(VI) M.Sc. (Forestry) Fsorest Products and Utilization

Major Courses

Course Code	Course Title	Credit Hrs.
	Semester I	
FPU 511	Pulp and Paper Technology	2+1
FPU 512*	Forest Products Laboratory Techniques	0+2
FPU 513	Breeding Techniques and Improvement of Medicinal and Aromatic Crops	2+1
FPU 514*	Wood Identification	0+2
FPU 515	Wood Seasoning and Preservation	2+1
	Semester II	
FPU 521	Applied Wood Technology	2+1
FPU 522	Composite Wood Technology	2+1
FPU 523*	Agro-techniques of Medicinal and Aromatic Crops	2+1
FPU 524	Chemistry and Processing of Medicinal and Aromatic Plants	2+1
FPU 525*	Chemistry of Forest Products and Industries	2+1
FPU 526	Wood Physics	1+1
FPU 527	Production of Medicinal and Aromatic Crops	1+1
FPU 528	Pharmacognosy of Medicinal and Aromatic Plants	1+1
	Semester III	
FPU 531*	Non Wood Forest Products Management	2+1
FPU 532	Wood Chemistry	1+1
FPU 533	Medicinal and Aromatic Plants in Health Care Systems	2 +0

***Compulsory Core Courses**

Syllabus of Major courses of Forest Products and Utilization

FPU 511 Pulp and Paper Technology 2+1

Theory

UNIT I- Raw material used in pulp and paper industries, characteristics and handling.

UNIT II -Pulping process, mechanical, chemical, semi-chemical and biopulping. Pulp bleaching, pulp treatment, defibering, de-knotting, brown stock washing, screening,cleaning, thickening, etc.

UNIT III- Recycled fibers, supplementary pulp treatment and additives. Paper making, paper drying, reeling, external sizing, coating, calendaring, etc.

UNIT IV-Structure of paper, its characterization and measuring strength method, optional and structural properties of paper, Type of paper: coated paper, corrugated containers, printing quality of paper, ageing of paper. Rayon industry.

Practical

a. Visit to pulp and paper industry;
b. Study of raw materials, techniques and pulp yield, making of paper and its quality determination.

Suggested Reading

Asuncion J. 2003. *The Complete Book of Paper Making.* Lark books, New York.
Bajpai P. 2018. *Biermann's Handbook of Pulp and Paper.* Vol. 1st:Raw material and pulp making. Elsevier Science, UK.
Biermann C. 1996. *Handbook of Pulping and Paper Making*. 2nd Ed. Academic Press San Diego, New York, Boston, London, Sydney, Tokyo, Toronito.
Britt KW. 1970. *Handbook of Pulp and Paper Technology*. 2nd Ed. Van Nostrand Reinhold

Company, New York.
Lavigne JR. 1979. *Instrumentation Applications for the Pulp and Paper Industry.* Miller Freeman Publications.Publishing and Distributors, New Delhi.
Sjostrom E and Alen R (Eds). 1999. *Analytical Methods in Wood Chemistry Pulping and Paper Making.* Springer Series in Wood Science.
Viikari L and Lantto R. 2002. *Progress in Biotechnology*. Vol. 21st. Biotechnology in the pulp and paper industry. 1st Ed. ICBPPI. Elsevier Science.

FPU 512 Forest Products Laboratory Techniques 0+2

Practical

a. Wood and non-wood product sampling, drying and storage. Estimation of extraneous components of wood. Analysis of volatile compounds;
b. Estimation of chemical composition of wood samples (hardwoods, softwood andother lignocellulosic material) and ash;
c. Separation of components by column, paper, and thin layer chromatography. HPLC techniques;
d. Determination of strength properties of paper and wood composites.

Suggested Reading

Meyland BA and Butterfield BG. 1972. *Three-Dimensional Structure of Wood: A Scanning Electron Microscope Study.* Syracuse University Press.
Rowell RM. 2013. *Handbook of Wood Chemistry and Wood Composites*. 2nd Ed. CRC Press, New York.
Skaar C. 1988. *Wood-Water Relations.* Springer Series in Wood Science.
Snyder LR, Kirkland JJ and Glajch JL. 2012. *Practical HPLC Method Development.* 2nd Ed. John Wiley & Sons.

FPU 513 Breeding Techniques and Improvement of Medicinal and Aromatic crops 2+1

Theory

UNIT I - Plant biodiversity, Major objectives of breeding of medicinal and aromatic crops. Plant introduction, domestication and germplasm conservation. Modes of pollination, male sterility, self incompatibility and apomixis. Production and maintenance of pure seeds of medicinal and aromatic plants.

UNIT II - Principles of plant breeding for self pollinated and cross pollinated crops. Selection, Hybridization-techniques and consequences. Hetersosis and inbreeding depression.Different plant breeding methods for self pollinated, cross pollinated and asexually propagated crops. Mutation and polyploidy breeding. Distinctiveness, uniformity, stability testing in medicinal and aromatic crops.

UNIT III - Breeding for quality parameters in medicinal and aromatic crops. Achievementsand prospects in breeding of important medicinal and aromatic crops- *Rauvolfia serpentina, Plantago ovata, Cassia angustifolia, Ocimum* spp., *Withania somnifera, Valeriana* spp., *Opium poppy, Gloriosa superb, Andrographis paniculata, Mentha* spp., *Geranium, Cymbopogon* spp., and other important crops.

UNIT IV- Legislation in conservation of medicinal and aromatic plants- IPR issues in medicinaland aromatic plants.

Practical

a. Identification based on morphological features;
b. Pollen viability and germination testing;
c. Stigma receptivity;
d. Field practice in emasculation, selfing and crossing in different medicinal andaromatic crops;
e. Determination of mode of pollination and hybridization in different medicinal andaromatic crops.

Suggested Reading

Alikhan I and Khanum A. 2008. *Role of Biotechnology in Medicinal and Aromatic Plants*. UKAZ Publishers.

Chadha KL and Gupta R. 2006. *Advances in Horticulture.* Vol. XI. Medicinal and aromatic plants. Malhotra Publishing House.

Gupta AK and Sharma M. 2008. *Reviews on Indian Medicinal Plants.* ICMR.

Gupta AK, Tandon N and Sharma M. 2008. *Quality Standards of Indian Medicinal Plants.* ICMR.

Johnson CB and Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants.* International Book Distributor.

Sharma R. 2004. *Agrotechniques of Medicinal Plants.* Daya Publishing.

Singh BD. 2010. *Plant Breeding- Principles and Methods.* Kalyani Publishers.

FPU 514 Wood Identification 0+2

Practical

a. Study of planes of wood, gross features and physical characteristics of important woods;
b. Identification of different types of cells and tissues;
c. Anatomical studies of soft and hard woods. Anatomical studies of reaction wood;
d. Classification of timber using dichotomous key;
e. Modern timber identification techniques.

Suggested Reading

Agarwal VK and Upadhaya SD. 2006. *Agrotechniques of Medicinal and Aromatic Plants.* Satish Serial Publishing House.

Anoop EV. 1971. *Timber Identification Manual.* Forest Research Institute, Dehradun.

Dutta JC. 1964. *Botany for Degree Students.* Oxford University Press, Bombay-Calcutta-Madras. Govil JN, Pandey J, Shivakumar BG and Singh VK. 2004. *Crop Improvement, Production Technology, Trade Commerce.*

Lakshman HC and Inchal RF. 2012. *Indigenous Medicinal Plants and their Practical Utility.* Meier E. 2015. *Wood Identifying and Using Hundreds of Woods Worldwide.* Wood database. Porter T. 2004. *Wood Identification and Use.* Guild of Master Craftsman, UK.

Purkayastha SK. 1982. *Indian Woods: Their Identification Properties and Uses.* Controller of Publication.

Rao R and Juneja KDS. 1971. *A Handbook for Field Identification of Fifty Important Timbers of India.* Manager of Publications.

Vashishta PC. 1985. *A Text Book of Botany.* S. Chand Publishing Company, New Delhi.

FPU 515 Wood Seasoning and Preservation 2+1

Theory

UNIT I - Wood water relationship, absorption behaviour and wood drying, Refractory and non refractory behaviour of wood, Wood seasoning, types- air, kiln and special seasoning methods like steaming, chemical, high temperature drying, vacuum drying and water conditioning.

UNIT II - Defects of timber- natural, seasoning defects, defects due to machining defects. Effect of defects on utilization.

UNIT III - Detection and diagnosis of discolouration and decay in wood: external decaying agencies- fungi, insects, borer, etc.

UNIT IV- Wood preservation: preservatives and treatment processes. Advantages and safety concern of wood preservatives, fire retardants. Graveyard test and anti-fungal activity of wood. Bio-preservation.

Practical

a. Determination of moisture content and swelling coefficients of different woods;
b. Comparative studies on air and kiln dried woods;
c. Analysis of decayed wood for physical and chemical parameters;
d. Treatment of wood with different types of preservatives. Graveyard test.

Suggested Reading

FAO. 2007. *Wood Preservation Manual*. International Book Distributor. Hunt GM. 1967. *Wood Preservation* 3rd Ed.

Mc GRAW-HILL Book Company. Pandey CN and Jain VK. 1992. *Wood Seasoning Technology*. FRI, Dehradun.

Purushotham A, Pande JN and Jadhav. 1959. *Wood Preservation In India.* Manager ofPublications.

Winn W. 1919. *Timbers and their Uses*. London George Rotledge & Sons Ltd.

FPU 521 Applied Wood Technology 2+1

Theory

UNIT I -Physical properties of wood-wood density, specific gravity and methods of their determination. Effect of growth on density of wood. Moisture content and its measurement. Effect of sound on wood resonance. Color of wood, phosphorescence, fluorescence and residual luminescence. Thermal properties-conductivity and diffusivity. Electrical properties-conductivity, dielectric constant and current resistivity. Wood permeability.

UNIT II- Mechanical properties-elastic constants, plasticity, Hook's Law, Poisson's ratio, elastic constants, modulus of elasticity, factors affecting strength properties, elastic theory of bending, shear stresses in simple beams, supported beams and cantilevers carrying concentrated and uniformly distributed loads, direct and bending safeworking stresses and their evaluation.

UNIT III- Standard tests of timber specimen's-compression, tensile strength. Mechanics and Rheology of wood, abrasion, brittleness and hardness. Suitability coefficient and indices of different wood species. Vibration properties.

UNIT IV- Effect of environment on mechanical properties of wood. Effect of radiations on strength of wood.

Practical

1. Determination of density, specific gravity, strength, hardness, modulus of elasticity, mechanical properties, thermal conductivity, electrical resistivity and dielectric constant of important domestic and imported timber species.

Suggested Reading

Bodig J and Benjamin AJ. 1993. *Mechanics of Woods and Woods Composites.* Krieger Publish Company.

Brown HP. 1925. *An Elementary Manual on Indian Wood technology.* Central Publication Branch, Government of India, Calcutta.

Brown HP. 1985. *Manual of Indian Wood Technology*. International Books and Periodicals Supply Service, New Delhi.

Hill CAS. 2006. *Wood Modification: Chemical, Thermal and other Processes.* John Wiley and SonsLtd.

Hoadley B. 2000. *Understanding Wood: A Craftsman's Guide to Wood Technology.* Taunton Press. Newtown, USA.

Kollmann FFP and Cote WAJ. 1968. *Principle of Wood Science and Technology.* Vol I, Solid wood.

George Allen and Unwin Ltd London, Springer-Verlag, Berlin, Heidelberg, New YoPanshin AJ and De ZC. 1980. *Textbook of Wood Technology*, 4th Ed. McGraw-Hill. New York.

FPU 522 Composite Wood Technology 2+1

Theory

UNIT I- Introduction to wood modification, its need and scope.Chemical modification of wood (acetylation, reaction with isocyanates, acetates, ethers, epoxides, etc.) Woodimpregnation and

compregnation, heat stabilization, wood densification.

UNIT II- Modern trends in composite wood. Wood adhesives – types, characteristics and application.

UNIT III- Plywood, laminated wood and inorganic wood composites- their manufacture, characteristics and application.

Practical

a. Use of different adhesives in plywood;
b. Study of composite boards, study of anti-shrink efficiency of wood treated with different chemicals;
c. Impregnation and compregnation of wood with chemicals.

Suggested Reading

Ansell MP. 2015.*Wood Composites*. Elsevier, Science and Technology.

Hill CAS. 2006. *Wood Modification: Chemical, Thermal and Other Processes*. John Wiley and Sons Ltd.

Pizzi A and Mittal KL. 2011. *Wood Adhesives*. CRC Press, New York.

Rowell RM. 2013. *Handbook of Wood Chemistry and Wood Composites*. 2nd Ed. CRC Press, New York.

USDA (U.S. Department of Agriculture). 1999. *Wood Handbook: Wood as an Engineered Material.* US Department of Agriculture, Forest Service. Forest Products Laboratory, Madison, WI.

FPU 523 Agro-techniques of Medicinal and Aromatic Crops 2+1

Theory

UNIT I- Importance of medicinal and aromatic plants in human health, national economy and related industries. Need of cultivation of medicinal and aromatic plants as agricultural crops. Concept of organic farming, GACP and GAP in medicinal and aromatic crops production. Quality concern in plant based drugs.

UNIT II- Introduction and importance, climate and soil requirements, cultural practices, harvesting and yield, important constituents of medicinal plants – Mulhathi, Senna, *Gloriosa superba*, *Valeriana jatamansi, Swertia chirayita,* Isabgol, *Rauwolfia serpentina, Withania sominifera,* Opium Poppy, *Aloe vera*, Satavar, *Stevia rebaudiana,* Safed Musli, Kalmegh and other important species of the region.

UNIT III- Introduction and importance, climate and soil requirements; cultural practices; harvest and yield; important constituents of aromatic plants – Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, *Tagetes minuta*, Lavender, Rosemary, Patchouli, Geranium and other important species of the region.

Practical

- Morphological identification of listed plants and their economic parts, maturity indices;
- Preparation and layout of nursery and field, methods of seed sowing/ transplantation, cultural operations in MAP crops;
- Raising and harvesting of at least one crop grown in the region;
- Visit to government and private Pharmaceutical units/ Institutes in adjoining areas;
- Visit to large scale herb growing and processing units engaged in commercial cultivation and preparation of purified phytochemical/ standardized extracts;
- Visit to nearby marketing/ trade centres.

Suggested Reading

Atul CK and Kapur BK. 1982. *Cultivation and Utilization Of Medicinal Plants*. RRL, CSIR, Jammu-Tawi.

Chadha KL and Gupta R. 2006. *Advances in Horticulture*. Vol. XI. Medicinal and aromatic plants. Malhotra Publishing House.

Chopra AK. 2007. *Medicinal Plants: Conservation, Cultivation and Utilization*. Daya Books. Chopra RN. Nayar SL and Chopra IC. 1956. *Glossary of Indian Medicinal Plants.* CSIR, New Delhi.

EIRI Board. 2007. *Handbook of Medicinal and Aromatic Plants: Cultivation, Utilization and*

Extraction Processes. Engineers India Research Institute, New Delhi.
Gunther E. 1975. *The Essential Oils.* Robert, K Krieger Pub. Co, New York.
Khan IA and Khanum A. 2005. *Medicinal and Aromatic Plants of India; Herbal Wealth for Human Health.* 1st Ed. Ukaaz Publications.
Muralia S. 2006. *Medicinal and Aromatic Plants* 1st Ed. Neha Publishers and Distributors.

FPU 524 Chemistry and Processing of Medicinal and Aromatic Plants 2+1

Theory

UNIT I - Organic compounds and their classification such as aliphatic, aromatic, alkaloids, steroids, terpenoids, glycosides, phenolic compounds, heterocyclic compounds and carbohydrates.

UNIT II - Primary and Secondary plant metabolites and theurapeutical uses of phytoconstituents such as anthraquinones, steroidal and triterpenoidal glycosides, phenolic compounds, lipids, alkaloids and terpenoids.

UNIT III - Basic principles and extraction techniques of different phytoconstituents. Analysis of active principles using TLC, HPLC, Gas chromatography, etc. Quality standards in herbal products. Drug descriptors for medicinal and aromatic plants.

UNIT IV - Postharvest processing-drying, grading and storage.essential oils. Extraction techniques of essential oils and their quality analysis.

Practical

Use of thin layer and column chromatography during extraction and purification of phytopharmaceuticals. Preparation of active constituent enriched extracts. Extraction of Essential oils and their quality evaluation, preparation of concretes and absolutes. Use of HPLC & GC in quality evaluation.

Suggested Readings

Bedi S, Singh T and Vyas SP. 2012. *A Handbook of Aromatic and Essential Oil Plants: Cultivation, Chemistry, Processing and Uses.* Agrobios (India).
Finar IL. 2002. *Organic Chemistry*. Vol. I & II. *Pearson Education* India.
Raaman N. 2006. *Phytochemical Techniques.* New India Publishing Agency, N. Delhi.
Singh MP and Panda H. 2005. *Medicinal Herbs with their Formulations.* Vol-1st. Daya Publishing House.
Singh S. 2009. *Essentials of Pharmacology*. 2nd Ed. New Age International Publisher.
Wagner H and Bladt S. 2009. *Plant Drug Analysis- A Thin Layer Chromatography Atlas.* Springer (India) Pvt. Ltd

FPU 525 Chemistry of Forest Products and Industries 2+1

Theory

UNIT I - Importance of forest based industries in relation to Indian economy. Role of Chemistry in relation to forest products.

UNIT II - Classification and description of different forest based industries – pulp and paper, composite wood, furniture, bamboo, sports goods, pencil making, match box and splint making. Use of lesser known wood species for commercial purposes.

UNIT III - Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood – water and organic solvent soluble.

UNIT IV - Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth, etc.).

UNIT V - Chemical nature and uses of volatile oils, tannins, katha and cutch and important forest based dyes and pigments.

Practical

a. Estimation of cell wall constituents – Hemicelluloses and lignin;
b. EXtraction of essential oils, resins and tannins;
c. Wood pulping. Acetylation of wood;
d. Visit to nearby forest based industries.

Suggested Reading

Bowyer JL, Shmulsky R and Haygreen JG. 2003. *Forest Products and Wood Science: An Introduction*. 4th Ed. Blackwell Publishing.

Chung and Deborah DL. 2003. *Composite Materials-Functional Materials for Modern Technologies*. Springer, Verlag London.

David AT. 2013. *Forest Products: Advanced Technologies and Economic Analyses*. Elsevier. Eriksson KEL, Blanchette RA and Ander P. 1990. *Microbial and Enzymatic Degradation of Wood and Wood Components*. Springer, Verlag Berlin Heidelberg.

Linskens HF and Jackson JF. 1991. *Essential Oils and Waxes* (Ed.). Springer-Verlag Berlin Heidelberg.

Panda H. 2005. *Hand Book on Specialty Gums, Adhesive, Oils, Rosin And Derivatives, Resins, Oleoresins, Katha, Chemicals with Others Natural Products*. Asia Pacific business press. Inc.

Rojas OJ. 2016. *Cellulose Chemistry and Properties: Fibers, Nanocelluloses and Advanced Materials (Ed.)*. Springer International Publishing.

Rowell RM. 2013. *Hand Book of Wood Chemistry and Wood Composites*. CRC press, Taylor and Francis group.

Shackleton S, Shackleton C and Shanley P. 2011. *Non-Timber Forest Products in the Global Context (Ed.)*. Springer, Verlag Berlin Heidelberg.

Sharma LC. 2012. *Development of Forests and Forest Based Industries*. M/s Bishen Singh Mahendra Pal Singh.

FPU 526 Wood Physics 1+1

Theory

UNIT I- Wood density, thermal, electrical and acoustic properties of wood. Mechanics and Rheology of wood, elasticity, plasticity and creep (tensile compression and bending strength)

UNIT II - Toughness, torsion, shear, hardness and abrasion strength. Acoustic and acousto-ultrasonics based non-destructive evaluation technique.

Practical

a. Determination of wood density;
b. Study of thermal, electrical and acoustic properties of wood;
c. Determination of tensile and bending properties of wood.

Suggested Reading

Brown HP. 1925. *An Elementary Manual on Indian Wood Technology.* Central Publication Branch Government of India.

Dutta AC. 1964. *Botany for Degree Students*. Oxford University Press.

Franz FP, Kollmann and Wilfred AJC. 1968. *Principle of Wood Science and Technology*. Vol I. Solid wood. George Allen and Unwin Ltd London, Springer-Verlag, Berlin, Heidelberg.

Franz FP, Kollmann, Kuwnzi E and Stamm AJ. 1975. *Principle of Wood Science and Technology.* Wood based material. Vol. II Springer-Verlag, Berlin, Heidelberg.

Meyland BA and Butterfield BG (Eds). 1972. *Three-Dimensional Structure of Wood: A Scanning Electron Microscope Study.* Syracuse University Press.

FPU 527 Production of Medicinal and Aromatic Crops 1+1

Theory

UNIT I - Modes of reproduction in MAP crops and their relevance in maintaining genetic purity of crops. Concept of quality seed production and maintenance.

UNIT II - Soil fertility, essential nutrient elements- functions, deficiency symptoms, availability and factors affecting their availability. Soil micro-organisms and their role in organic matter decomposition. Importance of pH and C:N ratio in plant nutrition. Conceptof bio-fertlizers and their potential for use in medicinal and aromatic crops.

UNIT III - Essentials of nursery production, criteria of site selection, and types of nursery, establishment of a model nursery. Nursery raising of medicinal plants. Tissue culture technique and *in-vitro* propagation of important MAPs.

UNIT IV -Plant protection measures in medicinal and aromatic crops, Quality parameters of seedlings and nursery stock.

Practical

a. ASeXual/ vegetative reproduction techniques- cutting, budding, layering, etc.*;* Methods of seed collection and storage techniques;
b. *In-vitro* propagation techniques;
c. Determination of pH, organic matter and N, P, K from soil.

Suggested Reading

Atul CK and Kapur BK. 1982. *Cultivation and Utilization of Medicinal Plants.* RRL, CSIR, Jammu-Tawi.

Chopra AK. 2007. *Medicinal Plants: Conservation, Cultivation and Utilization.* Daya Books. Chopra RN. Nayar SL and Chopra IC. 1956. *Glossary of Indian Medicinal Plants*. CSIR, New Delhi.

EIRI Board. 2007. *Handbook of Medicinal and Aromatic Plants: Cultivation, Utilization and Extraction Processes.* Engineers India Research Institute, New Delhi. Gunther E.1975. *The Essential Oils*. Robert, K Krieger Pub. Co, New York.

Khan IA and Khanum A. 2005. *Medicinal and Aromatic Plants of India; Herbal Wealth for Human Health.* 1st Ed. Ukaaz Publications.

Muralia S. 2006. *Medicinal and Aromatic Plants* 1st Ed. Neha Publishers and Distributor

FPU 528 Pharmacognosy of Medicinal and Aromatic Plants 1+1

UNIT I - History and scope of pharmacognosy, Pharmaceutical products. Classification of natural drugs. Chemical nature of drugs. Pharmacognostic analysis of drug plants based on botanical, chemical and histological features.

UNIT II - Evaluation based on pharmacopoeial standards for both single drugs and compound formulations most commonly used in different systems of medicines.

UNIT III - Pharmacognostic features of Sarpagandha, Jatamansi, Ashwagandha, Turmeric, Punarnava, *Ephedra, Gymnema*, Senna, Amla, Gokhru, Isabgol, Black pepper, Banafsha, Arjun or any other commercially species specific to the region.

Practical

a. Identification of drugs by morphological characters;
b. Physical and chemical tests for evaluation of drugs;
c. Gross anatomical studies of Ginger, Ashwagandha, Senna, *Gentiana*, Kalmegh, Sarpagandha, Mulhathi, *Aconitum* species or any other important species relevant to the region.

Suggested Reading

Atul CK and Kapur BK. 1982. *Cultivation and Utilization of Medicinal Plants*.RRL, CSIR, Jammu-Tawi.

Chopra AK. 2007. *Medicinal Plants: Conservation, Cultivation and Utilization*. Daya Books. Chopra RN, Nayar SL and Chopra IC. 1956. *Glossary of Indian Medicinal Plants*. CSIR, New Delhi.

Cunningham A. 2014. *Applied Ethnobotany: "People, Wild Plant Use and Conservation*". Taylor & Francis.

Cupp J and Tracy TS. 2003. *Dietary Supplements: Toxicology and Clinical Pharmacology*.

Humana Press.
Gunther E. 1975. *The Essential Oils*. Robert, K Krieger Pub. Co, New York.
Gupta K, Tandon N and Sharma M. 2008. *Quality Standards of Indian Medicinal Plants*. Jain SK. 1968. *Medicinal Plants*. National book trust, New Delhi. Oxford & IBH, New Delhi. Khan IA and Khanum A. 2005. *Medicinal and Aromatic Plants of India; Herbal Wealth for Human Health.* 1st Ed. Ukaaz Publications.
Maheshwari JK. 2000. *Ethnobotany and Medicinal Plants of Indian Subcontinent*. Scientific Publishers,Jodhpur, India.
Muralia S. 2006. *Medicinal and Aromatic Plants*. 1st Ed. Neha Publishers and Distributors

FPU-531 Non-Wood Forest Products Management 2+1

Theory

UNIT I -Classification of non wood forest products like gums and resins, katha, dyes, tannins,oils, raw drugs, bamboos, canes and other products.

UNIT II -Technologies for extraction of gums, resins, katha, dyes, tannins, oils, raw drugsand other products.

UNIT III- Utilization of various non wood forest products and their scientific management for processing, value addition, marketing and disposal.

UNIT IV- Quality assessment of important products and their methods for storage. Important industries based on non wood forest products and their management.

Practical

a. Extraction of resins, gums, katha, dyes, tannins, oils raw drugs, bamboos, canesand other products;
b. Value addition techniques for these products;
c. Visit to non wood forest products based industries.

Suggested Reading

Linskens HF and Jackson JF. 1991. *Essential Oils and Waxes* (Ed.). Springer-Verlag Berlin Heidelberg.
Mathe A. 2015. *Medicinal and Aromatic Plants of the World-Scientific, Production, Commercial and Utilization Aspects.* Springer Netherlands.
Panda H. 2005. *Hand Book on Specialty Gums, Adhesive, Oils, Rosin And Derivatives, Resins, Oleoresins, Katha, Chemicals with others Natural Products*. Asia Pacific business press. Inc.
Panshin AJ, Harrer ES and Bethel JS. *Forest Products, their Sources, Production and Utilization.*
Shackleton S, Shackleton C and Shanley P. 2011. *Non-Timber Forest Products in the Global Context* (Ed.). Springer, Verlag Berlin Heidelberg.

FPU 532 Wood Chemistry 1+1

Theory

UNIT I - Chemical composition of wood: Cell wall constituents- cellulose, lignin, hemicellulose, peptic substances, etc.

UNIT II - Volatile oils and extractives, cellulose derivatives and their applications.

UNIT III - Hydrolysis and fermentation of lignocellulosic materials. Pyrolysis and gasificationof wood.

Practical

a. Extraction of cellulose, hemicellulose, lignin, extractives and ash content of wood.

Suggested Reading

Coppen JJW. 1995. *Gums, Resin and Latex of Plant Origin.* Food and Agriculture Organizations, Rome.
Rowe JW. 1989. *Natural Products of Woody Plants.* Springer Series in Wood Science.
Rowell RM. 1984. *The Chemistry of Solid Wood (Advances in Chemistry Series)*. American Chemical Society.
Rowell RM. 2013. *Handbook of Wood Chemistry and Wood Composites.* 2nd Ed. CRC Press.
Singh A. 1967. *Plant Physiology.* Readers in Botany, Allahabad University.

FPU 533 Medicinal and Aromatic Plants in Health Care Systems 2 + 0 Theory

UNIT I - Concept of Health Care systems

UNIT II - Brief introduction to Ayurveda, Unani, Sidha, Homeopathy, Allopathy, Naturopathy, Electrohomoeopathy, etc.

UNIT III - Important medicinal plants used in treating various diseases in modern and complementary systems.

UNIT IV - Biological activity of selected medicinal plants. Methods of preparing poultices, decoctions, powders, tinctures, active content rich extracts.

Suggested Reading

Atul CK and Kapur BK. 1982. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu-Tawi.
Chopra AK. 2007. M*edicinal Plants: Conservation, Cultivation and Utilization.* Daya Books. Chopra RN. Nayar SL and Chopra IC. 1956. *Glossary of Indian Medicinal Plants*. CSIR, New Delhi.
Cunningham A. 2014. *Applied Ethnobotany: "People, Wild Plant Use and Conservation*". Taylor & Francis.
Gunther E. 1975. *The Essential Oils.* Robert, K Krieger Pub. Co, New York.
Jain SK. 1968. *Medicinal Plants.* National book trust, New Delhi. Oxford & IBH, New Delhi. Khan IA and Khanum A. 2005. *Medicinal and Aromatic Plants of India; Herbal Wealth for Human Health.* 1st Ed. Ukaaz Publications.
Maheshwari JK. 2000. *Ethnobotany and Medicinal Plants of Indian Subcontinent.* Scientific Publishers, Jodhpur, India.
Muralia S. 2006. *Medicinal and Aromatic Plants* 1st Ed. Neha Publishers and Distributors.