

SYLLABUS
(Credit based) FOR
M.Sc. Programme In
"Wood Science & Technology"

AT

**FOREST RESEARCH INSTITUTE DEEMED
TO BE UNIVERSITY**

DEHRADUN- 248006

FIRST SEMESTER

Course Code	Course	Credit	
		Theory	Practical
Foundation Course			
WOC 101	Orientation Course	2	.-
WCA 102	Computer Application	-	1
Core Course			
WWC 111	Wood Chemistry	2	1
WWP 112	Wood Physics - Physical Properties Of Wood	2	-
WWP 113	Wood Physics: Wood-Water Relationships	2	1
WSM 114	Sawmilling, Saw Doctoring And Log Yard Management	3	1
WWA 115	Wood Anatomy :Wood Structure And Identification	1	1
WWA 116	Wood Anatomy : Xylogenesi s and Functional Wood Anatomy	1	1
WEM 117	Timber Entomology and Microbiology	2	1
Total		15	7
Credits			
Total credits in first semester $15^a + 7^b = 22$			

SECOND SEMESTER

Course Code	Course	Credit	
		Theory	Practical
Foundation Course			
WSM 201	Statistics and Research Methods	1	1
WME 202	Marketing And Enterprise Development	2	-
Core Course			
WTM 211	Timber Mechanics: Testing And Suitability Of Indian Timbers	2	-
WTM 212	Timber Mechanics: Grading System And Applications	2	1
WWP 213	Wood Preservation :Durability And Treatments	2	1
WAD 214	Composite Wood - Wood Adhesives	2	-
WPW 215	Composite Wood - Plywood	2	1
WWS 216	Wood Seasoning: Principles And Practices	2	1
WWW217	Wood Working	2	1
Total Credits		17	6
Total credits in second semester $17^a + 6^b = 23$			

THIRD SEMESTER

Course Code	Course	Credit	
		Theory	Practical
Foundation Course			
WHR 301	Human Resource Management	1	-
Core Course			
WWS 311	Wood Seasoning Kilns And Operations	2	1
WWP 312	Wood Preservation And Modification : Practices And Application	2	1
WWF 313	Wood Finishing	2	1
WRW 314	Composite Wood -Reconstituted Wood	2	-
WLW 315	Composite Wood - Laminated Wood	2	1
WTE 316	Timber Engineering	2	1
WST 318	Study Tour	2	
WIA 319	Industrial attachment and Report	3	
Total Credits		13^a +5^b + 2^c+3^d=23	

FOURTH SEMESTER

Course Code	Course	Credit	
		Theory	Practical
Core Course			
WPD 317	Products Design and Fabrication	2	1
Elective Courses			
WFC 421	Forest Certification	5	-
WFJ 422	Finger Joints for Efficient Wood Utilization	3	2
WVS 423	Vaccum Seasoning Technology	3	2
WMT 441	Master thesis	12	
WMS 442	Master thesis seminar	2	
Total credits in fourth semester		2^a +5^b+12^f+2^g=22	

SEMESTER IST

WOC 101 ORIENTATION COURSE (Credit 2+0)

LEARNING OBJECTIVES: The course aims to impart knowledge on static and dynamic concepts in wood science and technology and its historical perspective. Moreover, this course also includes basic botany, forestry and scope and opportunities in Wood Science.

MODULE I BASIC BOTANY

- Morphological features of commercially important tree species of India. Macroscopic features for identification of a few commercially important bamboo. Utilization of plantation wood : problems and possibilities.

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MODULE II BASIC FORESTRY

- Historical background of forestry and forest product research.
- Status of Indian Forestry, forest types, changing trends in social agro and plantation forestry and its implication in future in the sector of WST, A brief introduction on plantation techniques and silvicultural practices, National Forest Policy and its salient changing features across the globe.

MODULE III INTRODUCTION TO WOOD SCIENCE

- Supply and demand status of wood, export and import of timber, its products and channels.
- Status of wood utilization research and broadening horizons of research at various ICFRE, CSIR and other institutes
- Growth of wood based industry in India, effect of globalization. Role of skilled manpower in this sector.
- Brief status of solid wood, reconstituted and handicraft industries; such as wood carving, basketry, executive desk accessories, furniture, joinery, cabinets, sport goods, saw mills, wood seasoning, flooring and paneling, automobile body building, wood treatment, wood preservation, building construction, packaging and boats.
- Basic introduction to plywood block boards, flush doors, MDF and fiber board, particle board, laminated wood, bamboo board, wood wool, wood adhesives, match wood, cooling towers, wooden houses/ bamboo huts and log cabins.
- Career in wood science and technology and scope of innovation, changing trends from solid wood to functional panels and composite material

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Module IV RELEVANCE OF WOOD AS MATERIAL IN PRESENT CONTEXT

- Global warming and wood utilisation
 - Introduction to Forest certification and its needs in the field of WST
 - Bioeconomy generated through wood based products
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WWC 111 WOOD CHEMISTRY (Credit 2+1)

LEARNING OBJECTIVES: The basic aim of the course is to explain the students about general chemistry of wood components, chemicals/ extractives present in wood, their utilization and spectroscopic techniques to analyse and characterize them.

MODULE I CHEMICAL CONSTITUENTS OF WOOD

- Chemical constituents of wood and bark, Cellulose: structure, chemical properties, effect of acids and bases. Hemi-cellulose: structure, chemical properties, effect of acids and bases. Lignin: structure and chemical properties. Changes in wood chemical constituents due to several modifications
- Major bioactive constituents of wood and woody parts of plants, their variation with respect to different plant parts, season/climate and phytogeographical regions.
- Extractives in some prominent timber species and their importance. Resins, oleo resins, gum oleo resins in some characteristic woods.

MODULE II EXTRACTION OF CHEMICALS FROM WOOD

- Pyrolysis of wood. Wood Gasification, Liquefaction of invasive wood species and bamboo, mechanism and usages, liquefied wood preparation and uses. Eco-friendly dyes from bark and wood.

MODULE III INDUSTRIAL UTILIZATION OF WOOD EXTRACTIVES

- Transparent wood, Delignification of timber, Industrial utilization of wood and bark

extractives such as natural rubber, resin and turpentine from pines, tannins, gums, resins, pharmacologically active metabolites and future directions for their utilization

MODULE IV SPECTROSCOPIC TECHNIQUES

- General account of spectroscopic techniques such as UV-Visible, IR, NMR and Mass spectroscopy, XRD, FTIR with special reference to characterization of chemical constituents of wood and bark

PRACTICAL

- Estimation of extractives in a given wood-bark sample Isolation of pure chemical constituents using thin layer and column chromatography.
- Estimation of turpentine and resin in the given oleo-resin sample
- Isolation of polysaccharides and characterization of mono sugars
- Proximate analysis: estimation of holo-cellulose, cellulose, hemicelluloses, lignin and extractives
- Separation of extract constituents using thin layer/paper chromatography and determination of respective Rf values.
- Estimation of polyphenolics/tannins in wood/bark samples essential oils in plant sample; extraction of natural dyes from wood/plant part and dyeing trials on different fabrics.

WSM 114 SAWMILLING, SAW DOCTORING AND LOG YARD MANAGEMENT

(Credit 3+1)

LEARNING OBJECTIVES: The objective of this course is to introduce sawmills and sawblade doctoring.

MODULE I INTRODUCTION

- Introduction to a wet mill: Layout of log yard, Prerequisites of setting up a log yard, Log yard operations and management, in-feed systems to log yard and to head rig. Measurement of log volume, dimension and inventories
- Saw mill layouts comprising horizontal- vertical band saws, chipper canters, frame saws, trim saws and surfacer. Computer control, head rig and reducer passes, setup and maintenance of the machines, saw waste management and utilisation.
- Log handling equipment- Loader, forklifts etc.
- Indian standards on sawing timber – IS 9576 and many more
- Storage of logs for various end uses (peeling, for specialty products etc), End coating, prophylactic treatments etc.

MODULE II SAW MILLING EQUIPMENT

- Horizontal band saw, vertical band saw, frame saw and chipper canters. Cross cut saws, re-saws, head rig, log scanners and BOF systems. Gantry equipment, conveyer systems. Sawing of logs prone to growth stresses, line bar system and gang sawing
- Advancements in log quality evaluation- log scanners for volume measurements, automated defect detection (e.g. CT scanner/ X-ray scanner) ; BOF

MODULE III ECONOMICS OF SAWN MATERIAL

- Economic conversion of logs, various interacting parameters and decision making. Timber scale Laser guided sawing, double edged sawing, thin kerf sawing etc
- Comparison of sawing for logs of forest and plantation origin. Difficulties associated in sawing of timbers, Possible Solution, Various associated systems relating to sawn material including scribber deck and auto stacking
- Sawing patters- radial (quarter sawing), tangential (plain sawing), balanced tangential sawing and special techniques.
- Portable sawmills
- Grading of sawn timber based on end uses and standards.

MODULE IV SAW BLADE DOCTORING

- Types of saw blades: band saw, circular saw etc,

- Saw blades for cutting different materials- solid wood, hard woods/soft woods, ply wood, particle board, MDF, HDF and other panels etc
- Saw blade geometry, rip saw, cross cut saws and all other saws mentioned above Saw blade geometry, rip saw, cross cut saws, Sharpening, tensioning, leveling, straightening, brazing, and setting of saw blades using saw doctoring equipment.
- High strain thin kerf saws. Threshold energy considerations in wood cutting

PRACTICAL

- Sketching of saw blade geometry and calculation of hook angle, clearance angle and sharpness angle
 - Calculation of saw blade length for a given machine
 - Calculation of peripheral-linear speed in a saw
 - Measurement of log dimensions and calculation of volume using Hoppus true volume of logs.
 - Calculation of sawn timber volume from measuring planks of different dimensions.
 - Measurement of a diametric over lap of two ends of logs and calculation of relative off cut losses
 - Measurement of girth at many points of a log and calculation of off cut losses per module length. Girth-output curve for 60mm x 60mm sawn sections Demonstration of setting of saw tooth and their pattern calculation of kerf losses. per cut or many cuts
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WCA 102 COMPUTER APPLICATION (Credit 0+1)

LEARNING OBJECTIVES: The course is designed to teach students basic level computer programme like internet, Microsoft office and Statistical software like SPSS and Auto- cad are also covered in this course.

MODULE I INTRODUCTION

- Basic Introduction to MS-Office : Basic introduction to PowerPoint, Excel, Word and Access
- Basic introduction to CAD and its applications in wood based industries
- Introduction to other designing softwares

MODULE II

- Introduction to softwares for visual and graphical representation of data
- Introduction to R
- MS Excel Applications : Electronic Spreadsheet: Introduction to MS Excel, worksheet, workbook, data entry, formula entry for calculations and creation of graphs

WWA 115 WOOD ANATOMY :WOOD STRUCTURE AND IDENTIFICATION (Credit 1+1)

LEARNING OBJECTIVES: This course equips students with the knowledge of the macro and micro-structure of softwoods and hardwoods and their relation with properties of wood. The course exposes students to wood identification skills and practices.

MODULE I

1. **Source of Timber**
2. Importance of knowledge of Wood Structure
3. How wood is formed:
 - Cambium & its derivatives
 - Secondary growth
4. Physical features of wood

Features visible on the cross surface of log

Sapwood and heartwood

Growth rings & growth marks

Colour, Luster, Odour & Taste, Weight, Grain & Texture

5. Macroscopic (Hand lens) features of conifers (Non-Porous) woods (Tracheids, Rays, Parenchyma, Resin canals)
6. Macroscopic (Hand lens) features of Dicots (Porous) woods
(Vessels, Fibres, Rays, Parenchyma, Gum canals, Ripple marks, included phloem)
7. Microscopic features of softwood
8. Microscopic features of hardwoods
9. Diagnostic features useful in identification
10. Microscopic features of Monocots (Bamboo, Canes & Coconut)
11. Different types of microscopes, their working, & utility
12. Ultra structure of the wood & techniques
13. Electron Microscopes
14. Ultra structure of Cell Wall
15. Micro fibril Angle

PRACTICAL

- Visit to Xylarium
- Section cutting & Mounting
- Physical features
- Gross (Hand lens) features
- Microscopic features of Softwoods
- Microscopic features of Hardwoods
- Microscopic features of Bamboo, Canes, Coconut
- Proportion of tissues
- Research, Polarized & Electron Microscopes
- Micro fibril angle

WWA 116 WOOD ANATOMY : XYLOGENESIS AND FUNCTIONAL WOOD

ANATOMY

(Credit 1+1)

LEARNING OBJECTIVES: The objective of the course is to explain the effect of silvicultural practices on wood quality, anatomical aspects of plantation timber and application of ultra structure of wood.

MODULE I WOOD QUALITY IN PLANTATION GROWN TIMBER

1. Natural defects of wood
 - Reaction wood
 - Knots
 - Silica content
 - Other defects due to stress
 - Defects of timbers to utilization
2. Heartwood initiation
3. Figure in wood
4. Juvenile wood & Mature Wood
5. Wood Structure in relation to properties and uses of wood
6. Criteria & methods of assessment of wood quality in plantation grown timbers
viz. Eucalyptus & Poplar, for pulp and timber end uses.

PRACTICAL

Tension & Compression wood

- Figure in wood
- Maceration techniques
- Study of macerated material for fibre and vessel characteristics
- Study of Increment core for wood quality

WEM 117 TIMBER ENTOMOLOGY & MICROBIOLOGY (Credit 2+1)

LEARNING OBJECTIVES: The main objective of the course to explain the forest insects and their broad classification like Leaf defoliators, wood borers, termites etc it also

comprises laws of quarantine and phyto-sanitary certification. Students will be introduced to biodegradation and biodeterioration by the microbes and physical, chemical and microscopic effects of decay, soft rot and discoloration in wood.

MODULE I INTRODUCTION TO TIMBER ENTOMOLOGY

- General introduction of insects and their body parts, head, thorax and abdomen, metamorphosis of adult larval mouth parts and caterpillars. Population dynamics, natality, mortality and endemic growth
- Forest insects and broad classification. Wood borers of standing trees, logs and converted materials for prominent species, Oak, *Juniper*, *Shoreas*, *Dipterocarpus*, *Toona cialiata*, *Dalbergia*, *Artocarpus* and *Ficus* species beside *Pines*. Leaf defoliators and their effect on forest and plantation species; regardless of durability of timber species

MODULE II TERMITES

- Termites, their identification, life history and distribution in forest lands, plantations and built structures. Termite resistance tests and termite control

MODULE III INSECT AND PEST CONTROL METHODS

- Biological control of insects and pests, pests control components, principles and practices. Integrated pest management, Economics of pest control. Insect fungi interaction, microbial control, insect behavior regulators and forest hygiene
- Laws of Quarantine and phyto-sanitary certification

PRACTICAL: ENTOMOLOGY

- Life cycle of some important insect pests of forest and plantation origin. Collection of insects from forest, plantation and infected sites, nurseries and log yard. Their up keep and dispatch techniques for expert advices.
- Study of damage specimens mainly wood borers of felled and converted wood, bark and pinhole borers, beetles, sap wood borers, short-hole borers, heartwood borers and dry wood borers
- Observations of termite nests, castes, and infected material in various forms such as poles, beams and planks
- Insect control techniques: Field application methods on forest crops, plantations, constructed structures and log yards

- Precautions and application methods for insecticides, fungicides in liquid, vapor and dust form
- Museum studies: Diagnosis of insect attack, protection of valuable documents in book, sheet leather form beside timber

MODULE IV INTRODUCTION TO WOOD MICROBIOLOGY

- Biodegradation and biodeterioration and broad idea about microbes involved in wood deterioration. Biotic and abiotic factors involved in attacking timber products ranging from logs, planks, wood chips, exterior and interior furniture and joinery products, plywood, MDF, particle board and bamboo products

MODULE V WOOD DEGRADATION

- Taxonomy of wood decaying fungi. Essentials of fungal attack on lignocellulosic material like solid wood
- Types of fungal degradation of wood, bamboo and their products. Physical, chemical and microscopic effects of decay, soft rot and discoloration
- Fungal decay in wood in buildings
- Natural decay resistance of wood and its assessment using accelerated laboratory tests. Quarantine regulation of import of timber/s

PRACTICAL (WOOD MICROBIOLOGY)

- Laboratory testing for natural decay resistance of wood.
- Demonstration of loss appraisal due to decay.
- Examination and identification of wood-decaying fungi, section cutting and preparation of slides.
- Isolation of white-rot, brown-rot and sap stain fungi.
- To study the conditions favouring fungal stains on bamboo in laboratory.
- Treatments to check fungal staining of bamboo in laboratory

WWP 112 WOOD PHYSICS :PHYSICAL PROPERTIES OF WOOD (Credit 2+0)

LEARNING OBJECTIVES: This course highlights and explains the physical properties and characteristics of wood and wood based components. It also develops understanding of students about practical knowledge of factors determining physical properties of wood.

MODULE I PHYSICAL PROPERTIES OF WOOD

- Density and specific gravity. Variation in density of early and late wood constituents. Effect of growth rings on density. Pith to peripheral density variations. Different modes of presentation in relation to moisture content. Physical properties of wood as influenced by moisture content and maximum moisture content of wood. Specific gravity of wood substance. Anisotropy in Wood

MODULE II THERMAL PROPERTIES OF WOOD

- Dimensional changes on heating green wood. Effect of dry and wet heat and heating in presence or absence of air on strength and dimensional stability
- Thermal expansion, specific heat, thermal conductivity and diffusivity. Change of temperature in wood under heating. Effect of moisture on thermal properties. Thermal properties of wood composites

MODULE III ELECTRICAL PROPERTIES OF WOOD

- Introduction, DC electrical conductivity-effect of moisture content, temperature and extractives. Activation energy associated with electrical conduction. Electro-osmosis in green wood. Voltage breakdown strength
- Dielectric properties of wood under alternating current and electro-magnetic field conditions, effect of specific gravity, moisture content, temperature and extractives.
- Principles of induction and dielectric heating. Piezo-electric properties of wood and its applications

MODULE IV ACOUSTICAL PROPERTIES OF WOOD

- Sound transmission and acoustics in buildings
- Response of defects to stress waves in timber

MODULE VI COMPARISON OF PROPERTIES OF SOLID WOOD WITH COMPOSITE WOOD

- Broad Comparison of Physical properties of wood, in relation to panel products, Plastic, steel and bamboo such as weight, density, specific gravity and effect of temperature

WWP 113 WOOD PHYSICS: WOOD-WATER RELATIONSHIPS (Credit 2+1)

LEARNING OBJECTIVES: To impart knowledge on wood water relationship based on permeability and capillarity concepts, thermodynamic aspects of wood drying and flow of water in different forms through wood. This will help in understanding wood water relationship as an important processing step in product manufacturing.

MODULE I INTRODUCTION

- Equilibrium moisture content and hygroscopicity of wood. Crystalline and amorphous zones in cellulose and hydrogen bonding

MODULE II THERMODYNAMIC ASPECTS OF WOOD

- Thermodynamic aspects such as heat of wetting, sorption, sorption hysteresis, sorption under stress, theories of sorption and effect of extractives on sorption. Thermodynamic method of measurement of Fibre Saturation Point

MODULE III FLOW OF WATER IN WOOD

- Flow of water in liquid-vapour form through wood. Flow channels, mechanism
- Theories and equations of flow through a permeating medium and through timber section: slip, viscous and turbulent flow. Permeability measurement of wood to water and its applications, specific permeability. Capillarity in relation to wood capillary tension and liquid tension collapse. Forces involved in overcoming capillary tension

MODULE IV ULTRA STRUCTURE AND ANISOTROPY

- Effect of cell ultra-structure on anisotropy-radial pitting. Relationships with density and factors causing departures in their form. Relative anisotropic changes and effect on cell ultra structure by extractives and pre-treatment such as pre-freezing, polar and non polar liquid and cell wall bulking

PRACTICAL

- Sonic and ultrasonic methods of determination of strength properties
 - Determination of specific gravity, F.S.P. from shrinkage and sorption
 - Measurement of thermal conductivity, dielectric constant, permeability of wood to air
 - Moisture content by oven-drying and distillation methods
 - Use of electrical moisture meters
 - Determination of linear and volumetric shrinkage
 - Determination of moisture diffusion coefficient of wood under steady state condition
 - Measurement of swelling of wood in liquor ammonia and water
 - Hot water- steam bending and ammonia plasticization of 15-30mm thick strips
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SEMESTER IInd

WAD 214 COMPOSITE WOOD: WOOD ADHESIVES (Credit 2+0)

LEARNING OBJECTIVES: The course deals with the chemistry and fundamentals of adhesion. It also emphasise on the application of adhesives in different wood composites.

MODULE I INTRODUCTION

- Introduction of linear and cross linking molecules, theory of adhesion, intermolecular, intra-molecular attraction, cohesion, adhesion and adherence. Application of adhesives: wood, plywood, laminated wood. Importance of colloidal state and rheological properties
- Application techniques of glues in relation to plywood, particle board, MDF, laminated woods
- Optimization of glue setting parameters: pressure, temperature, time

MODULE II ADHESIVE SCIENCE

- Influence of moisture content, pH interactions, surface preparation, pre-treatments. Fortifying, filling, extending, and spreading on glue bond strength. Chemistry, application, properties and classification of adhesives – cold setting, thermo-setting and thermo-plastic adhesives, elastomeric adhesive, gap filling adhesives

MODULE III NATURAL AND SYNTHETIC GLUES

- Animal glue, casein glue, blood albumin, soya bean and starch, silicate of soda glues
- Synthetic glues: Phenolic and substituted Phenolic adhesives. Urea and melamine formaldehyde, epoxy and polyurethane adhesives. Polyvinyl adhesives
- Importance of viscosity and setting time of glues and adhesives. Precautionary measures in formulation of glues, application techniques, curing factors of safety and hygiene. Protective gadgets

MODULE IV TRENDS IN WOOD ADHESIVES

- Health and environmental concerns over application of widely used adhesives.
- Measurement of formaldehyde emission and emission certification
- Emerging environmentally benign adhesives formulations.

LEARNING OBJECTIVES: Students will be able to explore the plywood manufactures processing from veneers to final panels. It also explains the preservative treatment and test methods to assess product quality.

MODULE I INTRODUCTION

- Historical perspective of plywood making, merits and demerits of plywood over solid wood for diverse reasons and end users

MODULE II PLYWOOD MANUFACTURING

- Veneering: peeling of logs and peeling characteristics of diverse range of soft woods and hardwoods. Equipment for peeling and stressing: spindle lathes and slicer
- Modern developments including veneering of small diameter logs and core veneer. Geometry of knife for veneering in relation to wood species, optimum conditions of setting of peeling lathes and slicer
- Quality of veneer obtained by peeling and slicing, defects in peeled veneer
- Veneer drying, types of veneer dryers, their application and relative merits; recommended drying times, temperatures, jet-air speeds and venting. Steam consumption. Shrinkage in veneer drying. Collapse and warp and their control. High temperature veneer drying, tenderizing of veneer
- Plywood manufactures processing: Jointers, splicer. Veneer jointing, splicing, repairing, spreaders, glue spreading, assembly pre-pressing, hot pressing, sizing, trimming, thickening and finishing
- Pressing equipment: cold and hot pressing equipment. Manufacturing process, choice of material, species for Block Board and Flush Doors.
- Laminated Veneer Lumber: Definition, difference with plywood and manufacture

MODULE III PLYWOOD TREATMENT

- Preservative treatment of plywood and allied products. Glue-line treatment and treatment of finished products
- Choice of glue compatible preservatives, dyes and fire retardant chemicals.

PRACTICAL

- Preparation of UF and PF adhesives and fortified UF adhesive
- Viscosity, gelling time, water tolerance, pH, solid contents and shear strength tests on adhesive
- Preparation of various type of plywood
- Testing of plywood, including accelerated ageing tests

WME 202 MARKETING AND ENTERPRISE DEVELOPMENT (Credit 2+0)

LEARNING OBJECTIVES: This course is designed to develop knowledge of marketing network of wood products and challenges faced in market competitiveness. It also includes the understanding of process and characteristics of entrepreneurship development.

MODULE I INTRODUCTION TO MARKETING

- Role of marketing in open market economy. Marketing functions, market segmentation, competition, regulation. cases studies of forest products, capital and credit management
- Fundamental principles, cost-benefit analysis; estimation of demand and supply
- Analysis of trends in the national and international market and changes in production and consumption patterns,

MODULE II ENTREPRENEURSHIP DEVELOPMENT

- Role of private sector and co-operatives, Socio-economic analysis of forest productivity and attitudes
- Entrepreneurship development. Formulation schemes, productions, sales and marketing strategies
- Overseas employment specialized training opportunities including research and development

MODULE III INTERNATIONAL TIMBER TRADE AND BUSINESS ENVIRONMENT

- International business environment, International marketing, Over view of timber Industries, marketing strategy of timber product
 - International timber trade, Global marketing and its challenges, Mode of Entry in international market
 - Trade Barriers, marketing segmentation, marketing strategy for global expansion, marketing mix
 - Case studies
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WSM 201 STATISTICS AND RESEARCH METHODS (Credit 1+1)

LEARNING OBJECTIVES: This course is designed to help the students to learn the basics of statistics and its application in the field of Wood science and technology. The course will also expose the students to the use of statistical methods in wood based industries.

MODULE I

- Importance of statistics and statistical methods in the fields of wood science and technology and forest products research.
- Collection, compilation, tabulation, of statistical data and their graphical presentation.
- Types of data: qualitative and quantitative, types of variates - univariates, bivariate and multivariate, measures of central tendency, measures of dispersion, measures of skewness and kurtosis and other moment measures.
- Regression analysis - simple and multiple regression, correlation and correlation coefficient, coefficient of determination.

MODULE II

- Basics of probability and probability function, expectation, parameter and sample statistic. Probability distributions: Normal, binomial and poisson's distribution.
- Statistical inference: estimation and testing of hypothesis- T-test, F-test, Chi-square test.

MODULE III

- Analysis of variance for one way and two way classification. Analysis of covariance.
- Tests for homogeneity and linearity.
- Selecting and defining a research problem, need for research design, design of experiments. Principles of designs of experiments. Completely randomized design, randomized block design, Latin square design, introduction of factorial experiments.
- Introduction to statistical softwares and their operations.

MODULE IV

- Statistical quality control- control charts and sampling inspection.

WTM 211 TIMBER MECHANICS: TESTING AND SUITABILITY OF INDIAN

TIMBERS (2+0)

LEARNING OBJECTIVES: The course emphasis on theory of solid mechanics in timber and its application in structural purposes.

MODULE I BASIC SOLID MECHANICS

- Brief account of isotropic, anisotropic, orthotropic, coordinate systems. Stress-strain relationships. Different type of stresses and strain. Simple shear, principle stress and Mohr circle diagram. Hook's law and modulus of elasticity, directional elastic constants. Non-linear behaviour of wood, hysteresis. Bulk modulus and Poisson's ratio. Shear forces and bending moments, stresses in beams, beam deflections, column buckling and torsion forces. Role of moisture on elastic constants Shrinkage: directional shrinkage and fibre saturation point. Swelling: Radial, Tangential & Volumetric swelling.

MODULE II STANDARD TESTS ON TIMBER SPECIMEN

- Testing of small clear specimens of timber as per IS 1708.
- Static bending, impact bending, compression parallel and perpendicular to the grain, hardness, shear, tension parallel and perpendicular to the grain, cleavage, torsion, nail and screw pulling, brittleness.
- Testing of specialised wood products, performance tests and method of evaluation for door shutters, joinery, furniture, packing cases, tool handles (IS 620), agricultural implements and sports goods.
- Effect of moisture content, grain angle, grain pattern etc on strength
- Indian standards on testing wood and products e.g.: IS 1708 (Small clear specimens), IS 4020 (doors), IS 2380 (particle boards), IS 4990 (shuttering ply), IS 1734 (plywood) etc

MODULE III THEORY OF CREEP

- Kelvin, Maxwell and Burger models. Effect of level of loading, moisture content, temperature, dynamic humidity conditions and pre-freezing on creep. Fatigue and its characteristics, orthotropic elasticity of reconstituted wood based systems including creep in lignocelluloses panels. Fracture Mechanics

MODULE IV SUITABILITY COEFFICIENTS AND INDICES OF INDIAN TIMBERS

- Determination of suitability coefficients and indices of Indian timbers. Safe working stresses and end uses of timber species based on strength data. Classification of timber for various end uses. Specialized uses of timbers and BIS Standards
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WTM 212 TIMBER MECHANICS: GRADING SYSTEM AND APPLICATIONS

(Credit 2+1)

LEARNING OBJECTIVES: This course imparts the knowledge of timber grading system and its application like LQI, CPR, and TCCS.

MODULE I TIMBER DEFECTS

- Timber a biological material: Various defects and their manipulation in logs and sawn form. Importance of grading in primary and secondary processing. Quantification of defects in softwood, hardwood logs and swan timber
- Effect of natural defects on strength and performance.
- Indian standards IS 3364) on measurement & evaluation of defects

MODULE II TIMBER GRADING

- Introduction to grading and its importance in various wood utilization sectors. Introduction to grading in relation to plywood and surface veneers.
- Stage of grading and grading rules, commercial and structural grading, Grading for specific end uses such as railway sleepers, pallets and packing cases, cooling tower, and relevant standards.
- NDT- Non destructive testing of wood, various methods and technologies. Velocity, Time of flight (ToF), CT scan etc.
- Visual grading: its merits and demerits
- Stress grading and its relationship to non-destructive testing and their importance
- Grading and its relevance for plantation and clonal material. Grading rules prevailing in various states and for different species.
- Futuristic application of grading: Log Quality Index (LQI), Comparative Price Relatives (CPR) and Timber Value Conversion Standard (TVCS). Growth stresses in timber and their measurement. Influence on grading

PRACTICAL

- Testing of small clear specimens of timber as per IS 1708- sample preparation & testing
 - Mechanical tests on timber. Static bending, impact bending, compression parallel and perpendicular to grain, hardness, shear, torsion, nail and screw pulling test, brittleness test and calculation of properties.
 - Identification and measurement of defects in wood and their evaluation.
 - Specialised tests on wood products
 - NDT- depends on availability of facility.
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(Credit 2+1)

LEARNING OBJECTIVES: This course is designed to describe the importance of preservatives and their types. Students are expected to learn different treatment methods and testing of efficacy of preservatives in lab as well as field condition.

MODULE I WOOD DURABILITY

- Natural durability, durability of heartwood and sapwood.
- Causes for natural durability.
- Classification of timbers on the basis of natural durability.
- Effect of preservative on physical and mechanical properties as well as weathering behavior of treated wood.

Biodeteriogens

- Biofoulers. Microfoulers. Macrofoulers. Wood-/deteriogens, Bacteria, Fungi, Insects, Bivalves, Pests of Mangroves
- Nature and conditions of attack by various wood- bio degrading organisms on land and marine conditions.
- Estimates of losses of wood by bio-degradation in storage, processing and service.

MODULE II TREATMENT PROCESSES

- Preparation of timber for treatment
- Non-pressure Treatment Process: Brushing, spraying, dipping, steeping, cold soaking, hot and cold bath & diffusion methods. Their efficacy and suitability for selected end uses
- Pressure treatment processes: Full cell, Rueping-Empty cell and Lowry treatments
- Special oscillatory pressure treatment for green timber with water soluble preservatives. Miscellaneous processes: Prophylactic treatment, Boucherie treatment and Osmosis treatment for green timber. Treatments for bamboo and thatch
- Treatability classes and Penetration Indices
- Dependence of penetration and retention of preservative on wood structure and permeability. Preparation of timber for treatment.
- Treatments for special end uses

MODULE III WOOD PRESERVATIVES

- Importance of wood preservation
- Wood preservatives, Types of wood preservatives, Requirement of an ideal Preservative. .
- Preservative materials toxic to various bio-degrading agents- their toxicity levels. Bio-degradable preservatives. Eco-friendly preservatives Micronized/nano-based preservatives, their efficacy, advantages, disadvantages and method of characterization)
- Leaching of preservatives and methods used for quantification of leachates.
- Measures adopted to minimize the impact of wood preservative on the Environment. Proper disposal practices of treated wood
- Merits-demeritsof different preservative compositions in relation to end use
- Recommended preservatives and their penetrations and retentions for various end uses
- Effect of preservative chemicals on the bonding strength/mechanism in composites
- Suitability of various preservative treatment methods (glue line poisoning/treatment of lignocellulosic substrate/final product) for wood based composites
- Effect of preservative on physical and mechanical properties as well as weathering behavior of treated wood.

PRACTICAL

- Treatment of timbers of different treatability classes with representative
 - Preservatives and evaluation of treatment parameters (time, temp. and pressure).
 - Boucherie, sap displacement. Hot and cold bath and diffusion treatment.
 - Calculation of voids for estimating maximum absorption.
 - Determination of penetration indices. Treatment of problematic refractory heartwood like eucalyptus
 - Testing of the efficacy of preservatives under laboratory and field conditions.
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WWS 216 WOOD SEASONING: PRINCIPLES AND PRACTICES (2+1)

LEARNING OBJECTIVES: To impart knowledge of seasoning process of timber, drying rate of timber and its dependence on different factors like temperature, RH, air flow speed, permeability of species, thickness of timber and its initial moisture content, seasoning defects and their cause prevention. This course will be followed by second course in wood seasoning.

MODULE I INTRODUCTION

- Objects and importance of wood seasoning
- Recommended moisture content of seasoned timber for different end uses in different climatic zones and permissible tolerances. Basis of the recommendations
- 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, moisture gradients in timber section
- Classification of Indian timbers according to refractoriness to seasoning

MODULE II SEASONING DEFECTS

- Surface and internal cracking, honey combing, end splitting, cupping, collapse, bow, spring, crookedness and diamonding. Their causes and prevention. Drying stress development: measurement of drying strains. Resultant plastic strains sets produced. Stress reversal and case hardening. Critical stages for surface and internal cracking
- Warp control: Top weighting, calculation of optimum loading, spring loading system, reduced crossers spacing
- Seasoning and warp control in short rotation plantation timber species
- Compression set, core strength, stress reversal and case hardening.

MODULE III SPECIEL DRYING TECHNIQUES

- Special seasoning methods and pre-treatment: Anti-shrink pre-treatment, their efficiencies, coldness shrinkage, chemical seasoning, pre-steaming, pre-freezing

Module IV HEAT REQUIREMENTS IN DRYING SYSTEMS

- Estimation of energy consumption for drying of unit volume timber, sensible heat demand of kiln and wood, heat of adsorption, heat of evaporation, heat losses, calculations with examples.

PRACTICAL

- Oven Dry method of MC %
 - Casehardening tests
 - Moisture Distribution Test
 - Measurement of drying strains
 - Stacking Methods
 - Calculation of heat Losses
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LEARNING OBJECTIVES: The course is structured to give knowledge of basic element of wood working design and theory used in industry. It also demonstrates the use of woodworking tools. Students will understand wood machining defects, their occurrence in Indian woods and evaluation of Working Quality Index (WQI) and Carving Quality Index (CQI) ease of working, overall performance and quality ratings of important basic operations.

MODULE I INTRODUCTION TO MILL OPERATIONS AND WOOD WORKING MACHINES

- Layout of wood workshop. Benefits of mechanization as against traditional carpentry tools; circular saw and range of jobs
- General features and designs of wood working machines such as planner, thicknessor, mortiser, tenonner, molders, routers, turning lathes and drill-boring machines. General features of universal wood working machines, copying lathes, four side planner-cum- molder and CNC router. Saws for panel products, radial arm saws, cross cut-trim saws. Disc and drum sanders. Portable power tools and dowel making machines

MODULE II BASIC JOINERY

- Elements of basic joinery, joints for furniture and joinery: tenon mortise, dovetail and mitre joints, their combinations. Knife geometry, cutter profiles, carbide tipped cutters

MODULE III WOOD MACHINING DEFECTS

- Various wood machining defects, their occurrence in Indian woods and evaluation of Working Quality Index (WQI) and Carving Quality Index (CQI) ease of working, overall performance and quality ratings of important basic operations
- Effect of machine parameters on quality of worked surface in basic wood working operations. Introduction to bamboo processing machines for downstream products

PRACTICAL

- Identification of wood machining defects from a given piece
 - Measurement of cutter marks on a given piece subjected to planing operation and verifications of feed speed
 - Turning of a given sample using wood turning lathe and observations with regard to surface quality and reasons thereof for the outcome
 - Effect of pre-moistening and drying on a given piece during sanding operation comparison with control samples
 - Calculation and verification of cutter block speed in relation to RPM of motor mounted via V belt and pulleys. Reasons of departure from calculated and observed values
 - Fabrication of tenon-mortise joint
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SEMESTER IIIrd

WRW 314 COMPOSITE WOOD : RECONSTITUTED WOODS (Credit 2+0)

LEARNING OBJECTIVES: The objective of the course is to impart into the students the knowledge of the manufacturing of various composite wood like particle Board, hardboard, fibre board and MDF. The course also described the testing methods for wood composite panels and their comparative study.

MODULE I PARTICLE BOARD MANUFACTURING

- Homogenization and reorientation of woody mass, functional property improvement of ligno-cellulosic materials
- Manufacture of particle Board from various ligno-cellulosic materials. Particle generating machines; range of particle dimensions preferred. Particle dryers, drying times, temperatures and steam consumption. Size separating, sieving machines, adhesive selection
- Resin blending of face and core particles; resin quantities. Face-core composition in board. Mat laying. Pre pressing and hot pressing. Temperatures and curing times. Use of wax emulsion and hardeners in glue, pressing technique, sizing, sanding and thicknessing of board

MODULE II PROPERTIES OF PARTICLE BOARD & ITS TESTING

- Density, moisture content, modulus of elasticity and bending, internal bond strength in dry state and after accelerated ageing
- Testing methods. End uses

MODULE III PARTICLES BOARD PRODUCTS FOR SPECIALIZED USES

- Rice husk particle board, cement bonded board, bamboo mat board, OSB. Manufacture of fibre board and MDF
- Properties of hardboard and MDF. Testing methods and end uses. Manufacture of LVL Laminated Veneered Lumber
- Molded ligno products
- Test method for ligno panels as structural forms

- Boards from agro-residues such as rice husk, wheat straw, bagasse, coir etc; Boards from forest residues e.g pine needle, weeds (e.g Lantana camera), mill and other residues

MODULE IV PROPERTY COMPARISON

- Comparative account of properties of particle board, hard board, MDF, as against solid wood products in the area of conservation of forest and growth of wood board industry
- Energy consideration and equipment costs of ligno-panels

WLW 315 COMPOSITE WOOD - LAMINATED WOOD (Credit 2+1)

LEARNING OBJECTIVES: This course explores the Scope and merits of laminated wood and modified wood as a commercial construction material, provides an understanding of glues, assembly, cold pressing, HF gluing and curing. It also describes the tests methods such as block shear test for bonding strength and tensile test for finger joint strength.

MODULE I INTRODUCTION TO LAMINATED WOOD

- Scope and merits of laminated wood in comparison to solid wood as counter parts
- Energy consideration in laminated wood in comparison to solid wood as structural engineer grade material
- Dimensional stability considerations and in laminated wood. Density averaging and shrinkage averaging concepts

MODULE II PARAMETRS OF LVL MANUFACTURING

- Choice of species and improvement of aesthetic and strength properties for load bearing structures
- Roles of dynamic pre-compression and its benefits in subsequent processing and for multispecies laminates. Edge glued material and its scope in areas of wooden flooring, doors, cabinet inserts, cabinets and furniture
- Laminated wood from bamboo and bamboo laminates. Choice of glues, assembly, cold pressing, HF gluing and curing

MODULE III TEST METHODS

- Tests methods such as block shear test for bonding strength and tensile test for finger joint strength

MODULE IV MODIFIED WOODS AND EMERGING COMPOSITES

- Densified wood, Compreg, Impreg, Wood-Polymer Composites - their preparation, properties and uses. Pressing pressures and cooling cycle in press for stabilizing
- Acoustic panels from laminated wood and sandwich forms. Densified laminate panels. Laminated wood from plantation species. Poplar, Rubber wood, Mango and *Alanthus excels*
- *Cross laminated timber (CLT): Introduction, scope, manufacture and applications*

PRACTICAL

- Preparation of particle board and hardboard
 - Testing of particle board and hardboard including accelerated ageing tests, glue shear and internal bond strength tests
 - Preparation of densified wood and Compreg
 - Testing of densified wood and Compreg
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WHR 301 HUMAN RESOURCE MANAGEMENT (Credit 1+0)

LEARNING OBJECTIVES: The course is structured to develop and understand human behavior in an around and in industries. The objective of this course is to prepare students for competitive world by developing their personal and professional skills.

MODULE I INTRODUCTION

- Human Resource Management – Introduction and Importance, Evolution, difference between personnel Management and HRM
- Strategic HRM
- Human Resources planning, Objectives, importance-HR Process Manpower Examination Job Analysis, Job description –Job Specification,
- Recruitment – Sources of Recruitment, selection Process, Placement and Induction, Retention of Employees

MODULE II TRAINING AND DEVELOPMENT

- Objectives and Needs – Training Process- Methods of Training – Tools and Aids
Evaluation of Training Programs. Career Planning – succession Planning

MODULE III PERFORMANCE MANAGEMENT SYSTEM

- Definition Concepts and Ethics-Different Methods of performance Appraisal- Rating Errors-competency management. Compensation Management – Concepts and Components – job Evaluation – Incentives and Benefits. Productivity Management concepts – TQM-Kaizen-Quality Circles
 - Industrial relations-Grievance procedure collective Bargaining Settlement of Disputes
 - Retirement / Separation – Superannuation- Voluntary Retirement Schemes- Resignation-Discharge- Dismissal- Suspension-Layoff
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WTE 316

TIMBER ENGINEERING (Credit 2+1)

LEARNING OBJECTIVES: The course is intended to expose the students to theory of engineering and basic engineering tools. The course will also in a comprehensive way help the students to know codal requirements for building material, scope of plantation grown material in engineered structures and Wooden Houses for hilly areas.

MODULE I INTRODUCTION

- Broader definitions of timber mechanics and timber Engineering and their inter relationships
- Introduction to basic engineering tools free hand sketching, different types of lines, materials breaks, principle orthographic projections and dimensioning. Method of representing a section for various materials, Isometric view and detail of assembly drawing
- Scope of Timber, bamboos, laminated wood and panel products in relation to concrete, steel, stone and plastics in Engineered constructions such as floors, walls, roofs, and grain silos
- Mass timber products

MODULE II TIMBER COMPONENTS FOR STRUCTURAL PURPOSES

- Design of linear timber components beams, tiles, purlins, columns and chords.

- Trusses and Arches, their configuration. Analysis of simply supported, 2-hinged, 3-hinged types
- Codal requirements for building material (wood, laminated wood, laminates) grading, proof loading, strength properties, moisture content, size effect - length, width, thickness, depth and presence of knots effecting tension, compression, shear stress systems
- Glue laminated linear and curved structural members; shear strength, analysis and design

MODULE III MECHANICAL PROPERTIES AND NATIONAL BUILDING CODES

- Strength Properties and classification of structural timber and bamboo. Dimensional optimization for beams columns and associated structural dimensions in a product. Minimum dimensions of sawn timber essential for timber engineering design
- Strength Properties and design of structural timber joints. Changing trends and role of fastener's metal rings, connector plates, newer technologies in effect of defect of design and performance
- National building code and its application with special reference to wood houses and Bamboo
- Statistical aspects in relation to engineered structures and fastener systems
- Prefabrication, do it yourself –knock down concepts in relation to engineered structures
- Scope of plantation grown material, silvicultural thinning, small dimensions timber beside poles in engineered structures
- Wooden Houses for hilly areas, log cabins
- Retaining walls for hilly areas and slopes and their beneficial effects
- Wooden culverts in forest areas and villages and canals

PRACTICAL

- Inspection and suitability of wooden structural members, engineered grade material

- Isometric sketching of engineered house –building
 - Ratio, proportion and projection
 - Preparation of a structural joint and its testing
 - Demonstration of glue lamination technique for a small beam
 - Elementary working drawings for a wooden sports floor
 - Testing of beams, columns, trusses
 - Nailing patterns on a joint and their importance
 - Bending testing of structural sized bamboo
 - Shear test of Bamboo
 - Compression test of Bamboo
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WWP 312 WOOD PRESERVATION AND MODIFICATION : PRACTICES
AND APPLICATION (Credit 2+1)

LEARNING OBJECTIVES: The course describes fundamentals of preservative retention and penetration with penetration index. It also imparts the knowledge of preservative treatment procedure and fumigation techniques to enhance the natural life span of wood products.

MODULE I WOOD MODIFICATION

- Need, advantages and disadvantages of Wood Modification
- What is modified wood, Benefits of using modified wood, Passive and active modification practices, Types of wood modification Thermal Modification, Chemical Modification, Microwave modification, THM, Surface densification
- Commercialisation of Wood modification practices
- LCA of modified wood

MODULE II PRESERVATION PLANTS AND QUALITATIVE AND QUANTITATIVE ANALYSIS OF PRESERVATIVES

- Design, specifications, layout, operation, inspection, maintenance and economic aspects. Pollution aspects
- Economics of preservative treatment
- Qualitative and Quantitative analysis of preservatives

MODULE III FLAME RETARDANTS AND FUMIGATION

- Fire protection of timber: General principles of combustibility; application of fire retardant chemicals; methods of testing fire resistance. Associated treatment to impart bio resistance. Appropriate eco friendly treatments for handicraft products,
- Advanced methods of fire testing (including product testing) such as TGA and DTG and Cone calorimeter in Fire Retardant Treatment, Single Burning Item (SBI)
- Fumigants

PRACTICAL

- Preparation of fire retardant formulations
- Tests for fire retardancy
- Demonstration of microwave treatment
- Demonstration of chemical modification
- Demonstration of Thermal modification

WWS 311 WOOD SEASONING KILNS AND OPERATIONS (Credit 2+1)

LEARNING OBJECTIVES: The main objective is to impart practical knowledge on stacking of timber for seasoning, kiln designs, their working principles, kiln drying schedules, types of kilns and their energy efficiencies, kiln specifications, boiler and energy conserving drying techniques.

MODULE I AIR SEASONING

- Stacking, practice for poles, posts, railway sleepers and sawn timber. Orientation of stacks relative to wind direction. Fork lift trucks for stacking. Air seasoning sheds: Forced air drying

MODULE II SEASONING SCHEDULES

- General outline of kiln drying schedules. Optimum drying conditions, control at different stages of degradation development. Kiln drying times. Modification of schedule for higher thickness, lower initial moisture contents and special quality for end uses. Removal of casehardening. Reverse casehardening. Scope of accelerating a

schedule. Equalization treatment

MODULE III KILN OPERATION

- Measuring instruments of different types for temperature, relative humidity and air velocity. Sample preparation. Seasoning kilns: General design features. steam, hot water, heated mineral oil, direct; indirect furnace, electric heated kilns. 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 and structural insulation. Steam traps

MODULE IV KILN DESIGN AND SPECIFICATIONS

- Minimum requirement as per Indian Standard. Calculation of kiln capacity required for a given output, kiln automation, boiler capacity, evaporative capacity. Kiln heat losses and energy efficiency data. Consumption of different types of fuel

MODULE V ENERGY CONSERVING DRYING TECHNIQUES

- Energy conserving drying processes: solar kilns, dehumidification kilns, vacuum drying in vapor with heat recovery, vacuum drying in RF field etc. Comparative economics: air seasoning, steam heated and solar kilns

MODULE VI WOOD SEASONING PSYCHROMETRY

- Introduction to Psychrometry, understanding the psychrometric chart: scales of dry bulb temperature, wet bulb temperature, specific volume, specific humidity, dew point, vapour pressure, relative humidity and enthalpy
- Practical utility of psychrometrics in wood seasoning operations: dehumidification, venting, conditioning, increase/ decrease in relative humidity; temperature etc along with some practical calculations

PRACTICAL

- Practice on operating a kiln charge, preparation of kiln samples, calibration of instruments, final moisture content

- Determination of total evaporation and condensate discharge, inspection of material
 - Measurement of air speeds in the timber stack and computation of total air volume discharged by fans
 - Kiln control under abrupt RH and temperature fluctuations
 - Measurement of solar energy
 - Psychrometrics measurements in wood seasoning
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WWF-313 WOOD FINISHING (Credit 2+1)

LEARNING OBJECTIVES: The course is designed to impart knowledge of theory and mechanism of wood finishing and equipments. Performance tests on wood finishes and test methods are also the integral part of this course.

MODULE I INTRODUCTION

- Wood finishing basics
- Analysis of Surface Condition
- Surface Preparation

- Surface Improvement Techniques

MODULE II FINISING OPERATIONS

- Filling, repeated sanding and staining operations using aniline based dye – stains or other environment friendly techniques- use of bark saw dust extracts and ammonia fumigation.
- Role of Oil Bound, Resin Bound and Catalyzed Fillers
- Sealing
- Penetrating and Film Forming Finishes
- No Treatment Finish
- Refinishing

MODULE III WOOD FINISHING EQUIPMENT

- Brushing, spraying, electrostatic spraying, powder coating, UV curing. Airless Spray Plant, Roller Coating Machine

MODULE IV PERFORMANCE TESTS ON WOOD FINISHES AND

TEST METHODS

- Role of moisture on pre-finished, finished wood surfaces
- Photo oxidation effects.
- Moisture Excluding Efficiencies (MEE) of wood coatings. Finishing qualities of Indian Woods. Test for surface smoothness and gloss
- Determination of Coating Thickness
- Adhesion Test on coatings as per ASTM/ ISO standards
- Introduction to CIE Lab system

PRACTICAL

- Polishing of a given sample and observations on surface gloss
- Aqueous dip test and permeation of water through a coating. Calculation of MEE or water uptake
- Wet contact of a coated surface for a overnight and measurement of reduction on gloss of the film as compared to control
- Fuming of wood with ammonia and observations
- Comparison of gloss using diverse pore filling treatments
- Film Thickness measurement on coated surface
- Measurement of change in colour as per CIE lab system due to different surface coatings

WPD 417

IVth SEMESTER
PRODUCT DESIGN AND FABRICATION

(Credit 2+1)

LEARNING OBJECTIVES: The emphasis of the course is on introducing the concept of wood products design and anthropometric aspects. The aim is also to impart knowledge of wood behavior in warm and humid climates that arise during service and changing trends in material use in wood industries.

MODULE I PRODUCT DESIGN AND CARVING

- Design, ratios and proportions, projections and anthropometric aspects, Manipulation of colour, figure, texture, and grain direction and visual grading, colour grading in fabrication of a product
- Wood carving and decorative wood working such as inlay work, parquetry and use of multiple species and wood waste in diaper and utility works
- Use of twigs, branches, roots, knots, and feature grade material including worm wood in making of “new wave” products
- The range and relevance of “Windsor chair” as a classic example of time tested multiple utility and dynamic trendsetter

MODULE II PRODUCT BEHAVIOUR IN APPLICATION

- Behaviour of Furniture, cabinets, wall panels, wooden floors, table tops, wooden doors in warm and humid climates and weather-climate related fluctuations. Movement or working in wood
- Method of estimating movement of different timber species and panel products.
- “System or product movement” and measures to contain them in a joint, solid wood door and a table top

MODULE III FASTNERS

- Role of various nails, screws, and fastners corrugated pins, and dowel pins along a design, with or without association of a joint
- The net gain or benefits of these aspects. Forces operating on a upright Timber chair calculation of bending moment on back to side rail connecting joints
- Possible design improvements, material selection and production aspects
- Changing trends in material use in wood based industry

PRACTICAL

- Fabrication of photo frame through mitre joint
- Estimation of finger geometry
- Fabrication of different joints
- Scratch hardness test for paints on metal surface

ELECTIVE COURSE

WFC 421 FOREST CERTIFICATION

(Credit 5+0)

LEARNING OBJECTIVES: The basic objective of this course is to introduce role of nano science in wood as material and to study the life cycle analysis of wood and wood based products.

MODULE I INTRODUCTION

- Forest certification: concept, definition, origin, evolution, relevance and needs and limitation of forest certification, Scope and opportunity, Emerging issues, trends and schemes, certification and labelling, type of certification- Detail about FM, CoC, fact and figures of certification(Global and India)

MODULE II FOREST CERTIFICATION PROGRAMME

- Standards, certification process, accreditation, auditing, managing audit, organizational process, national and international schemes, certificate processes at global level, Bhopal-India Process

MODULE III CERTIFICATION OF FOREST PRODUCTS

- NTFPs and their role in forest management, certification of NTFPs, issues, merits and demerits of NTFPs certification, Need of certification for wood based Industries

MODULE IV SUSTAINABILITY, CHALLENGES AND POTENTIAL OF FOREST CERTIFICATION

- Framework for forest certification in India, Government policies and their objectives, Indian forest certification agencies, Standards of certification for sustainable utilization, and management of forest resources, progress of certification in India, stakeholder expectation and economics of forest certification, Visit to certified Industry/Govt. Organization

MODULE V CLIMATE CHANGE

- Climate change: Carbon sequestration and climate change –introduction. Carbon credits and possibilities in timber, timber products and processes

WFJ 422 FINGER JOINTS FOR EFFICIENT WOOD UTILIZATION

(Credit 3+2)

LEARNING OBJECTIVES: One of the ways to meet the growing demand of solid wood is to use up the short pieces that go waste in the mills and workshops for different end uses. Finger jointing is a technique through which small pieces can be used in applications ranging from panels to furniture parts and even in very high end structural members

MODULE I FINGER JOINTING TECHNOLOGY

- The Finger jointing technique, Need and uses
- Design and Adhesive aspects
- Machinery, Structural and non-structural usages
- Introduction to glulams, Strength and Finishing aspects

PRACTICAL

- Finger shaping
 - Adhesive application
 - Finger pressing
 - Calculating finger geometry
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WVS 423

VACCUM SEASONING TECHNOLOGIES

(Credit 3+2)

LEARNING OBJECTIVES: To impart knowledge on vacuum technology for timber seasoning

MODULE I

Behavior of Gases: Kinetic theory of gases, Gas Transport phenomenon, state for ideal gases, real gases, velocity and speed of gas molecules ,the mean free path ,volume occupied by gas molecules, gas laws, general principles of gas-solid interactions

MODULE II

Introduction: Vacuum, Pressure, Type of Vacuum, Application of Vacuum Technology-: Applications in science, technology, research, space science, food science, medical science, day to day life. Importance of Vacuum Technology

MODULE III

Vacuum/Pressure gauges: classification and ranges of vacuum gauges, Pressure gauges for low to high vacuum, Pressure gauges for high to ultrahigh vacuum, Measuring Units.

MODULE IV

Production of Vacuum: Mechanical pumps, Diffusion pump, Cryo-pumps; Pump fluids there types and working, Strategies and tactics for Robust Vacuum Systems: Chamber Design, Materials for vacuum.

MODULE V

Vacuum Drying of Wood: Introduction, Effect of vacuum on EMC of wood, principles of conduction, convection and radiation vacuum drying of wood, Type of vacuum drying kilns and their working (Convective vacuum kiln, Microwave vacuum kiln, Vacuum press drying kiln, Radio-frequency vacuum kiln), concept of drying cycles including heating of timber, drying rate

MODULE VI

Wood vacuum drying mechanism and theories- Chen and Lamb's theory, Newman's theory.

MODULE VII - Economics of vacuum wood drying, Energy efficiency

PRACTICAL

1. Expansion of air under vacuum
2. Verification of atmospheric pressure
3. Effect of vacuum on RH (Relative Humidity)
4. Role of vacuum in boiling of water
5. Impregnation of chemicals in wood with the application of vacuum and pressure.
6. Effect of continuous and pulsed vacuum on drying of wood (Convective and Microwave system)
7. Vacuum degassing

