COURSE CATALOGUE & SYLLABUS
(As Per ICAR-BSMA COMMITTEE)

FOR

M.Sc. (FORESTRY)
FOREST PRODUCTS AND UTILIZATION

Dept. of Forest Products and Utilization
College of Forestry
Sam Higginbottom University of
Agri., Tech. & Sci. (SHUATS)
Prayagraj (Allahabad), U.P., India

M.Sc. (FORESTRY) FOREST PRODUCTS AND UTILIZATION

Course work

1. **Major courses (20 credits)**

Course Code	Title of the Course	L	T	P	Total Credits	Semester
FPU-501*	Non-Wood Forest Products management	2	0	1	3	I
FPU-502	Applied wood technology	2	0	1	3	II
FPU-503	Pulp and paper technology	2	0	1	3	I
FPU-504	Composite wood technology	2	0	1	3	II
FPU-505*	Forest products laboratory techniques	0	0	2	2	I
FPU-506	Agro-techniques of medicinal and aromatic crops	2	0	1	3	II
FPU-507	Breeding techniques and improvement of medicinal and aromatic crops	2	0	1	3	I
FPU-508	Chemistry and processing of medicinal and aromatic plants	2	0	1	3	II
FPU-509*	Wood identification	0	0	2	2	I
FPU-510	Chemistry of forest products and industries	2	0	1	3	II
FPU-511	Wood chemistry	1	0	1	2	I
FPU-512	Wood physics	1	0	1	2	II
FPU-513	Wood Seasoning & Preservation	2	0	1	3	I
FPU-514	Production of medicinal and aromatic crops	1	0	1	2	II
FPU-515	Medicinal and aromatic plants in healthcare system	2	0	0	2	I
FPU-516	Pharmacognosy of medicinal and aromatic plants	1	0	1	2	II
Total Credits		24		17	41	

2. **Minor courses (8 credits)**

Courses from Forest Biology and Tree Improvement or Silviculture and Agroforestry or Natural Resource Management and Environmental Science

3. Supporting courses (6 credits)

Course Code	Title of the Course	L	T	P	Total Credits	Semester
MAS-815*	Experimental Design	2	0	1	3	I
MAS-511	Statistical Methods (Deficiency)	2	0	1	3	I
CSIT-701	Computer Orientation	2	0	1	3	I

4. Common Courses (5 credits)

Course Code	Title of the Course	L	T	P	Total Credits
PGS-501	Library and information Services	0	0	1	I
LNG-502	Technical Writing and Communication skills	0	0	1	I
AEAB-503	Intellectual Property & its management in Agriculture	0	0	1	I
SAF-515	Basic Concept in Laboratory Technique	0	0	1	I
AEAB-505	Agricultural Research, Research Ethics and Rural Development programme	0	0	1	I

5. Seminar (1 credits)

Course Code	Title of the Course	L	T	P	Total Credits	Semester
FPU-591*	Master's Seminar -I	0	0	1	1	II

6. Research (30 credits)

Course Code	Title of the Course	L	T	P	Total Credits
FPU-599	Master's Thesis Research	0	0	30	30

*Compulsory Core Courses

Course Title : Non-Wood Forest Products Management

Course Code : FPU-501

Credit Hours : 2+1

Aim of the course

To make students to understand and learn about the different Non-Wood Forest Products (NWFPs) and their scientific extraction, processing and disposal.

Theory

UNIT I

Classification of Non-Wood Forest Products (NWFPs) 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 drugs and 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

Extraction of resins, gums, katha, dyes, tannins, oils raw drugs, bamboos, canes and other products; Value addition techniques for these products;• Visit to Non-Wood Forest Products (NWFPs) 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.

Theory

Sl. No	Topic	No of Lecture(s)
1	Classification of Non-Wood Forest Products (NWFPs) like; gums and resins, katha, dyes, tannins, oils, raw drugs and other products	9
2	Technologies for extraction of gums, resins, katha, dyes, tannins, oils, raw drugs and other products	8
3	Utilization of various Non-Wood Forest Products (NWFPs) and their scientific management for processing, value addition and disposal	6
4	Quality assessment of important products and their methods for storage	6
5	Important industries based on Non-Wood Forest Products (NWFPs) and their management	3
	Total	32

Practical

Sl. No	Topic	No of Practicals(s)
1	Extraction of resins, gums, katha, dyes, tannins, oils, raw drugs and other products	8
2	Value addition techniques resins, gums, katha, dyes, tannins, oils, raw drugs and other products	5
3	Visit to Non-Wood Forest Products (NWFPs) based industries	3
	Total	16

Course Title : Applied Wood Technology

Course Code : FPU-502

Credit Hours : 2+1

Aim of the course

To acquaint students with various aspects of wood technology and their role in different applications.

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. Colour 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 safe working 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

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 Sons Ltd.
- 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 York.
- Panshin AJ and De ZC. 1980. *Textbook of Wood Technology*, 4th Ed. McGraw-Hill. New York.

Theory

Sl. No	Topic	No of Lecture(s)
1	Physical properties of wood-wood density, specific gravity and methods of determination	4
2	Standard tests of timber specimen's-compression, tensile strength, Mechanics and Rheology of wood, abrasion, brittleness and hardness.	4
3	Physical properties of wood-wood density, specific gravity and methods of determination	4
4	Effect of growth on density of wood. Moisture content and its measurement. Effect of sound on wood resonance. Phosphorescence, fluorescence and residual luminescence	4
5	Thermal properties-conductivity and diffusivity	2
6	Electrical properties-conductivity, dielectric constant and current resistivity. Wood permeability	3
7	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 leads, direct and bending safe working stresses in simple and their evaluation	5
8	Suitability coefficient and indices of different wood species. Vibration properties	3
9	Effect of environment on mechanical properties of wood. Effect of radiations on strength of wood	3
	Total	32

Practical

Sl. No	Topic	No of Practical(s)
1	Determination of density, strength, hardness modulus of elasticity of wood and mechanical properties of important domestic and imported	9

	timber species	
2	Determination electrical resistivity and dielectric constant of important domestic and imported timber species	7
	Total	16

Course Title : Pulp and Paper Technology

Course Code : FPU-503

Credit Hours : 2+1

Aim of the course

To acquaint the students with the resources and processes for making pulp and paper.

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

Visit to pulp and paper industry; 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.
- Rao KP. 2007. *Pulp and Paper Technology: Technology, Testing and Applications.* CBS 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.

Theory

Sl. No	Topic	No of Lecture(s)
1	Raw materials used in pulp and paper industries, characteristics and handling	6
2	Pulping process, mechanical, chemical, semi-chemical and biopulping. Pulp bleaching, pulp treatment, defibering, de-knotting, brown stock washing, screening, cleaning, thickening, etc.	8
3	Recycled fibers, supplementary pulp treatment and additives. Paper making, paper drying, reeling, external sizing, coating, calendaring, etc. Structure of paper, its characterization and measuring strength method	10
4	Optional and structural properties of paper, Type of paper: coated paper, corrugated containers, printing quality of paper, ageing of paper	6
5	Rayon industry	2
	Total	32

Practical

Sl. No	Topic	No of Practical(s)
1	Visit to pulp and paper industry	6
2	Study of raw materials, techniques and pulp yield, making of paper and its quality determination	10
	Total	16

Course Title : Composite wood technology

Course Code : FPU-504

Credit Hours : 2+1

Aim of the course

To impart knowledge regarding the scope and processes for developing composite and modified woods.

Theory

UNIT I

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

- Use of different adhesives in plywood; Study of composite boards, study of anti-shrink efficiency of wood treated with different chemicals; 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.

Theory

Sl. No	Topic	No of Lecture(s)
1	Introduction to wood modification, its need and scope	4
2	Chemical modification of wood (acetylation, reaction with isocyanates, acetates, ethers, epoxides, etc.)	6
3	Wood impregnation and compregnation, heat stabilization, wood densification	6
4	Modern trends in composite wood	4
5	Wood adhesives – types, characteristics and application	4
6	Plywood, laminated wood and inorganic wood composites- their manufacture, characteristics and application	8
	Total	32

Practical

Sl. No	Topic	No of Practical(s)
1	Use of different adhesives in plywood	4
2	Study of composite boards, study of anti-shrink efficiency of wood treated with different chemicals	6
3	Impregnation and compregnation of wood with chemicals	6
	Total	16

Course Title : Forest Products Laboratory Techniques
Course Code : FPU-505
Credit Hours : 0+2

Aim of the course

To expose the students to the practical aspects of laboratory techniques employed in forest products.

Practical

- Wood and non-wood product sampling, drying and storage. Estimation of extraneous components of wood. Analysis of volatile compounds; Estimation of chemical composition of wood samples (hardwoods, softwood and other lignocellulosic material) and ash; Separation of components by column, paper, and thin layer chromatography. HPLC techniques; 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.

Practical

Sl. No	Topic	No of Practical(s)
1	Wood and non-wood products sampling, drying and storage	4
2	Estimation of extraneous components of wood. Analysis of volatile compounds	6
3	Estimation of chemical composition of wood samples (hardwoods, softwood and other lignocellulosic material) and ash	10
	Separation of components by column, paper, and thin layer chromatography. HPLC techniques	6
	Determination of strength properties of paper and wood composites	6
	Total	32

Course Title: Agro-techniques of Medicinal and Aromatic Crops

Course Code: FPU-506

Credit Hours : 2+1

Aim of the course

To equip the student with the conventional and commercial production techniques of medicinal and aromatic plant species.

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.

Theory

Sl. No	Topic	No of Lecture(s)
1	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	4
2	Concept of organic farming, GACP and GAP in medicinal and aromatic crop production. Quality concern in plant based drugs	4
3	Introduction and importance, botanical features, climate and soil requirements, cultural practices, harvesting and yield and important constituents of medicinal plants – Mulhathi, Senna, *Gloriosa superba*, *Valeriana jatamansi*, *Swertia chirayita*, Isabgol, *Rauwolfia serpentina*, *Withania somnifera*, Opium Poppy, *Aloe vera*, Satavar, *Stevia rebaudiana*, Safed Musli, Kalmegh and other important species of the region	12
4	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	12
	Total	32

Practical

Sl. No	Topic	No of Practical(s)
1	Morphological identification of listed plants and their economic parts, maturity indices	3
2	Preparation and layout of nursery and field, methods of seed sowing/ transplantation, cultural operations in MAP crops	4
3	Raising and harvesting of at least one crop grown in the region	3
4	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	4
5	Visit to nearby marketing/ trade centres	2
	Total	16

Course Title : **Breeding Techniques and Improvement of Medicinal and Aromatic crops**

Course Code : **FPU-507**

Credit Hours : **2+1**

Aim of the course

To acquaint with the breeding techniques and quality improvement of medicinal and aromatic crops.

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. Achievements and prospects in breeding of important medicinal and aromatic crops- *Rauvolfia serpentina, Plantago ovata, Cassia angustifolia, Ocimum* spp., *Withania somnifera, Valeriana* spp., *Opium poppy, Gloriosa superba, Andrographis paniculata, Mentha* spp., *Geranium, Cymbopogon* spp., and other important crops.

UNIT IV

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

Practical

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

Theory

Sl. No	Topic	No of Lecture(s)
1	Plant biodiversity, Major objectives of breeding of medicinal and aromatic crops. Plant introduction, domestication and germplasm conservation	3
2	Modes of pollination, male sterility, self-incompatibility and apomixis. Production and maintenance of pure seeds of medicinal and aromatic plants	2
3	Principles of plant breeding for self-pollinated and cross-pollinated crops	3
4	Selection, Hybridization-techniques and consequences	3
5	Hetersosis and inbreeding depression	2
6	Different plant breeding methods for self-pollinated, cross pollinated and asexually propagated crops	3
7	Mutation and polyploidy breeding	2
8	Distinctiveness, uniformity, stability testing in medicinal and aromatic crops	5
9	Breeding for quality parameters in medicinal and aromatic crops	2
10	Achievements and prospects in breeding of important medicinal and aromatic crops- *Rauvolfia serpentina, Plantago ovata, Cassia angustifolia, Ocimum*sp., *Withania somnifera, Valeriana* sp., *Opium poppy, Gloriosa superba, Andrographis paniculata, Mentha* sp., *Geranium, Cymbopogon* sp., and other important crops	4
11	Legislation in conservation of medicinal and aromatic plantsIPR issues in medicinal and aromatic plants	3
	Total	32

Practical

Sl. No	Topic	No of Practical(s)
1	Identification based on morphological features	3
2	Pollen viability and germination testing	3
3	Stigma receptivity	2
4	Field practice in emasculation	2
5	Selfing and crossing in different medicinal and aromatic crops	4
6	Determination of mode of pollination and hybridization in different medicinal and aromatic crops	2
	Total	16

Course Title : Chemistry and Processing of Medicinal and Aromatic Plants

Course Code : FPU-508

Credit Hours : 2+1

Aim of the course

To understand the chemistry of phytopharmaceuticals and their processing as industrial products.

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 therapeutical 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. 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 and GC in quality evaluation.

Suggested Reading

- 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.

Theory

Sl. No	Topic	No of Lecture(s)
1	Organic compounds and their classification such as aliphatic, aromatic, alkaloids, steroids, terpenoids, glycosides, phenolic compounds, heterocyclic compounds and Carbohydrates	9
2	Primary and secondary plant metabolites	4
3	Therapeutical uses of phytoconstituents such as anthraquinones, steroidal and triterpenoidal glycosides, phenolic compounds, lipids, alkaloids and terpenoids	6
4	Basic principles and extraction techniques of different Phytoconstituents Analysis of active principles using TLC, HPLC, Gas chromatography, etc. Quality standards in herbal products	4
5	Drug descriptors for medicinal and aromatic plants	2
6	Postharvest processing-drying, grading and storage	4
7	Extraction techniques of essential oils and their quality analysis	3
	Total	32

Practical

Sl. No	Topic	No of Practical(s)
1	Use of thin layer and column chromatography during extraction and purification of phytopharmaceuticals	3
2	Preparation of active constituent enriched extracts	3
3	Extraction of Essential oils and their quality evaluation	2
4	Preparation of concretes and absolutes	2
5	Use of HPLC and GC in quality evaluation	6
	Total	16

Course Title : Wood Identification
Course Code : FPU-509
Credit Hours : 0+2

Aim of the course
The course deals with the use of anatomical features of wood in timber identification and classification.

Practical
Study of planes of wood, gross features and physical characteristics of important woods; Identification of different types of cells and tissues; Anatomical studies of soft and hard woods. Anatomical studies of reaction wood; Classification of timber using dichotomous key; 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.

Practical

Sl. No	Topic	No of Lecture(s)
1	Study of planes of wood, gross features and physical characteristics of important woods	6
2	Identification of different types of cells and tissues	5
3	Anatomical studies of soft and hard woods. Anatomical studies of reaction wood	10
4	Classification of timber using dichotomous keys	6
5	Modern timber identification techniques	5
	Total	32

Course Title : Chemistry of Forest Products and Industries
Course Code : FPU-510
Credit Hours : 2+1

Aim of the course

The course will equip the students regarding forest based industries and their impact on the economy of the country. To support the studies on the role of various products such as pulp, paper, composite wood, furniture match boxes, sports, pencil making, resins and gums, katha, tannins and various types of other non- timber and wood products either produced or processed in these industries. Practicals will make them aware regarding extraction and processing methods of different forest products.

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

Estimation of cell wall constituents – Hemicelluloses and lignin; Extraction of essential oils, resins and tannins; Wood pulping. Acetylation of wood; 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.

Theory

Sl. No	Topic	No of Lecture(s)
1	Importance of forest-based industries in relation to Indian economy	1
2	Role of chemistry in relation to forest products	1
3	Classification and description of different forest-based industries – pulp and paper and composite wood	6
4	Classification and description of different forest-based industries like; Furniture, bamboo, sports goods, pencil making, match box and splint making	5
5	Use of lesser-known wood species for commercial purposes	2
6	Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin	4
7	Extraneous components of wood – water and organic solvent soluble	2
8	Chemical composition of oleoresin from major pine species	3
9	Structural difference among different gums (arabic, ghatti, tragacanth, etc.)	2
10	Chemical nature and uses of volatile oils, tannins, katha and cutch	3
11	Chemical nature and uses of important forest-based dyes and pigments	3
	Total	32

Practical

Sl. No	Topic	No of Practical(s)
1	Estimation of cell wall contents – Hollo cellulose and lignin	2
2	Extraction of essential oils	2
3	Extraction of resins and tannins	3
4	Wood pulping	2
5	Acetylation of wood	2
6	Visit to nearby forest-based industries	5
	Total	16

Course Title : Wood Chemistry

Course Code : FPU-511

Credit Hours : 1+1

Aim of the course

To impart knowledge about the chemical properties of wood, cell wall constituents and wood extractions.

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 gasification of wood.

Practical

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.

Theory

Sl. No	Topic	No of Lecture(s)
1	Chemical composition of wood: Cell wall constituents- cellulose, lignin, hemicellulose, peptic substances, etc.	5

2	Volatile oils and extractives, cellulose derivatives and their applications	4
3	Hydrolysis and fermentation of lignocellulosic materials	4
4	Pyrolysis and gasification of wood	3
	Total	16

Practical

Sl. No	Topic	No of Practical(s)
1	Extraction of cellulose	3
2	Extraction of Hemicellulose	3
3	Extraction of lignin	4
4	Extraction of wood extractives	3
5	Extraction of ash content of wood	3
	Total	16

Course Title : Wood Physics

Course Code : FPU-512

Credit Hours : 1+1

Aim of the course

To acquaint with the physical characteristics and strength properties of wood.

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

Determination of wood density; Study of thermal, electrical and acoustic properties of wood; 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.

Theory

Sl. No	Topic	No of Lecture(s)
1	Wood density, thermal, electrical and acoustic properties of wood.	4
2	Mechanics and Rheology of wood, elasticity, plasticity and creep (tensile compression and bending strength)	5
3	Toughness, torsion, shear, hardness and abrasion strength	4
4	Acoustic and acousto-ultrasonics based non-destructive evaluation technique	3
	Total	16

Practical

Sl. No	Topic	No of Practical(s)
1	Determination of wood density,	7
2	Study of thermal, electrical and acoustic properties of wood	5
3	Determination of tensile and bending properties of wood	4
	Total	16

Course Title : Wood Seasoning and Preservation
Course Code : FPU 513
Credit Hours : 2+1

Aim of the course

To understand the importance of wood seasoning and preservation for utilizing secondary timber for multipurpose use.

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 external agencies, machining defects. Effect of defects on utilization.

UNIT III

Detection and diagnosis of discolouration and decay in wood: 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

Determination of moisture content and swelling coefficients of different woods; Comparative studies on air and kiln dried woods; Analysis of decayed wood for physical and chemical parameters; 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 of Publications.
- Winn W. 1919. *Timbers and their Uses*. London George Rotledge& Sons Ltd.

Theory

Sl. No	Topic	No of Lecture(s)
1	Wood water relationship, absorption behaviour and wood drying	4
2	Refractory and non-refractory behaviour of wood	4
3	Wood seasoning, types- air, kiln and special seasoning methods like steaming, chemical, high temperature drying, vacuum drying and water conditioning	6
4	Defects of timber- natural, seasoning defects, defects due to external agencies, machining defects	4
5	Effect of defects on utilization	2
6	Detection and diagnosis of discolouration and decay in wood: decaying agencies- fungi, insects, borer, etc.	4
7	Wood preservation: preservatives and treatment processes	2
8	Advantages and safety concern of wood preservatives, fire retardants	2
9	Graveyard test and anti-fungal activity of wood. Bio-preservation	4
	Total	32

Practical

Sl. No	Topic	No of Practical(s)
1	Determination of moisture content and swelling coefficients of different woods	3
2	Comparative studies on air and kiln dried woods	3
3	Analysis of decayed wood for physical and chemical parameters	4
4	Treatment of wood with different types of preservatives. Graveyard test	6
	Total	16

Course Title : Production of Medicinal and Aromatic Crops

Course Code : FPU-514

Credit Hours : 1+1

Aim of the course

To acquaint the students with the plant production techniques.

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. Concept of biofertilizers and their potential for use in medicinal and aromatic crops.

UNIT III

Essentials of nursery production, criteria of site selection, and types of nurseries, 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

Asexual/ vegetative reproduction techniques- cutting, budding, layering, etc.; Methods of seed collection and storage techniques; *In-vitro* propagation techniques; 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 Distributors.

Theory

Sl. No	Topic	No of Lecture(s)
1	Modes of reproduction in crop plants and their relevance in maintaining genetic purity of crops. Concept of quality seed production and maintenance	2
2	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. Concept of biofertilizers and their potential for use in medicinal and aromatic crops	5
3	Essentials of nursery production, criteria of site selection, and types of nurseries, establishment of a model nursery. Nursery raising of medicinal plants. Mode of plant propagation techniques. Tissue culture technique and *in-vitro* propagation of important MAPs	6
4	Plant protection measures in medicinal and aromatic crops, Quality parameters of seedlings and nursery stock	3
	Total	16

Practical

Sl. No	Topic	No of Practical(s)
1	Asexual/ vegetative reproduction techniques-cutting, budding, layering, etc.	5
2	Methods of seed collection and storage techniques	2
3	*In-vitro*-propagation techniques	3
4	Determination of pH, Organic matter and N,P,K from soil	6
	Total	16

Course Title : Medicinal and Aromatic Plants in Healthcare Systems
Course Code : FPU-515
Credit Hours : 2 + 0

Aim of the course

To acquaint the student with the importance of plants used in modern and AYUSH methods of treatment.

Theory

UNIT I

Concept of Health Care systems

UNIT II

Brief introduction to Ayurveda, Unani, Siddha, Homeopathy, Allopathy, Naturopathy, Electro-homoeopathy, 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.

Theory

Sl. No	Topic	No of Lecture(s)
1	Concept of Health Care systems	2
2	Brief introduction to Ayurveda, Unani, Siddha, Homeopathy,	10

	Allopathy, Naturopathy, Electro-homoeopathy, etc.	
3	Important medicinal plants used in treating various diseases in modern and complementary systems.	6
4	Biological activity of selected medicinal plants.	6
5	Methods of preparing poultices, decoctions, powders, tinctures, active content rich extracts	8
	Total	32

Course Title : Pharmacognosy of Medicinal and Aromatic Plants

Course Code : FPU-516

Credit Hours : 1+1

Aim of the course

To develop understanding about microscopical, macroscopical and chemical methods of drug identification.

Theory

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

Identification of drugs by morphological characters; Physical and chemical tests for evaluation of drugs; 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.

Theory

Sl. No	Topic	No of Lecture(s)
1	History and scope of pharmacognosy	1
2	Pharmaceutical products. Classification of natural drugs. Chemical nature of drugs	3
3	Pharmacognostic analysis of drug plants based on botanical, chemical and histological features	4
4	Evaluation based on pharmacopoeial standards for both single drugs and compound formulations most commonly used in different systems of medicines	3
5	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	5
	Total	16

Practical

Sl. No	Topic	No of Practical(s)
1	Identification of drugs by morphological characters	3
2	Physical and chemical tests for evaluation of drugs	6
3	Gross anatomical studies of Ginger, Ashwagandha, Senna, Gentiana, Kalmegh, Sarpagandha, Mulhathi, *Aconitum* species or any other important species relevant to the region	7
	Total	16

Course Title : Experimental Designs

Course Code : MAS- 815

Credit Hours : 2+1

Theory

Analysis of variance- Definition and assumptions, one way classification, two way classification. Sampling Techniques, Simple random sampling, stratified random sampling, systematic sampling. Design Experiments- Randomized Block design, Latin Square design, Factorial design (2^2, 2^3, 3^2, 3^3 factorials), Some P x Q experiments, Split Plot Experiments. Balanced Incomplete Block design.

Practical

Analysis of variance, Randomized Block Design.

Suggested Readings

- Ostle, B. and. Mensing, R.W. 1964. Statistics in Research.
- Goulden, C.H. 2007. Method of Statistical Analysis.
- Snedecor, G.W. and Cochran, W.G. 1989. Statistical Methods.
- Steel, R.G. and Torrie, J.H. 1980. Principles and Procedures of Statistics (with special reference to Biological Sciences).
- Rangaswamy, R. 2010. A Text Book of Agricultural Statistics.
- Chandel, S.R.S. 2014. A Text Book of Agricultural Statistics.
- Cochran, W.G. and Cox, G.M. 1992. Experimental Designs.

Theory

Sl. No	Topic	No of Lecture(s)
1	Analysis of variance	2
2	Definition and assumptions	2
3	One way classification	2
4	Two-way classification	2
5	Sampling Techniques	2
6	Simple random sampling	2
7	Stratified random sampling	2
8	Systematic sampling	2
9	Design Experiments	2
10	Randomized Block design	2
11	Latin Square design	2
12	Factorial design (2^2, 2^3, 3^2, 3^3 factorials)	3
13	Some P x Q experiments	3
14	Split Plot Experiments	2
	Balanced Incomplete Block design	2
	Total	32

Practical

Sl. No	Topic	No of Practical(s)
1	Analysis of variance	6
2	Randomized Block Design	10
	Total	16

Course Title : Statistical Methods
Course Code : MAS- 511
Credit Hours : 2+1

Theory

Statistical Methods- Measures of Skewness and Kurtosis, standard error of mean, Coefficient of variation. Theory of Probability- Definitions, Additions and Multiplication rules of Probability, Conditional Probability. Probability distributions- Normal, Binomial and Poisson distributions. Correlation and Regression- Simple correlation, Rank correlation, Regression Coefficient, Multiple and Partial Correlation, Regression lines between two variables, Multiple

Regression. Tests of Significance- X^2 - test, t - test one sample, two sample t - tests, paired t-test, F - test, Fisher's 2- transformation.

Practical

Coefficient of variation, SE of mean, Skewness and Kurtosis. Fitting of Normal, Binomial and Poisson distribution. Simple Correlation, Multiple and Partial Correlation with three variables only. Regression lines between two variables. X^2, t and F- tests.

Suggested Readings

- Ostle, B. and. Mensing, R.W. 1964. Statistics in Research.
- Goulden, C.H. 2007. Method of Statistical Analysis.
- Snedecor, G.W. and Cochran, W.G. 1989. Statistical Methods.
- Steel, R.G. and Torrie, J.H. 1980. Principles and Procedures of Statistics (with special reference to Biological Sciences).
- Rangaswamy, R. 2010. A Text Book of Agricultural Statistics.
- Chandel, S.R.S. 2014. A Text Book of Agricultural Statistics.
- Cochran, W.G. and Cox, G.M. 1992. Experimental Designs.

Theory

Sl. No	Topic	No of Lecture(s)
1	Statistical Methods: Measures of Skewness and Kurtosis	1
2	Standard error of mean	1
3	Coefficient of variation	1
4	Theory of Probability- Definitions	1
5	Additions and Multiplication rules of Probability	2
6	Conditional Probability	2
7	Probability distributions: Normal, Binomial and Poisson distributions	2
8	Correlation and Regression, Simple correlation	2
9	Correlation and Regression, Simple correlation	2
10	Rank correlation	2
11	Regression Coefficient	2
12	Multiple and Partial Correlation	1
13	Regression lines between two variables	1
14	Multiple Regression	2
15	Tests of Significance- X^2 - test	2
16	t- test one sample	2

17	Two sample t- tests	2
18	Paired t-test, F- test	2
19	Fisher's 2- transformation	2
	Total	32

Practical

Sl. No	**Topic**	**No of Practical(s)**
1	Coefficient of variation	2
2	SE of mean	1
3	Skewness and Kurtosis	2
4	Fitting of Normal	2
5	Binomial and Poisson distribution	1
6	Simple Correlation	2
7	Multiple and Partial Correlation with three variables only	2
8	Regression lines between two variables	2
9	X^2, t and F- tests	2
	Total	16

Course Title : Computer Orientation

Course Code : CSIT-701

Credit Hours : 2+1

Theory

Information Concepts , Data and Information, Information System- Application, Elements, types, Computers basics- Definition, Characteristics & Application of Computers, Computer Hardware- I/O devices, Memory, CPU, Software Concepts, Operating System- DOS, Windows, Application Software- MS Word, MS Excel, MS Access, MS Power Point, Adobe Reader, Computer Programming-Algorithm & Flowchart, Introduction to 'C' Language, History, Input & Output Statements, Variables & Constants, Expressions & Operators, Control Statements, Branching Statements (if, if-else, Nested if), Looping Statements (while, do-while, for), Functions & Arrays, Internet Concepts & Search Engine, Application of statistical packages.

Practical

Demo session on computer & its components, I/O devices, Memory, CPU, MS DOS-Internal DOS Command- md, cd, dir, time, del, type, edit, copy, exit, path, prompt, rem, ren,ver. External DOS Commands- attrib, backup, chkdsk, diskcomp, diskcopy, doskey, format, label, xcopy,

move, tree, undelete, Windows- Login, Desktop, Icons & Folders, Taskbar, Changing Desktop properties, My computer, My Network places, Recycle bin, My Documents, Control panel, Application Software- MS Word- Getting familiar with various tool bars. Tables and Columns, Mail merge. MS Excel- Working with Spreadsheets, Mathematical & Statistical functions, Generating Charts, Creating Macros. MS Access- database table, forms, reports MS Power Point- Designing slides, Adding animation tools to slides, C programming- Programs illustrating use of print f () and scan f () statements, practicing with decision making statements like IF, IF-ELSE, Nested IF,ELSE-IF, Ladder, Switch, Goto, Working with loops, Illustration of Arrays, Designing programs to demonstrate concept of functions, Internet- Website, website, browser, URL, Surfing, Searching, creating mail accounts. A glance over statistical packages like SPSS, MATLAB etc.

Suggested Readings

- Dixit, J. B. 2006. Fundamentals of Computers & programming in C, Laxmi Publications (P) Ltd.
- Kanetikar, Y. 2016. Let us C, BPH Publications.
- Balaguruswamy, E. 1992. ANSI C, TMH.

Theory

Sl. No	Topic	No of Lecture(s)
1	Information Concepts	2
2	Data and Information	2
3	Information System: Application, Elements, types	1
4	Computers basics- Definition, Characteristics & Application of Computers	1
5	Computer Hardware: I/O devices, Memory, CPU	1
6	Software Concepts	2
7	Operating System- DOS	2
8	Windows	2
9	Application Software - MS Word, MS Excel, MS Access, MS Power Point, Adobe Reader	3
10	Computer Programming-Algorithm & Flowchart	2
11	Introduction to ‘C’ Language , History	2
12	Input & Output Statements	1
13	Variables & Constants	1
14	Expressions & Operators	1
15	Control Statements	1

16	Branching Statements (if, if-else, Nested if)	1
17	Looping Statements (while, do-while, for)	1
18	Functions & Arrays	2
19	Internet Concepts & Search Engine	2
20	Application of statistical packages	2
	Total	32

Practical

Sl. No	**Topic**	**No of Practical(s)**
1	Demo session on computer & its components, I/O devices, Memory, CPU	2
2	MS DOS: Internal DOS Command- md, cd, dir, time, del, type, edit, copy, exit, path, prompt, rem, renver	2
3	External DOS Commands- attrib, backup, chkdsk, diskcomp, diskcopy, doskey, format, label, xcopy, move, tree, undelete	2
4	Windows- Login, Desktop, Icons & Folders, Taskbar, Changing Desktop properties, My computer,	2
5	My Network places, Recycle bin, My Documents, Control panel	2
6	Application Software- MS Word- Getting familiar with various tool bars, Tables and Columns, Mail merge	1
7	MS Excel: Working with Spreadsheets, Mathematical & Statistical functions, Generating Charts, Creating Macros	1
8	MS Access: database table, forms, reports	1
9	MS Power Point: Designing slides, Adding animation tools to slides	1
	C programming- Programs illustrating use of print f () and scan f () statements, practicing with decision making statements like IF, IF-ELSE, Nested IF,ELSE-IF, Ladder, Switch, Goto	2
10	Working with loops, Illustration of Arrays, Designing programs to demonstrate concept of functions	2
11	Internet: Website, website, browser, URL, Surfing, Searching, creating mail accounts	1
12	A glance over statistical packages like SPSS, MATLAB etc	1
	Total	16

NON-CREDIT COURSE CONTENTS

Course Title : Library and Information Services

Course Code : PGS- 501

Credit Hours : 0+1

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services, Role of libraries in education, research and technology transfer; Classification systems and organization of library, Sources of information- Primary Sources, Secondary Sources and Tertiary Sources, Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.), Tracing information from reference sources, Literature survey, Citation techniques/ Preparation of bibliography, Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services, Use of Internet including search engines and its resources, e-resources access methods.

Practical

Sl. No	Topic	No of Practical(s)
1	Introduction to library and its services	1
2	Role of libraries in education, research and technology transfer	1
3	Classification systems and organization of library	1
4	Sources of information- Primary Sources, Secondary Sources and Tertiary Sources	2
5	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.)	3
6	Tracing information from reference sources	1
7	Literature survey	1
8	Citation techniques/ Preparation of bibliography	1
9	Use of CD-ROM Databases	1
	Online Public Access Catalogue and other computerized library	2

	services	
10	Use of Internet including search engines and its resources	1
11	e-resources access methods	1
	Total	16

Course Title : Technical Writing and Communication Skills

Course Code : PGS- 502

Credit Hours : 0+1

Objective

To equip the students/scholars with skills to write dissertations, research papers etc. To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing- Various forms of scientific writings, thesis, technical papers, reviews, manuals, etc., Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion), Writing of abstracts, summaries, precise, citations etc., commonly used abbreviations in the thesis and research communications, illustrations, photographs and drawings with suitable captions, pagination, numbering of tables and illustrations, writing of numbers and dates in scientific write-ups, Editing and Proof-reading, Writing of a review article.

Communication Skills- Grammar (Tenses, parts of speech, clauses, punctuation marks), Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription, Accentual pattern, Weak forms in connected speech, Participation in group discussion, Facing an interview, presentation of scientific papers.

Suggested Readings

- Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
- Collins, H. 1995. Collins' Cobuild English Dictionary
- Gordon, H.M and Walter, J.A. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Hornby, A.S. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
- James, H.S. 1994. Handbook for Technical Writing. NTC Business Books.
- Joseph, G. 2000. MLA Handbook for writers of Research Papers. 5th Ed. Affiliated East-West Press.
- Mohan, K. 2005. Speaking English Effectively. MacMillan India.

- Richard, W.S. 1969. Technical Writing. Barnes & Noble.
- Robert, C. (Ed.). 2005. Spoken English, Flourish Your Language.
- Sethi, J. and Dhamija, P.V. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
- Wren, P.C and Martin, H. 2006. High School English Grammar and Composition. S. Chand & Co.

Practical

Sl. No	Topic	No of Practical(s)
1	Technical Writing- Various forms of scientific writings thesis, technical papers, reviews, manuals, etc	3
2	Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion)	3
3	Writing of abstracts, summaries, precise, citations etc	1
4	commonly used abbreviations in the thesis and research communications	1
5	illustrations, photographs and drawings with suitable captions, pagination, numbering of tables and illustrations, writing of numbers and dates in scientific write-ups	1
6	Editing and Proof-reading, Writing of a review article	1
7	Communication Skills- Grammar (Tenses, parts of speech, clauses, punctuation marks	2
8	Concord, Collocation, Phonetic symbols and transcription, Accentual pattern	1
9	Weak forms in connected speech, Participation in group discussion	2
	Facing an interview, presentation of scientific papers	2
	Total	16

Course Title : Intellectual Property & Its Management in Agriculture

Course Code : AEAB-503

Credit Hours : 0+1

Objective

The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Practical

Historical perspectives and need for the introduction of Intellectual Property Right regime, TRIPs and various provisions in TRIPs Agreement, Intellectual Property and Intellectual Property Rights (IPR). Benefits of securing IPRs, Indian Legislations for the protection of various types of intellectual properties, Fundamentals of patents, copyrights geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection, Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection, National Biodiversity protection initiatives, convention on Biological Diversity, International Treaty on Plant Genetic Resources for Food and Agriculture, Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

- Erbisch, F.H. and Maredia, K. 1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli, P. 2001. Intellectual Property Rights; Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights; Key to New Wealth Generation. 2001. NRDC& Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild, M. and Scott, N. (Ed.) 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha, R. (Ed). 2006. Intellectual Property Rights in NAM and other Developing Countries- A Compendium on Law and Policies. Daya Publ. House.
- The Indian Acts- Patents Act, 1970 and amendments, Design Act, 2000, Trademarks Act, 1999, The Copyright Act, 1957 and amendments, Layout Design Act, 2000, PPV and FR Act 2001, and Rules 2003, National Biological Diversity Act, 2003.

Practical

Sl. No	Topic	No of Practical(s)
1	Historical perspectives and need for the introduction of Intellectual Property Right regime	1
2	TRIPs and various provisions in TRIPs Agreement	2
3	Intellectual Property and Intellectual Property Rights (IPR)	1
4	Benefits of securing IPRs	1
5	Indian Legislations for the protection of various types of intellectual properties	1
6	Fundamentals of patents, copyrights geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection	2
7	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection	2
8	National Biodiversity protection initiatives, convention on Biological Diversity	1
9	International Treaty on Plant Genetic Resources for Food and Agriculture	1
10	Licensing of technologies, Material transfer agreements	2
11	Research collaboration Agreement, License Agreement	2
	Total	16

Course Title : Basic Concepts in Laboratory Techniques

Course Code : SAF-515

Credit Hours : 0+1

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Safety measures while in Lab, Handling of chemical substances, Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes washing, drying and sterilization of glassware, Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution, Handling techniques of solutions, Use and handling of

microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-wave, incubators, sand-bath, water-bath. Preparation of media and method of sterilization. Seed viability testing, testing of pollen viability. Tissue culture of plants and trees. Description of flowering plants in relation to utilization of different parts. Study about Haga altimeter, Ravi altimeter, Bark gauge, Preservation and seasoning unit, Caliper, Oven, and their application.

Suggested Readings

- Furr, A.K. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
- Gabb, M.H. and Latchem, W.E. 1968. A Handbook of Laboratory Solutions. Chemical Publ Co.

Practical

Sl. No	Topic	No of Practical(s)
1	Safety measures while in Lab, Handling of chemical substances, Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes washing, drying and sterilization of glassware, Drying of solvents/chemicals	02
2	Weighing and preparation of solutions of different strengths and their dilution, Handling techniques of solutions	02
3	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-wave, incubators, sand-bath, water-bath	02
4	Preparation of media and method of sterilization	01
5	Seed viability testing, testing of pollen viability	01
6	Tissue culture of plants and trees	02
7	Description of flowering plants in relation to utilization of different parts	01
8	Study about Haga altimeter, Ravi altimeter, Bark gauge	02
9	Preservation and seasoning unit, Caliper, Oven, and their application	03
	Total	16

Course Title : Agricultural Research, Research Ethics and Rural Development
Course Code : AEAB-505
Credit Hours : 0+1

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Practical

Unit- I

History of agriculture in brief, Global agricultural research system- need, scope, opportunities, Role in promoting food security, reducing poverty and protecting the environment, National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions, Consultative Group on International Agricultural Research (CGIAR), International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels, International fellowships for scientific mobility.

Unit- II

Research ethics- research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

Unit- III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes- Community Development Programme, Intensive Agricultural District Programme, Special group Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives. Voluntary Agencies/Non-Governmental Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

- Bhalla, G.S. and Singh, G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
- Punia, M.S. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
- Rao, B.S.V. 2007. Rural Development Strategies and Role of Institutions Issues, Innovations and Initiatives. Mittal Pub.
- Singh, K. 1999. Rural Development- Principles, Policies and Management. Sage Pub.

Practical

Sl. No	Topic	No of Practical(s)
1	History of agriculture in brief, Global agricultural research system-need, scope, opportunities, Role in promoting food security, reducing poverty and protecting the environment	2
2	National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions, Consultative Group on International Agricultural Research (CGIAR), International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system	2
3	strengthening capacities at national and regional levels, International fellowships for scientific mobility	1
4	Research ethics- research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics	2
5	Concept and connotations of rural development, rural development policies and strategies	1
6	Rural development programmes- Community Development Programme, Intensive Agricultural District Programme, Special group Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives	3
7	Voluntary Agencies/Non-Governmental Organizations	1
8	Critical evaluation of rural development policies and programmes	2
9	Constraints in implementation of rural policies and programmes	2
	Total	16

FPU-591	**MASTER'S SEMINAR**	**0+1**
FPU-599	**MASTER'S RESEARCH**	**0+30**