per Unit representation. Fault analysis. Transient and steady-state stability of power systems. Equal area criterion. Power system Transients. Power system Protection Circuit breakers. Relays. HVDC transmission.

## 8. ANALOG AND DIGITAL ELECTRONICS AND CIRCUITS

Semiconductor device physics, PN junctions and transistors, circuit models and parameters, FET, Zener, tunnel, Schottky, photo diodes and their applications, rectifier circuits, voltage regulators and multipliers. switching behavior of diodes and transistors. Small signal amplifiers, biasing circuits. frequency response and improvement, multistage amplifiers and feed-back amplifiers, D.C. amplifiers. coupling methods, push pull amplifiers, operational amplifiers, wave shaping circuits. Multivibrators and flipflops and their applications. Digital logic gate families, universal gates combinational circuits for arithmetic and logic operational, sequential logic circuits. Counters. registers, RAM and ROMs.

## 9. MICROPROCESSORS

Microprocessor architecture-Instruction set and simple assembly language programming. Interfacing for memory and I/O. Applications of Micro-processors in power system.

## 10. COMMUNICATION SYSTEMS

Types of modulation; AM, FM and PM. Demodulators. Noise and bandwidth considerations. Digital communication systems. Pulse code modulation and demodulation. Elements of sound and vision broadcasting. Carrier communication. Frequency division and time division multiplexing. Telemetry system in power engineering.

## 11. POWER ELECTRONICS

Power Semiconductor devices. Thyristor. Power transistor, GTOs and MOSFETs. Characteristics and operation. AC to DC Converters; 1-phase and 3-phase DC to DC Converters. AC regulators. Thyristor controlled reactors; switched capacitor networks. Inverters; single-phase and 3-phase. Pulse width modulation. Sinusoidal modulation with uniform sampling. Switched mode power supplies.

(25)

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

## Civil Engineering:

### 1. BUILDING MATERIALS

**Timber:** Different types and species of structural timber, density-moisture relationship, strength in different directions, defects, influence of defects on permissible stress, preservation, dry and wet rots, codal provisions for design, plywood. **Bricks:** Types, Indian Standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength. **Cement:** Compounds of, different types, setting times, strength. **Cement Mortar:** Ingredients, proportions, water demand, mortars for plastering and masonry. **Concrete:** Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, elasticity, non-destructive testing, mix design methods.

### 2. SOLID MECHANICS

Elastic constants, stress, plane stress, Mohr's circle of stress, strains, plane strain, Mohr's circle of strain, combined stress; Elastic theories of failure; Simple bending, shear; Torsion of circular and rectangular sections and simple members.

### 3. STRUCTURAL ANALYSIS

Analysis of determinate structures - different methods including graphical methods. Analysis of indeterminate skeletal frames - moment distribution, slope deflection, stiffness and force methods, energy methods, Muller-Breslau principle and application. Plastic analysis of indeterminate beams and simple frames - shape factors.

### 4. DESIGN OF STEEL STRUCTURES

Principles of working stress method. Design of connections, simple members, Built-up sections and frames. Design of Industrial roofs. Principles of ultimate load design. Design of simple members and frames.

### 5. DESIGN OF CONCRETE AND MASONRY STRUCTURES

Limit state design for bending, shear, axial compression and combined forces. Codal provisions for slabs, beams, walls and footings. Working stress method of design of R.C. members. Principles of prestressed concrete design, materials, methods of prestressing, losses. Design of simple members and determinate structures. Introductions to prestressing of indeterminate structures. Design of brick masonry as per I.S. Codes.

### 6. CONSTRUCTION PRACTICE, PLANNING AND MANAGEMENT

Concreting Equipment: Weight Batcher, Mixer, vibrator, batching plant, concrete pump. Cranes, hoists, lifting equipment. Earthwork Equipment : Power shovel, hoe, dozer, dumper, trailers and tractor, rollers, sheep foot rollers, pumps. Construction, Planning and Management : Bar chart, linked bar chart, work-break down structures, Activity - on - arrow diagrams. Critical path, probabilistic activity durations; Event-based networks. PERT network: Time-cost study, crashing; Resource allocation.

## **1. (a) FLUID MECHANICS, OPEN CHANNEL FLOW, PIPE FLOW**

Fluid Properties. Pressure, Thrust, Buoyancy; Flow Kinematics; Integration of flow equations; Flow measurement; Relative motion; Moment of momentum; Viscosity, Boundary layer and Control. Drag, Lift; dimensional Analysis, Modelling; Cavitation; Flow oscillations; Momentum and Energy principles in Open channel flow, Flow controls, Hydraulic jump, Flow sections and properties; Normal flow, Gradually varied flow; Surges; Flow development and losses in pipe flows. Measurements; Siphons; Surges and Water hammer; Delivery of Power Pipe networks.

## **(b) HYDRAULIC MACHINES AND HYDROPOWER**

Centrifugal pumps, types, performance parameters, scaling, pumps in parallel; Reciprocating pumps. air vessels, performance parameters; Hydraulic ram; Hydraulic turbines, types, performance parameters, controls, choice; Power house, classification and layout, storage, pondage, control of supply.

## **2. (a) HYDROLOGY**

Hydrological cycle, precipitation and related data analyses, PMP, unit and synthetic hydrographs; Evaporation and transpiration; Floods and their management, PMF; Streams and their gauging; River morphology; Routing of floods; Capacity of Reservoirs.

## **(b) WATER RESOURCES ENGINEERING**

Water resources of the globe: Multipurpose uses of Water: Soil-Plant-Water relationships, irrigation systems, water demand assessment; Storages and their yields, ground water yield and well hydraulics; Waterlogging, drainage design; Irrigation revenue; Design of rigid boundary canals. Lacey's and Tractive force concepts in canal design, lining of canals; Sediment transport in canals; Non-Overflow and overflow sections of gravity dams and their design, Energy dissipators and tailwater rating; Design of headworks, distribution works, falls, cross-drainage works, outlets; River training.

## **3. ENVIRONMENTAL ENGINEERING**

### **(a) WATER SUPPLY ENGINEERING**

Sources of supply, yields, design of intakes and conductors; Estimation of demand; Water quality standards; Control of Water-borne diseases; Primary and secondary treatment, detailing and maintenance of treatment units; Conveyance of treatment units; Conveyance and distribution systems of treated water, leakages and control; Rural water supply; Institutional and industrial water supply.

### **(b) WASTE WATER ENGINEERING**

Urban rain water disposal; Systems of sewage collection and disposal; Design of sewers and sewerage systems; pumping; Characteristics of sewage and its treatment, Disposal of products of sewage treatment. streamflow rejuvenation Institutional and industrial sewage management; Plumbing Systems: Rural and semi-urban sanitation.

### **(c) SOLID WASTE MANAGEMENT**

Source, classification collection and disposal; Design and Management of landfills.

### **(d) AIR AND NOISE POLLUTION AND ECOLOGY**

Sources and effects of air pollution, monitoring of air pollution; Noise pollution and standards; Ecological chain and balance, Environmental assessment.

## **4. (a) SOIL MECHANICS**

Properties of soil, classification and interrelationship; Compaction behaviour, methods of compaction and their choice; Permeability and seepage, flow nets, Inverted filters; Compressibility and consolidation; Shearing resistance, stresses and failure; soil testing in laboratory and insitu; Stress path and applications; Earth pressure theories, stress distribution in soil; soil exploration, samplers, load tests, penetration tests.

### **(b) FOUNDATION ENGINEERING**

Types of foundations, Selection criteria, bearing capacity, settlement, laboratory and field tests; Types of piles and their design and layout, Foundations on expansive soils, swelling and its prevention, foundation on swelling soils.

## **5. (a) SURVEYING**

Classification of surveys, scales, accuracy; Measurement of distances - direct and indirect methods: optical and electronic devices; Measurement of directions, prismatic compass, local attraction; Theodolites - types; Measurement of elevations - Spirit and trigonometric levelling; Relief representation; Contours; Digital elevation modelling concept; Establishment of control by triangulations and traversing - measurements and adjustment of observations, computation of coordinates; Field astronomy, Concept of global positioning system; Map preparation by plane tabling and by photogrammetry; Remote sensing concepts, map substitutes.

### **(b) TRANSPORTATION ENGINEERING**

Planning of highway systems, alignment and geometric design, horizontal and vertical curves, grade separation; Materials and construction methods for different surfaces and maintenance; Principles of pavement design; Drainage. Traffic surveys, Intersections, signalling; Mass transit systems, accessibility, networking. Tunnelling, alignment, methods of construction, disposal of muck, drainage, lighting and ventilation, traffic control, emergency management. Planning of railway systems, terminology and designs, relating to gauge, track, controls, transits, rolling stock, tractive power and track modernisation; Maintenance; Appurtenant works; Containerisation. Harbours - layouts, shipping lanes, anchoring, location identification; Littoral transport with erosion and deposition; sounding methods; Dry and Wet docks, components and operational Tidal data and analyses. Airports - layout and orientation; Runway and taxiway design and drainage management; Zoning laws; Visual aids and air traffic control; Helipads, hangers, service equipment.

## SYLLABUS FOR BIHAR INDUSTRIES SERVICE.

Syllabus for Metallurgical Engineering (MT)

### METALLURGICAL ENGINEERING:

**Thermodynamics and Rate Processes:** Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, Ellingham and phase stability diagrams, thermodynamics of surfaces, interfaces and defects, adsorption and segregation; basic kinetic laws, order of reactions, rate constants and rate limiting steps; principles of electro chemistry- single electrode potential, electro-chemical cells and polarizations, aqueous corrosion and protection of metals, oxidation and high temperature corrosion – characterization and control; heat transfer – conduction, convection and heat transfer coefficient relations, radiation, mass transfer – diffusion and Fick's laws, mass transfer coefficients; momentum transfer – concepts of viscosity, shell balances, Bernoulli's equation, friction factors.

**Extractive Metallurgy:** Minerals of economic importance, comminution techniques, size classification, Flotation, gravity and other methods of mineral processing; agglomeration, pyro- hydro- and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals – aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making – principles, role structure and properties of slags, metallurgical coke, blast furnace, direct reduction processes, primary and secondary steel making, ladle metallurgy operations including deoxidation, desulphurization, sulphide shape control, inert gas rinsing and vacuum reactors; secondary refining processes including AOD, VAD, VOD, VAR and ESR; ingot and continuous casting; stainless steel making, furnaces and refractories.

**Physical Metallurgy:** Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers, structure of surfaces and interfaces, nano-crystalline and amorphous structures; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, cast iron and aluminum alloys; surface treatments; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; industrial ceramics, polymers and composites; electronic basis of thermal, optical, electrical and magnetic properties of materials; electronic and opto-electronic materials.

**Mechanical Metallurgy:** Elasticity, yield criteria and plasticity; defects in crystals; elements of dislocation theory – types of dislocations, slip and twinning, source and multiplication of dislocations, stress fields around dislocations, partial dislocations, dislocation interactions and reactions; strengthening mechanisms; tensile, fatigue and creep behaviour; super-plasticity; fracture – Griffith theory, basic concepts of linear elastic and elasto-plastic fracture mechanics, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing – tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability.

**Manufacturing Processes:** Metal casting – patterns and moulds including mould design involving feeding, gating and risering, melting, casting practices in sand casting, permanent mould casting, investment casting and shell moulding, casting defects and repair; hot, warm and cold working of metals, Metal forming – fundamentals of metal forming processes of rolling, forging, extrusion, wire drawing and sheet metal forming, defects in forming; Metal joining – soldering, brazing and welding, common welding processes of shielded metal arc welding, gas metal arc welding, gas tungsten arc welding and submerged arc welding; welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welded joints; powder metallurgy; NDT using dye-penetrant, ultrasonic, radiography, eddy current, acoustic emission and magnetic particle methods.

(246)

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

## Syllabus for Textile Engineering and Fibre Science (TF)

### TEXTILE ENGINEERING AND FIBRE SCIENCE:

**Textile Fibres:** Classification of textile fibres; Essential requirements of fibre forming polymers;

Gross and fine structure of natural fibres like cotton, wool and silk. Introduction to important bast fibres; properties and uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Molecular architecture, amorphous and crystalline phases, glass transition, plasticization, crystallization, melting, factors affecting  $T_g$  and  $T_m$ ; Process of viscose and acetate preparation. Polymerization of nylon-6, nylon-66, poly(ethylene terephthalate), polyacrylonitrile and polypropylene; Melt Spinning processes, characteristic features of PET, polyamide and polypropylene spinning; wet and dry spinning of viscose and acrylic fibres; post spinning operations such as drawing, heat setting, tow-to-top conversion and different texturing methods.

Methods of investigating fibre structure e.g., Density, X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods (DSC, DMA/TMA, TGA); structure and morphology of man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

**Yarn manufacture and yarn structure & properties:** Principles of opening, cleaning and mixing/blending of fibrous materials, working principle of modern opening and cleaning equipments; the technology of carding, carding of cotton and synthetic fibres; Drafting operation, roller and apron drafting principle, causes of mass irregularity introduced by drafting; roller arrangements in drafting systems; principles of cotton combing, combing cycle, mechanism and function, combing efficiency, lap preparation; recent developments in comber; Roving production, mechanism of bobbin building, roving twist; Principle of ring spinning, forces acting on yarn and traveler; ring & traveler designs; mechanism of cop formation, causes of end breakages; working principle of ring doubler and two for one twister, single and folded yarn twist, properties of double yarns, production of core spun yarn, compact spinning, principle of non conventional methods of yarn production

such as rotor spinning, air jet spinning, wrap spinning, twist less spinning and friction spinning. Yarn contraction, yarn diameter, specific volume & packing coefficient; twist strength relationship in spun yarns; fibre configuration and orientation in yarn; cause of fibre migration and its estimation, irregularity index, ~~properties of ring, rotor and air-jet yarns.~~ Fabric manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttle-less weaving machines, principles of multiphase and circular looms.

Principles of weft and warp knitting; basic weft and warp knitted structures. Classification, production and areas of application of nonwoven fabrics. Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, leno and double cloth constructions. Peirce's equations for fabric geometry; elastica model of plain woven fabrics; thickness, cover and maximum sett of woven fabrics.

**Textile Testing:** Sampling techniques, sample size and sampling errors. Measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity and trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, ~~yarns and fabrics;~~ evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength, bursting strength and abrasion resistance. FAST and Kawabata instruments and systems for objective fabric evaluation. Statistical data analysis of experimental results. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

**Preparatory Processes:** Chemistry and practice of preparatory processes for cotton, wool and silk. Mercerization of cotton. Preparatory processes for nylon, polyester and acrylic and polyester/cotton blends.

**Dyeing:** Classification of dyes. Dyeing of cotton, wool, silk, polyester, nylon and acrylic with appropriate dye classes. Dyeing polyester/cotton and polyester/wool blends. Batchwise and continuous dyeing machines. Dyeing of cotton knitted fabrics and machines used. Dye fibre interaction. Introduction to thermodynamics and kinetics of dyeing. Methods for determination of wash, light and rubbing fastness. Evaluation of fastness properties with the help of grey scale.

**Printing:** Styles of printing. Printing thickeners including synthetic thickeners. Printing auxiliaries. Printing of cotton with reactive dyes. Printing of wool, silk, nylon with acid and metal complex dyes. Printing of polyester with disperse dyes. Methods of dye fixation after printing. Resist and discharge printing of cotton, silk and polyester. Printing of polyester/cotton blends with disperse/reactive combination. Transfer printing of polyester. Developments in inkjet printing.

**Finishing:** Mechanical finishing of cotton. Stiff. Soft, wrinkle resistant, water repellent, flame retardant and enzyme (bio-polishing) finishing of cotton. Milling, decatizing and shrink resistant finishing of wool. Antistat finishing of synthetic fibre fabrics. Heat setting of polyester.

**Energy Conservation:** Minimum application techniques.

**Pollution:** Environment pollution during chemical processing of textiles. Treatment of textile effluents.

243

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

## Syllabus for Chemical Engineering (CH)

### CHEMICAL ENGINEERING:

**Process Calculations and Thermodynamics:** Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis. First and Second laws of thermodynamics. First law application to close and open systems. Second law and Entropy. Thermodynamic properties of pure substances: equation of state and departure function, properties of mixtures: partial molar properties, fugacity, excess properties and activity coefficients; phase equilibria: predicting VLE of systems; chemical reaction equilibria.

**Fluid Mechanics and Mechanical Operations:** Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation. Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

**Heat Transfer:** Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

**Mass Transfer:** Fick's laws, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, drying, humidification, dehumidification and adsorption.

**Chemical Reaction Engineering:** Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time distribution, single parameter model; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

**Instrumentation and Process Control:** Measurement of process variables; sensors, transducers and their dynamics, transfer functions and dynamic responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response and controller tuning, cascade, feed forward control. Plant Design and Economics: Process design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in design.

**Chemical Technology:** Inorganic chemical industries; sulfuric acid, NaOH, fertilizers

(Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and

Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

(242)

## SYLLABUS FOR BIHAR INDUSTRIES SERVICE

### **CS Computer Science:**

1. Digital Logic Boolean algebra. Combinational and sequential circuits. Minimization. Number representations and computer arithmetic (fixed and floating point).
2. Computer Organization and Architecture Machine instructions and addressing modes. ALU, data-path and control unit. Instruction pipelining. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).
3. Programming and Data Structures Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.
4. Algorithms Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph search, minimum spanning trees, shortest paths.
5. Theory of Computation Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and context-free languages, pumping lemma. Turing machines and undecidability.
6. Compiler Design Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation.
7. Operating System Processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems. Section
8. Databases ER-model. Relational model: relational algebra, tuple calculus, SQL. Integrity constraints, normal forms. File organization, indexing (e.g., B and B+ trees). Transactions and concurrency control.
9. Computer Networks Concept of layering. LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP). Basics of Wi-Fi. Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

(241)

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

**1. Electronics & Telecommunication Engineering :**

- i. **Materials and Components** — Materials and Components are the vertebral column of Electronics and Telecommunication zone. Electronic materials are at the central part of design, expansion of electronic component built-up at the same time electronic components are the empathy of electronic equipment hardware. New-fangled technologies used for trimness of electronic hardware a which are driven by innovations in progression technologies. This includes:- Structure and properties of Electrical Engineering materials; Semiconductors , Conductors, and Insulators, Ferroelectric, magnetic, Piezoelectric, Optical, Ceramic and Super-conducting materials. Passive components and characteristics Capacitors , Resistors and Inductors; Electromagnetic and Electromechanical components , Ferrites, Quartz crystal Ceramic resonators.
- ii. **Physical Electronics, Electron Devices and ICs** – Physical electronics , various electronics devices, ICs form the core of Electronics and Telecommunication branch. This part includes Electrons and holes in semiconductors, Mechanism of current flow in a semiconductor, Carrier Statistics, Hall effect; Different types of diodes and their characteristics; Junction theory; Bipolar Junction transistor; Power switching devices like GTOs, SCRs, power MOSFETs; MOS and CMOS types , Basics of ICs – bipolar; Field effect transistors; basic of Opto Electronics.
- iii. **Signals and Systems** – A Signal is a description of how one parameter varies with another parameter whereas a system is a process that results an output signal when an input signal is given. This section includes Classification of systems and signals; System modelling in terms of differential and difference equations; Fourier series; State variable representation; Fourier transforms and their application to system analysis; Convolution and superposition integrals and their applications; Laplace transforms and their application to system analysis; Z-transforms and their applications to the analysis and characterisation of discrete time systems; Correlation functions , Random signals and probability; Response of linear system to random inputs; Spectral density.

- iv. **Network theory** – A network is a anthology of interrelated components. Analysis of network is the method of finding the currents through, voltages across every module in the network. There are diverse techniques for scheming these values .This includes Network analysis techniques; transient response, Network theorems, steady state sinusoidal response; Tellegen's theorem. Two port networks; Network graphs and their applications in network analysis; Z, Y, h and transmission parameters. Analysis of common two ports , Combination of two ports. Network functions : obtaining a network function from a given part , parts of network functions. Elements of network synthesis. Transmission criteria : Elmore's and other definitions effect of cascading ,delay and rise time.
  
- v. **Electromagnetic Theory** – The electromagnetic force is considered to be one of the basic interactions in nature. This force is depicted by electromagnetic forces which has immeasurable physical instances along with the interface of particles charged electrically and the interface of uncharged magnetic force fields This segment includes:- Boundary value problems and their solutions; Laplace's and Poisson's equations; Analysis of magnetostatic and electrostatic fields; Maxwell's equations; Transmission lines : basic theory, matching applications, standing waves, microstrip lines; Basics of wave guides and resonators; application to wave propagation in unbounded and bounded media; Elements of antenna theory.
  
- vi. **Electronic Measurements and Electronic instrumentation** – Electronic Instrumentation and Measurements represents a inclusive handling of the operation, applications, performance and limitations of both analog and digital instruments. This includes  
 Basic concepts, standards and error analysis; Electronic measuring instruments and their principles of working : analog and digital, application , comparison, characteristics. Transducers; Measurements of basic electrical quantities and parameters; basics of telemetry for industrial use; Electronic measurements of non electrical quantities like pressure, temperature, humidity etc .

## 2. Electronics & Telecommunication Engineering :

- i. **Analog Electronic Circuits** – Analog electronics considered to be systems in electronics with a Continuous inconsistent signal .The word “analogue” describes the relative association amid current or voltage and a signal .This includes:- Transistor biasing and stabilization. Power amplifiers. Frequency response. Small signal analysis. Feedback amplifiers. Wide banding techniques. Tuned amplifiers. Power supplies and Rectifiers. PLL, Op Amp, other linear integrated circuits and applications. Oscillators. Waveform generators and Pulse shaping circuits .
- ii. **Digital Electronic Circuits** – Digital electronics circuits correspond to signals by distinct bands of analog level. All levels inside a band symbolize the identical signal status. This includes:- Transistor as a switching element; Simplification of Boolean functions, Karnaguh map Boolean algebra, and applications; IC logic families : DTL, ECL, TTL, NMOS, CMOS and PMOS gates and their comparison; Full adder , Half adder; IC Logic gates and their characteristics; Digital comparator; Multiplexer Demulti-plexer; Flip flops. J-K, R-S, T and D flip-flops; Combinational logic Circuits; Different types of registers and counters Waveform generators. Semiconductor memories.A/D and D/A converters. ROM an their applications.
- iii. **Control Systems** – A control system is said to be a gadget or a lay down of devices that commands, manages, regulates the performance of supplementary systems. In industrial fabrication control systems are used. This includes:- Transient and steady state response of control systems; Root locus techniques; Concepts of gain and phase margins: Constant-N Nichol’s Chart and Constant-M ; Effect of feedback on stability and sensitivity; Approximation of transient response from Constant-N Nichol’s Chart; Design of Control Systems, Compensators; Approximation of transient response from closed loop frequency response; Industrial controllers. Frequency response analysis.
- iv. **Communication Systems** – It’s a collection of individual communication networks, relay stations,transmission systems and data terminal equipments which are interfaced together to form an integrated system. In communications system its subsystem are said to be a functional assembly of systems . This includes:- Basic information theory; Sampling and data reconstructions; Modulation and detection in analogue and digital systems: Quantization & coding; Frequency division multiplexing and Time division ; Optical Communication : in free space & fiber optic; Equalization; Propagation of signals at VHF, HF, UHF and microwave frequency; Satellite Communication.
- v. **Microwave Engineering** – Microwave engineering deals with the study and planning of microwave components, circuits and systems. Elementary ideology are applied to design , analyze and measure techniques. This includes:- Microwave Tubes and solid state devices, Waveguides and other Microwave Components and Circuits, Microwave generation and amplifiers, Microstrip circuits, Microwave Measurements, lasers ,Masers, Microwave Antennas; Microwave Communication Systems terrestrial and Satellite based. Microwave propagation.

- VI. **Computer Engineering** – Computer engineering is a branch that integrates numerous fields of computer science necessary to build up computer software as well as hardware. Computer engineers are mainly concerned with hardware and software aspects of computing from design of computer microprocessors and other circuit designs. This includes:- Number Systems. Programming; Data representation; Elements of a high level programming language PASCAL/C; Control unit design; Fundamentals of computer architecture; Processor design; Use of basic data structures; I/o System Organisation , Memory organisation. Microprocessors : Architecture and instruction set of Microprocessors 8086 and 8085, Assembly language Programming. Personal computers and their typical uses. Microprocessor Based system design : typical examples.

237

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

## **Economics:**

### **1. Advanced Micro Economics:**

- (a) Marshallian and Walrasian Approaches to Price determination.
- (b) Alternative Distribution Theories: Ricardo, Kaldor, Kalecki
- (c) Markets Structure: Monopolistic Competition, Duopoly, Oligopoly.
- (d) Modern Welfare Criteria: Pareto Hicks & Scitovsky, Arrow's Impossibility Theorem, A.K. Sen's Social Welfare Function.

**2. Advanced Macro Economics:** Approaches to Employment Income and Interest Rate determination: Classical, Keynes (IS-LM) curve, Neo classical synthesis and New classical, Theories of Interest Rate determination and Interest Rate Structure.

### **3. Money - Banking and Finance:**

(a) Demand for and Supply of Money: Money Multiplier Quantity Theory of Money (Fisher, Pique and Friedman) and Keynes's Theory on Demand for Money, Goals and Instruments of Monetary Management in Closed and Open Economies. Relation between the Central Bank and the Treasury. Proposal for ceiling on growth rate of money.

(b) Public Finance and its Role in Market Economy: In stabilization of supply, allocation of resources and in distribution and development. Sources of Govt. revenue, forms of Taxes and Subsidies, their incidence and effects. Limits to taxation, loans, crowding-out effects and limits to borrowings. Public Expenditure and its effects.

### **4. International Economics:**

(a) Old and New Theories of International Trade

- (i) Comparative Advantage

• (ii) Terms of Trade and Offer Curve.

- (iii) Product Cycle and Strategic Trade Theories.

- (iv) Trade as an engine of growth and theories of under development in an open economy.

(b) Forms of Protection: Tariff and quota.

(c) Balance of Payments Adjustments: Alternative Approaches.

- (i) Price versus income, income adjustments under fixed exchange rates,
- (ii) Theories of Policy Mix
- (iii) Exchange rate adjustments under capital mobility
- (iv) Floating Rates and their Implications for Developing Countries: Currency Boards.

- (v) Trade Policy and Developing Countries.
- (vi) BOP, adjustments and Policy Coordination in open economy macro-model.
- (vii) Speculative attacks
- (viii) Trade Blocks and Monetary Unions.
- (ix) WTO: TRIMS, TRIPS, Domestic Measures, Different Rounds of WTO talks.

## 5. Growth and Development:

### (a) Theories of growth:

- (i) Harrod's model, *Solow growth model*
- (ii) Lewis model of development with surplus labour
- (iii) Balanced and Unbalanced growth,
- (iv) Human Capital and Economic Growth.
- (v) Research and Development and Economic Growth

(b) Process of Economic Development of Less developed countries: Myrdal and Kuznets on economic development and structural change: Role of Agriculture in Economic Development of less developed countries.

### (c) Economic development and International Trade and Investment, Role of Multinationals:

(d) Planning and Economic Development: changing role of Markets and Planning, Private- Public Partnership

(e) Welfare indicators and measures of growth – Human Development Indices. The basic needs approach.

(f) Development and Environmental Sustainability – Renewable and Non Renewable Resources, Environmental Degradation, Intergenerational equity development.

6.

1. **Indian Economy in Pre-Independence Era:** Land System and its changes, Commercialization of agriculture, Drain theory, Laissez faire theory and critique. Manufacture and Transport: Jute, Cotton, Railways, Money and Credit.

### 2. Indian Economy after Independence:

#### A The Pre Liberalization Era:

- (i) Contribution of Vakil, Gadgil and V.K.R.V. Rao, *planning*
- (ii) Agriculture: Land Reforms and land tenure system, Green Revolution and capital formation in agriculture,

- (iii) Industry Trends in composition and growth, Role of public and private sector, Small scale and cottage industries.
- (iv) National and Per capita income: patterns, trends, aggregate and Sectoral composition and changes their in.
- (v) Broad factors determining National Income and distribution, Measures of poverty, Trends in poverty and inequality.

#### **B The Post Liberalization Era:**

- (i) New Economic Reform and Agriculture: Agriculture and WTO, Food processing, Subsidies, Agricultural prices and public distribution system, Impact of public expenditure on agricultural growth.

(ii) New Economic Policy and Industry: Strategy of industrialization, Privatization, Disinvestments, Role of foreign direct investment and multinationals.

- (iii) New Economic Policy and Trade: Intellectual property rights: Implications of TRIPS, TRIMS, GATS and new EXIM policy.
- (iv) New Exchange Rate Regime: Partial and full convertibility, Capital account convertibility.
- (v) New Economic Policy and Public Finance: Fiscal Responsibility Act, Twelfth Finance Commission and Fiscal Federalism and Fiscal Consolidation.
- (vi) New Economic Policy and Monetary system. Role of RBI under the new regime.
- (vii) Planning: From central Planning to indicative planning, Relation between planning and markets for growth and decentralized planning: 73rd and 74th Constitutional amendments.

(viii) New Economic Policy and Employment: Employment and poverty, Rural wages, Employment Generation, Poverty alleviation schemes, New Rural, Employment Guarantee Scheme.

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

## Mathematics:

**(1) Linear Algebra:** Vector spaces over  $\mathbb{R}$  and  $\mathbb{C}$ , linear dependence and independence, subspaces, bases, dimension; Linear transformations, rank and nullity, matrix of a linear transformation. Algebra of Matrices; Row and column reduction, Echelon form, congruence's and similarity; Rank of a matrix; Inverse of a matrix; Solution of system of linear equations; Eigenvalues and eigenvectors, characteristic polynomial, Cayley-Hamilton theorem, Symmetric, skew-symmetric, Hermitian, skew-Hermitian, orthogonal and unitary matrices and their eigenvalues.

**(2) Calculus:** Real numbers, functions of a real variable, limits, continuity, differentiability, meanvalue theorem, Taylor's theorem with remainders, indeterminate forms, maxima and minima, asymptotes; Curve tracing; Functions of two or three variables: limits, continuity, partial derivatives, maxima and minima, Lagrange's method of multipliers; Jacobian. Riemann's definition of definite integrals; Indefinite integrals; Infinite and improper integrals; Double and triple integrals (evaluation techniques only); Areas, surface and volumes.

**(3) Analytic Geometry:** Cartesian and polar coordinates in three dimensions, second degree equations in three variables, reduction to canonical forms, straight lines, shortest distance between two skew lines; Plane, sphere, cone, cylinder, paraboloid, ellipsoid, hyperboloid of one and two sheets and their properties.

**(4) Ordinary Differential Equations:** Formulation of differential equations; Equations of first order and first degree, integrating factor; Orthogonal trajectory; Equations of first order but not of first degree, Clairaut's equation, singular solution. Second and higher order linear equations with constant coefficients, complementary function, particular integral and general solution. Second order linear equations with variable coefficients, Euler-Cauchy equation; Determination of complete solution when one solution is known using method of variation of parameters. Laplace and Inverse Laplace transforms and their properties; Laplace transforms of elementary functions. Application to initial value problems for 2nd order linear equations with constant coefficients.

**(5) Dynamics & Statics:** Rectilinear motion, simple harmonic motion, motion in a plane, projectiles; constrained motion; Work and energy, conservation of energy; Kepler's laws, orbits under central forces. Equilibrium of a system of particles; Work and potential energy, friction; common catenary; Principle of virtual work; Stability of equilibrium, equilibrium of forces in three dimensions.

**(6) Vector Analysis:** Scalar and vector fields, differentiation of vector field of a scalar variable; Gradient, divergence and curl in cartesian and cylindrical coordinates; Higher order derivatives; Vector identities and vector equations. Application to geometry: Curves in space, Curvature and torsion; Serret-Frenet's formulae. Gauss and Stokes' theorems, Green's identities.

**(7) Algebra:** Groups, subgroups, cyclic groups, cosets, Lagrange's Theorem, normal subgroups, quotient groups, homomorphism of groups, basic isomorphism theorems, permutation groups, Cayley's theorem. Rings, subrings and ideals, homomorphisms of rings; Integral domains, principal ideal domains, Euclidean domains and unique factorization domains; Fields, quotient fields.

**(8) 1. Real Analysis:** Real number system as an ordered field with least upper bound property; Sequences, limit of a sequence, Cauchy sequence, completeness of real line; Series and its convergence, absolute and conditional convergence of series of real and complex terms, rearrangement of series. Continuity and uniform continuity of functions, properties of continuous functions on compact sets. Riemann integral, improper integrals; Fundamental theorems of integral calculus. Uniform convergence, continuity, differentiability and integrability for sequences and series of functions; Partial derivatives of functions of several (two or three) variables, maxima and minima.

**2. Complex Analysis:** Analytic functions, Cauchy-Riemann equations, Cauchy's theorem, Cauchy's integral formula, power series representation of an analytic function, Taylor's series; Singularities; Laurent's series; Cauchy's residue theorem; Contour integration.

**(9) Linear Programming:** Linear programming problems, basic solution, basic feasible solution and optimal solution; Graphical method and simplex method of solutions; Duality. Transportation and assignment problems.

**(10) Partial differential equations:** Family of surfaces in three dimensions and formulation of partial differential equations; Solution of quasilinear partial differential equations of the first order, Cauchy's method of characteristics; Linear partial differential equations of the second order with constant coefficients, canonical form; Equation of a vibrating string, heat equation, Laplace equation and their solutions.

**(11) Numerical Analysis and Computer programming:** Numerical methods: Solution of algebraic and transcendental equations of one variable by bisection, Regula-Falsi and Newton-Raphson methods; solution of system of linear equations by Gaussian elimination and Gauss-Jordan (direct), Gauss-Seidel (iterative) methods. Newton's (forward and backward) interpolation, Lagrange's interpolation. Numerical integration: Trapezoidal rule, Simpson's rules, Gaussian quadrature formula. Numerical solution of ordinary differential equations: Euler and Runge-Kutta methods. Computer Programming: Binary system; Arithmetic and logical operations on numbers; Octal and Hexadecimal systems; Conversion to and from decimal systems; Algebra of binary

numbers. Elements of computer systems and concept of memory; Basic logic gates and truth tables, Boolean algebra, normal forms. Representation of unsigned integers, signed integers and reals, double precision reals and long integers. Algorithms and flow charts for solving numerical analysis problems.

**(12) Mechanics and Fluid Dynamics:** Generalized coordinates; D' Alembert's principle and Lagrange's equations; Hamilton equations; Moment of inertia; Motion of rigid bodies in two dimensions. Equation of continuity; Euler's equation of motion for inviscid flow; Stream-lines, path of a particle; Potential flow; Two-dimensional and axisymmetric motion; Sources and sinks, vortex motion; Navier-Stokes equation for a viscous fluid.

(231)

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

## Statistics:

1. Sample space and events, probability measure and probability space, random variable, as a measurable function, distribution function of a random variable, discrete and continuous-type random variable, probability mass function, probability density function, vector-valued random variable, marginal and conditional distributions, stochastic independence of events and of random variables, expectation and moments of a random variable, conditional expectation, convergence of a sequence of random variable in distribution, in probability, in  $p$ -th mean and almost everywhere, their criteria and inter-relations, Chebyshev's inequality and Khintchine's weak law of large numbers, strong law of large numbers and Kolmogoroff's theorems, probability generating function, moment generating function, characteristic function, inversion theorem, Linderberg and Levy forms of central limit theorem, standard discrete and continuous probability distributions.

## 2. Statistical Inference:

Consistency, unbiasedness, efficiency, sufficiency, completeness, ancillary statistics, factorization theorem, exponential family of distribution and its properties, uniformly minimum variance unbiased (UMVU) estimation, Rao-Blackwell and Lehmann-Scheffe theorems, Cramer-Rao inequality for single parameter. Estimation by methods of moments, maximum likelihood, least squares, minimum chi-square and modified minimum chi-square, properties of maximum likelihood and other estimators, asymptotic efficiency, prior and posterior distributions, loss function, risk function, and minimax estimator. Bayes estimators.

Non-randomised and randomised tests, critical function, MP tests, Neyman-Pearson lemma, UMP tests, monotone likelihood ratio, similar and unbiased tests, UMPU tests for single parameter likelihood ratio test and its asymptotic distribution. Confidence bounds and its relation with tests.

Kolmogoroff's test for goodness of fit and its consistency, sign test and its optimality. Wilcoxon signed-ranks test and its consistency, Kolmogorov-Smirnov two-sample test, run test, Wilcoxon-Mann-Whitney test and median test, their consistency and asymptotic normality.

Wald's SPRT and its properties, OC and ASN functions for tests regarding parameters for Bernoulli, Poisson, normal and exponential distributions. Wald's fundamental identity.

### 3. Linear Inference and Multivariate Analysis:

Linear statistical models', theory of least squares and analysis of variance, Gauss-Markoff theory, normal equations, least squares estimates and their precision, test of significance and interval estimates based on least squares theory in one-way, two-way and three-way classified data, regression analysis, linear regression, curvilinear regression and orthogonal polynomials, multiple regression, multiple and partial correlations, estimation of variance and covariance components, multivariate normal distribution, Mahalanobis-D2 and Hotelling's T2 statistics and their applications and properties, discriminant analysis, canonical correlations, principal component analysis.

### 4. Sampling Theory and Design of Experiments:

An outline of fixed-population and super-population approaches, distinctive features of finite population sampling, probability sampling designs, simple random sampling with and without replacement, stratified random sampling, systematic sampling and its efficacy, cluster sampling, two-stage and multi-stage sampling, ratio and regression methods of estimation involving one or more auxiliary variables, two-phase sampling, probability proportional to size sampling with and without replacement, the Hansen-Hurwitz and the Horvitz-Thompson estimators, non-negative variance estimation with reference to the Horvitz-Thompson estimator, non-sampling errors.

Fixed effects model (two-way classification) random and mixed effects models (two-way classification with equal observation per cell), CRD, RBD, LSD and their analyses, incomplete block designs, concepts of orthogonality and balance, BIBD, missing plot technique, factorial experiments and  $2n$  and  $32$ , confounding in factorial experiments, split-plot and simple lattice designs, transformation of data Duncan's multiple range test.

### 5. Industrial Statistics:

Process and product control, general theory of control charts, different types of control charts for variables and attributes,  $\bar{X}$ ,  $R$ ,  $s$ ,  $p$ ,  $np$  and  $c$  charts, cumulative sum chart. Single, double, multiple and sequential sampling plans for attributes, OC, ASN, AOQ and ATI curves, concepts of producer's and consumer's risks, AQL, LTPD and AOQL, Sampling plans for variables, Use of Dodge-Roming tables.

Concept of reliability, failure rate and reliability functions, reliability of series and parallel systems and other simple configurations, renewal density and renewal function, Failure models: exponential, Weibull, normal, lognormal.

Problems in life testing, censored and truncated experiments for exponential models.

## 6. Optimization Techniques:

Different types of models in Operations Research, their construction and general methods of solution, simulation and Monte-Carlo methods formulation of linear programming (LP) problem, simple LP model and its graphical solution, the simplex procedure, the two-phase method and the M-technique with artificial variables, the duality theory of LP and its economic interpretation, sensitivity analysis, transportation and assignment problems, rectangular games, two-person zero-sum games, methods of solution (graphical and algebraic).

Replacement of failing or deteriorating items, group and individual replacement policies, concept of scientific inventory management and analytical structure of inventory problems, simple models with deterministic and stochastic demand with and without lead time, storage models with particular reference to dam type.

Homogeneous discrete-time Markov chains, transition probability matrix, classification of states and ergodic theorems, homogeneous continuous-time Markov chains, Poisson process, elements of queuing theory, M/M/1, M/M/K, G/M/1 and M/G/1 queues.

Solution of statistical problems on computers using well-known statistical software packages like SPSS.

## 7. Quantitative Economics and Official Statistics:

Determination of trend, seasonal and cyclical components, Box-Jenkins method, tests for stationary series, ARIMA models and determination of orders of autoregressive and moving average components, forecasting.

Commonly used index numbers-Laspeyre's, Paasche's and Fisher's ideal index numbers, chain-base index number, uses and limitations of index numbers, index number of wholesale prices, consumer prices, agricultural production and industrial production, test for index numbers - proportionality, time-reversal, factor-reversal and circular.

General linear model, ordinary least square and generalized least squares methods of estimation, problem of multicollinearity, consequences and solutions of multicollinearity, autocorrelation and its consequences, heteroscedasticity of disturbances and its testing, test for independence of disturbances, concept of structure and model for simultaneous equations, problem of identification-rank and order conditions of identifiability, two-stage least square method of estimation.

Present official statistical system in India relating to population, agriculture, industrial production, trade and prices, methods of collection of official statistics, their reliability and limitations, principal publications containing such statistics, various official agencies responsible for data collection and their main functions.

8. **Demography and Psychometry:** Demographic data from census, registration, NSS other surveys, their limitations and uses, definition, construction and uses of vital rates and ratios, measures of fertility, reproduction rates, morbidity rate, standardized death rate, complete and abridged life tables, construction of life tables from vital statistics and census returns, uses of life tables, logistic and other population growth curves, fitting a logistic curve, population projection, stable population, ~~quasi-stable~~ population, techniques in estimation of demographic parameters, standard classification by cause of death, health surveys and use of hospital statistics.

Methods of standardisation of scales and tests, Z-scores, standard scores, T-scores, percentile scores, intelligence quotient and its measurement and uses, validity and reliability of test scores and its determination, use of factor analysis and path analysis in psychometry.

229

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

## Physics

**1. (a) Mechanics of Particles:** Laws of motion; conservation of energy and momentum, applications to rotating frames, centripetal and Coriolis accelerations; Motion under a central force; Conservation of angular momentum, Kepler's laws; Fields and potentials; Gravitational field and potential due to spherical bodies, Gauss and Poisson equations, gravitational self-energy; Two-body problem; Reduced mass; Rutherford scattering; Centre of mass and laboratory reference frames.

**(b) Mechanics of Rigid Bodies:** System of particles; Centre of mass, angular momentum, equations of motion; Conservation theorems for energy, momentum and angular momentum; Elastic and inelastic collisions; Rigid body; Degrees of freedom, Euler's theorem, angular velocity, angular momentum, moments of inertia, theorems of parallel and perpendicular axes, equation of motion for rotation; Molecular rotations (as rigid bodies); Di and tri-atomic molecules; Precessional motion; top, gyroscope.

**(c) Mechanics of Continuous Media:** Elasticity, Hooke's law and elastic constants of isotropic solids and their inter-relation; Streamline (Laminar) flow, viscosity, Poiseuille's equation, Bernoulli's equation, Stokes' law and applications.

**(d) Special Relativity:** Michelson-Morley experiment and its implications; Lorentz transformations-length contraction, time dilation, addition of relativistic velocities, aberration and Doppler effect, mass-energy relation, simple applications to a decay process; Four dimensional momentum vector; Covariance of equations of physics.

## 2. Waves and Optics:

**(a) Waves:** Simple harmonic motion, damped oscillation, forced oscillation and resonance; Beats; Stationary waves in a string; Pulses and wave packets; Phase and group velocities; Reflection and Refraction from Huygens' principle.

**(b) Geometrical Optics:** Laws of reflection and refraction from Fermat's principle; Matrix method in paraxial optics-thin lens formula, nodal planes, system of two thin lenses, chromatic and spherical aberrations.

**(c) Interference:** Interference of light-Young's experiment, Newton's rings, interference by thin films, Michelson interferometer; Multiple beam interference and Fabry-Perot interferometer.

**(d) Diffraction:** Fraunhofer diffraction-single slit, double slit, diffraction grating, resolving power; Diffraction by a circular aperture and the Airy pattern; Fresnel diffraction: half-period zones and zone plates, circular aperture.

**(e) Polarization and Modern Optics:** Production and detection of linearly and circularly polarized light; Double refraction, quarter wave plate; Optical activity; Principles of fibre optics, attenuation; Pulse dispersion in step index and parabolic index fibres; Material dispersion, single mode fibres; Lasers-Einstein A and B coefficients; Ruby and He-Ne lasers; Characteristics of laser light-spatial and temporal coherence; Focusing of laser beams; Three-level scheme for laser operation; Holography and simple applications.

226

### 3. Electricity and Magnetism:

(a) **Electrostatics and Magnetostatics:** Laplace and Poisson equations in electrostatics and their applications; Energy of a system of charges, multipole expansion of scalar potential; Method of images and its applications; Potential and field due to a dipole, force and torque on a dipole in an external field; Dielectrics, polarization; Solutions to boundary-value problems-conducting and dielectric spheres in a uniform electric field; Magnetic shell, uniformly magnetized sphere; Ferromagnetic materials, hysteresis, energy loss.

(b) **Current Electricity:** Kirchhoff's laws and their applications; Biot-Savart law, Ampere's law; Faraday's law, Lenz's law; Self and mutual inductances; Mean and r.m.s. values in AC circuits; DC and AC circuits with R, L and C components; Series and parallel resonances; Quality factor; Principle of transformer.

(c) **Electromagnetic Waves and Blackbody Radiation:** Displacement current and Maxwell's equations; Wave equations in vacuum, Poynting theorem; Vector and scalar potentials; Electromagnetic field tensor, covariance of Maxwell's equations; Wave equations in isotropic dielectrics, reflection and refraction at the boundary of two dielectrics; Fresnel's relations; Total internal reflection; Normal and anomalous dispersion; Rayleigh scattering; Blackbody radiation and Planck's radiation law, Stefan-Boltzmann law, Wien's displacement law and Rayleigh-Jeans' law.

### 4. Thermal and Statistical Physics:

(a) **Thermodynamics:** Laws of thermodynamics, reversible and irreversible processes, entropy; Isothermal, adiabatic, isobaric, isochoric processes and entropy changes; Otto and Diesel engines, Gibbs' phase rule and chemical potential; van der Waals equation of state of a real gas, critical constants; Maxwell-Boltzmann distribution of molecular velocities, transport phenomena, equipartition and virial theorems; Dulong-Petit, Einstein, and Debye's theories of specific heat of solids; Maxwell relations and applications; Clausius-Clapeyron equation; Adiabatic demagnetisation, Joule-Kelvin effect and liquefaction of gases.

(b) **Statistical Physics:** Macro and micro states, statistical distributions, Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac distributions, applications to specific heat of gases and blackbody radiation; Concept of negative temperatures.

### 5.

**Quantum Mechanics:** Wave-particle duality; Schrodinger equation and expectation values; Uncertainty principle; Solutions of the one-dimensional Schrodinger equation for a free particle (Gaussian wave-packet), particle in a box, particle in a finite well, linear harmonic oscillator; Reflection and transmission by a step potential and by a rectangular barrier; Particle in a three dimensional box, density of states, free electron theory of metals; Angular momentum; Hydrogen atom; Spin half particles, properties of Pauli spin matrices.

**Atomic and Molecular Physics:** Stern-Gerlach experiment, electron spin, fine structure of hydrogen atom; L-S coupling, J-J coupling; Spectroscopic notation of atomic states; Zeeman effect; Frank-Condon principle and applications; Elementary theory of rotational, vibrational and electronic spectra of diatomic molecules; Raman effect and molecular structure; Laser Raman spectroscopy; Importance of neutral hydrogen atom, molecular hydrogen and molecular hydrogen ion in astronomy; Fluorescence and Phosphorescence; Elementary theory and applications of NMR and EPR; Elementary ideas about Lamb shift and its significance.

7.

**Nuclear and Particle Physics:** Basic nuclear properties-size, binding energy, angular momentum, parity, magnetic moment; Semi-empirical mass formula and applications, mass parabolas; Ground state of deuteron, magnetic moment and non-central forces; Meson theory of nuclear forces; Salient features of nuclear forces; Shell model of the nucleus - successes and limitations; Violation of parity in beta decay; Gamma decay and internal conversion; Elementary ideas about Mossbauer spectroscopy; Q-value of nuclear reactions; Nuclear fission and fusion, energy production in stars; Nuclear reactors. Classification of elementary particles and their interactions; Conservation laws; Quark structure of hadrons; Field quanta of electroweak and strong interactions; Elementary ideas about unification of forces; Physics of neutrinos.

8.

**Solid State Physics, Devices and Electronics:** Crystalline and amorphous structure of matter; Different crystal systems, space groups; Methods of determination of crystal structure; X-ray diffraction, scanning and transmission electron microscopies; Band theory of solids - conductors, insulators and semiconductors; Thermal properties of solids, specific heat, Debye theory; Magnetism: dia, para and ferromagnetism; Elements of superconductivity, Meissner effect, Josephson junctions and applications; Elementary ideas about high temperature superconductivity. Intrinsic and extrinsic semiconductors; pn- p and n-p-n transistors; Amplifiers and oscillators; Op-amps; FET, JFET and MOSFET; Digital electronics-Boolean identities, De Morgan's laws, logic gates and truth tables; Simple logic circuits; Thermistors, solar cells; Fundamentals of microprocessors and digital computers.

# SYLLABUS FOR BIHAR INDUSTRIES SERVICE

224

## Chemistry:

1. **Atomic structure & chemical bonding-** Quantum theory, Heisenberg's uncertainty principle, Schrödinger wave equation (time independent). Interpretation of the wave function. particle in a one- dimensional box, quantum members, hydrogen atom wave function. particle in a one- dimensional box, quantum members, hydrogen atom wave functions. Shapes of s,p and d orbital's. ionic bond; lattice energy, born- Haber cycle, fajans' fuel dipole moment, characteristics of ionic compounds, electronegativity differences. Covalent bond and its general characteristics valence bond approach. Concept N<sub>2</sub>, F<sub>2</sub>, NO, CO and HF molecules in terms of molecular orbital approach. Sigma and Pi bonds. Bond order, bond strength & bond length.
2. **Thermodynamics-** Work heat and energy. First law of thermodynamics. Enthalpy, heat capacity relationship between C<sub>p</sub> and C<sub>v</sub>. Laws of thermo chemistry. Kirchhoff's equation. Spontaneous and non gases for reversible and irreversible processes. Third law of thermodynamics. Free energy, variations of free energy of gas with temperature, pressure and volume. Gibbs- Helmholtz equation. Chemical potential. Thermodynamic criteria for equilibrium, free energy change in chemical reaction and equilibrium constant. Effect of temperature and pressure on chemical equilibrium constant. Effect of temperature and pressure on chemical equilibrium. Calculation of equilibrium constants from thermodynamic measurements.
3. **Solid State-** forms of solids, law of constancy of interfacial angles. Crystal systems and crystal classes (crystallography groups). Designation of crystal faces, lattice structure and unit cell. Laws of rational indices. Bragg's law, x-ray diffraction by crystals. Defects in crystals. Elementary study of liquid crystals.
4. **Chemical Kinetics-** Order and molecularity of a reaction. Rate equations (differential & integrated forms) of zero, first and second order reaction. Half life of a reaction. Effect of temperature, pressure and catalysts on reaction rates. Collision theory of reaction rates of bimolecular reactions. Absolute reaction rate theory. Kinetics of polymerization and photo chemical reactions.
5. **Electrochemistry-** limitations of Arrhenius theory of dissociation, Debye- Muckel theory of strong electrolytes and its quantitative treatment, electrolytic conductance theory and theory of activity co- efficient. Derivation of limiting law for various equilibria and transport properties of electrolyte solutions.

6. **Concentration cells**, liquid junction potential, application of e.m.f. measurements of fuel cells.

7. **Photochemistry**- Absorption of light. Lambert- Beer's laws of photochemistry. Quantum efficiency. Reasons for high and low quantum yields. Photo- electric cells.

8. **General Chemistry of 'd' block elements:**

- (a) Electronic configuration, introduction to theories of bonding in transition metal complexes. Crystal field Theory and its modification; applications of the theories in the explanation of magnetism and electronic spectra of metal complex.
- (b) Metal Carbonyls; Cyclopentadienyl, Olefin and acetylene complex.
- (c) Compounds with metal- metals bonds and metal atom clusters.

9. **General Chemistry of 'f' block elements;** lanthanides and actinides; Separation, oxidation states, magnetic and spectral properties.

10. **Reactions in non- aqueous solvent** (liquid ammonia and sulphur dioxide).

11. **Reaction mechanisms**- General methods (both kinetic and non kinetic) of study of mechanism of organic reactions illustrated by examples.

Formation and stability of reactive intermediates (Carbonations, carbanious, free radicals, carbenes, nitrenes and benzyne). SN1 and SN2 mechanisms- H, E2 and E1 cb eliminations- cis and Tran's addition to carbon to carbon double bonds- Mechanisms of additional to carbon- oxygen double bonds- Micheal addition- to conjugated carbon- carbon double bonds- atomic electrophilic and nucleophilic substitutions- allylic and benzylic substitutions.

12. **Pericyclic reactions** : Classification and examples- and elementary study of Woodward- Hoff- Mann rules of pericyclic reactions.

13. **Chemistry of the following name reaction:** Aldol condensation, Claisen condensation, Dieck Mann reaction, Perkin reaction reamer- Tiemann reaction, Cannizzaro reaction.

14. **Polymeric Systems:**

- (a) Physical chemistry of polymers; End group analysis, sedimentation, Light Scattering and Viscosity of polymer.
- (b) Polyethylene, Polystyrene, Polynyl chloride, Ziegler Natta Catalysis, nylon, Terylene.
- (c) Inorganic Polymeric Systems; Phosphonitric halide compounds; silicones; Borazines. Friedel- Craft reaction, reformat sky reaction, Pinacol- pinacolone Wagner- Meerwein and Beck- mann rearrangements, and their mechanisms- uses of the following reagents in organic synthesis: O5' O4' HIO4' NBS, dib crane, Na- liquid ammonia. NaNh4' LiAlN4'.

922

15. **Photochemical reactions of organic and inorganic compounds:** Types of reaction and examples. and synthetic uses Methods used in structure determination: Principles and applications of visible, IR, <sup>1</sup>H, NMR and mass spectra for structure determination of simple organic and inorganic molecules

16. **Molecular structural determinations:** Principles and Applications to simple organic and inorganic molecules.

- (i) Rotational spectra of diatomic molecules (Infrared and Raman) isotopic substitution and rotational constants.
- (ii) Vibrational spectra of diatomic, linear symmetric, linear asymmetric and bent tri-atomic molecules (Infrared and Raman).
- (iii) Specificity of the functional groups (Infrared and Raman).
- (iv) Electronic Spectra- singlet and triplet states, conjugated double bonds,  $\alpha$ -Bunsaturated carbonyl compounds.
- (v) Nuclear Magnetic Resonance, chemical shift, spin-spin coupling.
- (vi) Electron Spin Resonance: Study of inorganic complexes and free radicals.

(221)

**SYLLABUS  
FOR  
BIHAR INDUSTRIES SERVICE**

**Business Management:**

1. Nature and purpose of business
2. Business Undertakings
3. Sole – Proprietorship
4. Partnership
5. Joint Stock Company
6. Co-Operative organization
7. Public Sector
8. Promotion Of A Business
9. Size of A Business Unit And Scale of operations
10. Organisation of home trade
11. Wholesalers
12. Retailers
13. Large Scale Retail Organisations
14. Business Combinations
15. Scientific Management
16. Rationalisation
17. Plant Location
18. Industrial Finance
19. Stock Exchange
20. Commodity/Produce Exchanges
21. Introduction to management
22. Functions of Management
23. Organisation
24. Organisation Structure
25. Methods of Remuneration Labour Question Papers
26. Classification of the functions of management
27. Managerial and operative functions
28. Brief Description of Managerial Functions
29. Principles of Management
30. Fayol's fourteen Principles of Management
31. Universality of Management

220

# SYLLABUS FOR BIHAR INDSUTRIES SERVICE

## **Chartered Accountancy:**

### **1. Financial Accounting:**

Accounting as a Financial Information System; Impact of Behavioural Sciences. Accounting Standards e.g., Accounting for Depreciation, Inventories, Research and Development Costs, Long-term Construction Contracts, Revenue Recognition, Fixed Assets, Contingencies, Foreign Exchange Transactions, Investments and Government Grants, Cash Flow Statement, Earnings Per Share. Accounting for Share Capital Transactions including Bonus Shares, Right Shares, Employees Stock Option and Buy-Back of Securities. Preparation and Presentation of Company Final Accounts. Amalgamation, Absorption and Reconstruction of Companies.

### **2. Cost Accounting:**

Nature and Functions of Cost Accounting. Installation of Cost Accounting System. Cost Concepts related to Income Measurement, Profit Planning, Cost Control and Decision Making. Methods of Costing: Job Costing, Process Costing, Activity Based Costing. Volume – cost – Profit Relationship as a tool of Profit Planning. Incremental Analysis/ Differential Costing as a Tool of Pricing Decisions, Product Decisions, Make or Buy Decisions, Shut-Down Decisions etc. Techniques of Cost Control and Cost Reduction: Budgeting as a Tool of Planning and Control. Standard Costing and Variance Analysis. Responsibility Accounting and Divisional Performance Measurement.

### **3. Taxation:**

Income Tax: Definitions; Basis of Charge; Incomes which do not form Part of Total Income. Simple problems of Computation of Income (of Individuals only) under Various Heads, i.e., Salaries, Income from House Property, Profits and Gains from Business or Profession, Capital Gains, Income from other sources, Income of other Persons included in Assessee's Total Income. Set - Off and Carry Forward of Loss. Deductions from Gross Total Income. Salient Features/Provisions Related to VAT and Services Tax.

### **4. Auditing:**

Company Audit: Audit related to Divisible Profits, Dividends, Special investigations, Tax audit. Audit of Banking, Insurance, Non-Profit Organizations and Charitable Societies/Trusts/Organizations.

## **Financial Management, Financial Institutions and Markets**

### **1. Financial Management:**

Finance Function: Nature, Scope and Objectives of Financial Management: Risk and Return Relationship. Tools of Financial Analysis: Ratio Analysis, Funds-Flow and Cash-Flow Statement. Capital Budgeting Decisions: Process, Procedures and Appraisal Methods. Risk and Uncertainty Analysis and Methods. Cost of capital: Concept, Computation of Specific Costs and Weighted Average Cost of Capital. CAPM as a Tool of Determining Cost of Equity Capital. Financing Decisions: Theories of Capital Structure - Net Income (NI) Approach, Net Operating Income (NOI) Approach, MM Approach and Traditional Approach. De-signing of Capital structure: Types of Lever-ages (Operating, Financial and Combined), EBIT- EPS Analysis, and other Factors. Dividend Decisions and Valuation of Firm: Walter's

Model, MM Thesis, Gordon's Model Lintner's Model. Factors Affecting Dividend Policy. Working Capital Management: Planning of Working Capital. Determinants of Working Capital. Components of Working Capital -Cash, Inventory and Receivables. Corporate Restructuring with focus on Mergers and Acquisitions (Financial aspects only)

## **2. Financial Markets and Institutions:**

Indian Financial System: An Overview

Money Markets: Participants, Structure and Instruments. Commercial Banks. Reforms in Banking sector. Monetary and Credit Policy of RBI. RBI as a Regulator.

Capital Market: Primary and Secondary Market. Financial Market Instruments and Innovative Debt Instruments; SEBI as a Regulator.

Financial Services: Mutual Funds, Venture Capital, Credit Rating Agencies, Insurance and IRDA.

## **5. Organisation Theory and Behaviour, Human Resource Management and Industrial Relations Organisation Theory and Behaviour**

### **1. Organisation Theory:**

Nature and Concept of Organisation; Ex-ternal Environment of Organizations -Technological, Social, Political, Economical and Legal; Organizational Goals - Primary and Secondary goals, Single and Multiple

Goals; Management by Objectives.

Evolution of Organisation Theory: Classical, Neo-classical and Systems Approach. Modern Concepts of Organisation Theory: Organisational Design, Organisational Structure and Organisational Culture. Organisational Design-Basic Challenges; Differentiation and Integration Process; Centralization and Decentralization Process; Standardization / Formalization and Mutual Adjustment. Coordinating Formal and Informal Organizations. Mechanistic and Organic Structures. Designing Organizational structures-Authority and Control; Line and Staff Functions, Specialization and Coordination. Types of Organization Structure -Functional. Matrix Structure, Project Structure. Nature and Basis of Power , Sources of Power, Power Structure and Politics. Im-pact of Information Technology on Organizational Design and Structure. Managing Organizational Culture.

### **2. Organisation Behaviour:**

Meaning and Concept; Individual in organizations: Personality, Theories, and Determinants; Perception - Meaning and Process. Motivation: Concepts, Theories and Applications. Leadership-Theories and Styles. Quality of Work Life (QWL): Meaning and its impact on Performance, Ways of its En-hancement. Quality Circles (QC) - Mean-ing and their Importance. Management of Conflicts in Organizations. Transactional Analysis, Organizational Effectiveness, Management of Change.

## **6. Human Resources Management and Industrial Relations**

### **1. Human Resources Management (HRM):**

Meaning, Nature and Scope of HRM, Human Resource Planning, Job Analysis, Job Description, Job Specification, Recruitment Process, Selection Process, Orientation and Placement, Training and Development Process, Performance Appraisal and 360° Feed Back, Salary and Wage Administration, Job Evaluation, Employee Welfare, Promotions, Transfers and Separations.

## **2. Industrial Relations (IR):**

Meaning, Nature, Importance and Scope of IR, Formation of Trade Unions, Trade Union Legislation, Trade Union Movement in India. Recognition of Trade Unions, Problems of Trade Unions in India. Impact of Liberalization on Trade Union Movement. Nature of Industrial Disputes : Strikes and Lockouts , Causes of Disputes, Prevention and Settlement of Disputes. Worker's Participation in Management: Philosophy, Rationale, Present Day Status and Future Prospects. Adjudication and Collective Bargaining. Industrial Relations in Public Enterprises, Absenteeism and Labour Turnover in Indian Industries and their Causes and Remedies. ILO and its Functions.