SYLLABUS FOR DIPLOMA COURSE IN PULP AND PAPER TECHNOLOGY

1. PAPER MAKING & CHEMISTRY OF FIBROUS RAW MATERIALS

(i). Paper Making Raw Materials:

- History of Pulp and Paper making
- Status of Indian paper industry.
- Paper making raw materials
- Selection of pulp and paper making raw materials.
  (i) Wood based raw materials.
  (ii) Non-woody raw materials.
  (iii) Recycled fibres.
  (iv) Synthetic fibres.
- Brief description of pulp & paper making process (Introduction)
- Description of various grades of pulp & paper.
- Properties of paper

(ii). Chemistry Of Fibrous Raw Materials:

- Chemical composition of fibrous raw materials
- Cellulose- Isolation, structure and chemical properties
- Cellulose derivatives- Preparation & end use.
- Hemicelluloses-Isolation, importance in paper making, reactions during pulping.
- Lignin-Isolation, structure linkage, physical and chemical properties.
- Extractives – Isolation and significance in pulp & paper making

(iii) Raw Material Preparation:

- Preparation and storage of conventional wood based raw material.
- Preparation of wood chips, chip screening, storage and chip conveying.
- Equipments used for raw material preparation, chipping, chip screening and conveying
- Effect of chip size on pulping properties
- Storage of conventional (non-woody) raw materials like Bamboo, chip preparation, screening and conveying
- Storage of non-conventional straws, grasses and bagasse
- Raw material preparation using straws, grasses and bagasse
- Straws and grasses cutters and screens
- Bagasse depithing dry and wet depitting, Effect of depithing on pulping and paper making properties, Disposal of pith

(iv) **Practicals:**

- Wood Anatomy- identification.
- Fibre identification and tissue analysis (proportion of fibres, vessels, rays, paranchyma) and determination of dimensions.
- Proximate chemical analysis.
- Determination of $\alpha$, $\beta$ and $\gamma$ cellulose, silica in raw material.

### 2. PULP TECHNOLOGY-I

(i) **Chemical Pulping:**

(i).a. **Alkaline pulping**
- Introduction to standard terms used.
- Chemical composition of cooking liquor
- Batch and continuous pulping process
- Process variable
- Blow heat recovery systems.
- Characteristics of alkaline pulps.
- Odour emissions and its reasons.

(i).b. **Sulphite pulping**
- Introduction to standard terms used.
- Chemical composition and preparation of cooking liquor
- Process variables.
- Factors effecting sulphite pulping
- Characteristics of sulphite pulping

(ii) **Mechanical Pulping:**
- Mechanical pulping processes
- Process of fibre separation
- Stone ground wood process
- Advantages and limitations of process
- Pulp quality, characteristics and end use of pulp
- Refiner Mechanical and Chemical refiner Mechanical pulping process,
- Theory of refining
- Process variable
- Pulp quality
- Thermo-mechanical & Chemi-Thermomechanical pulping process
- General Principal of RMP, CRMP, TMP & CTMP Processes

(iii) Semi Chemical And Chemi Mechanical Pulping:
- Types of process
- Chemical treatment employed
- Composition of cooking liquor and chemical reaction during treatment
- Process variables and pulp characteristics and uses.

(iv) Waste Paper Pulping:
- Advantages of recycling of waste paper
- Broad categories of waste paper, sorting and dusting of waste paper
- Fibre separation of waste paper
- Process variable during pulping
- Production of unbleached pulps
- Deinking of waste paper.
- Various deinking systems
- Quality of deinked pulp

(v) Practicals:
- Raw materials preparation-chipping, chip classification, measurement of dimensions, chip density, bulk density.
- Depithing of Bagasse.
- Analysis of white liquor.
- Pre hydrolysis Kraft and soda-pulping
- Alkaline Sulphite pulping.
- Pulp analysis - Kappa/Permanganate number, copper number viscosity and lignin.
- Refiner mechanical pulping.
- Semi chemical and chemi mechanical pulping, evaluation of strength properties.
- Fibre classification
- Waste paper processing/deinking and evaluation.
3. PULP TECHNOLOGY-II

(i) Processing Of Pulp:

(i).a. Brown Stock Pulp Washing
- Brown stock pulp washing
- Dilution factor, washing losses, factors affecting pulp washing. Construction and operation of multistage washing system

(i).b. Screening & Cleaning of Pulp
- Screening and cleaning of pulps, Reasons for pulp screening and cleaning
- Undersizable constituents in unscreened pulp. Objectives and mechanisms of screening and cleaning
- Variables affecting screening efficiency. Type of screens and their process design
- Use of centrifugal cleaners, variables affecting centrifugal cleaning. Type of centrifugal cleaners. Theory and operation of centrifugal cleaners

(ii) Pulp Bleaching:
- Objectives and fundamental of pulp bleaching
- Bleaching process for chemical, mechanical, semichemical and waste paper pulps.
- Single and multistage bleaching system for chemical pulps, chorine water system, cholorination Alkali extraction, use of hypochlorite and chlorine dioxide in bleaching operation
- Chemical reactions and process parameters
- Recent bleaching process- use of hydrogen peroxide, oxygen, ozone, per acids, bio- bleaching,
- Non-wood fibre bleaching systems
- Preparation of various bleaching chemicals

(iii) Practicals:
- Determination of soda losses.
- Determination of Kappa number, total chlorine demand, copper number, viscosity, solubility in 1% NaOH.
- Pulp bleaching - single and multistage.
- Bleached pulp evaluation.
4. PULP TECHNOLOGY-III

(i) Chemical Recovery:

- Introduction to conventional chemical recovery systems. Various terms associated with chemical recovery process, impact of pulping and washing on chemical recovery.
- Properties of black liquor.
- Evaporation of black liquor, Types of evaporators, and latest innovations, Design aspects of evaporator, Heat and chemical balance, Trouble shooting.
- Historical development and evolution of recovery furnace, Roaster and smelter, Vertical stationary type furnace.
- Chemical reactions in recovery furnaces.
- Recovery furnace description of various equipments of furnace operating techniques, problem and trouble shooting, Properties of green liquor, Boiler mounting and steam production.
- Chemical reaction during causticizing operating techniques, problems and trouble shooting. White liquor clarification and washing of lime sludge, process, lime sludge reburning.
- Problems related to agrobase pulping recovery.

(ii) Practicals:

- Analysis of black liquor.
- Analysis of green liquor.
- Analysis of lime and lime sludge.
- Water analysis - total solids, hardness, pH.

5. PAPER TECHNOLOGY-I

(i) Stock Preparation:

- Introduction to stock preparation and its importance.
- Beating and refining mechanism of refining. Variable affecting refining controlling parameters, Types of refiners, Effect of refining on behaviour of fibre during paper making and end products, Blending of pulp.
- Non fibrous additives, Internal sizing of paper, theory of sizing, Different kind of sizing, Use of rosin sizing, Alkyl keten drmer sizing (AKD), Alkyl succinic anhydride (ASA),
Role of pH on sizing, Variable and process control in sizing, Method of addition of sizing chemicals

- Role of Fillers in papermaking, Type of fillers, Selection criteria, Addition of fillers and their retention. Effect of fillers on optical surface strength properties of paper, Methods of addition of fillers
- Introduction to strength enhancing additives, Use of starch, CMC and other gums, wet strength enhancing additives Mechanism of wet strength development, Preparation and method of addition
- Retention of additives during papermaking, Theory of retention, Zeta potential and its role in retention of additives, common retention aids, Fibre flocculation

(ii) Dyeing Of Paper:

- Reason of dyeing, Role of dyes and pigments
- Types of dyes, factors associated with dyeing of paper stock, Two sidedness and reasons for the same, colour matching and process control

(iii) Practicals:

- Determination of pulp consistency, °SR and CSF.
- Fibre classification.
- Beating and refining in different laboratory beaters.
- Stock sizing and evaluation of paper properties.
- Analysis of rosin and alum.

6. PAPER TECHNOLOGY-II

(i) Paper Making:

- History and development of papermaking, Type of paper making machine
- Role of screening and cleaning operation before sheet formation, Role and control of consistency in papermaking
- Flow approach system & its significance
- Head Box designs and development, Modern head boxes for high speed machines, Function of type of slice * its adjustment, Control of cross directional profile of paper
- Introduction to sheet formation single wire Fourdriniers machines, Twin & multiplayer wire systems, Foormic fabrics and their role, Operation of wire part, various parts
on wire part, water drainage and sheet formation on forming fabric, Energy conservation measures on Fourdrinier forming machines using Lovac, High Vac, Hydrofoil and table rolls. Role of suction boxes, various designs of foils and suction boxes, Need of vacuum and its control. Construction of wire table and various supporting rolls, operation and control of wire plant

- Description of dryer parts, Theory of drying advances in dryer runnability, Single cylinder and multi cylinder dryer. Steam heating and condensate removal system, Role of fabric on drying, Design of dryer hood, Description of various parts in dryer section
- Need for surface sizing, chemical used in surface sizing, Improvement in surface properties, Construction of size press.
- Reason for Calendering paper. Hardnip and soft nip calendars, process parameters during calendaring, Construction of calender section, Online coating of paper and board
- Paper reeling, rewinding, sheet cutting equipments, paper finishing and packing practices
- Need of drive control of various sections, Type of drive and control functions, line shaft and sectional drives
- Paper making common problems and trouble shooting, operational parameters and controls, Quality control on paper machine
- Specialized paper and multi layered board machines, their principal and operation, Modern concept of papermaking

(ii) Paper Conversion:

Introduction to various conversion process like offline coating, corrugating, box making, printing, laminating etc. Short description of process and equipments

(iii) Recent Developments In Pulp & Paper Making Technology:

Introduction to recent development in various areas of pulping and paper making
Introduction to basic training of computer application in relation to pulp & paper technology.

(iv) Practicals:

- Laboratory sheet making.
- Laboratory sheet testing
- Machine made sheet testing.
- Special tests on machine made paper
- Optical properties testing.
- Back water analysis, single pass retention.
- Fibre loss analysis.

7. ENVIRONMENTAL POLLUTION CONTROL

- Definition of environment, ecology, ecosystems, green house effects. Environmental audit. Forest ecosystem vis-a-vis environment, Man made forest. Social forestry. Forests and paper industry
- Water pollution in paper Industry, Definition of terms used.Water pollution problems of small/medium paper mills, Characteristics of effluents from different sections of a mill, Effluent treatment systems, Recycling of process/black water.
- Final treatment of wastewater, Discharge characteristics, Primary treatment, secondary biological treatment, Anaerobic, system, Aerobic system, Activated sludge process, Methane generation and other modern methods to clarify effluent discharge
- Air pollution control, Sources of air pollution ambient air monitoring and analysis, Air emission control devices like Mechanical cillectors, wet scrubbers, Odour control etc. An approach to zero effluent discharge concept.
- Solid waste management and control in paper mills, Nature of solid waste, Sludge dewatering devices, Uncineration, Land file application and other uses

Practicals:

- Analysis of influent and treated effluent for total solids, dissolved solids, pH, BOD, COD,. Dissolved oxygen.
8. PLANT & EQUIPMENT DESIGN AND CONSTRUCTION

(i) Plant & Equipment Design:
- Introduction to plant and equipment design. Selection of equipment and suitable material of construction. Introduction to operation and design and construction of water treatment plant, boilers, air compressors, vacuum pumps, centrifugal pumps, dosing pumps. Conveyers, Basic calculation of pulp & paper equipments.
- Plant location, plant layout and basic knowledge of installation.

(ii) Material & Energy Balance:
Material and energy balance related to pulp and paper making. Production of steam. Definition of various energy related terms. Energy audit and consumption of inputs in paper making (raw material, steam, electricity, water, compressed air etc.)

9. MILL VISITS

Students will be sent to paper mills and other Institutes for educational training during the first and second semester for one to two weeks. The objective is to provide an opportunity to stay in mill environment and understand the mill operating conditions, instruments and other details. Faculty members will be deputed to accompany the students.

The students will maintain a daily diary for recording their observations and technical data etc. At the end of the visit each student will independently submit a detailed report giving mill process flow sheets, equipment sketches and other relevant data of the mill(s) visited.
10. Examinations:

Examinations (theory/practicals) will be held -1st semester and IInd Semester as per the following schedule.

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Mill Visit Report 200

Total Marks 1200