

# **SYLLABUS**

## **SEMESTER 1**

### **WST C 001. FORESTRY AND DENDROLOGY (54 hrs./Semester)**

#### **Module 1**

Forests – definition, classification and brief description of forest types. Forestry – its scope and branches. Silviculture - definition, scope and objects. Forest plantations - different types. Rotation - definition and types. Site and species selection, planting, maintenance and other silvicultural operations. High density short rotation plantations, pulpwood plantations and energy plantation. Trees outside forests (TOF). Forest plantations and CDM. Forest certification.

#### **Module 2**

Forest health and its management. Sustainable forest management. Social forestry and its role in timber production. Participatory forest management

#### **Module 3**

Taxonomy and its relevance to wood science. Taxonomic identification tools: bark, stem, leaf, flower, fruit, seed. Plant nomenclature: International Code of Botanical Nomenclature and its rules. Systems of classification (Natural, artificial and phylogenetic, brief description of Bentham and Hooker system of classification).

#### **Module 4**

Systematic positions and diagnostic features of important trees of 10 major timber producing families (Verbenaceae, Leguminosae, Dipterocarpaceae, Lythraceae, Meliaceae, Combretaceae, Ebenaceae, Salicaceae, Betulaceae, Pinaceae).

### **WST C 002. WOOD STRUCTURE AND IDENTIFICATION (54 hrs. /Semester)**

#### **Module 1**

Wood anatomy – an introduction. Softwoods and hardwoods – important species. Formation of wood - cambium & its derivatives: secondary growth. Anatomical structure of wood: Gross anatomical and minute anatomical structures - sapwood and heartwood, growth rings and growth marks, rays, vessels or pores – ring porous and diffuse porous wood, fibres, etc.

### ***Module 2***

General and physical features of wood: colour, lustre, odour, taste, weight, grain, texture, figure etc. Variability of anatomical structure: reaction wood, abnormal rings - false rings and discontinuous rings. Important characteristics employed for wood identification – handlense features of wood – soft wood – hardwood; microscopic features of softwood and hard wood. Juvenile wood and its characteristics and importance.

### ***Module 3***

Defects in wood – Natural defects - knots, shakes, cross grain and other defects due to stress. Defects other than natural.

### ***Module 4***

Anatomical features of some important timber species. Wood structure in relation to silviculture, agri-silvi practices, genetics and properties. Criteria and methods of assessment of wood quality in plantation timbers.

## **WST C 003. VENEER, PLYWOOD AND COMPOSITES (54 hrs. /Semester)**

### ***Module 1***

Introduction to veneering. Pre-treatment of logs prior to peeling and slicing. Steaming, boiling, and cooking of round logs, debarking and cleaning, methods of veneer production. Lathes - Lathes for small diameter logs - Telescopic spindle lathes. Peeling, slicing, clipping.

### ***Module 2***

Veneer drying – Types of veneer driers - Veneer matching.- Veneer jointing – splicing - adhesive applications - glue spreaders - assembly time- hot pressing- hydraulic multiday light presses. Defects in peeled veneers.

### ***Module 3***

Plywood- Principles of manufacture, composition with regard to veneer thicknesses and species. . Glue spreaders. Optimum glue spreads. Pre-pressing- Advantages of pre-pressing. Storage before pre-pressing/hot pressing.Assembly, Hot pressing - Hot Press design parameters recommended pressing time - sizing, trimming, thickening and finishing.Compression in hot pressing.Defects in pressed plywood, their control and repair.Properties of plywood- elasticity and rigidity-tensile strength-compressive strength-bending strength-shear strength- hardness- Resistance against destruction - Preservative treatments of plywood.

### ***Module 4***

Laminated wood arrangements. Laminated Veneer Lumber(LVL). Glued laminated products- applications as structural composites.General information on production and properties of reconstituted wood. Sandwich Composites - Flush doors- block boards— manufacture- properties and applications. Compreg- production and properties - Reduction of global warming potential of wood products.

## **WST E 001. LOGGING AND ERGONOMICS (54 hrs. /Semester)**

### ***Module 1***

Brief overview of tree felling operations: rules and methods. Logging: definition and scope. Logging plan and execution.Location and demarcation of the area for logging.Marking of trees and estimation of produce available for extraction. Merchantable wood and cull volume estimation. Implements used in felling and logging operation; traditional and improved tools. Maintenance of various records and registers in logging operations.Conversion, measurement and description of converted material.

### ***Module 2***

Modern methods of timber transportation. Central and State rules relating to timber transit. Timber grading. Storage of timber: timber depots - depot management. Pricing, auctioning, E - auctioning or other types of marketing, allotment to industries, pricing etc. Measures to reduce wastage of wood in harvesting, storage and service.

### ***Module 3***

Wood based industries. Demand and supply of wood. Local and industrial consumption of wood. bamboos, reed bamboos, and sandalwood - resource base, availability, industrial utilization and end products.

### ***Module 4***

Ergonomics: definition, components and provision of energy. Requirement of energy and rest periods. Effect of heavy work, posture, weather and nutrition. Personal protective equipments, safety helmets, ear and eye protections. Accidents: causes, statistics, safety rules and first aids. Plants, animals and insect infestations; diseases and their management

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## **WST E002.FOREST MANAGEMENT AND PLANNING (54 hrs. /Semester)**

### ***Module 1***

Forest management- definition, object and scope. Forest policies and Acts as the basis of management. Forest organisation- various classification. Sustained yield- concept, scope and limitation. Biotic and abiotic factors including forest fire affecting forest health. Forest health management.

### ***Module 2***

Rotation: definition and types of rotation. Felling series in selection forest and coppice with standard system. Increment- CAI - MAI relationship. Growing stock: concept and definition - determination of growing stock- normal growing stock in regular, shelter, wood system, selection system.

### ***Module 3***

Yield regulation: principles and objective - types of yield- yield regulation in regular forests- various modifications - yield regulation in irregular forests - regulation based on volume increment, volume and increment only.

#### **Module 4**

Working plan: introduction, definitions, objective and scope. Preparation of working plans - preliminary working plan report. Constitution of a working plan division- field work- compartment histories- maps- working plan maps, stock maps, geology map, regeneration map, forest type map, management map- role of GIS in forest management. Method of writing working plan- Part I and Part II- Use of Modern tools in WP preparation.

#### **WST C 004. WOOD SCIENCE LABORATORY I (108 hrs. /Semester)**

1. Herbarium collection of important timber yielding species for the understanding of its features of identification;
2. Field identification of important timber trees and its importance- Hand lens features and identification of wood.
3. Anatomical keys and methods to use them. Dichotomous keys, punched card keys and computer aided identification;
4. Microscopic features, slide inspection of important characteristics species;
5. Anatomical studies of reaction wood. Modern timber identification techniques.
6. Traditional and modern equipments/tools used in logging operations and their uses.
7. Instructions regarding maintenance of various records and registers in logging operations.
8. Conversion of felled trees into logs, poles, firewood, pulpwood etc.
9. Visit during the auction sale in the government timber depots;
10. Preparation of ergonomic check lists.
11. Determination of density of wood.
12. Determination of moisture content.

13. Preservative treatments of plywood.
14. Treatment of logs prior to peeling and slicing.

## **WST C 005. WOOD TECHNOLOGY WORKSHOP I (12 hrs./week)**

### **PLYWOOD TECHNOLOGY**

#### **I. Storage Yard**

Wood species used for production of plywood and other wood based materials in the Western India Plywoods, Application of knowledge of Wood Anatomy learnt in theory, identification of species based on hand lens features ,

At the Log storage – need for storage, dry storage, wet storage, precautions in storage, measurement of log volume, Identify defects in wood, identify the wood destroying organisms such as insects and termites present in stored log, suggest treatment for protection of wood (Theory)

#### **Seminar Topics- presentation and submitting report for evaluation**

##### **Discuss /report on**

1. Timber measurements
2. The anatomical features of timber species used in WIP
3. The insects , termites identified from the logs
4. Recommendation of treatment to protect the logs
5. “Report on the appropriate information gathered from library for this seminar

#### **II. Plywood Processing (Green end)**

The students should study the following processes with the help of the factory staff:

Steaming and boiling - determination of heating schedules- calculation and comparison with actual practice , effect of heating on properties of wood, advantages and disadvantages of heating. Preparation of logs for peeling - cross cutting, debarking and cleaning. Log centering - purpose and economic importance of centering, centering errors and their influence on veneer yield, methods of centering. Veneer peeling lathe - machine parts, cutting action, undesirable movement of wood on lathe, play in lathe machine parts, spindle overhanging, dynamic equilibrium and slackness. Peeling lathe settings- setting of knife, setting of pressure bar, and setting of the gap.

#### **Seminar Topics- presentation and submitting report for evaluation:**

1. Reasons for boiling the logs. Calculation for determination of time of boiling
2. Centering the logs for peeling and the benefits

3. "Report on the appropriate information gathered from library for this seminar

Rotary cutting of veneer - lathe settings and veneer quality, mechanism of veneer formation, type A and B veneer, effect of pressure bar compression and temperature on veneer yield. Peeling defects, their cause and control - thickness variation-application of SQC -, roughness, identification of loose and tight side, loose veneer corrugation, raised grain, torn grain, bump formation, wooliness, knife and pressure bar marks. Measurement of veneer recovery, Yield calculation, Quality evaluation.

Maintenance of peeling lathe - general procedures, lubricants and lubrication, storage of spare parts for replacement

#### **Seminar Topics- presentation and submitting report for evaluation**

1. Rotary peeling of veneers
2. Veneer recovery to be discussed with the staff of WIP
3. To discuss on the Maintenance of peeling lathe carried out
4. "Report on the appropriate information gathered from library for this seminar  
Veneer Clipping - functions, types, clipping efficiency, clipping allowance, veneer yield, dry clipping,

Preparation of flitches for slicing - sawing patterns, cutting plan, tangential cutting, radial cutting, box flitches, half sawn flitches, quarter sawn flitches. Veneer slicer - machine parts, cutting action, advantages of slicing, undesirable movement of wood on slicer, play in slicer machine parts. Slicer settings and veneer quality - setting of knife, setting of pressure bar, effect of knife and pressure bar settings on veneer quality. Matching of sliced decorative veneers - side matching or drawn across, book matching or tuned over or cathedral matching, quartered matching, half quartered matching. Slicing defects, their causes and control. Maintenance of slicer-general maintenance procedure, lubrication.

#### **Seminar Topics- presentation and submitting report for evaluation**

1. Presentation of the report slicing of veneers
2. "Report on the appropriate information gathered from library for this seminar

### **III. Plywood Processing (Dry End)**

#### **III. A Drying of veneers**

Veneer drying - purpose, drying variables, moisture movement in veneers during drying, special measures for controlling final moisture content, drying defects and their control, types of dryers, internal design details, air velocity measurement, drying time, dryer productivity, dryer capacity. Splicers and splicing veneers

#### **Seminar Topics- presentation and submitting report for evaluation**

1. Principles of drying veneers and discuss how the veneer drying is different from wood seasoning

2. Discuss different types of dryers
3. Discuss the internal design details of WIP the dryers

### **III.B Glue spreading**

Glue spreaders – Examine the components, operation and maintenance of the machine

#### **Seminar Topics- presentation and submitting report for evaluation**

1. Discuss the components of glue spreader
2. Type of elastomeric materials employed for the fabrication of rolls in roll coatings
3. “Report on the appropriate information gathered from library for this seminar

### **III. C Hydraulic presses**

Hydraulic presses - cold and hot. Hydraulic system, Pascal's law, calculation of specific pressure, Pneumatic system. Heating modes, steam generation boilers, high pressure hot water boilers, thermic fluid, briquettes and briquetting machine. Identify the number of Plate and Column presses in the factory and report their construction.

Also identify Single-day light and multi-opening presses the important parts to be studied .Parts to be identified:

1. Rams (chilled hardened steel), 2. Cylinders (forged steel), 3. Cooling platens, 4. Heat balancing platens, 5. Press table, 6. Insulation, 7. Hot platens, 8. Insulation, 9. Upper beam, 10. Heat balancing plates, 11. Bearing plate, 12. Press frame'

Find out the heating mediums employed in hydraulic hot presses and individually identify them and report. Discuss the advantages and disadvantages of each of them. Ascertain different types of forces to which the structural load bearing parts of a press are subjected and report. Learn about press deflection and also causes for press damage and report

Study the time of pressing for different thicknesses. Calculation of time of pressing from theory

#### **Seminar Topics- presentation and submitting report for evaluation**

1. Discuss on each type of hydraulic hot presses in the WIP and the specifications of the presses. The student should cover all the presses.
2. Discuss on how the specific pressures are calculated
3. Discuss the plate and column presses and relative merits of each
4. Discuss on press deflection and damages that can be caused to the press
5. Discuss on the heating medium employed in different presses in WIP
6. Discuss on the need to have simultaneous closing press.



7. Discussion on the calculation of time of pressing in hydraulic hot press
8. "Report on the appropriate information gathered from library for this seminar

### **III D. Trimming and sanding**

Trimming - machines and operation. Drum and belt sanders - machines and operation. Abrasives, types abrasives, grain size, grade, structure, bond, wheel selection, grinding head, grinding bed,

#### **Seminar Topics- presentation and submitting report for evaluation**

1. To discuss on sanding machines and the different types of abrasives used
2. "Report on the appropriate information gathered from library for this seminar

### **III E. Workshop practice**

Knife grinding machine and grinding wheels - knives, grinding machines, composition, coolant, grinding procedures, maintenance. Jointing and splicing of veneers

#### **Seminar Topics- presentation and submitting report for Plywood**

1. Discuss the workshop practice carried out
2. "Report on the appropriate information gathered from library for this seminar

### **III F. Sawmill operation,**

Studying the timber yard and layout of log unloading, stacks, movement of mechanical log loaders and transport of logs to the mill. Spraying prophylactic preservatives and end coating of logs for protection against bio-degradation Sawmilling equipment, record their capacities and specifications, log chain saws, band saws, circular re-saw, circular cross-cut saw, Study and record Saw doctoring-saw blade geometry, measurement of clearance, sharpness and hook angles and pitch Study and report Gullet capacity, peripheral linear saw speed, feed speed, bite Measurement of yield of converted timber. Identify defects of representative log based on Hoppus and true log volume measures. Finger joining technique- machine for producing fingers and jointing using cold setting adhesive.

#### **Seminar Topics- presentation and submitting report**

1. Discuss different machines employed in saw mills
2. Discuss finger joining machine and report on the tensile strength of normal and the finger jointed timber
3. "Report on the appropriate information gathered from library for this seminar

### **III G. Block boards and flush doors**

Batten preparation and core composing for flush door and block board. Block boards and flush doors - core preparation, veneers, adhesives, construction, hot press schedules.

### **III H. Preservative treatment**

Testing of efficacy of preservatives in the laboratory and field conditions Hot and cold bath diffusion treatment. Calculation of voids for estimating maximum absorption. Impregnation of wood panels with vacuum and pressure.

#### **IV. Boilers and Briquetting plant**

Students should study the working of boilers using steam, high pressure hot water, oil heating and briquettes. Students should also study the working of briquetting machine

### **Semester II**

#### **WST C 006. PHYSICAL AND CHEMICAL PROPERTIES OF WOOD(54 Hrs. /Semester)**

##### ***Module 1***

Physical properties of wood: colour, odour, lustre, florescence, weight and density, specific gravity, moisture content variations and their practical significance.

##### ***Module 2***

Basic important mechanical properties of wood. Young's modulus, stress vs strain in wood, modulus of elasticity, anisotropy and various elasto-plastic nature of wood, strength of wood; Various stresses acting upon wood: Tensile, Compressive, Bending, Shearing Stress and torsion; Important factors affecting the strength of wood-inherent characteristics-growth conditions, tree age etc.

##### ***Module 3***

Electrical, piezo-electrical, optical, acoustical and thermal properties of wood. Wood-water relationship, hygroscopic nature of wood, free and bound water, fibre saturation point, equilibrium moisture content in wood. Movement of moisture in wood, differential shrinkage. Effect of moisture loss in the dimensional stability of wood.

##### ***Module 4***

Chemical composition and analysis of wood. Chemistry of wood-cell wall components, cellulose, hemi-cellulose, pectin and lignin; extractives, organic and inorganic materials. Their impact on the various strength properties.

#### **Module 5**

Structure and ultrastructure of wood –anatomical aspects-ultrastructure of cell walls. Chemistry of wood and bark extractives. Extractive of heartwood and softwood. rosin-fats and waxes-Tall oil.

### **WST C 007. *WOOD BIODEGRADATION AND PRESERVATION* (54 hrs./Semester)**

#### **Module 1**

Insect pests of natural forests and plantations, standing and felled trees, timber in storage. Biology, life history and extent of damage caused due to wood boring insects. Control measures against wood boring insects. Nature of damage - Galls, cankers etc. Wood attacking termites. Identification, life history and distribution of major and minor wood destroying termites associated with forest and in building structures. Termite control measures.

#### **Module 2**

Ecology of microbial invasion of wood. Fungal degradation of wood. Wood decay types: White rot, brown rot, soft rot, sap stain, moulds, discolouration and blemishes. Essentials of fungal attack on wood. Classification of wood attacking decay fungi. Bacterial decay of wood; symptoms and causes. Detection of wood decay: destructive and non-destructive methods. Symptoms and effects of wood decay. Decay in buildings. Heart rot in standing timber, management of timber with heart rot.

#### **Module 3**

Natural decay resistance of timbers and its evaluation, causes of decay resistance. Principles of pest control. Integrated Pest Management with respect to forest management: Natural, nutritional, biotic, silvicultural, mechanical, physical and chemical methods of insect control. Quarantine: principles and practices in plant protection. Phytosanitary certification.

#### **Module 4**

Importance of wood preservation. Natural durability: Durability of heartwood and sapwood, causes for natural durability, classification of timbers on the basis of natural durability, methods of determination of natural durability. Types of wood preservatives. Merits and demerits of different preservative compositions in relation to end use. Bio-degradable preservatives. Requirements of an ideal preservative. Testing of the efficacy of preservatives under laboratory and field conditions. Preservatives/preservative materials toxic to various bio-degrading agents - their toxicity levels.

#### **Module 5**

Non-pressure treatment processes: brushing, spraying, dipping, steeping, cold soaking, hot and cold bath, sap displacement and diffusion methods. Pressure treatment processes: Full cell, rueping (empty cell) and lowry treatments. Miscellaneous processes: prophylactic treatment, Boucherie treatment and Osmose treatment for green timber. New generation-eco-friendly preservatives.

### **WST C 008. *WOOD SEASONING* (54 hrs. /Semester)**

#### ***Module 1***

Objectives and importance of wood seasoning. Fundamentals of wood - water relationship. Protection of logs, protection of green sawn timber from fungal stains, insect attack and chemical stain. Prevention of end cracks and surface checks. Recommended moisture content of seasoned timber for different end uses in different climatic zones. Basis of the recommendations.

#### **Module 2**

Factors affecting drying rate of timber - thickness, moisture content, temperature, relative humidity and velocity of the drying air, diffusion and permeability characteristics of the species (form of moisture gradients in the timber section), sapwood and heartwood.

### **Module 3**

Seasoning defects - Surface & internal cracking, end splitting, cupping, warping etc.; their causes and prevention. Warp control - Top weighting, calculation of optimum loading (spring loading system); Drying stress development; measurement of drying strains. Resultant plastic strains (sets) produced. Stress reversal and case hardening. Critical stages for surface and internal cracking; drying conditions control; Partial pre-air drying; SDR procedure.

### **Module 4**

Classification of Indian timbers according to refractoriness to seasoning: Air seasoning: Stacking practice for poles, posts, railway sleepers and sawn timber.

### **Module 5**

Air seasoning sheds. FAN-AIR drying. Kiln seasoning - kiln drying schedules. Kiln operation: Measuring instruments of different types for temp., relative humidity and air velocity. Selecting material for kiln samples, maintenance of steam traps. Seasoning kilns: General design features and specifications. Heating (steam, hot water, heated mineral oil, direct/indirect heating by wood or gas-fired furnace, electricity). Steam and water spray humidification. Features of propeller and axial flow fans. Venting. Location of fans relative to timber stack. Baffles, uniformity of air circulation & structural insulation. Possibilities of kiln automation. Boiler capacity required, kiln heat losses and energy efficiency data. Consumption of different types of fuel.

### **Module 6**

Energy in kiln drying: energy consumption in drying systems, heat transfer concepts, energy demands of various wood drying systems. Energy conserving drying processes: Solar kilns, dehumidification kilns, vacuum drying in vapour with heat recovery, vacuum drying in RF field etc. Comparative economics: Air seasoning, steam heated & solar

kilns. Special seasoning methods & pretreatments: (High temperature drying, press drying, chemical seasoning.),

## **WST E 003.RECONSTITUTED WOOD PANELS AND ADVANCED COATINGS FOR WOOD PANELS (54 hrs. /Semester)**

### **Module 1**

Particleboard - definition- types – raw materials - wood and other lingo-cellulosic materials - adhesives- additives- General technology - particle preparation-drying- of chips - size separation and storage of chips. Chip blending – mat lay up- pre-pressing- hot pressing- multidaylight presses-extruded particleboards- Properties of particleboards - factors affecting the properties-density-moisture content-modulus of elasticity- modulus of rupture-internal bond strength in dry state and after accelerated aging test methods and end uses

### **Module 2**

Fibreboard- definition- types- raw materials and their preparation- wet and dry process - Pulping- chemical and mechanical pulping- Thermo-mechanical pulping- Asplundsdefibrator method- wet process of manufacture of hardboard - mat formation - hot pressing – press cycles. Oil tempering.Dry process of hardboard.MDF- Raw materials- wood & lingo-cellulosic agricultural residues. Testing methods and end uses

### **Module 3**

Advanced coatings for wood panels- Coatings definition- composition of coatings- Film forming resins/binders. Binders based on amino resins- Melamine formaldehyde resins (MF) - reactions with Urea-formaldehyde resins, urethanes- and alkyds in coatings.

### **Module 4**

Drying oils - composition of natural oils- drying, semi-drying and non-drying oils. Autoxidation and cross-linking- non-conjugated and conjugated drying oils.

### **Module 5**

Pigment dispersion Pigment volume relationship.- Application methods- Brushes- Spray applications - Dip coating- Roller coatings- Precision roller and Reverse roll coatings- Curtain coatings - Film defects.

### **Module 6**

Environmental impact of coatings.Environmentally friendly coatings.Hih solids coatings, Radiation curable coatings - Powder coatings. Nanotechnology-inorganic-organic hybrid materials - sol-gel route – scratch resistant coatings. Film defects.Mechanical properties- Abrasion and mark resistance- Measurement of mechanical properties.

## **WST E 004.WOOD VARIATION (54 hrs. /Semester)**

### **Module 1**

General concepts of tree improvement.Definition, objectives, advantages and disadvantages.Variation and its use. Provenance variation, site to site variation, variation among stands within sites, between tree and within tree variation. Importance of exotic trees.

### **Module 2**

Selection- types of selection. In self pollinated trees- Mass selection, pure-line selection, hybridization, pedigree breeding, bulk population method; In cross pollinated trees- Mass selection, hybridization, Synthetic varieties, mutation breeding.

### **Module 3**

Seed production.Seedling seed orchard, clonal seed orchard.Mass multiplication, clonal propagaton, Evaluation and screening, genetic testing program-experimental designs. Tree improvement trial, advanced generations and continued improvement. Gene transfer, genetic markers, DNA finger printing. Quantitative aspects of tree improvement; Testing and estimating population mean, Variance-phenotypic, genotypic and environmental variance. Breeding value, dominance, modes of gene action, genetic values, heritability, genetic gain, genetic advance.

### **Module 4**

Wood and tree improvement; Improvement in wood properties like specific gravity and wood density, importance of specific gravity variation for different end uses, Juvenile and mature wood variation. Tree form, fibre and tracheid length, cellulose and lignin content. High yield.

### **WST C 009. WOOD SCIENCE LABORATORY II (108 hrs. /Semester)**

1. Review of literature on Wood variation
2. Marking and conversion of wood into small clear specimens for testing
3. Test for mechanical properties of wood - Static bending, impact bending, compression parallel and perpendicular to grain, hardness, shear, torsion, nail and screw pulling test, brittleness test and calculation of properties;
4. Extractive content analysis of wood sample; Isolation of pure chemical constituents using thin layer and column chromatography;
5. Life cycle of some important insects of forest and plantation origin; Insect control techniques;
6. Seasoning schedule for important timber species; Identification and measurement of different seasoning defects in wood and their evaluation;
7. Visits to paper testing labs/industries and seasoning kilns
8. Visit to seed orchards- seedling seed and clonal seed orchards, Hybrid evaluation techniques

### **WST C 010. WOOD TECHNOLOGY WORKSHOP II (12 hrs./week)**

#### **Reconstituted Panel Products**

#### **Fibreboards**

#### **I Raw Materials**

Raw materials - fibre characteristics, fibre strength, fibre morphology, cell wall thickness and density of wood, Wet process and dry process hardboard, S1S and S2S types, wood chips, saw mill chips, wastes from lumber and plywood mill such as planer shavings, sawdust, sanderdust, plywood trims, whole-wood- tree chips, non-wood raw materials- lignocellulosic fibres Mill yard, type of logs and how they are delivered at the storage sites, Measurement of quantity, standard methods solid contents,



### **Seminar Topics- presentation and submitting report for evaluation**

1. Deterioration of chips during storage, identification of deteriorating organisms in the field (field examination)
2. Cleaning and chip washing system
3. Report on the appropriate information gathered from library for this seminar

### **II Size Reduction and Screening**

Manufacture of pulp chips, slashing, debarking, chipping, type of chippers, gravity feed and horizontal feed, examining the geometry of rotating knives, screening-overs, accepts and fines, type of movement of the screen, blinding(plugging of the finer screens) and how the plugging is prevented by bouncing rubber balls, size openings of various screens, screen analysis to be carried out, dulling of knives, wearing of bed plate, Chip moisture content determination, chip handling, silos storage,

### **Seminar Topics- presentation and submitting report for evaluation**

1. Presentation of details of rotating knives. Frequency of change of knives due to dulling of knives
2. Grain direction of the chips of the desired size. Report on the screen analysis
3. "Report on the appropriate information gathered from library for this seminar

### **III Defibration and refining**

Pulping process- freeness of pulp, disk refining, types of disk refiners, single disk and double disk, profiled cutting plates, material of construction, classification of plates based on the profile

### **Seminar Topics- presentation and submitting report for evaluation**

1. Presentation of functioning of disk refiners
2. Refiner plate profile as used in WIP and compare the same with other types . The photograph of the disk plates should be presented. The specifications of the material of construction should be reported.
3. "Report on the appropriate information gathered from library for this seminar

### **IV Pressurized disk refining**

Pressurized disk refining- complete interior details of the machines to be studied and reported, Asplunds (Sundsdefibrator) ,its operation, the process sequence, chip chute, conical horizontal feed screw, compression ratio, splines in the plug pipe and for

preventing the plug from rotating. Pre-heater, internal design and functioning, conveyor screws to the defibrator, the design of the conveyor screw, grinding disks stationary and rotating mounted on main shaft rotors, closely examining the steel alloy grinding segments profiled for shearing action to defibrize .

#### **Seminar Topics- presentation and submitting report for evaluation**

1. Report on adjusting of the gap between the disks by adjusting the pressure differential by oil hydraulic piston
2. Report on the profiled segments.
3. Report on the conical horizontal screw feeder functioning, compression ratio, spline
4. Report on the disturbances that can be caused by variation in the raw material composition, wear of refiner plates and other known and unknown causes.
5. "Report on the appropriate information gathered from library for this seminar

#### **V. Level Control in Pre-heater**

The pre-heater control such as speed of the conveyor controlling the amount of chips going into the pre-heater to keep the level in the pre-heater constant based on gamma gauge measurement

#### **Seminar Topics- presentation and submitting report for evaluation**

1. Discuss the importance of level control provided in the pre-heater
2. Report the refiner motor power
3. "Report on the appropriate information gathered from library for this seminar

Pressure in the pre-heater and the adjustment of fresh steam flow into the pre-heater. Observing and recording the temperature in the pre-heater (Observation and report). Observe refiner motor power, Flow of dilution water to the screw conveyor feeding the refiner (Report). Observe the refiner housing pressure to give the pulp free flow through the refiner (Report)

#### **VI Chemical Additives**

#### **Seminar Topics- presentation and submitting report for evaluation**

The additives are added to the pulp in the 'stock chests'

1. Discussion on the acidity control , Improvement of water resistance (sizing) defoamers, and release agent

2. Discussion on specific sizing agents , rosin size, wax size, asphalt size
3. “Report on the appropriate information gathered from library for this seminar

## **VII Pulp consistency**

Effect of pulp consistency on the uniformity fibre distribution and the hence board properties  
Experimental : Determination of freeness of pulp

## **VIII Fourdrinier machine**

Study the functioning of the Fourdrinier machine for the formation of the wet mat. Identify the following: head box, overflow, breast roll, deckles, table rolls, Rota-belt suction unit, wire guide, wet press, wire guide, wire. Identify the ‘wet line’.’ Identify the location of ‘Puddler’. Observe the functioning of the trimming of the fibre mat and study how the mat is trimmed by the steel disk while the mat is travelling

### **Seminar Topics- presentation and submitting report for evaluation**

1. Discussion on Fourdrinier machine, construction, functioning, various parts, dewatering action. Trimming of wet mat.
2. “Report on the appropriate information gathered from library for this seminar

## **IX Hot Pressing**

To study the construction of the press, heating medium (high pressure hot water), fast closing and pressure build up, hydraulic pressure fluid at very high rate of flow. Identify ‘jack rams’ and accumulators. Study the press cycle and the different (3) phases such as high pressure-squeeze, low pressure drying and consolidation phase

### **Seminar Topics- presentation and submitting report for evaluation**

1. Discussion on press construction, fast closing type, heating medium, press cycle
2. “Report on the appropriate information gathered from library for this seminar

## **X. Tempering of hardboard**

Tempering hardboard with linseed oil. Study the temperature, time duration for the polymerisation. Water treatment for boiler infeed, hydrazine treatment

Experimental: (1) Determination of freeness of hardboard pulp, 2) Determine the MOR of both normal and oil tempered hardboard

## **III. G Wood Seasoning**

Factors affecting the rate of drying, effect of thickness, moisture content, temperature, relative humidity, and velocity of air , diffusion and permeability characteristics of species of timber, stacking of sawn timber for air drying, mill maintenance, seasoning

kilns, construction, classification of timbers according to ease of seasoning, refractory timbers, seasoning schedules, seasoning defects Seasoning defects –surface and internal cracking, end splitting, cupping, collapse, bow, crookedness. Find out the causes and prevention. Classification of Indian timbers according to refractoriness in seasoning.

### **Seminar Topics- presentation and submitting report**

1. Discuss on classification of Indian timbers according to refractoriness in seasoning and Identification of seasoning defects (based on field examination)
2. Discuss on the principle of dry bulb and wet bulb temperatures
3. “Report on the appropriate information gathered from library for this seminar

Kiln seasoning: Stacking practice, kiln drying schedules (IS: Specifications). Optimum drying conditions to control at different critical stages. Modification of schedules for higher thickness, lower initial moisture contents. Removal of case hardening. Reverse case hardening. Seasoning kilns- general design features. Heating (steam, hot water, oil,. Steam and water spray humidification, Features of propeller and axial flow fans. Venting, location of fans relative to timber stack,, baffles, uniformity of air circulation,

### **Seminar Topics- presentation and submitting report**

1. Discuss the Kiln seasoning chambers
2. Discuss the kiln seasoning schedule
3. Report on the appropriate information gathered from library for this seminar

## **XI Solid waste management**

Wastes: Kinds of solid wastes –classification –What makes a waste hazardous? –What are the dangers? –Sources of wastes – Effects of waste if not manages wisely –What should be done –Objectives of SWM Systems, Basic components: -Collection – Transportation –Disposal technologies available –Composting –Incineration – Pelletisation –Pyrolysis –Biomethanation -Landfill gas recovery, Composting –Concept –Process – Types of composting – Aerobic –Anaerobic - Vermicomposting  
Vermicomposting 1.Earthworms 2.Methods- Pit below the ground -Heap above the ground - Tank above the ground - Cement ring - Commercial model 3.Nutritional composition 4. Benefits

### **Seminar Topics- presentation and submitting report**

- (1) To discuss the basic principles involved in composting

- (2) To discuss on the various microorganisms involved in the conversion process.
- (3) To discuss on the bio-deterioration and bio-degradation
- (4) "Report on the appropriate information gathered from library for this seminar

### ***OPEN COURSE***

#### **\*WST O 001. WOOD AND CLIMATE CHANGE MITIGATION (54 Hrs. /Semester)**

##### **Module 1**

Introduction to forests, wood and climate change - forests and the global carbon cycle; options for mitigating climate change using forestry, wood products and its strategies, the significance of wood as a carbon store.

##### **Module 2**

Trends in wood markets and forests- Global market for wood products and links to forest production. Underlying global trends in the use of industrial wood. Changing patterns of forest cover and the production of industrial wood. Sustainability issues relating to different product types.

##### **Module 3**

Comparing wood with competing non-wood materials- Greenhouse gas profiles of competing wood and non-wood based materials; barriers to material substitution; potential for market substitution

##### **Module 4**

Wood products and concerns of sustainable development. Situations where SFM and sustainable development can be impeded by the climate change mitigation agenda; assessing sustainable development in the context of SFM and climate change mitigation. A comparison of SEA and EIA. Wood products certification.

### **SEMESTER III**

**WST C 0011. ADHESIVES FOR PLYWOOD AND PANEL PRODUCTS (54 hrs. /Semester)**

## **Module 1**

Theory of adhesion - intermolecular forces-cohesion and adhesion. Conditions for good adhesion, importance of optimum spread, pressing pressure and wood moisture content. Surface preparation and pretreatment. Stresses in glued joints

## **Module 2**

Definition of adhesives. Rheology and viscoelasticity of adhesives (qualitative)- colloidal state of glues- sol-gel transformation- Basics of flow; determination of viscosity of adhesives- (Ostwald viscometer; plate and cone viscometer; Brookfield viscometer etc.) Bubble viscometer. Natural adhesives and synthetic resin adhesives- thermoplastic and thermosetting adhesives- transformation of liquid adhesives into solids

## **Module 3**

Chemistry, application, properties and classification of adhesives. Phenol-formaldehyde adhesives; Resoles and novolacs; resorcinol-formaldehyde adhesive. Hydrolysis, polymerization and pH changes causing degradation of glue joints.

## **Module 4**

Description of substituted phenol-formaldehyde resins, PRF adhesives, melamine – formaldehyde adhesives and MUF adhesives. Epoxy resins; polyamine hardeners; polyurethanes. Polyvinyl acetate glues and applications-

## **Module 5**

Electrical grade phenolic resins, CNSL-Phenol-formaldehyde adhesives- Tannin based adhesives. Hot melt adhesive –raw materials- manufacture. Fillers and extenders for UF and PF. Phenolic and amino resins in other areas of applications. Testing of adhesion bonds.

## **WST C 012. PULP AND PAPER (54 hrs. /Semester)**

### **Module 1**

Introduction to paper making: Raw materials - classification- selection- sources- storage- debarking- chipping- screening of chips- types of screens- chip classification- analysis- conveying of chips- chip storage. Pulping processes: Types- principles and

details of processes- properties of pulp- cooking processes. Washing, screening and cleaning of pulp. Types of cleaners and screeners.

## **Module 2**

Bleaching of pulp: Principles of bleaching- bleaching chemicals- Stages of bleaching – Important parameters of bleaching.bleaching equipments- . Chemical recovery: Black liquor-properties- evaporation: working principles, types - boiler and furnace: types, function- efficiency and steam economy, boiler feed water properties. Causticizing: green liquor classification and sludge removal- white liquor, classifiers and washers, operating techniques, make up chemicals, Zeolite process, demineralization process.

## **Module 3**

Effluent treatment: Physical and chemical nature of effluents and their treatment- pollution control and norms, chemicals used in effluent treatment- air pollution and control.

## **Module 4**

Stock preparation.Loading of fillers - types, properties and efficiencies of fillers, effect on paper properties. Sizing - types of sizing, materials used, mechanism of sizing, effect of paper properties. Additives- types, and their effects.Colour and Pigments- dyes, optical whiteners, types and properties, effect on paper.

## **Module 5**

Overview of paper machines, dry and wet ends, stock and water systems, related machinery. Basic Lab measurements - paper machine operation. Fourdrinier paper making.Twin and multiple paper making.Pressing, drying, surface sizing.Characteristics of materials used, surface preparation, sizing application, properties of sized papers. Coating- calendering and super calendering- types of machines used, principles of operation and control, properties and applications of coated papers.

## **WST C 013. WOOD WORKING & WOOD FINISHING (54 hrs. /Semester)**

### **Module 1**

Introduction to various wood working industries and operations- planning, thicknessing, mortising, tenoning, rebating, grooving, moulding and shaping, turning, drilling, carving, sanding etc.

## **Module 2**

Essential principles of operation. General features, specifications and design of machines; planer, thicknesser, mortiser, tenoner, moulder, router, turning lathe, drill, etc. Cutting speed of cutter/tool, feed speed, feed mechanism of machines. Advanced woodworking machines.

## **Module 3**

Various working defects; their occurrence in Indian woods and remedies. Moisture related problems in wood working. Method of assessment- ease of working based on energy consumption and assignment of quality ratings for important basics operations; computation of composite working quality index for the species.

## **Module 4**

Elements of basic joinery. Wood working joints. Furniture designs. Knock-down and ready to assemble panel furniture. Bent-wood furniture. Glues recommended for furniture and joinery. Ergonomic considerations in furniture design.

## **Module 5**

Knife geometry. Automatic knife sharpening machine. Tungsten carbide tipped cutters. Figure in wood occasioned by growth increments, nature of woody tissues, radial or tangential cut, grain, uneven infiltration of colouring material, etc.

## **Module 6**

Finishing qualities of Indian woods. Filling, staining and sanding before application of surface coatings. Compositions used. Water based, spirit, oil & NGR, pigment oil and chemical stains. Opaque and clear finishes. Penetrating and non-film forming finishes. Figure and color upgrading by ammonia fumigation and use of natural dyes.

## **WST E 005. SAW MILLING AND SAW DOCTORING (54 hrs. /Semester)**

### **Module 1**



Wood based industry - Saw mills - types, requirements and layout. Saw mill improvement programme. Timber log yard and its management. Layout comprising space of logs unloading, log stacks, movement of mechanical log loaders/stacker and transport of logs to sawmill. Measures for yard hygiene. Hoppus rule and true volume method for measurement of logs. Smalian's formula, Newton's formula and Huber's formula for volume estimation. Economic conversion of logs. Conversion terms for sawn timber: Baulks, waney baulks, half baulks, hakries, poles, beams, scantlings, blocks, planks etc.

### **Module 2**

Sawmilling: Saw milling equipments, their capacities and specifications. Log chain saws, Horizontal band mill, Vertical band saw benches, Circular re-saws, Circular cross cut saws. Log scanners and computerized BOF system. Sawing equipments for small-girth logs. Gantry equipment for loading/unloading of logs on machines.

### **Module 3**

Modern developments and innovations in saw milling. Degree of automation and mechanical feeds available in indigenous and imported saw mill equipment.

### **Module 4**

Saw doctoring: Saw blade geometry and maintenance: Clearance, sharpness and hook angles, Pitch, Gullet capacity, peripheral/linear saw speed, Feed speed, Bite etc. Quality and choice of metal in saw blades. Tensioning, leveling, straightening, brazing, setting and tempering of saw blades. Automatic/Semi-automatic saw doctoring equipment.

## **WST E 006. WOOD MECHANICS AND TIMBER ENGINEERING (54 hrs. /Semester)**

### **Module 1**

Mechanics of wood columns and beams. Standard tests on timber specimen; static bending, impact bending, compression parallel & perpendicular to grain, hardness, shear, tension perpendicular and parallel to grain, cleavage, torsion, nail and screw pulling, brittleness tests, effects of specimen size and its standardization.

### **Module 2**

Testing of specialized finished wood products - different types of performance test and methods of evaluation for products like door shutters, joinery, furniture, packing cases, tool handles agricultural implements and sports goods. Determination of suitability coefficients and indices of Indian timbers, Classification of timbers for different end uses based on suitability indices and safe working stresses. Non-destructive testing methods for timber strength.

### **Module 3**

Scope and significance of modern timber engineering in India in relation to concrete, steel and plastics as construction materials, new development, economy, building code and its application. Strength properties and design of structural timber joints, conventional vs new types. Linear structural components: Beams, Ties, Purlins, Columns, Joints. Trusses & arches—Configuration, analysis of simply supported 2 hinged, 3 - hinged types. Timber Lamellas' & timber flooring.

### **Module 4**

Web type girder, composite construction, stressed skin construction, rigid frames, shells, transmission line towers etc. Glue laminated linear and curved structures, shear strength, analysis and design. Design of low cost structures; principles involved in destruction resistant timber structures.

## **WST C 014. MASTERS SEMINAR (36 hrs./Semester)**

### **Module 1**

Introduction to web browsing, E-Journals, E-books, digital library, softwares and search engines with special reference to wood science and technology. **General criteria followed for preparation of review paper/ seminar presentation. Methods of collection of data, arrangement of text, tabulation, graphical representation of data. Search / preparation of audio-visual materials relevant to the selected topics, incorporation. Mock presentation, discussion and time management.**

### **Module 2**

**Finalizing the computer aided presentation and Seminar Records for evaluation.**

## **WST C 015. WOOD TECHNOLOGY WORKSHOP III (12 hrs./Week)**

Adhesives, Speciality Wood Products such as moulded products and compreg .Production of Surface Coatings and Surface Enhanced Panel Products (WIPLAC), Paper impregnation plant. DAP Plant

### **I Production of phenolic and amino resins**

- (a) To study the formulations of producing general purpose alkali catalysed PF resin and ammonia catalysed PF resin. Study the exothermic process and find out how the temperature is controlled. Following up the degree of conversion with Ford Cup viscometer.
- (b) Manufacture of ammonia catalysed alcohol soluble PF resin for electrical grade compreg.
- (c) Determination of water tolerance, solid content. Preparation of 1 square foot board for testing the adhesive strength.
- (d) To produce UF resin. Determine the solid content. Formulation of hardener for WWR grade plywood.
- (e) To produce Resorcinol-formaldehyde resin
- (f) Experimental Prepare 1 square foot WWR grade plywood and test for glue shear.
- (g) "Report on the appropriate information gathered from library for this seminar

### **II Speciality resins: DAP and Unsaturated polyester(UP) resin.**

DAP and UP resins and the various equipments such as high temperature reaction vessel for preparing DAP monomer, polymerizer for pre-polymer, solid-liquid and liquid-liquid separation equipment, bucket, tubular and disk centrifuges. Mixing equipment such as ribbon blender, sigma blender, two-roll mill, granulators, drying of DAP granules. Steam jet ejector for vacuum distillation, Calendra evaporator.- Compression and transfer moulding presses. DAP molding powder spiral flow testing. Special characteristics of DAP and applications- Study the operation of paper impregnation plant and lamination of the impregnated paper ( overlaying) on shuttering plywood.

### **Seminar Topics- presentation and submitting report for evaluation**

To discuss on

- (a) the manufacture of PF .Exothermicity and control
- (b) the manufacture of UF and hardener
- (c) the manufacture of ammonia catalysed resin and its special characteristics

- (d) the manufacture of DAP monomer, prepolymer, moulding compounds. Various separation equipment. Special characteristics of DAP and application
- (e) Paper impregnation and overlaying on shuttering plywood. plywood
- (f) "Report on the appropriate information gathered from library for this seminar

### **Practical**

- (a) Determination of phenol
- (b) Determination of formaldehyde
- (c) Determination of solid content of PF and UF

### **III Compreg production**

Impregnation with both normal PF and ammonia catalysed PF. Study the impregnator, make a drawing of the internal parts. Observe how vacuum is applied. Write down the units of vacuum. Study the drying schedules - Study the pressing of compreg in high pressure hydraulic hot press. Study and report the design and functioning of the high pressure press. Learn how the specific pressures are determined. The pressing schedule for producing compreg

Manufacture of moulded wood products by cold pressing technique as well as hot pressing by employing steam and low voltage high amperage heating systems, Determination of Physical Mechanical and Electrical properties of wood products Indian standardization organization BIS. Studying all the BIS specifications pertaining to wood and wood products Universal testing equipment for determination of MOR.MOE in the tensile and bending modes. Impact testing equipment for impact resistance of wood products. Fire resistance tests. Electrical testing of wood products for high voltage resistance (Dielectric strength)

### **Seminar Topics- presentation and submitting report for evaluation**

- a. Pressure vacuum impregnation of veneers. Explaining the vacuum and pressure levels employed
- b. High pressure hot presses
- c. Moulding of wood products by cold and hot pressing techniques. Clamping facilities
- d. "Report on the appropriate information gathered from library for this seminar

### **IV Compreg Machine shop**

To study the machining of compreg to convert to a number of products by using pattern millers and routers

### **V. Production of surface coatings**

To get acquainted with the production of base coats, filler coats, printing of wood grains, UV curable top coats. The equipment such as high speed dissolver and pearl mill,

Coating sequence requires to be studied. The functioning of planer for calibration, application of filler coat by reverse roller coater, drying of base coat, Printing wood grains. Application of top coat by precision roller coater/ curtain coater, UV curing

#### **Seminar Topics- presentation and submitting report for evaluation**

1. To discuss the functioning of reverse roller coater, precision roller coater and curtain coater
2. To discuss on UV curable coatings
3. "Report on the appropriate information gathered from library for this seminar

#### **VI Paper Impregnation plant**

To observe impregnation of paper with phenolic resin. Drying by jet of air from top and bottom to provide a cushion. The dried resin (B-stage) is laminated on plywood.

#### **Seminar Topics- presentation and submitting report for evaluation**

1. Discuss the basic principle of PF impregnated overlaying paper
- 2.
3. "Report on the appropriate information gathered from library for this seminar

#### **VI Furniture Unit**

Students should study the machines used in the furniture factory and all the operations involved in furniture production. Students should refer to the journals in the library and a number of furniture designs are published. Students should study them and apply the creative designs and fabricate the furniture in the furniture factory

#### **Seminar Topics- presentation and submitting report for evaluation**

1. "Report on the appropriate information gathered from library for this seminar on the design of furniture which could be fabricated in the furniture unit.

### **SEMESTER IV**

## **WST C 016.MANAGEMENT PRINCIPLES AND MARKETING OF WOOD**

**PRODUCE (54 hrs. /Semester)**

### **Module 1**

Concept, nature and importance of marketing management - marketing mix. Product and pricing decisions-product line and product mix, product life cycle stages. Promotion and distribution-wholesaling and retailing.Consumer behavior-buying roles and behaviour.

### **Module 2**

Basic concepts of demand, supply of wood produce, derived demand, demand and supply schedules, Types of markets for timber produce, market locations of timber produce and their features. Demand forecasts. Price determination in timber.

### **Module 3**

Economic features of specialized markets in terms of degree and type of competition in buying and selling, price spread, costs of marketing functions involved like pre-commercial thinning, commercial thinning, harvesting, hauling, sawing, transportation, treatment of wood, carpentry, and other processing activities involved in teakwood, rosewood, matchwood, pulpwood, sandalwood, veneers;

### **Module 4**

Type and degree of competition in market for services of saw mill and other intermediate wood processing industries, price spreads across different channels of marketing. Domestic demand and trade in timber and non-timber forest products. International demand and trade in timber and non-timber forest produce. Market inefficiencies in timber, non-timber forest produce and measures to check in efficiencies. Essentials of World Trade Organization, GATT, Dunkel proposals, Intellectual Property Rights and Patenting.International Timber Trade Organization (ITTO) and Timber Certification.

## **WST E 007. BIOSTATISTICS & COMPUTER APPLICATION (54 hrs. /Semester)**

### **Module 1**

Statistics- Importance and basic concepts.Data- collection, classification, tabulation, graphical representation of data. Measures of central tendency- mean, median, mode, geometric mean, harmonic mean. Measures of dispersion- range, quartile deviation, mean deviation, standard deviation. variance and coefficient of variation, probability and probability distributions – binomial, poisson and normal distributions.

## **Module 2**

Hypothesis testing-basic concepts and test of hypothesis- Z test, t- test, chi square test, F test. Analysis of variance (ANOVA) and its assumptions, one way and two way ANOVA. Correlation- types of correlation, scatter diagram, coefficient of correlation, Test for significance of correlation coefficient. Regression- regression coefficients, linear and curvilinear regressions.Multiple regressions. Test for significance of regression coefficients.

## **Module 3**

Sampling- definition and basic concepts-parameter, statistic, standard error, confidence interval, sampling and non-sampling error. Types of sampling (probability sampling)- simple random, stratified, systematic, cluster and multi-stage sampling. Experimental designs- principles (randomization, replication and local control), Experimental designs- CRD, RBD, LSD and Factorial experiments.

## **Module 4**

Basic concepts of computer, hardware, operating systems: Windows and Linux, word processing, spreadsheets, introduction to web browsing, softwares and search engines with special reference to wood science and technology.

## **WST E 008. PRODUCTION MANAGEMENT (54 hrs. /Semester)**

### **Module 1**

*Production as an organization function-Importance of production function- Scope of production and operations management- Characteristics of modern production and operation function. Production processes, manufacturing and service operations-classification of manufacturing processes-product design and process design*

## **Module 2**

*Plant location and layout-nature-Location theories-Steps in location-Location models-Plant layout—Factors influencing lay out-Principles of lay out-Layout tools and techniques- Materials handling principles.*

## **Module 3**

*Production /Operations planning & Control- Factors determining production planning- Production planning system-Production control- Elements of production control- Factors determining production control-Objectives of production planning and control.*

## **Module 4**

*Quality control-Organization for quality control- Quality control techniques-Statistical quality control- Types of control charts- Total Quality Management; Plant maintenance - definition- Scope- Importance- Objectives of Plant maintenance; management- Models for maintenance management- Implementation of maintenance management.*

## **WST C 0017. WOOD TECHNOLOGY WORKSHOP IV (12 hrs./week)**

Introduction: Raw materials - classification- selection- sources—storage- debarking- chipping- screening of chips- types of screens- chip classification- analysis- conveying of chips- chip storage. Pulping processes: Types- principles and details of processes- properties of pulp- cooking processes. Washing and screening of pulp: principles of washing- types of washers - presses- screening and cleaning of pulp- types of cleaners and screeners.

Bleaching of pulp: Principles of bleaching- bleaching chemicals- stages of bleaching important parameters of bleaching- bleaching equipments- preparation of bleaching chemicals.

Chemical recovery: Black liquor-properties- evaporation: working principles, types - boiler and furnace: types, function- efficiency and steam economy, boiler feed water properties. Causticizing: Functions, batch and continuous processes, green liquor classification and sludge removalwhite liquor, classifiers and washers, operating techniques, make up chemicals, Zeolite process, demineralization process.



Effluent treatment: Physical and chemical nature of effluents and their treatment-pollution control and norms, chemicals used in effluent treatment- air pollution and control.

History of paper; Pre- treatment for paper making: Stock preparation; Loading of fillers : types, properties and efficiencies of fillers, effect on paper properties

Sizing: types of sizing, materials used, mechanism of sizing, effect of paper properties; Additives: types, wet strength resins and their effect on strength properties, flocculants, biocides and their effects, synthetic fibers, improvement of dry strength by synthetic polymers; Color and Pigments: dyes, optical whiteners, types and properties, effect on paper, shade matching, color mechanism, retention aids.

**Paper making:** Introduction to paper making, overview of paper machines, dry and wet ends, stock and water systems, related machinery ; Wet end colloid chemistry, retention performances ; Deposit control in paper making : problems and control;

Basic Lab measurements: experimental methods, liquid –mass balance, paper machine operation; Fourdrinier paper making; Twin and multiple paper making. Pressing: types of presses, pressing operation variables; Drying : theory, systems, plant and equipment; Surface sizing : characteristics of materials used, surface preparation, sizing application, properties of sized papers; Coating: types and properties, types of coating machines and principles of operation; Calendaring and Super Calendaring: types of machines used, principles of operation and control, properties and applications of coated papers

## **WST C 018. DISSERTATION AND VIVA (14 hrs. / Week)**

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### **Module 1**

Research Methodology – introduction - Motives and benefits of doing research. Methods of research - Induction and Deduction. Types of research - Basic and Applied. Collection of qualitative and quantitative data. Methods of sampling - experiments and surveys. Experimental designs. Case studies. Action research. Participatory research.

### **Module 2**

Fixing the objective of research, research hypothesis and time and venue of research. Research management - Manning the research and building the research infrastructure. Collection and analysis of data. Statistical analysis - Tests of hypothesis, Drawing inference. Data entry and verification. Use of Statistical packages - Packages

for Statistical investigation and Social Sciences. Preparing diagrams and charts. Validation and correction of data and results. Importance of safe storage of data and results. Documenting and reporting research results. Preparation of research papers - structuring, content validation, acknowledgement etc. Reference citation - styles. Tips for technical writing. Public presentation of research results. Tools and tips for effective communication. Preparation of slides - Conventional methods, Computer Aided presentations - Power of Power point.

### ***Module 3(Practical Session)***

1. Use of Library - Familiarization with various features of library.
2. Familiarization with internet and search engines
3. Computer-aided literature search - Familiarization of important databases relevant to the field of wood science & Technology
4. Paraphrasing in the context of plagiarism
5. Structure of a research paper
6. Structure of a thesis
7. Exercises on citing and listing references
8. Exercises on processing of data and illustrations
9. Formulation of a research project
10. Presentation of scientific papers
11. Common errors in technical writing