

**SYLLABUS  
(Credit based)**

**FOR**

**MSc. Programme**

**In**

**“M. Sc. Cellulose and Paper Technology”**

**AT**

**FOREST RESEARCH INSTITUTE  
DEEMED UNIVERSITY**

**DEHRADUN- 248006**

**(In collaboration with Central Pulp and  
Paper Research Institute, Saharanpur)**

**Forest Research Institute (Deemed) University  
M.Sc. Cellulose and Paper Technology**

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**Programme objectives:** The academic programme emphasizes on skills in multidisciplinary and advance education in Cellulose and Paper Sciences. Programme includes courses in modern areas of applied paper science, industrial processing and paper technology. During the university's educational programme at Masters level, the students receive adequate exposure of theoretical and practical aspects of cellulose and paper technology and gain competence in a distinctive set of skills to lead in paper industry. The course is also ideal for engineers and scientists currently working in the industry who wish to retrain and refresh in a new field. The current demand for pulp and paper experts indicates that this programme will be in high demand in the near future.

**Programme structure:** The programme consists of courses and other requirements worth a total of 91 credits. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week. Each semester will consist of 18-20 weeks of academic work equivalent to 90 teaching days. The programme structure and respective credits are given below as:

<b>Programme Structure</b>	<b>Credits</b>
Core courses	: 77
Foundation courses	: 3
Project work	: 8
In Plant training	: 3
<b>Total</b>	<b>: 91</b>

**Allotment of credits to different courses**

**FIRST SEMESTER**

<b>S. No.</b>	<b>Course Code</b>	<b>Course</b>	<b>Credit</b>
<b>Foundation course</b>			
1.	PP-111	Basic Forestry	3
<b>Core Course</b>			
2.	PP-112	Paper Industry and Fibrous Raw Materials	4
3.	PP-113	Pulping	4
4.	PP-114	Elements of Mechanical and Electrical Engineering	4
5.	PP-115	Washing of pulp	3
6.	PP-116	Practical	5
<b>Total credits in first semester : 23</b>			

**SECOND SEMESTER**

### THIRD SEMESTER

S. No	Course code	Course	Credit
<b>Core Course</b>			
1.	PP-121	Refining, Beating and Chemical Additives	4
2.	PP-122	Paper Machines-I	4
3.	PP-123	Paper Machines-II	3
4.	PP-124	Papermaking Chemistry	3
5.	PP-125	Screening and Cleaning	3
6.	PP-126	Practical	5
<b>Total Credits in second semester: 22</b>			

S. No	Course code	Course	Credit
<b>Core course</b>			
1.	PP-211	Chemical Recovery	4
2.	PP-212	Bleaching Technology	4
3.	PP-213	Material and Energy Balance	4
4.	PP-214	Paper Properties	3
5.	PP-215	Secondary Fibre Technology	4
6.	PP-216	Practical	5
<b>Total Credits in third semester: 24</b>			

### FOURTH SEMESTER

S. No	Course code	Course	Credit
<b>Core course</b>			
1.	PP-221	Specialty Paper	3
2.	PP-222	Environmental Pollution Control	3
3.	PP-223	Project Work	8
4.	PP-224	In Plant Training	3
5.	PP-225	Practical	5
<b>Total Credits in fourth semester: 22</b>			

## **1<sup>st</sup> SEMESTER FOUNDATION COURSE**

### **PP-111 BASIC FORESTRY**

**LEARNING OBJECTIVES:** To introduce the fundamental knowledge of forestry science, silviculture and processing of woody materials for pulp and paper industry.

#### **MODULE I FORESTS**

- Forests their composition, distribution and Physiognomy, importance of forests for supplying raw materials to various industries
- Forestry issues, Act, Policy, available land, practices to be adopted to supply raw material to Industry. Nature and functions of social forestry, farm forestry their social and physical interactions as an integrated system

#### **MODULE II SILVICULTURE OF IMPORTANT SPECIES FOR PAPER AND PULP**

- Silviculture practices of a) Eucalyptuses b) poplar c) Casurina d) Bamboo etc

#### **MODULE III TIMBER HARVESTING AND TRANSPORTATION**

- Harvesting methods, marking the timber transportation to Depot, grading of logs

#### **MODULE IV NON-WOODY FIBROUS MATERIALS**

- Distribution, Occurrence, availability like bagasse, cotton linters, Jute, hemp, cereals, straws etc

#### **MODULE V WOOD HANDLING AND DETERIORATION OF WOOD**

- Measurement of wood, wood stacking, Effect of storage on pulp and paper making. Physical and biological deteriorations, Deterioration by fungus, termites etc
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### **CORE COURSE**

#### **PP-112 PAPER INDUSTRY AND FIBROUS RAW MATERIALS**

**LEARNING OBJECTIVES:** The course is designed to impart knowledge on the status of Indian paper industry and to train students in the theoretical and practical aspects of raw material morphology and physico-chemical characteristics.

#### **MODULE I INTRODUCTION**

- Status of Indian Paper Industry and Global Scenario. Demand and Supply consumption, Exports and Imports, Projected Production, Consumption

- Structure of Indian Paper Industry, Issues and challenges, Technological gaps, definition of pulp, paper and paper board, flow-sheet of complete pulp and paper making process, fibrous raw materials for paper making: issues and availability, Project demand forecast and supply covering Wood and non-wood (Bamboo, Bagasse, Shrubs and other grasses) and Recycled waste paper.

## **MODULE II MORPHOLOGICAL CHARACTERISTICS**

- Morphological characteristics of fibrous raw material used in Paper manufacturing covering softwoods, hardwood, non-wood including agro residues viz. Bamboo, Reeds, Bagasse, heat Straw, Rice straw, Sarkanda, Cotton and other alternate ligno-cellulosic fibers.

## **MODULE III PHYSICAL PROPERTIES**

- Density of chip, chip size, chip structure and chip distribution and their influence on paper making properties.

## **MODULE IV CHEMISTRY OF FIBROUS RAW MATERIALS**

- Chemical properties of cellulose, hemi-cellulose, lignin, extractives and in-organic components. Structure of hemi-cellulose and lignin, importance of hemi-cellulose in paper making, chemical reaction of lignin during alkaline process.
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### **PP- 113 PULPING**

**LEARNING OBJECTIVES:** To provide detailed knowledge and skills in the pulping technology. To train students in the practical aspects of mechanical, chemical, semi chemical and chemi-mechanical pulping by practical problem-solving exercises in the context of pulping operations

#### **MODULE I INTRODUCTION**

- Overview of alkaline pulping, kraft and soda pulping, standard definitions and terminologies

#### **MODULE II ALKALINE PULPING, PULP MILL OPERATION AND PULPING ON NON-WOOD**

- Description of alkaline cooking process, composition and analysis of white liquor and process variables, dependence of time and temperature (H-factor), control parameters, effect of raw material on pulp quality, evaluation of pulp, Kappa number, viscosity and drainability
- Batch and continuous digesters and their operations, heating systems, hot and cold blowing, blow heat recovery system

- Brief description of conventional techniques for soda pulping of bagasse, straws and kenaf etc., pulping equipments and cooking processes
- Kraft Process Modification: Digester additives, extended delignification processes, modified continuous cooking, super batch, RDH process, oxygen delignification, poly sulphide pulping

### **MODULE III MECHANICAL, SEMI-CHEMICAL AND CHEMI-MECHANICAL PULPING**

- Classification of mechanical pulping process, RMP, CRMP, TMP and CTMP, grinders, pulp store, control practices and testing methods, properties and end uses of mechanical pulps
- NSCC pulping, cold soda, acid sulphide, bi-sulphite and hot sulphite, chemic-mechanical pulping processes, composition of cooking liquors, process variables and characteristics of pulps

### **MODULE IV BIO-PULPING**

- Bio-chemical Pulping, Bio-mechanical Pulping – Process, Potential and Benefits

### **MODULE V ADVANCES IN CHEMICAL PULPING**

- Other Pulping Process (Organosolv, Additive pulping, Explosion and their combinations. Super critical pulping and Easters pulping processes
  - Process and characteristics of dissolving grade pulp
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## **PP- 114 ELEMENTS OF MECHANICAL AND ELECTRICAL ENGINEERING**

**LEARNING OBJECTIVES:** To understand the fundamentals and applications of mechanical and electrical engineering in pulp and paper industry. The course is designed to develop competence in machine models and their workings used in pulp and paper industry. To learn mills operations and techniques including fluid mechanics and electrical circuits.

### **MODULE I STEAM, STEAM BOILERS, FURNACE, DRAFT, FUEL AND COMBUSTION**

- Steam: Generation and use of wet, dry and super heated steam, Dryness fraction, Enthalpy (total Heat) of steam, specific volume, external work, external energy. Use of steam table and charts
- Steam boilers: Fire tube and water tube boilers, high pressure boilers mountings and accessories. Capacity and efficiency of boilers, Boiler Act and rules
- Furnace: Types and method of fuel firing

- Draft: Definition, Natural and artificial draft, Calculation of chimney height and H.P of draft fan
- Fuel and Combustion: Different fuels and their calorific value, products of combustion

## **MODULE II STEAM TURBINE, STEAM TO POWER CYCLES, COOLING DEVICE, BOILER FEED WATER TREATMENT**

- Steam Turbine: Introduction, Classification, Impulse and Reaction turbine, Compounding for pressure and velocity
- Steam to power Cycles: Back pressure, Extraction cum condensing and extraction cum back pressure turbine
- Cooling device: Spray pond and cooling tower
- Boiler feed water treatment: Treatment methods and specifications of boilers feed water

## **MODULE III FERROUS AND NON FERROUS METALS, METAL FORMING, HEAT TRANSFER AND TRANSMISSION OF POWER**

- Ferrous and non ferrous metals: Classification of iron and steel, Cast iron and their alloy, Steel and their alloy, Copper, Zinc and their alloy, Nickel and Chromium alloys, properties and applications
- Metal Forming: Casting, Forging, Welding, Soldering and brazing, advantages and applications
- Heat Transfer: Method of heat transfer, radiation, conduction and convection, heat exchanger types and application, rate of heat transfer, overall heat transfer coefficient, thermal insulation, selection of insulating materials
- Transmission of power: Belt and gear drive type and applications

## **MODULE IV FLUID MECHANICS AND INTRODUCTION TO ENERGY SOURCES**

- Fluid Mechanics: Fluid pressure, density, specific weight, specific gravity, viscosity and their measurement. Flow of liquid, flow through pipes, loss of head in pipes, mechanism of fluid flow, Reynold's number, Laminar and Turbulent flow, velocity profile
- Fluid machines, Centrifugal / Reciprocating pumps, vacuum pumps, design and applications
- Introduction to Energy Sources: Steam and power requirement in pulp & paper industry, co-generation, co-generation economics

## **MODULE V ELECTRICAL CIRCUITS AND MACHINES**

- Electrical circuits: Single-phase and three-phase circuits, Star and delta connections, power in single phase and three phase circuits, Earthing of equipments
  - Electrical Machines: Three phase induction motors, D.C Generators and motors their industrial applications. Speed control of D.C motor
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**PP- 115**

### **WASHING OF PULP**

**LEARNING OBJECTIVES:** The course is designed to deal with washing process of pulp and its measurement. To understand the working of washing equipments and types of washing phenomenon in paper industry and to study various principles and factors of washing for the proper management and planning of water resources. \_

### **MODULE I WASHING**

- Processing of pulp before washing, mechanism of washing, Brown stock washing, dilution washing, displacement washing, dilution factor, washing efficiency, washing losses, factors affecting pulp washing, washing equipments, operation of brown stock washing systems, types of washing equipments, construction details and operational principles

### **MODULE II MEASUREMENT OF WASHING PERFORMANCE**

- Displacement ratio, washing efficiency, Dilution factor, washing losses etc., Factors affecting pulp washing

### **MODULE III PULP WASHING EQUIPMENTS**

- Types, construction details and operational principles
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**PP-116**

### **PRACTICAL**

**LEARNING OBJECTIVES:** To provide a practical understanding and hand on experience on wood anatomy, raw material analysis and preparations. To gain competence in white liquor preparation, its analysis and in pulping operations at laboratory level.

- Wood anatomy – Identification
  - Microscopic study of morphological characteristics of papermaking fibers
  - Proximate chemical analysis i.e. Solubilities, Klason lignin, Holocellulose, Ash, Pentosans and cellulose ( $\alpha$ -cellulose)
  - Raw material preparation – Debarking, chipping, chip classification etc.
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- Analysis of white liquor (Soda and Kraft)
  - Determination of Kappa number and viscosity
  - Refiner mechanical pulping
  - Fiber classification
  - Determination of soda loss
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## **2<sup>nd</sup> SEMESTER**

### **CORE COURSE**

#### **PP- 121 REFINING, BEATING & CHEMICAL ADDITIVES**

**LEARNING OBJECTIVES:** To train the students for basic composition, applications and reaction mechanism of different additives used in paper industry. To gain competence in beating and refining aspects along with broad understanding of stock preparation equipments.

#### **MODULE I BEATING AND REFINING**

- Introduction to paper making and Stock preparation Beating and Refining action structure of fiber, Effect of refining on fiber, stock web and paper properties. Measurement of refining, Quantification of refining action, Concept of Spectic Edge Load. Process variables during refining controlled variables, conventional variables Active and passive process variable calculations on Refiner parameters.
- Biorefining-Enzymes for refining: Process parameters for enzyme refining, advantages, limitations and economic aspects.

#### **MODULE II WET AND DRY STRENGTH ADDITIVES**

- Introduction to wet and additives additives, rosin, sizing, rosin size preparation, fortified size, dispersed size, factors effecting sizing, measurement methods of sizing synthetic size.
- Wet strength additives, mechanism of wet strength development. Handing of wet strength broke, dry strength additives, starches, different types of starches and their modification. Application of starch CMC and gums in surface sizing as wet end additive and coating

#### **MODULE III FILLERS AND DYES**

- Introduction to fillers, addition of filler and retention phenomena, effect of fillers on paper properties. Introduction to dyeing. Principle of light interaction with paper Different type of dyes and their application in paper

#### **MODULE IV STRENGTH AND CONTROL ADDITIVES, SIZING CHEMICALS**

- Dry and wet strength additives, types of dry and wet strength additives, mechanism of strength development, factors affecting wet and dry strength properties
- Mechanism of retention and drainage on paper machine, type of retention chemicals, deformers, surfactants and slimicides and micro organism slime formation, chemical slime control through eco-friendly slimicides
- Basic surface science considerations in sizing, types of sizing agents, AKD, ASA, Rosin, trouble shooting of sizing problems

## **MODULE V EQUIPMENTS**

- Design and construction of stock preparation, equipments including Beaters Conical and Disc-refiner. Stock chest and agitators etc

PP- 122

## **PAPER MACHINES-I**

**LEARNING OBJECTIVES:** To provide detailed knowledge and skills in the papermaking process, machines with a focusing on key engineering and technical aspects involved. Understanding of the basic principles of approach flow system, headbox, four drainer and paper former will be supplemented.

## **MODULE I GENERAL OVERVIEW OF PAPERMAKING PROCESS**

- Definition, importance and regulation of consistency regulators and point of controls in system, consistency regulators

## **MODULE II APPROACH FLOW SYSTEM**

- Significance and function of constant level box . Fan pump – function and characteristics
- Need for cleaning stock and principle of cleaning system used in paper industry, centri-cleaners systems for cleaning pulp stock. Selection of approach flow system for various machines

## **MODULE III HEADBOX AND FOUR DRAINER TABLE**

- Function design and types. Level control system. Components of headbox. Function of slice types. Adjustment of slice. Jet geometry and speed in papermaking .Relation between formation and jet placement
- Components of a four drainer table and their function. Theory of sheet formation –Drainage, thickening, filtration, orientation due to shake, brest roll,

forming board, table roll, hydrofoils, wet and suction boxes. Suction boxes function and vacuum control, forming fabrics. Couch roll function, Design features. Dandy–functions structure

#### **MODULE IV WEBS TRANSFER AND CYLINDER MOLD FORMATION**

- Open, pickup, lick-up, draw control. Importance of draw and effect features
- Uni and counter flow cylinder formers

#### **MODULE V STOCK AND WHITE WATER SYSTEM AND ADVANCES IN PAPER FORMER**

- Short circulation, large circulation, fiber recovery through saveall
  - Twin wire former- roll former, blade former, hybrids, top former
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PP- 123

#### **PAPER MACHINES-II**

**LEARNING OBJECTIVES:** To provide detailed knowledge and skills in paper machines with a focusing on wet pressing, sizing and calendaring.

#### **MODULE I WET PRESSING**

- Press section, mechanism of pressing, types of presses, operating variables, factors affecting water removal of presses, common paper defects, originated in press section, hot pressing

#### **MODULE II DRYING AND YANKEE DRYERS**

- Drying theory, general description of dryer parts, conventional cylinder dryers and their modifications, steam and condensate handling system, hoods and hood exhaust, development in dryers and drying methods – air drying, IR drying, runnability, pocket ventilation system
- Design and construction, steam and condensate, handling, tissue creeping

#### **MODULE III SURFACE SIZING, CALENDERING AND SUPER CALENDARING**

- Surface sizing chemicals, size press configurations, modified size press designs
- Operating variables for calendar stack, sheet variables, super calendarers,

gloss calenders, soft calenders, anti-deflection rolls, crowning of rolls

#### **MODULE IV PAPER MACHINE CLOTHING**

- Selection of forming, press and dryer fabrics. Paper machine drives / felt conditioner

#### **MODULE V RE-WINDER AND SHEETERS**

- Equipment components and Defects developed during operation. Quality checks in the finishing house. Description of process of lamination. Extrusion coating, Carborizing, making tracing papers, ammonia papers

### **PP- 124 PAPERMAKING CHEMISTRY**

**LEARNING OBJECTIVES:** It is aimed at students looking to gain a sound appreciation of the principles and practice of paper making chemistry and how to use it to help address important paper making requirements, problems and science questions.

#### **MODULE I INTRODUCTION**

- Importance of papermaking chemistry, fiber–fiber water bonding, rheology, surface energy and surface tension of colloidal systems

#### **MODULE II ELECTRO-KINETIC PROPERTIES OF CELLULOSE**

- Ion-exchange, electro-kinetic phenomena, effects of chemical environment and processing operations such as pulping, bleaching and refining on electro-kinetic properties

#### **MODULE III COAGULATION AND FLOCCULATION IN PAPERMAKING**

- Coagulation with electrolytes, theory of flocculation and dispersion of colloidal materials, effect of additives on fiber flocculation

#### **MODULE IV RETENTION MECHANISM**

- Charge neutralization, patch model, bridging, complex flocculation, dissolved and colloidal substances

#### **MODULE V FOAM AND SLIME CONTROL**

- Nature of foam, foam formation and stabilization, effect of additives on foam stability, theory of anti foam action etc
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### **PP- 125 SCREENING AND CLEANING**

**LEARNING OBJECTIVES:** The course introduces pulp processing and provides a broad understanding for screening, cleaning and thickening mechanisms and importance.

### **MODULE I SCREENING**

- Objectives of screening, types of contaminants in pulp, types of screens: vibrating screens, gravity centrifugal screens and pressure screen
- Mechanism of debris removal, measuring of screening performance and arrangements of screens

### **MODULE II CLEANING**

- Centrifugal cleaning, variables affecting cleaner performance, operating problems, arrangement of cleaners and design modification

### **MODULE III Thickening**

- Reason of thickening of pulp, thickening equipments and their application.  
Effect of drying on pulp properties
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**PP-126**

### **PRACTICAL**

**LEARNING OBJECTIVES:** To provide a practical understanding and hand on experience on analysis of pulp, hand sheet preparation, applications and impacts of sizing and additives chemicals etc. on paper properties. To gain competence in back water analysis and fiber loss analysis at laboratory level.

- Determination of pulp consistency, CSF and °SR
  - Beating and refining of pulp in laboratory refiners / beaters
  - Preparation of hand sheets in laboratory sheet formers
  - Preparation of hand sheets with sizing chemicals
  - Preparation of hand sheets with different doses of fillers
  - Evaluation of paper properties of hand sheets prepared
  - Laboratory Sheet making and Drying
  - Back water analysis, Single pass retention
  - Fiber loss analysis
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### **3<sup>rd</sup> SEMESTER CORE COURSE**

#### **PP-211 CHEMICAL RECOVERY**

**LEARNING OBJECTIVES:** To provide an understanding of the chemical recovery process, black liquor characteristic, desilication and concentration.

#### **MODULE I INTRODUCTION**

- Kraft and soda recovery cycles, standard terms, impact of pulping on quality and composition of black liquor for wood and non-woods. Influence of dilution, factor on concentration of black liquor

#### **MODULE II BLACK LIQUOR CHARACTERISTICS**

- Detailed studies on physico-chemical, Thermal and Rheological properties of black liquor. Various properties to be studied includes TDS, TSS, RAA, TA, organically bound sodium, elemental analysis, physico-chemical properties,

colloidal stability at high concentrations, foaming characterization, boiling point rise, thermal properties, calorific value, SVR, thermal conductivity, specific heat, heat swelling volume ratio, IPDT, TIG, polymeric properties

### **MODULE III DESALINATION OF BLACK LIQUOR**

- Source of silica, its effect on concentration and incineration, various processes available and their description. Alternate system for black liquor management including LRP and value addition

### **MODULE IV CONCENTRATION OF BLACK LIQUOR**

- Types of evaporators including Direct contact evaporators, construction details, merit and demerits, concept of MEE, calculation of steam requirement, steam economy and heat transfer area for single effect and multiple effect evaporator, factors affecting steam economy, steam pressure and vacuum, various feeding sequences, condensate handling system

### **MODULE V PROCESS CONTROL PARAMETERS**

- Scale formation and their remedies, instrumentation and control of MEE's, optimum calculation time, calculations on heat transfer rate, case study and trouble-shooting on scale formation
  - Causticization and Lime Kiln: Basic and operation
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## **PP-212 BLEACHING TECHNOLOGY**

**LEARNING OBJECTIVES:** To provide an understanding of the importance, mechanisms and processes of bleaching technology used for various classes of pulp. To understand various terms used in bleaching treatment and to acquaint with different steps involved in bleaching operations.

### **MODULE I GENERAL PRINCIPLES OF BLEACHING**

- Objectives of bleaching, bleach-ability and its measurement, brightness reversion. Bleaching of chemical pulps -single stage and multistage. Bleaching processes viz. chlorination, extraction, hypochlorite and chlorine-dioxide. Chemical reactions and process parameter at each stage. Calculation on bleaching of pulp
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### **MODULE II BLEACHING OF MECHANICAL AND SEMI- CHEMICAL PULPS**

- Brief study of dithionite and borohydride bleaching techniques. Brief description of bleaching equipments and their material of construction. Preparation of hypo-chlorite, chlorine dioxide, and peroxide bleach liquor and their analysis. Instrumentation and process control in bleach plants. Introduction to nonchlorine bleaching process

### **MODULE III BLEACHING FUNDAMENTALS**

- Numbers for different bleaching reactions, reaction kinetics and operating variables  
H<sub>2</sub>O<sub>2</sub>, bio-bleaching, dithionite

### **MODULE IV BLEACHING OPERATIONS**

- Oxygen delignification, chlorination, extraction, hypochlorite bleaching, ozone bleaching, peroxide bleaching, operating variables of different bleaching stages, ECF and TCF bleaching systems, bleaching system for mechanical & high yield pulp

### **MODULE V**

- Advances in bleaching technologies including Bio bleaching

### **PP-213 MATERIAL AND ENERGY BALANCE**

**LEARNING OBJECTIVES:** To provide an understanding of material and energy balance with suitable examples/cases related to pulp and paper industry. This course is designed to provide students with the necessary background and knowledge pertaining to the material balance, vapour-liquid equilibrium, psychometric and fuels.

### **MODULE I INTRODUCTION**

- Unit and dimension, Moles, Density, Concentration, Temperature and Pressure Composition, Relation, Stoichiometry and Chemical Equations. Ideal Gas Laws, Equation of states for non ideal gases

### **MODULE II MATERIAL BALANCE**

- Law of conservation of mass. System boundaries and surrounding. Tie elements, Recycling, By-pass and Purging streams. Examples of Material balance with out chemical reactions

### **MODULE III VAPOUR LIQUID EQUILIBRIUM**

- Vapourization, Condensation, Vapour pressure. Effect of temperature and pressure, Vapour Pressure Plots, Saturation, Multicomponent gas Liquid Equilibrium. Steam tables and their use
- Definition of various energy related terms. Heat capacity and its estimation, Koop's rule. Calculation of Enthalpy changes with and without phase change. Latent Heat of vaporization. General energy balance equation

- Mechanical energy balance with chemical reaction, standard heat of formation and combustion. Heat of reaction at constant pressure and volume. Effect of temperature on heat of reaction at constant pressure

#### **MODULE IV PSYCHOMETRIC AND FUELS**

- Definition of DB, WB, Absolute humidity, Humid volume, Humid heat etc. Use of Psychometric charts and its application
- Combustion of different types of fuels, GHV, NCV, Proximate and Ultimate Analysis
- Example of material and energy balance related to pulp and paper industry

#### PP- 214 **PAPER PROPERTIES**

**LEARNING OBJECTIVES:** The course is designed to train students in the practical aspects of paper properties and their applications for different grades. The course is also designed to deal with physical, mechanical, resistance, barrier and optical properties of paper. Understanding of the basic principles of statistical tools used in paper testing and environmental effect on paper properties will also be delivered.

#### **MODULE I INTRODUCTION**

- Different grades of papers, boards and newsprint and their specifications, BIS and ISO standards of paper, paper properties and their dependence on paper making processes, calibration of instruments

#### **MODULE II PHYSICAL, MECHANICAL AND OPTICAL PROPERTIES**

- Physical properties: Definition and methods of determination of grammage, caliper bulk, smoothness, porosity, dimensional stability, curl etc
- Mechanical Properties: Definitions and methods of determination of tensile strength, tear strength, burst strength, folding endurance and bending stiffness
- Optical Properties: Interaction of light with paper, reflectance, definition and methods of determination of brightness, opacity, gloss and color

#### **MODULE III RESISTANCE / BARRIER PROPERTIES**

- Penetration of fluid through paper, water absorbency, Cobb test, oil absorbency, water vapor permeability

#### **MODULE IV EFFECT OF ENVIRONMENT ON PROPERTIES**

- Interaction between paper and moisture on strength and general properties on paper shape and dimension. Standard conditions of paper testing, conditioning of paper prior to testing

#### **MODULE V STATISTICAL EVALUATION**

- Statistical aspects of testing, confidence limit, reliability of test

#### **PP-222 ENVIRONMENTAL POLLUTION CONTROL**

**LEARNING OBJECTIVES:** Introduction of major problems in air and water pollutions. To provide detailed knowledge and skills in the management, treatment, disposal and recycling options for solid wastes. To provide basic understanding of legal acts related to environment and hazardous management.

#### **MODULE I AIR AND WATER POLLUTION**

- Contaminants, Industrial pollutants, odour control. Effects of air pollution and weather, Natural cleansing of pollution and dispersion
- Particulate and its control. Gaseous emission its control, Absorption, Adsorption, Combustion
- Explanation of terms like BOD, COD, Aerobic and Anaerobic condition

#### **MODULE II SOLID WASTE GENERATION AND MANAGEMENT-I**

- Pollution Control standard: Treated, untreated, irrigation water
- Problems of small/medium paper mills. Characteristics of effluent from different sections of a mill. Standardization of pulp Mill effluent for Irrigation
- Effluent treatment methods: Primary treatment, Secondary treatment (Aerobic and anaerobic, Activated sludge process ), Tertiary treatment, In plant measures to reduce discharges, Zero-effluent concept, Rapson-Reeve process, Solid waste, Land pollution, Control methods

#### **MODULE III SOLID WASTE GENERATION AND MANAGEMENT-I**

- Bioremediation of effluents: Microbial quality of water (Total and faecal coliform, Total microbial count). Physicochemical and Biological technologies of color and

other pollutant removal

- Waste biomass into Biofuels: First and second generation biofuels, production of bioethanol from cellulosic biomass adopting biorefinery approach in pulp and paper industry. Environmental Protection Act, Hazardous waste management and Public liability insurance act etc
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## **PP-215 SECONDARY FIBER TECHNOLOGY**

**LEARNING OBJECTIVES:** To make students learn evaluation of secondary fibers for paper manufacturing and about processing techniques including equipment knowledge.

### **MODULE I SECONDARY FIBERS AND THEIR SOURCES**

- Availability of secondary fiber, waste paper supply and demand, Definition and grades, throw outs and prohibitive material, broad categories of wastes, secondary fiber source, storage and handling, waste paper preparation and contaminants removal classification and sorting, coatings, adhesives and printing inks, consumption and use of secondary fiber, economics of secondary fiber utilization

### **MODULE II PROCESSES AND THEIR EQUIPMENTS**

- Cold process, hot process, deinking processes etc
- Pulping system: Batch vs continuous systems, high vs low consistency pulping stock before cooking, effect of temperature, pressure, agitation, consistency, chemicals and process water reuse
- Washing ink from the pulp slurry: Thickening vs dilatation washing, theory of counter current dilution washing, effect of particle size and ink dispersion, low, intermediate and high consistency washes, economic comparison of washing devices, comparison of washing and froth flotation
- Flotation Deinking: Fundamentals of flotation, Flotation cell, Flotation deinking process, measurement of flotation efficiency, quality of deinking pulp

### **MODULE III CLEANING AND SCREENING**

- Forward cleaners, forward operating parameters, control of operating parameter,

lightweight cleaner, core bleed cleaner, pressure screen. Measuring Screen performance, application of pressure screen, controlling pressure screen, reject screens, screening system design conditions

#### **MODULE IV BLEACHING OF SECONDARY FIBER**

- Bleaching deinked newsprint, bleaching of chemical pulp, bleaching of post consumer office waste
  - Effect of recycling on pulp quality, Impact of secondary fiber on paper machine, water and waste water treatment in recycling mills, Environmental impact of paper recycling
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#### **PP-216 PRACTICAL**

**LEARNING OBJECTIVES:** To provide a practical understanding and hand on experience on analysis of various liquors, bleaching of pulp, post bleaching analysis of pulp, and coating preparation. To gain competence in Analysis of coated sheet and waste paper processing.

- Analysis of black liquor
- Analysis of green liquor
- Analysis of salt cake
- Analysis of lime including available lime index and lime sludge
- Determination of Residual  $\text{Na}_2\text{O}$  in lime
- Determination of calorific value of black liquor
- Analysis of scale samples
- Bleaching of Pulp- Single Stage and Multi-stage
- Bleached pulp evolution
- Laboratory bleaching of pulp, delignification stages

- Laboratory bleaching of pulp, brightening stages
  - Determination of viscosity, PC number and ash of pulp
  - Determination of copper number of pulp
  - Preparation of coating slurry
  - Application of coating slurry on paper by laboratory
  - Hard nip / soft nip calendaring of coated paper
  - Analysis of coated sheet for different properties
  - Waste paper processing, deinking and evaluation
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**4<sup>th</sup> SEMESTER  
CORE COURSE**

**PP- 221 SPECIALITY PAPER**

**LEARNING OBJECTIVES:** The course is designed to train students in the advances of types, manufacturing, characteristics and applications of speciality papers.

**MODULE I BASE PAPER AND INGREDIENTS**

- Requirements of coating base paper, mechanical and wood free papers, coating pigments, Kaolin, GCC, PCC, talc, TiO<sub>2</sub>, aluminum trihydrates, synthetic plastic pigments, coating binders, CMC, polyvinyl alcohol, coating additives, characteristics and application of dispersants, viscosity modifiers, insolubilizers, lubricants and others

**MODULE II COATING PROCESSES**

- Coating color preparation, coating techniques, multiple coating of paper, drying of coated paper, Rheology of pigment slurries

**MODULE III PRINTING, WRITING PAPERS AND PAPERBOARD GRADES**

- Characteristics of various grades such as newsprint, SC papers, coated mechanical papers, uncoated fine papers, coated fine papers, special fine papers
- Carton boards classification and quality requirements for various applications, container boards and liner board, corrugating medium, special boards, core board and plaster board

**MODULE IV TISSUE AND AIR-LAID PAPERS**

- Tissue converting, embossing, printing and perforation, process of manufacture of air-laid papers, their characteristics and applications

**MODULE V CHARACTERISTICS OF SPECIALTY GRADES**

- Electrical papers, absorbent papers, filter papers, special strong papers, copy and imaging papers, wrapping and packaging papers, cigarette papers and other functional papers

## **PP-223 PROJECT WORK**

Each student will be given a project assignment at the beginning of the IV semester under a supervisor. Students will be required to work on the project related to pulp and paper technology including environmental and energy aspects based on the theoretical and for experimental studies. Students will be required to work on the project independently and submit a detailed project report before the commencement of the final examination. Students will be also required to make an oral presentation on the project.

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## **PP-224 IN PLANT TRAININGS**

**LEARNING OBJECTIVES:** The aim of this course is to provide the students an opportunity to understand the actual working environment of a mill. The student will be sent to mills in II year (III<sup>rd</sup> semester) examination for two months training. The students will utilize the opportunity in understandings the mill operating conditions, equipments and process details and to get an in sight into the over all working of the organization. Student will go to different section of the mill to get a fair idea of their working. The student will maintain a detailed daily diary recording their observations, equipments and process details, material and energy flows, instruments etc. Each student will submit a consolidate mill training report, given mill process flow sheets, equipments and other relevant data of the mill visited.

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## **PP-225 PRACTICAL**

- Identification of wire side / top side, MD/CD of paper sample
- Determination of gsm, thickness, bulk and density of paper samples
- Determination of moisture and ash content of paper samples
- Determination of sizing of paper by Cobb method

- Determination of strength properties of paper
- Determination of optical properties of paper
- Determination of surface properties of paper
- Analysis of effluent and treated effluent for solids, dissolve solids, pH, BOD, COD, dissolve oxygen

### SCHEME OF EXAMINATION

#### FIRST YEAR – SEMESTER – I

Subject Code	Subjects	Total Marks
PP- 111	Forestry	100
PP-112	Paper Industry & Fibrous Raw Materials	100
PP-113	Pulping	100
PP-114	Elements of Mechanical and Electrical Engineering	100
PP-115	Washing of pulp	100
PP-116	Practical	100
<b>Grand Total</b>		<b>600</b>

#### FIRST YEAR – SEMESTER – II

Subject Code	Subjects	Total Marks
PP- 121	Refining, Beating & Chemical Additives	100
PP-122	Paper Machines-I	100
PP-123	Paper Machines-II	100
PP-124	Papermaking Chemistry	100
PP-125	Screening & Cleaning	100
PP-126	Practical	100
<b>Grand Total</b>		<b>600</b>

## SCHEME OF EXAMINATION

### SECOND YEAR – SEMESTER – III

<b>Subject Code</b>	<b>Subjects</b>	<b>Total Marks</b>
PP- 211	Chemical Recovery	100
PP-212	Bleaching Technology	100
PP-213	Material and Energy balance	100
PP-214	Paper Properties	100
PP-215	Secondary fiber Technology	100
PP-216	Practical	100
<b>Grand Total</b>		<b>600</b>

### SECOND YEAR – SEMESTER – IV

<b>Subject Code</b>	<b>Subjects</b>	<b>Total Marks</b>
PP-221	Specialty Paper	100
PP-222	Environmental Pollution control	100
PP-223	Project Work	200
PP-224	In plant training	100
PP-225	Practical	100
<b>Grand Total</b>		<b>600</b>