Syllabus

For

Four Year Under-Graduate Course

In

Forestry

Semester III, IV, V and VI

[New Curriculum and Credit Framework for Undergraduate Programmes]
Following NEP 2020

With effect from the Academic Session 2024-2025

BANKURA UNIVERSITY

BANKURA, WEST BENGAL

PIN- 722155

Introduction

In line with NEP-2020 and the new Curriculum and Credit Framework for Undergraduate Programmes (CCFUD), the undergraduate Forestry syllabus has been drafted to align with UGC guidelines while offering students the flexibility to shape their educational journey. The revised syllabus is designed to provide a well-rounded understanding of Forestry, blending core concepts with practical techniques, and allowing individual universities to adapt the content according to their specific resources and expertise.

The framework includes a flexible choice-based credit system and emphasizes a multidisciplinary approach, enabling students to tailor their studies to their interests and career goals. This new structure not only supports a broad and adaptable curriculum but also ensures that students gain a robust foundation in both theoretical and practical aspects of Forestry.

The syllabus incorporates contemporary techniques and emerging trends in the field, ensuring that students are well-prepared for current and future challenges. It is designed to equip graduates with essential skills for immediate employment, thereby enhancing job prospects without necessarily requiring further academic pursuits.

Recognizing the diversity in institutional resources and student needs, the syllabus accommodates variations in infrastructure and faculty expertise. It also integrates opportunities for research and internships, providing students with valuable hands-on experience and exposure to real-world applications in Forestry.

A. Program Outcomes:

1. To impart students with practical knowledge and to assist them in becoming well-known forestry professionals.
2. To impart students with awareness for conserving and managing forest resources, as well as protecting wildlife.
3. To develop both quantitative and qualitative methods to analyse resources and solve problems.

4. To develop the design to provide students with the most up-to-date equipment and technology used in the field of forestry.
5. To develop consciousness among students for managing forest resources, incorporate knowledge of fundamental biology, physical science, forest and wildlife ecology, and social science.
6. To develop consciousness among students for information and methods from the fields of geomatics, silviculture, economics, operations, bioproducts, and policy to design and assess alternative approaches for managing forest resources.
7. To develop appropriate concepts, models, and efficient approaches to create and assess forest resource plans that take into account numerous conflicting objectives, from woodlots to landscapes.
8. It will help to establish bonding with forest - dependent community. Thus it will help in community development.

B. Program Specific Outcomes:

1. To impart knowledge about forestry techniques from antiquity to the present.
2. To disseminate comprehensive practical knowledge of technique of growing forest tress.
3. To provide thorough knowledge about agricultural related industries.
4. To develop knowledge consciousness for geomatics, silviculture, economics, bioproducts, and policy to design and assess alternative approaches for managing forest resources.
5. Detailed knowledge about forest policies and management of forests.

Course Structure- 2024-25

Semester-Wise courses in Four Years B. Sc. (Honours) in Forestry

Semester I (20 Credit Hours)

Sl. No.	Course Code	Course	Credit		Marks			Total Marks	Teaching Hours/Week		
			Theory	Practical	End Semester Exam		Internal Marks		Lec.	Tu.	Pr.
					Theory	Practical					
1	S/FST/101/MJC-1	Introduction to Forestry and Agroforestry	3	1	25	15	10	50	3	NA	2
2	S/FST/102/MN-1 (For students of other discipline)	Introduction to Forestry	3	1	25	15	10	50	3	NA	2
3	S/FST/103/MD-1 (For students of other discipline)	Apiculture	1	2	25	15	10	50	1	NA	4
4	S/FST/104/SEC-1	Tree Seed, Nursery and Plantation Management	2	1	25	15	10	50	2	NA	2
5	ACS/105/AEC-1	Compulsory English: Literature and Communication	2	0	40	0	10	50	2	NA	NA
6	ACS/106/VAC-1	Environmental Studies	4	0	40	0	10	50	4	NA	NA
		Total	15	5	**180**	**60**	**60**	**300**	**15**	**0**	**10**

Semester II (20 Credit Hours)

Sl. No.	Course Code	Course	Credit		Marks			Total Marks	Teaching Hours/Week		
			Theory	Practical	End Semester Exam		Internal Marks		Lec.	Tu.	Pr.
					Theory	Practical					
1	S/FST/201/MJC-2	Silviculture	3	1	25	15	10	50	3	NA	2
2	S/FST/202/MN-2 (For students of other discipline)	Forest Silviculture and Management	3	1	25	15	10	50	3	NA	2
3	S/FST/203/MD-2 (For students of other discipline)	Forest Seed technology and Nursery Management	2	1	25	15	10	50	2	NA	2
4	S/FST/204/SEC-2	Forest Soil, Nutrient and Degraded Land Management	2	1	25	15	10	50	2	NA	2
5	ACS/205/AEC-2	MIL-1 (Santali or Sanskrit or Bengali)	2	0	40	0	10	50	2	NA	NA
6	ACS/206/VAC-2	Any one of the following : A: Health and Wellness, B: Understanding India: Indian Philosophical Traditions and Value, C: Basics of Indian Constitution, D: Arts and Crafts of Bengal Systems, E:Historical Tourism in West Bengal	4	0	40	0	10	50	4	NA	NA
		Total	16	4	180	60	60	300	16	0	8
*Summer Internship (Compulsory for 1 Year Certificate course)	ACS/207/INT-1 (Additional)		0	4*	0	50	00	50	NA	NA	NA

***1st and 2nd Semester already approved in last year.

Semester III (20 Credit Hours)

Sl. No.	Course Code	Course	Credit		Marks			Total Marks	Teaching Hours/Week		
			Theory	Practical	End Semester Exam		Internal Marks		Lec.	Tu.	Pr.
					Theory	Practical					
1	S/FST/301/MJC-3	Forest Measurements and Inventory	3	1	25	15	10	50	3	NA	2
2	S/FST/302/MJC-4	Forest Plant Biology	3	1	25	15	10	50	3	NA	2
3	S/FST/303/MN-3 (For students of other discipline)	Forest Biometry	4	0	40	0	10	50	4	NA	0
4	S/FST/304/MD-3 (For students of other discipline)	Non Timber Forest Product	3	0	40	0	10	50	3	NA	NA
5	S/FST/305/SEC-3	Forest Survey & Engineering	2	1	25	15	10	50	2	NA	2
6	ACS/306/AEC-3	MIL-2 (Bengali/Sanskrit/Santali)	2	0	40	0	10	50	2	NA	NA
		Total	17	3	195	45	60	300	17		6

Semester IV (22 Credit Hours)

Sl. No.	Course Code	Course	Credit		Marks			Total Marks	Teaching Hours/Week		
			Theory	Practical	End Semester Exam		Internal Marks		Lec.	Tu.	Pr.
					Theory	Practical					
1	S/FST/401/MJC-5	Wood Anatomy and Identification	3	1	25	15	10	50	3	NA	2
2	S/FST/402/MJC-6	Forest Ecology and Management	3	1	25	15	10	50	3	NA	2
3	S/FST/403/MJC-7	Tree Physiology and Biochemistry	3	1	25	15	10	50	3	NA	2
4	S/FST/404/MJC-8	Commercial Forest Products and NTFP	3	1	25	15	10	50	3	NA	2
5	S/FST/405/MN-4 (For students of other discipline)	Ecology & Biodiversity	4	0	40	0	10	50	4	NA	0
6	ACS/406/AEC-4	Compulsory English: Literature, Language and Communication	2	0	40	0	10	50	2	NA	0
		Total	18	4	180	60	60	300	18		8
*Summer Internship (Compulsory for 2 Year diploma course)	ACS/407/INT-2 (Additional)		0	4*	0	50	0	50	0	0	0

Semester V (22 Credit Hours)

Sl. No.	Course Code	Course	Credit		Marks			Total Marks	Teaching Hours/Week		
			Theory	Practical	End Semester Exam		Internal Marks		Lec.	Tu.	Pr.
					Theory	Practical					
1	S/FST/501/MJC-9	Forest Health and Protection	3	1	25	15	10	50	3	NA	2
2	S/FST/502/MJC-10	Wood Science and Technology	3	1	25	15	10	50	3	NA	2
3	S/FST/503/MJC-11	Fundamentals of Forest Genetics & Biotechnology	3	1	25	15	10	50	3	NA	2
4	S/FST/504/MJC-12	Forest Logging and Ergonomics	3	1	25	15	10	50	3	NA	2
5	S/FST/505/MN-5 (For students of other discipline)	Principles and Practices of Agroforestry	4	0	40	0	10	50	4	NA	0
6	ACS/506/INT-3	Internship	0	2	0	40	10	50	0	NA	0
		Total	16	6	140	100	60	300	16		8

Semester VI (20 Credit Hours)

Sl. No.	Course Code	Course	Credit		Marks			Total Marks	Teaching Hours/Week		
			Theory	Practical	End Semester Exam		Internal Marks		Lec.	Tu.	Pr.
					Theory	Practical					
1	S/FST/601/MJC-13	Remote Sensing and GIS	3	1	25	15	10	50	3	NA	2
2	S/FST/602/MJC-14	Forest Resource Management, Laws and Policies	3	1	25	15	10	50	3	NA	2
3	S/FST/603/MJC-15	Wildlife and Rangeland Management	3	1	25	15	10	50	3	NA	2
4	S/FST/604/MJC-16	Tree Improvement	3	1	25	15	10	50	3	NA	2
5	S/FST/605/MN-6 (For students of other discipline)	Forest Protection	4	0	40	0	10	50	4	NA	0
Total			16	4	140	60	50	250	16	NA	8

Course	Major	Minor Stream	Multidisciplinary (MD)	Skill Enhancement Courses (SEC)	Ability Enhancement Courses(AEC)	Value Added Courses	Internship	Research project/ Dissertation	Total Credit
Certificate course	2x4=8	2x4=8	2x3=6	2x3=6	2x2=4	2x4=8	4*	0	40+4
Diploma	8x4=32	4x4-16	3x3=9	3x3=9	4x2=8	2x4=8	4*	0	82+4
UG HONS.	24x4=96	8x4=32	3x3=9	3x3=9	4x2=8	2x4=8	1x2=2	0	164
UG HONS. WITH RESEARCH	21x4=84	8x4=32	3x3=9	3x3=9	4x2=8	2x4=8	1x2=2	12	164

(MJC-Major Course, MN=Minor, MD=Multi Disciplinary, SEC=Skill Enhancement Course, AEC=Ability Enhancement Course, VAC=Value Added Course, INT=Internship, RPD=Research Project/Dissertation)

Summer Internship (Compulsory for 1 Year Certificate course)

Theory:-1Credit =1hour/Week, Practical:-1Credit =2hours/Week

*Students who want to exit after first or second year have to complete one Summer Internship of 4 credits in addition to the 40 credits of First Year and 82 credits after Second Year.

**Honours students not undertaking research will do 3 courses for 12 credits for Major in lieu of a research project/Dissertation and total four courses in Major in VIII semester.

***Honours with Research students will opt any one core course from available courses in Major in VIII semester.

**Honours with Research Students Will Opt Any One Course from Available Four (4) Courses in Major in VIII Semester

UG Honours Total Credit	MJC=24x4=96 MN=8x4=32 MD=3x3=9 SEC=3x3=9 AEC=4x2=8 VAC=2x4=8 INT=1x2=2	164
4 Year Honours with Research Total Credit	MJC=21x4=84 MN=8x4=32 MD=3x3=9 SEC=3x3=9 AEC=4x2=8 VAC=2x4=8 INT=1x2=2 RPD=1x12=12	164

Note: Forestry Syllabus (NEP-2020) under new curriculum and credit framework are prepared at par with the other B. Sc. (Major/Minor/Honours) syllabus of Bankura University but there are some uniqueness in forestry.

1. The students who opt for Forestry (Major) will not be able to change **Major and Minor** in the forthcoming semester.
2. The question pattern is different from other B. Sc. Subject. The patters and number of the questions are enclosed herewith.
3. There is a compulsory internship & District/State forest visit in the specific semester.

Distribution of Marks: For a course of 50 marks, 10 marks allotted for Internal Assessment and 40 marks for End Semester Examination (MJC-Major Course, MN=Minor, MD=Multi Disciplinary, SEC=Skill Enhancement Course)

Examination:

Question pattern: End-Semester Examination				
Sl. No	Questions to be answered	Out of	Marks of each question	Total Marks
For 40 Marks				
1	05	8	1	5×1 = 5
2	05	8	2	5×2 = 10
3	05	8	5	5×5 = 25
For 25 Marks				
1	5	08	1	5×1 = 5
2	5	08	2	5×2 = 10
3	2	05	5	2×5 = 10

Practical Exam Marks Pattern for Credit Course

For 15 Marks

Exam/ Hand Practice/ Laboratory work/Field Work/ Experiment etc.	Note Book/ Record	Viva-Voce	Total
5	5	5	15

For 50 Marks

Internship/Project or Dissertation planning and Report writing/ Study Tour Report etc.	Regularity	Presentation	Viva-Voce	Total
20	10	15	5	50

For 40 Marks

Internship/Project or Dissertation planning and Report writing/ Study Tour Report etc.	Regularity	Presentation	Viva-Voce	Total
20	5	10	5	40

Semester III (20 Credit Hours)

Sl. No.	Course Code	Course	Credit		Marks			Total Marks	Teaching Hours/Week		
			Theory	Practical	End Semester Exam		Internal Marks		Lec.	Tu.	Pr.
					Theory	Practical					
1	S/FST/301/MJC-3	Forest Measurements and Inventory	3	1	25	15	10	50	3	NA	2
2	S/FST/302/MJC-4	Forest Plant Biology	3	1	25	15	10	50	3	NA	2
3	S/FST/303/MN-3 (For students of other discipline)	Forest Biometry	4	0	40	0	10	50	4	NA	0
4	S/FST/304/MD-3 (For students of other discipline)	Non Timber Forest Product	3	0	40	0	10	50	3	NA	NA
5	S/FST/305/SEC-3	Forest Survey & Engineering	2	1	25	15	10	50	2	NA	2
6	ACS/306/AEC-3	MIL-2 (Bengali/Sanskrit/Santali)	2	0	40	0	10	50	2	NA	NA
		Total	17	3	195	45	60	300	17		06

1. S/FST/301/MJC-3: Forest Measurements and Inventory (3+1)

Objective	To impart various methods of measurements on standing, felled trees, crops and determining the volume of trees. To inculcate knowledge on volume table preparation for trees.

Theory	Topic	Lectures/ Hours
Unit I	Forest Mensuration - Definition and objectives - Scales of measurement - Units of measurements - Precision, bias and accuracy aimed and reasons. Diameter and girth measurements - Breast height measurements - instruments used.	**10**
Unit II	Measurement of height - Definitions - Methods of measurement of height - Ocular – non instrumental and instrumental methods. Sources of error in height measurement - Height measurement of leaning trees.	**10**
Unit III	Tree stem form - Metzger's theory - Form factor - Types of form factor - Form height, form quotient - Form class. Area measurement in trees and timber - Cross sectional and basal area. Volume table - Definition - Preparation of volume tables - Graphical, regression equation and alignment chart method. Forest inventory - Sampling techniques and methods - Measurement of crops - Sample plots.	**10**
Unit IV	Volume measurement of standing trees – Volume of felled logs - Branch wood.	**15**

	Increment - CAI & MAI -Increment Percent - Instruments and methods - Increment Borer. Stump analysis - Stem analysis – Increment Boring. Yield tables- definition- Preparation of yield table - Application and use of yield tables - Stand table-definition and use. –Forest Inventory - Point sampling Forest Inventory - Definition-objectives- Kinds of enumeration- Tree assessment techniques	
Practical	Determination of pace length- Measurements of diameter-girth and basal area of trees using Calipers, Tape, Ruler, Penta Prism Tree Caliper etc. Measurement of height using non instrumental method- Measurement of tree height using instrumental methods- Abneys level- Haga altimeter- Relascope- Clinometer- Blumeleiss Hypsometer-Laser Hypsometer- Volume determination of standing and felled trees. Exercise on Stump analysis. Exercise on stem analysis-Annual ring counting using ring borer. Preparation of volume tables- local volume table. Yield Table - preparation and application. Field exercise on Horizontal Field demonstration of various sampling techniques. Visit forest areas for forest enumerations- point sampling- use of wedge prism and Relascope. Field exercise on the determination of site quality.	**30**

Outcome	The students will gain knowledge on tree measurements for assessing the outturn of individual as well as group of trees.

Suggested Readings

- Chaturvedi, A.N and L.S. Khanna. 2011. Forest Mensuration and Biometry (5th edition). Khanna Bandhu. Dehra Dun. 364 pp.
- Forest mensuration: A Handbook for Practitioners. 2006. Forestry Commission Publications. 330 pp.
- Manikandan, K and S.Prabhu. 2014. Indian Forestry. A breakthrough approach to Indian Forest Service. Jain Brothers, New Delhi
- Husch, B., Beers, T.W. and Kershaw, J. J.A. 2002. Forest Mensuration (4th edition). John Wiley & Sons, Nature. 456 pp.
- Laar, V. A. and Akca, A. 2007. Forest Mensuration. Managing Forest Ecosystems. Vol.13. Springer. 384pp.
- West, P.W. 2009. Tree and Forest Measurement (2nd edition). Springer. 192pp.

2. S/FST/302/MJC-4: Forest Plant Biology (3+1)

Objective	To impart fundamental knowledge of botany and the taxonomy of gymnosperms and angiosperms.

Theory	**Topic**	**Lectures/ Hours**

Unit I	Plant classification and systematic. Botanical Nomenclature – ICBN (International code of Botanical Nomenclature) - Rules and Codes of ICBN, Binomial and Polynomials. Systems of classification - Natural, Artificial and Phylogenetic classification. Principles of systematics. Demerits and merits of plant classification as given by Engler and Prantl, Bentham and Hooker. Outline classification Bentham and Hooker.	**10**
Unit II	Morphology as a tool for tree identification - Field characters - Branching pattern, Leaf, Fruit and Bark. Role of reproductive characters - Flower types, floral formulas and floral diagrams. Reproductive morphology of plants with reference to description and identification of reproductive parts - General form of woody trunk and deviations like buttresses, flutes, crooks, etc. Morphology and description of bark of common Indian trees - Types of exfoliation patterns in bark. Methods of Floristic survey and need for botanical explorations.	**10**
Unit III	Herbarium techniques -Collection, processing and preservation of plant material. General study of herbarium, arboretum, Palmetum, Fruticetum, Bambusetum and Xylarium. Origin, geographical distribution, phylogenetic position, taxonomic description and economic importance of the flora of families of Gymnosperms viz., Pinaceae, Taxaceae, Cupressaceae, Cycadaceae, Araucariaceae, Gnetaceae etc.	**10**
Unit IV	Origin, geographical distribution, phylogenetic position, taxonomic description and economic importance of the flora for the families of Angiosperms viz., Magnoliaceae, Rhizophoraceae, Ebenaceae,Caesalpiniaceae, Santalaceae, Mimosaceae, Fabaceae, Meliaceae, Salicaceae, Lauraceae, Apocynaceae, Betulaceae, Moraceae, Euphorbiaceae, Dipterocarpaceae, Bixaceae, Guttiferae (Clusiaceae), Myrtaceae, Rubiaceae, Anacardaceae etc.	**15**
Practical	Morphological description of plant parts with special reference to identification. Study on types of leaves, phyllotaxy and venation, Inflorescence, Bark with suitable examples. Methods of plant collections and herbarium preparation. Laboratory and field identification of important forestry species such as Malvaceae, Ebenaceae, Fabaceae, Meliaceae, Pinaceae, Myrtaceae, Rubiaceae, Sterculiaceae, Bignoniaceae, Combretaceae, Apocynaceae Caesalpiniaceae.	**30**

Outcome	Students will acquire theoretical and practical skills in identifying plant species through morphological identification keys and understanding their economic significance.

Suggested Readings

- Mishra, S.R. (2010). Textbook of Dendrology. Discovery Publishing House Pvt. Ltd.
- Bhatnagar, S.P. and Alok Moitra. 2000. Gymnosperms. New age International (P) Ltd.
- Datta, S.C. 1999. Systematic Botany. New Age International (p) Ltd. Publ. New Delhi, India.
- Dasgupta, S.1998. Systematic Botany for Foresters. Khana Bandhu Publ., New Delhi, India.
- R. Naqshi. 1993. An Introduction to Botanical Nomenclature. Scientific Publishers. Jodhpur.
- Ashok Kumar (2001). Botany in Forestry and Environment. Kumar Media (P) Ltd. Gandhinagar, Gujarat.
- Charles McCann. (1966). 100 Beautiful Trees of India. D. B. Taraporevala Sons & C. Pvt. Ltd. Mumbai. (Available online PDF)
- D. Brandis. Revised by R. D. Jakarti (2010). Indian Trees. Dehradun.
- D. N. Tewari (1992). Tropical Forestry in India. International Book Distributors, Dehradun.
- Eric A. Bourdo Jr. (2001). The Illustrated Books of Trees. A Visual Guide to 250 species. Published by Salamander Books Pvt. Ltd. London. (Available online PDF)
- Father H. Santapau. (1966). Common Trees. (Available online PDF)
- Gurucharan Singh. (2000). Plant Systematics. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- K. C. Sahni. (2000). The Book of Indian Trees. Bombay Natural History Society. Mumbai.
- M. S. Randhawa. (1957). Flowering Trees in India. Sree Saraswati Press Ltd. Kolkatta.
- N. L. Bor (1990). Manual of Indian Forest Botany. Periodical Expert Book Agency. New Delhi.
- PradipKrishnen (2013). Jungle Trees of Central India. Published by Penguin Books India Pvt. Ltd. New Delhi.
- S. K. Jain and R. R. Rao. (1977). Handbook of Field and Herbarium Methods. Today and tomorrow's Printers and Publishers. New Delhi.
- S. N. Pandey and S. P. Mishra. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.
- S. R. Mishra. (2010). Textbook of Dendrology. Discovery Publishing House Pvt. Ltd. New Delhi

3. S/FST/303/MN-3: Forest Biometry (4+0) (For students of other discipline)

Objective	To impart various methods of measurements on standing, felled trees, crops and determining the volume of trees.

	To inculcate knowledge on volume table preparation for trees

Theory	Topic	Lectures/ Hours
Unit I	Forest Mensuration- Definition and objectives- Scales of measurement- Units of measurements- Precision, bias and accuracy.	**10**
Unit II	Diameter and girth measurements- Breast height measurements instruments used- Measurement of height-Definitions- Methods of measurement of height-occular-non instrumental and instrumental methods- Sources of error in height measurements- leaning trees.	**20**
Unit III	Tree stem form-Metzgr's theory –form factor- types of form factor-form height for quotient-form class. Volume measurements of standing trees-logs-branch wood- formulae- involved Definitions - Volume Table, preparation of volume tables-graphical method-regression methods.	**15**
Unit IV	Determination of growth of trees- Increment-CAI & MAI- increment percent-increment borer- Stump analysis- Stem analysis. Measurement of tree crops-objects-crop diameter-crop height-crop age-crop volume.	**15**

Outcome	The students will gain knowledge on tree measurements for assessing the outturn of individual as well as group of trees.

Suggested Readings

- Chaturvedi, A.N and L.S. Khanna. 2011. Forest Mensuration and Biometry (5th edition). Khanna Bandhu. Dehra Dun. 364 pp.
- Forest mensuration: A Handbook for Practitioners. 2006. Forestry Commission Publications. 330 pp.
- Husch, B., Beers, T.W. and Kershaw, J. J.A. 2002. Forest Mensuration (4th edition). John Wiley & Sons, Nature. 456 pp.
- Laar, V. A. and Akca, A. 2007. Forest Mensuration. Managing Forest Ecosystems. Vol.13. Springer.384pp.
- Manikandan, K. and Prabhu, S. 2012. Indian Forestry. Jain Brothers. New Delhi. 590 pp.
- West, P.W. 2009. Tree and Forest Measurement (2nd edition). Springer. 192pp.

4. S/FST/304/MD-3: Non Timber Forest Product (3+0) (For students of other discipline)

Objective	To acquire knowledge on different NTFP's and their role in rural and tribal development

Theory	**Topic**	**Lectures/ Hours**
Unit I	Introduction, management and importance of Non-Timber Forest Products (NTFP) methods of collection, Fodder, canes and bamboos.	**10**
Unit II	Essential Oils, Non – essential oils methods of extraction, storage, uses. Gums and resins – Resins and Oleoresins – classification, methods of extraction, storage, uses. Factors affecting gum formation. Important Gum yielding plants.	**10**
Unit III	Tans - classification and sources of tans, Dyes – classification and sources of dyes. Fibers and flosses. Katha and Cutch- sources, extraction and uses. Beedi leaves - sources, collection and Processing. NTFP resources of West Bengal region.	**10**
Unit IV	Drugs, wild fruits, spices, edible products, poisons, bio- pesticides and other miscellaneous products. Animal products, lac, honey and wax- fish, trophies like tiger, panthers, elephants etc- minor products. Types of markets for timber and non-timber forest produce. Resource quantification techniques and methods for NWFPs. Domestic demand and trade in non-timber forest products. International demand and trade in non-timber forest produce.	**15**

Outcome	The student will gain knowledge about the various wood products, non-wood forest products its utility and marketing.

Suggested Readings

- BS Publications Mishra, T.K., Banerjee, S.K and Pal, D.C. (2004). An Omnibus of Non- Timber Forest Products of India, PrashantGahlot at Valley Offset Printers and Publishers, Dehra Dun.
- FRI [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
- Gray, J. W. 1993. Forest resource systems in developing countries. Food and agricultural organization. Rome. 259p.
- ITTO. [International Tropical Timber Organisation]. 1993. The economic linkages between international trade in tropical timber and sustainable management of tropical forests. London environmental economic centre, International Institute for Environment and Development, London, UK. 330p.

- ITTO. [International Tropical Timber Organisation]. 2012. Annual review and assessment of the world timber situation, Yogyakarta, Indonesia. 182p.
- Krishna murthi T.(1993) Minor forest products of india, Oxford & IBH Publishing Co Pvt. Ltd. Krishna murthi T.(2010) Minor forest products of india(Non- Timber Forest Products), Second edition.
- Kula, E. 1996. The economics of forestry: Modern theory and practice. Timber press, Portland, Oregon. 182p.
- Mehta, T. (1981). A Handbook of Forest Utilization, Periodical Expert Book Agency.
- Nautiyal, S and Kaul, A.K. (2003). Non –Timber Forest Products of India, Jyothi-Publishers and Distributors, Dehra Dun.

5. S/FST/305/SEC-3: Forest Survey & Engineering (2+1)

Objective	Develop the understanding the tool and technique used for area evolution and construction.

Theory	Topic	Lectures/ Hours
Unit I	Forest survey, scope and types of surveying, chain surveying, types and instruments used; Traversing, triangulation, survey stations, base line, check and tie lines; ranging of survey lines; offsets and their types; chain of sloppy grounds, chaining across obstacles; cross staff surveying, Areas of irregularly bounded fields- different methods; Simpson‘s, trapezoidal rule.	**10**
Unit II	Compass surveying, chain and compass traversing, magnetic and true bearing, prismatic compass, local attraction. Computation of interior angles and balancing of closed traverse. Plane table surveying; plane table and its accessories, methods of plane table surveying. Leveling: terms used types of level. Theodolite and its uses.	**10**
Unit III	Contour surveying buildings materials- types, strength and characteristics, site selection for building construction, forest roads- alignment, construction and drainage; retaining walls, breast wall, water ways and culverts; bridges-types, selection of site, simple wooden beam bridge, check dams, spurs, farm ponds, earth dams.	**10**
Practical	Chain surveying, compass traversing; plane table surveying, leveling, calculations of earth work for construction of forest; roads & earth dams; alignment of forest roads; preparation building plans; design of water ways; design of simple wooden beam bridge; design of retaining walls. Design of check dams.	**30**

Outcome	The theoretical and practical knowledge gained in this course will help in adaptation of surveying techniques in forest areas. The studies on roads will give a clear vision of laying out roads, its alignment and also on the various types of crossings as bridges and culverts in forest areas for its adoptability. The course will help on the practical applicability on different materials used for construction.

Suggested Readings

- Kanetkar, T.P.andKulkarni, S.V.(1989). Surveying and levelling. Vidyarthi Griha Prakashan, Pune.
- Masani, N.J.(2006). Forest Engineering –without tears (2ndedition). Natraj Publishers, Dehra Dun.
- Murthy, V.V.N. (1985). Land and water management engineering. Kalyani Publishers, New Delhi.

6. ACS/306/AEC-3: MIL -2 (Bengali, Sanskrit/ Santali) Drawn from University Pool (2+0)

Semester IV (22 Credit Hours)

Sl. No.	Course Code	Course	Credit		Marks			Total Marks	Teaching Hours/Week		
			Theory	Practical	End Semester Exam		Internal Marks		Lec.	Tu.	Pr.
					Theory	Practical					
1	S/FST/401/MJC-5	Wood Anatomy and Identification	3	1	25	15	10	50	3	NA	2
2	S/FST/402/MJC-6	Forest Ecology and Management	3	1	25	15	10	50	3	NA	2
3	S/FST/403/MJC-7	Tree Physiology and Biochemistry	3	1	25	15	10	50	3	NA	2
4	S/FST/404/MJC-8	Commercial Forest Products and NTFP	3	1	25	15	10	50	3	NA	2
5	S/FST/405/MN-4 (For students of other discipline)	Ecology & Biodiversity	4	0	40	0	10	50	4	NA	0
6	ACS/406/AEC-4	Compulsory English: Literature, Language and Communication	2	0	40	0	10	50	2	NA	0
		Total	18	4	180	60	60	300	18		8
*Summer Internship (Compulsory for 2 Year diploma course)	ACS/407/INT-2 (Additional)		0	4*	0	50	0	50	0	0	0

1. S/FST/401/MJC-5: Wood Anatomy and Identification (3+1)

Objective	To develop basic understanding on wood identification, anatomical characterization of both Gymnosperms and Angiosperms, also impart knowledge on Tree growth and its mechanism.

Theory	Topic	Lectures/ Hours
Unit I	Basics and introduction of wood anatomy - Classification of plant kingdom - Gymnosperms versus angiosperms - Kinds of woody plants. The plant body - a tree and its various parts. Meristems -Promeristem, primary meristem, secondary meristem. Simple tissues - Parenchyma, collenchyma, sclerenchyma and the vascular tissues. Parts of the primary body - Typical stems and roots of dicots and monocots. Basic process in tree growth - Vascular cambium – Expansion of cambium layer – Duration of cambial activity – Secondary growth in woody plants.	**15**
Unit II	Mechanism of wood formation - Special reference to typical dicot stem. Ray initials and fusiform initials -Anticlinal and periclinal division. Physiological significance of wood formation. The macroscopic features of wood - Sapwood, heartwood, pith, early wood, late wood, growth rings, dendrochronology, wood rays, Knots, Grain orientation etc - Sapwood versus heart wood – Anatomical differences. Transformation of sapwood to heartwood - Factors affecting transformation.	**10**
Unit III	Prosenchymatous elements, tracheids, vessels, fibers, parenchyma and rays, resin	**10**

	canals, gum canals, latex canals and infiltrants in wood. Three dimensional features of wood - Transverse, tangential and radial surfaces. Elements of wood cell walls. Structure and arrangement of cells - Simple pit and bordered pits. Extractives in wood.	
Unit IV	Comparative anatomy of gymnosperms and angiosperms. Anatomical features of common Indian timbers - Classification into porous and non-porous woods, ring porous and diffuse porous woods. Effect of growth rate on wood properties. Juvenile wood and mature wood. Reaction wood. Bark structure - Composition and functions.	**10**
Practical	Study of primary growth in stems of typical dicots and monocots. Study of wood formation in typical dicot stem. Study of vascular bundles in monocots. Parts of the logs (Woody trunks), and the three distinctive surfaces of wood (I.e. cross, radial and tangential planes). Timber identification and its importance. Procedures for field identification of timbers and examination of wood samples. Study of physical features of wood. Study of gross features of wood. Study of anatomical features of wood, pores or vessels, different types. Study of soft tissue in timbers and their different types distributions. Study of wood rays, and their different types. Study of the non-porous woods, their physical and anatomical description. Anatomical keys and methods to use them. Dichotomous keys, punched card keys and computer aided identification- mention only. Field identification of important timbers of West Bengal.	**30**

Outcome	The students will gain knowledge on wood anatomy, Tree growth and its mechanism of wood formation. Also gain knowledge of anatomical differences on gymnosperms and angiosperms.

Suggested Readings

- Hoadley, B. 2000. Identifying wood-Accurate results with simple tools. Taunton Press, Newtown,
- USA. 223p.Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.
- Rao, R. K. and Juneja, K. B. S. 1992. Field identification of fifty important timbers of India. Indian Council of Forestry Research and Education, New Forest, Dehra Dun. 123p.
- Brown HP (1995) Text Book of Wood Technology, Vol I & II International Books and Periodical supplement service, New Delhi.
- Haygreen, J.G and Bowyer,J.L (1982) Forest Products and Wood Science-An Introduction. The Iowa
- State University press, America P.495

2. S/FST/402/MJC-6: Forest Ecology & Management (3+1)

Objective	➢ Develop basic understanding on ecology and its application in Forest ecology, biodiversity and conservation. ➢ Develop a working knowledge on forest ecosystem, productivity and interaction of

	forest with environment to solve forest based environmental issues. ➢ Be able to apply this knowledge base to unknown situations related to forest ecology.

Theory	Topic	Lectures/ Hours
Unit I	Historical development of ecology as a science. Levels of biological organization. Major forest Ecosystem. Forest environment-major abiotic and biotic components and their interaction, Nutrient cycling, trophic levels, food webs, ecological pyramids and energy flow.	**15**
Unit II	Population ecology - definition, population dynamics and carrying capacity, preparation of life table and its importance in forest management. Community ecology-species interactions, ecological succession, terminology, basic concepts, theories of succession- climax vegetation types, forest management and succession.	**10**
Unit III	Island Biogeography. Autecology of important tree species. Perturbation ecology- Biodiversity and conservation – definition, levels of study, distribution of diversity in life forms, hotspots of biodiversity, measurement of diversity and diversity indices.	**10**
Unit IV	Principles of conservation biology, Ex-situ and In-situ methods of conservation, Genetic and evolutionary principle sin conservation. Biosphere concept. Conservation–efforts in India and worldwide. Sacred groves-concept-uses. Biosphere concept. Conservation – efforts in India and worldwide. – National Biodiversity Authority (NBA) - Salient features of NB Act - Convention on biological diversity (CBD) -Access and benefit sharing (ABS).	**10**
Practical	Study of ecological modifications in plants; Effects of fire on forest ecosystem; Study of population dynamics using model systems; Preparation of life tables; Study of spatial dispersion among plants; Study of Forest composition; Niche analysis; Computation of diversity indices; Measurement of diversity of plants and insects in a nearby forest; Forest productivity estimation methods through harvest, Leaf area, LAI. Study of succession in field and water bodies; Visit to different ecosystems. Recording light transmission in forest relative to open fields. Estimation of growth and productivity of Plantation/site. Field data processing and analysis-Calculation of IVI, Diversity indices Assessment of tree volume and carbon sequestration.	**30**

Outcome	The student will gain knowledge to solve problems related to forest and their ecology, student also develop skills to conserve the ecology and biodiversity.

Suggested Readings

- Odum EP 1983. Basic Ecology. Saunders College Publishing, Philadelphia etc. 613p

- Misra KC 1974. Manual of Plant Ecology. Oxford &IBH Pub Co. New Delhi etc. 491p
- Michael P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Pub. Co. New Delhi, 404p
- Montagnini, Fand Jordan, C.F.2005. Tropical Forest Ecology: The Basisfor Conservation and Management. Springer. 295p.
- Frankel, O.H., Brown, A.H.D., Burdon, J.J. 1995. The Conservation of Plant Biodiversity.
- Cambridge University Press. Cambridge. 299p
- Sagwal, S.S. 1995. Forest Ecology of India. Pioneer Publishers, India.368p

3. S/FST/403/MJC-7: Plant Physiology and Biochemistry (3+1)

Objective	To provide the fundamental knowledge of botany and taxonomy of gymnosperms and angiosperms. To impart basic knowledge on various functions and processes related to production, mineral nutrition, plant growth regulators and environmental stresses with reference to forestry. The course aims to inculcate the knowledge of the Carbohydrate, lipid etc and different plat hormones and their importance.

Theory	Topic	Lectures/ Hours
Unit I	Introduction to plant/tree physiology. Photosynthesis-C3, C4 and CAM plants–Photorespiration- Factors affecting photo synthesis. Respiration-energetic of dark respiration. Plant-water relations, Concept of water potential, ascent of sap and water balance. Stomatal physiology - stomatal conductance – resistance.	**10**
Unit II	Mineral nutrition macro and micro nutrients Arnon‘s criteria of essentiality– deficiency and deficiency symptom of macro and micro elements. Plant growth regulators- Role of hormone in growth regulation and development. Tree structure, Growth and development growth kinetics. Growth regulation and co-ordination- Plant growth analysis Canopy architecture. Forest Biomes. Light interactions models of forest canopies - Sun plants and shade plants shade tolerance. Temperature influence on forest development energy budgets low and high temperature - Physiological adaptations for high temperature chilling injury.	**10**
Unit III	Water stress –Mechanism of drought tolerance and drought resistances-Physiological basis of drought avoidance and tolerance. Water relations of forest trees – Transpiration from-forest canopies– Evapo-transpiration models of forest stands - Water use efficiency of forest stands. Salinity	**15**

	stresses its effects on tree growth. Resistance to salinity. Forest and micro climate. Carbon balance and dry matter production in forest trees - Dry matter production and partitioning – source/sink - . GPP and NPP of forest stands -Carbon cycling - Nutrient dynamics and plant growth –Nutrient cycling of C,N,P,S.	
Unit IV	Chemistry of carbohydrates, lipids, amino acids, proteins nucleic acids – Definition, classification, function and structure.	**10**
Practical	Preparation of different types of solutions, Measurement of plant water potential by different methods, Estimation of chlorophyll, Estimation of stomatal index- Determination of leaf area of plants, Estimation of transpiration, Estimation of photosynthetic efficiency, Growth analysis – LAI, CGR, LAD etc., Identification of macro nutrients and micro nutrients deficiencies, Measurement of stress tolerance parameters in trees – soluble protein, membrane stability index, chlorophyll stability index, pro line content, wax and cuticle thickness, Demonstration of practical applications of PGRs. Observation on tree architecture of important species. Qualitative tests for carbohydrates, Quantitative estimation of reducing sugars by DNS method, Quantitative test for total carbohydrates by Anthronereagent, Qualitative tests for lipids, Determination of Saponification number of oils/fats, Determination of Iodine number of fatty acids, Qualitative tests for proteins/amino acids, Estimation of protein by Lowry's method, Estimation of DNA/RNA, Solution preparation of different pH, and concentrations M, N, p/p, p/m etc.	**30**

Outcome	The student will gain knowledge about the various concepts of tree physiology, Photosynthesis, tree structure, Growth and development etc. The student will gain knowledge about the various types of Carbohydrate, lipid, fat etc and also gain knowledge on different plat hormones and their importance.

Suggested Readings

- Hopkins,W.G. and Huner,N.P.A.(2008)Introduction to plant physiology. Wiley.
- Kramer, P.J. and Kozlowski, T.T. (1979). Physiology of Woody Plants. John Wiley and sons. New York
- Larcher, W. (2003). Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups. Springer Science & Business Media
- Lambert, Chapin, F.S. and Pons, T.L. (1998). Plant Physiological Ecology. Springer Scientific+ usiness Media inc.Newyork.
- Landsberg, J.J (1986). Physiological Ecology of Forest Production. Academic Press Inc., London
- Landsberg, J.J and Gower, S.T (1997). Applications of Physiological Ecology to Forest Management. Academic Press Inc., London.

- Nobel P. S. (2005). Physicochemical and Environmental Plant Physiology. Elsevier Academic Press, Amsterdam
- Salisbury, F. B. and Ross,C. W. (2004) . Plant Physiology. Thomson Asia Ptd, Ltd.Singapore.
- Taiz, L. and Zeiger, E. (2010) 5th edition Plant Physiology. Sinauer Associates, Inc., Massachusetts.
- Conn, E.E. and Stumpf, P.K.(1989). Outlines of Biochemistry, Wiley Eastern Ltd., New Delh
- Mazur, Aand Harrows, B.(1971). Text book of Biochemistry. W.B. Sanders Publications, New Delhi.
- Robert, C.B.(1983). Modern concepts in Biochemistry. Allyn and Bacon Inc. London
- William, H.E. and Daphne, C.E.(2005). Biochemistry and Molecular Biology, Oxford University Press.

4. S/FST/404/MJC-8: Commercial Forest Products and NTFP (3+1)

Objective	To provide basic knowledge about the various wood products and non-wood products To acquire knowledge on different NTFP's and their role in rural and tribal development

Theory	Topic	Lectures/ Hours
Unit I	Uses of wood in different sectors. Growth of wood based industry in India, effect of globalization. Importance of forest based industries in relation to Indian economy. Wood as a source of energy and chemicals, wood as raw material. Description of different forest based industries- paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of wood of lesser known forest species for commercial purposes. Structural uses of Timber – bridges and other super structures. Primary conversion; sawing and veneering. Composite wood; plywood, laminated wood, core board, sandwich board, fibre board, particle board; Cross – Laminated Timber (CLT), Wood Plastic Composites (WPCs), Wood Inorganic Composites (WIC) approach manufacturing process, uses and properties. Introduction to wood modification, its need and scope, chemical modification of wood (acetylation, reaction with isocyanates, acetates, ethers, epoxides etc.).	**15**
Unit II	Adhesives used in manufacture of composite wood. Improved wood; compressed wood, impregnated wood etc.; manufacturing process, uses and properties. Nano technology in wood. Manufacture of rayon and match. Wood carving and handicrafts. Destructive distillation of wood. Saccharification of wood. Production of wood molasses, alcohol and yeast. Biochar, technology, bioenergy concepts – short rotation crops as raw materials.	**5**
Unit III	Introduction, management and importance of Non-Timber Forest Products (NTFP) methods of collection, Fodder, canes and bamboos. Essential Oils, Non – essential oils methods of extraction, storage, uses. Gums and resins – Resins and Oleoresins – classification, methods of extraction, storage,	**20**

	uses. Factors affecting gum formation. Important Gum yielding plants. Tans - classification and sources of tans, Dyes – classification and sources of dyes. Fibers and flosses. Katha and Cutch- sources, extraction and uses. Beedi leaves - sources, collection and Processing. NTFP resources of West Bengal region. Drugs, wild fruits, spices, edible products, poisons, bio-pesticides and other miscellaneous products.	
Unit IV	Animal products, lac, honey and wax- fish, trophies like tiger, panthers, elephants etc- minor products. Types of markets for timber and non-timber forest produce. Resource quantification techniques and methods for NWFPs. Domestic demand and trade in non-timber forest products. International demand and trade in non-timber forest produce.	**5**
Practical	Estimation of specific gravity and calorific value of wood specimens. Maceration techniques and determination of sizes of fibres, vessels etc. Visits to various wood based industries like, plywood, packing case, match, tannins, furniture, saw mills etc. to study the manufacturing process. Visit to saw mill to study veneering and different kinds of sawing. Handicraft manufacturing unit. Visit to wood distillation unit. Visit to nearby industrial plantations. Visit to nearby forests to study important NTFP yielding plants. Study of fodder: grasses and leaves. Study of canes and bamboos and their sources. Study of essential oils and their uses. Study of gums and resins and their collection. Study of plant yielding drugs, spices, wild fruits, poisons and bio- pesticides and their collection from nearby forests. Visit to nearby extraction units. Visits to timber produce and NTFP markets to collect price data and quantity sold and to observe auctions and competitions. Analysis of price and quantitative data of NTFP for examining trend; seasonal, cyclical variations. Development of hypotheses to study the marketing of forest produces. Presentation of results on analysis of price and quantity.	**30**

Outcome	The student will gain knowledge about the various wood products, non-wood forest products its utility, value and their marketing.

Suggested Readings

- Baldwin, R. F. 1981. Plywood manufacturing practices. Revised 2nd Ed. Miller and Freeman Publication, Inc.USA. 388p.
- FRI [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute andcolleges, Dehradun. 941p.
- Hoadley, B. 2000. Understanding Wood: A Craftsman's guide to wood technology. Taunton Press. Newtown,USA. 223p.
- FRI (Forest Research Institute). 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
- Krishnamurthi T. (1993) Minor forest products of India, Oxford & IBH Publishing Co Pvt. Ltd.
- Krishnamurthi T. (2010) Minor forest products of India (Non- Timber Forest Products), Second edition. BS Publications

- Mehta, T. (1981). A Handbook of Forest Utilization, Periodical Expert Book Agency.
- Mishra, T.K., Banerjee, S.K and Pal, D.C. (2004). An Omnibus of Non- Timber Forest Products of
- India, Prashant Gahlot at Valley Offset Printers and Publishers, Dehra Dun.
- Nair, K.K.N. (2000). Manual of Non-Wood Forest Produce Plants of Kerala, Kerala Forest Department, Government of Kerala, Thiruvananthapuram.
- Nautiyal, S and Kaul, A.K. (2003). Non –Timber Forest Products of India, Jyothi- Publishers andDistributors, Dehra Dun.

5. S/FST/405/MN-4: Ecology and Biodiversity (4+0) (For students of other discipline)

Objective	➢ Develop a balanced and broad understanding on forest ecology, biodiversity and conservation. ➢ Develop a working knowledge on forest ecosystem, productivity and interaction of forest with environment to solve forest based environmental issues. ➢ Be able to apply this knowledge base to unknown situations related to forest ecology.

Theory	Topic	Lectures/ Hours
Unit I	Historical development of ecology as a science. Levels of biological organization. Major forest Ecosystem. Forest environment-major a-biotic and biotic component sand their interaction, Nutrient cycling, trophic levels, food webs, ecological pyramids and energy flow.	**15**
Unit II	Population ecology - definition, population dynamics and carrying capacity, preparation of life table and its importance in forest management. Community ecology-species interactions, ecological succession, terminology, basic concepts, theories of succession- climax vegetation types, forest management and succession.	**15**
Unit III	Island Biogeography. Autecology of important tree species. Perturbation ecology- Biodiversity and conservation – definition, levels of study, distribution of diversity in life forms, hotspots of biodiversity, measurement of diversity and diversity indices.	**15**
Unit IV	Principles of conservation biology, Ex-situ and In-situ methods of conservation, Genetic and evolutionary principles in conservation. Biosphere concept. Conservation–efforts in India and worldwide.	**15**

Outcome	The student will gain knowledge to solve problems related to forest and their ecology, student also develop skills to conserve the ecology and biodiversity.

Suggested Readings

- Odum EP 1983. Basic Ecology. Saunders College Publishing, Philadelphia etc. 613p

- Misra KC 1974. Manual of Plant Ecology. Oxford &IBH Pub Co. New Delhi etc. 491p
- Michael P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Pub. Co. New Delhi, 404p
- Montagnini, Fand Jordan, C.F.2005. Tropical Forest Ecology: The Basisfor Conservation and Management. Springer. 295p.
- Frankel, O.H., Brown, A.H.D., Burdon, J.J. 1995. The Conservation of Plant Biodiversity.
- Cambridge University Press. Cambridge. 299p
- Sagwal, S.S. 1995. Forest Ecology of India. Pioneer Publishers, India.368p

6. ACS/406/AEC-4: Compulsory English: Literature, Language and Communication (2+0)

Drawn from University Pool

7. ACS/407/INT-2: Summer Internship (Compulsory for 2 Year Diploma course) (0+4)

Practical	Topic
	The students will have an internship or training. The internship should be preferably arranged outside of the parent institution at any assigned organisation, industry, research institution, project, or with a progressive farmer, agribusiness, related to course etc. After the completion of their internship, the students will have to submit a report of their learning's and also present it in the form of a seminar before faculty members and other students. The assessment will be based on the report or assessment received from the industry or organisation, the report, and the presentation made at the University or college.

Semester V (22 Credit Hours)

Sl. No.	Course Code	Course	Credit		Marks			Total Marks	Teaching Hours/Week		
			Theory	Practical	End Semester Exam		Internal Marks		Lec.	Tu.	Pr.
					Theory	Practical					
1	S/FST/501/MJC-9	Forest Health and Protection	3	1	25	15	10	50	3	NA	2
2	S/FST/502/MJC-10	Wood Science and Technology	3	1	25	15	10	50	3	NA	2
3	S/FST/503/MJC-11	Fundamentals of Forest Genetics & Biotechnology	3	1	25	15	10	50	3	NA	2
4	S/FST/504/MJC-12	Forest Logging and Ergonomics	3	1	25	15	10	50	3	NA	2
5	S/FST/505/MN-5 (For students of other discipline)	Principles and Practices of Agroforestry	4	0	40	0	10	50	4	NA	0
6	ACS/506/INT-3	Internship	0	2	0	40	10	50	0	NA	0
		Total	16	6	140	100	60	300	16		8

1. S/FST/501/MJC-9: Forest Health and Protection (3+1)

Objective	The objective is to create professional knowledge on various disturbances, problems and other Issues to forest and the associated heath and protection.

Theory	Topic	Lectures/ Hours
Unit I	Introduction–Importance of forest protection in Indian Forestry– classification of injurious agencies. Factors that determines the forest protection. Injury to forest due to fires causes and character of forest fires– fire prevention & control measures. Deforestation – Causes of deforestation – Effects of deforestation – Preventive and remedial measures – effect and control of lopping, Encroachment, illegal felling etc. Shifting Cultivation – Causes – Impact - Preventive and remedial measures. Forest weeds, woody climbers, parasites and epiphytes management.	**15**
Unit II	Importance of Forest Pathology, tree disease classification, Principles of tree disease management, Causes and symptoms- losses due to forest tree diseases, root diseases (wilt, root- and butt rot), stem diseases (heart rots, stem blisters, rusts, stem wilt, cankers, pink diseases, gummosis, water blister) and foliar diseases (rust, powdery mildew, leaf spot, leaf and twig blight, abnormal leaf fall, needle blight etc.) Etiology, symptoms, mode of spread, epidemiology and management, including chemical, biological, cultural and silvicultural practices. Nursery diseases and their management. Disease due to physiological causes. Abiotic diseases. IDM (Integrated Disease Management) in forest trees. Major diseases of some economic and valuable trees and their	**15**

	management	
Unit III	Forest Entomology in India. Methods and principles of pest control: Mechanical, physical, silvicultural, legal, biological and chemical. Principles and techniques of Integrated Pest Management in forests. Classification of forest pests: types of damages and symptoms; factors for outbreak of pests. Nature of damage and management: Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest and Plantation forest species. Insect pests of freshly felled trees, finished timbers and their management. Major pests of some economic and valuable trees and their management.	**15**
Practical	Visit to forest areas with fire damages, Studying fire registers as records, studying encroachments and problems caused due to disturbance-visit to illegally felled areas- Visit to fire station, Study and acquaint with machinery used for fire control, identification of weeds, parasites and epiphytes. Observation of symptoms in laboratory and in forests-examination of scrapings-host-parasite relationships-causal organisms of above forest diseases. Examination of cultures of important pathogens. Visit to nurseries and plantations. Insect pests of forest seeds; forest nurseries; standing trees; freshly felled trees and finished products. Survey and identification of invertebrate fauna from forest areas. Methods of isolating soil invertebrate macro and micro fauna. Insecticide sand their formulations, plant protection appliances.	**30**

Outcome	At the end of the course, the students are expected to gain knowledge on forest fire, weeds, and basic concepts of disease& insect- pests of forest such as causal agents, symptoms, host parasite relationship of trees and logs and gain knowledge on management practices.

Suggested Readings

- Agrios, G.N. (1997). Plant Pathology. 4th Edn, Horcourt Asia Pvt. Ltd., Singapore.
- Bakshi, B.K. (1976), Forest Pathology; Principles and Practices in Forestry. Pub. Comptroller of Publications, Delhi. 400p.
- Basher, A.E.S. (1983).Forest Fires and Their Control. Gulab Primlani Amerind Publishing, New
- Boyce, J.S. (1961). Forest Pathology, 3rd edition. McGraw-Hill. New York, New York. 572 pp
- Brown, A.A and Davis, K.P. (1973). Forest Fire Control and Use. McGraw Hill Book Co. New York. Delhi.159p.
- Devasahayam, H.L. and Henry, L.D.C. (2009). Illustrated Plant Pathology- Basic Concepts. New India Publishing Agency
- Elton, C. S. (2000). The Ecology of Invasions by Animals and Plants. University of Chicago

Press.

- Fuller, M. (1991). Forest Fires. Wiley Nature Editions, New York.
- Ghadekar, S.R. (2003) Meteorology. Agromet Publishers, Nagpur
- Hal, R.B. (1990). Principles and Procedure of Range Management. International Book Distributors, Dehra Dun.
- Johnson, A.E and Miyanishi, K. (2001). Forest Fires: Behavior and Ecological Effects. Academic Press.
- Khanna, L.S. (1988). Forest Protection. KhannaBandhu, Dehradun.206p.
- Lenka, D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi
- Luna, R.K. (2007). Principles and Practices of Forest Fire Control. International Book Distributors, Dehradun.466p.
- Mavi, H.S. (1994) Agrometerology. Oxford &IBH, New Delhi
- Mohanan, C. (2011). Macro fungi of Kerala, KFRI, Peechi.p.597
- Negi, S.S. (1999). Handbook of Forest Protection. International Book Distributors.271p.
- Pathak, V.N., Khatri, N.K. and Manish Pathak. (2000). Fundamentals of Plant Pathology. Eds. Agribios (India), Jodpur. 356 p.
- Rao, GSLHVP (2003) Agrometeorology, KAU, Thrissur, Kerala,
- Seemann, J., Chirkov, Y.I., Lomas, J., and Primault, B. (2012) Agrometeorology. Springer Berlin Heidelberg
- Singh, R.S (2002).Introduction Principles of Plant Pathology. Oxford & IBH, New Delhi.
- Varshney, M.C. and Pillai, P.B. (2003) Textbook of Agrometeorology. ICAR, New Delhi.

2. S/FST/502/MJC-10: Wood Science and Technology (3+1)

Objective	It aims to provide opportunity to the students wishing to pursue professional careers in science and technology of wood as natural resource and to make themselves aware about the problems related to wood as basic material to manufacture various useful products. This course also helps in understanding the wood treatment requirement.

Theory	Topic	Lectures/ Hours
Unit I	Wood – Natural defects in wood. Electrical, thermal and acoustic properties of wood. Mechanical properties of wood like tension, compression, bending, shearing, cleavage, hardness, impact resistance, nail and screw holding capacities. Wood water relationship - Hygroscopic nature of wood – Free and bound water – Shrinkage and swelling - Fibre saturation point - Equilibrium moisture content. Moisture content determination.	**15**
Unit II	Durability and treatability of wood – Natural defects and wood deterioration. Wood seasoning; merits, principles, Seasoning of timber – Introduction and history of seasoning in India - purpose and scope - Factors influencing seasoning,	**15**

	Mechanism of drying and types; Selection and preparation of material for seasoning. Air seasoning, kiln seasoning and chemical seasoning. Refractory classes of timbers, kiln schedules; Special seasoning methods, Seasoning defects and their control. Wood bio-deterioration. Classification of timbers based on durability and seasoning behavior.	
Unit III	Wood preservation; Introduction– Development and progress of wood preservation in India - mechanism of wood preservation. Preparation of wood for preservative treatment principles, processes, need, types of wood preservatives (Water soluble, oil based, etc.). General idea about fire retardants and their usage, Durability of timbers. Methods of application of wood preservatives-Non pressure methods-Brushing-Steeping-Hot and cold bath process –Diffusion process-Momentary dip process-Sap displacement method - Boucherie method. Pressure method-Full cell process - Empty cell process-Merits and demerits.	**15**
Practical	Mechanical tests on timber. Static bending, impact bending, compression parallel and perpendicular to the grain, hardness, shear, torsion, nail and screw pulling test, brittleness test and calculation of properties. Estimation of combustibility of wood using bomb calorimeter. Estimation of directional shrinkage and swelling of wood. Familiarization of non-destructive wood testing instruments. Visit to timber depot/saw mill to study the stacking methods and various defects in wood. Determination of moisture content by different methods. Visit to Wood seasoning unit to study the various types of seasoning methods and Safety aspects. Visit to wood preservation unit to study the different methods of application of wood preservatives. Study on the environmental health and safety aspects of wood preservatives. Non pressure and pressure methods of application of preservatives. Seasoning and preservative treatments for important tree species.	**30**

Outcome	The knowledge gained in this course will help the students on the various types of wood and their mechanisms. The course also helps to gain knowledge on treatment of timber and there management which is improving the market value.

Suggested Readings

- Bowyer J. L., Shmulsky, R. and Haygreen, J. G. 2007. Forest products and wood science: A introduction. 5th Ed. Blackwell publishing, Ames, IA. 496p.
- Brown, H. P. 1985. Manual of Indian wood technology. International books and periodicals supply service, New Delhi. 121 p.
- FRI. [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute, Dehradun. 941p.
- Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th Ed. McGraw-Hill.New York, USA: 722p.
- USDA [U.S. Department of Agriculture]. Wood handbook - Wood as an engineered material. 1999.
- U.S. Department of Agriculture, Forest Service. Forest Products Laboratory, Madison, WI. 508p.

3. S/FST/503/MJC-11: Fundamentals of Forest Genetics & Biotechnology (3+1)

Objective	• Develop a balanced and broad understanding of concepts and techniques related to Forest Genetics • Develop a working knowledge on tree breeding strategies. • To impart the art of biotechnology and their applications in forestry for higher productivity and conservation.

Theory	**Topic**	**Lectures/ Hours**
Unit I	Definition of genetics, heredity, inheritance, cytology, cytogenetics; Brief history of developments in genetics and cytogenetics. Mendel's principles of inheritance– segregation–independent assortment. Cell – structure and functions. Cell reproduction – mitosis – meiosis and its significance. Chromosome theory of inheritance. Linkage and crossing over – cytological consequence of crossing over. Chromosomal aberrations-numerical and structural.	**15**
Unit II	Structure of DNA and types and its replication. Chromosomes– its structure and function. Fine structure of gene; Gene expression and their functions.RNA its structure function and types. Gene action–protein synthesis. Mutation, its classification and uses.	**5**
Unit III	Concepts and history of Plant Biotechnology: Scope and importance in tree Improvement: Totipotency and Morphogenesis, Nutritional requirements of in-vitro cultures; Techniques of in- vitrocultures, Micro propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture; Applications and Achievements in tree improvement; Soma clonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production echnology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids.	**15**
Unit IV	Applications in tree improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer– Gene cloning–Direct and indirect method of gene transfer- Transgenic plants. their applications, achievements and bio safety regulations, DNA based markers–RFLP, AFLP, RAPD, SSR, VNTRS, CAPS, SNPs, ESTs and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in tree improvement.	**10**
Practical	Study of fixatives and stains. Preparation of slides showing various stages of mitosis. Preparation of slides showing various stages of meiosis. Working out problems related to monohybrid cross, di-hybrid cross, independent assortment, gene mapping, probability and chi-square, etc. Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis	**30**

	and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Flow chart: Isolation of DNA; Gene transfer techniques, direct methods, direct methods; Confirmation of Genetic transformation; gel- electrophoresis technique.	

Outcome	Basic principles of inheritance and modern concepts of genetics will be exposed to student. The forestry students will gain biotechnological skills for mass multiplication, utilization and conservation of forest genetic resources.

Suggested Readings

- Fletcher, H. and Hickey, I. (2012). Genetics. Garland Science,
- Garner, E. J., Simmons, M. J. and Sunstad, P. D. (2008). Principles of Genetics (8th edn.).
- Wiley India (P.) Ltd., Daryaganj, New Delhi.
- Gupta P. K. (1999). CytogeneticsRastogi Publishers, Meerut
- Strickberger, M.W. (1996). Genetics (3rd edn.). Mac Millan Publishing Co., New Delhi
- Tamarin, R. (2002). Principles of Genetic (7th Ed). Tata McGraw-Hill Education.
- White, T.L., Adams, W.T., and Neale, D.B. (2007). Forest Genetics. CABI
- Bajaj, Y.P.S. (Ed) (1988). Biotechnology in Agriculture and Forestry 2. Crops 1. Springer-Verlag, Berlin.
- Dhawan, V (2012) Applications of Biotechnology in Forestry and Horticulture. Springer US
- Guptha, P.K. (2000). Elements of Biotechnology. Rastogi publications, Meerut.
- Neumann, K.H., Kumar, A., and Sopory, S.K. (2008) Recent Advances in Plant Biotechnology and Its Applications. I. K. International Pvt Ltd
- Punia, M.S. (1998). Plant Biotechnology and Molecular Biology. A laboratory manual. Scientific Publishers, Jodhpur
- Thieman, W.J. and Palladino, M.A. (2009). Introduction to Biotechnology, Second Edition. Pearson Benjamin Cummings, San Fransis

4. S/FST/504/MJC-12: Forest Logging and Ergonomics (3+1)

Objective	The purpose of this course is to provide an understanding about the tools and implements used for logging mechanism, reduced impact during logging, transportation, grading and storage of felled logs.

Theory	Topic	Lectures/ Hours
Unit I	Definition, history, objective, and scope of harvesting, harvesting plan and execution. Location and demarcation of the area for logging and estimation of produce available for extraction – Phases of harvesting. Tools and Implements used in harvesting operation; traditional and improved tools, axes, saws, types of	**15**

	saws, accessory implements, mechanized felling machines and operations. Felling rules, felling season, felling methods, safety rules Work contracts related to felling and removing (Contract system, convener systems) etc.	
Unit II	Conversion, cross cutting, hand and machine sawing, conversion of specialized logs, measurement and description of converted material. Recent trends in timber harvesting. Reduced impact logging (RIL), Concept - scope and objectives – impediments to adoption - difference between reduced impact logging and conventional logging - Criteria and Indicators - operations and ITTO guidelines - Steps beyond reduced impact logging towards Sustaining timber yield (STY) – Recent developments.	**10**
Unit III	Timber logistics; types and means of transport of timber, off and on road transportation; Minor transportation methods carts, dragging, skidding, overhead transport, ropeways, skylines. Major transportation methods, Transport by road and railways. Transport by water; floating, rafting and concept of booms. Grading of timbers - storage and disposal of timber in the depots - Temporary and final storage. Timber Depots; types, layout and management. Protection from plants, animals and insect infestations – Diseases and their prevention. Systems of disposal of timber. Harvesting productivity – Economics of recovery – Cost of production – Constraints and Techniques used in harvest unit.	**15**
Unit IV	Ergonomics: Definition, components and provision of energy. Requirement of energy and rest periods. Effect of heavy work, posture, weather and nutrition. Personal protective equipments, safety helmets, ear and eye protections. Accidents: causes, statistics, safety rules and first aids.	**5**
Practical	Equipments and tools used in harvesting operations, their uses and their maintenance. Instructions regarding maintenance of various records and registers in harvesting operations; Conversion of felled trees into logs, poles, firewood, pulpwood. Visit to local saw mills to study the equipments used and process of conversion. Field exercise on uses of axes (Traditional and improved), saws (Manual and power operated), felling of trees. Field exercise on estimation of felling and conversion waste. Visit to industrial plantation to study the mechanized means of felling and conversion of trees. Measurement of logs, poles and firewood in forests and maintenance of records in relevant registers. Visit to Timber depot to trace the logs delivered from different forest sites. Sorting of logs, poles and firewood in the depots according to species, quality, length and girth classes. Stacking and stock checking of different logs, poles and firewood in the depots so as to confirm that all the converted materials in the forests have reached their destination. Stacking of the lots for display and final disposal; recording of the lots for auction sale. Final disposal of the material. Visit during the auction sale in the government timber depots; Visit to Range Office to understand about transit permits for various types of forest produce. Cost of production of timber harvesting. Preparation of ergonomic check lists. Familiarize thee-auctioning procedure of State Forest Department**.**	**30**

Outcome	Students gain their knowledge on the various types of logging instrument and their mechanisms. The course also helps to gain knowledge on felling and logging procedure which is directly or indirectly improving the physical and mantel problems of forestry workers

Suggested Readings

- Brown, N. C. 2002. Principles and methods of harvesting of timber. Biotech books, Delhi. 430p.
- FRI. [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II.Forest Research Institute and colleges, Dehradun. 941p.
- GFC.[Guyana Forestry Commission]. 2002. Code of practice for timber harvest. 2nd Ed.
- Hakkila, P. 1989. Utilization of residual forest biomass. Springer-verlag, Berlin. 567p.
- Jones, J. T. 1993. A guide to logging aesthetics.Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.
- Mehta, T. 1981. A handbook of forest utilization.IBD Dehradun. 298p.
- Staaf, K.A.G. and Wiksten, N.A. (1984).Tree Harvesting Techniques.MartinusNijhoff/DR W. Junk Publishers, Netherlands.
- Wakermann, A. E. 2002. Harvesting timber crops. Biotech books, Delhi. 433p.

5. S/FST/505/MN-5: Principles and Practices of Agroforestry (4+0)(For students of other discipline)

Objective	To impart knowledge about the basic concepts of Agriculture and agroforestry, the students familiarize about developments in the field of basic agriculture and agroforestry.

Theory	Topic	Lectures/ Hours
Unit I	Overview of the Indian Agriculture – its structure and constraints. Concept of sustainable agriculture and land use management. Paradigm shift in Agriculture development-impacts of green revolution–Agro biodiversity– significance, threat sand conservation strategies.	**15**
Unit II	Agroforestry definition and scope – rising demands of fuel wood, fodder and timber. Social, ecological, and economic reasons for agroforestry. History of agroforestry. Components of Agroforestry -Provisioning and regulator services of agroforestry- Nutrient cycling, Soil improvement, Increased production and productivity, Micro climate amelioration and carbon sequestration.	**15**
Unit III	Tree-crop interaction in agroforestry– Definition, kind of interaction – Positive interactions-complimentarity - compatibility - mutualism, commensalism - Negative interactions – allelopathy and competition- Interaction management - Aboveground and belowground interactions-	**15**

	Manipulation of density, space, crown and roots.	
Unit IV	Tree Management – structure and growth of trees, crown and root architecture, agroforestry practices to minimize negative interaction – coppicing, thinning, pollarding and pruning–crop planning and management–selection of suitable crop–management of nutrients, water and weeds – Classification of agroforestry systems – National Agroforestry Policy 2014—National and International organizations in Agroforestry. Major Agroforestry practices in different agro-ecological zones of India- arid and semi arid regions-agroforestry practices for wasteland reclamation.	**15**

Outcome	The student will gain knowledge about the various concepts, types, and developments in the field of agroforestry.

Suggested Readings

- Michael,P. 1984. Ecological Methodsf or Field and Laboratory Investigations. Tata McGraw-HillPub.Co.New Delhi.
- Kumar, B.M. and Nair, P.K.R (eds). 2011. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. Advances in Agroforestry 8. Springer Science, The Netherlands: 307p
- Nair, P.K.R, Rao MR, and Buck, L.E (eds), 2004. New Vistas in Agroforestry: A Compendium for the 1st World Congress of Agroforestry, Kluwer, Dordrecht, TheNetherlands.
- Nair, P.K.R. 1993. An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Huxley, P.A. 1983 (ed). Plant Research and Agroforestry, ICRAF, Nairobi, Kenya.
- Huxley, P. 1999. Tropical Agroforestry. Wiley: 384p.
- Nair, P.K.R. Agroforestry Systems in the Tropics. Springer. 680p.
- Nair, P.K.R., Kumar, B.M. and Vimala D. N. 2009. Agroforestry as a strategy for carbon sequestration. J. Plant Nutr. Soil Sci. 172: 10–23.
- Pathak P.S. and Ram Newaj (eds.) 2003. Agroforestry: Potentials and Opportunities. Agrobios, Jodhpur.

6. S/FST/506/INT-3: Internship (2+0)

Objective	• An appropriate exposure to applied aspects of forestry • An insight into the various factors which the forests and on which the forester react • To equip the students with adequate knowledge on range administration, forest resources, forest and wildlife management, forest economics, tribal welfare, agroforesty, social forestry, forest protection, etc. • To understand socio-economic and institutional aspects of a village ecosystem • To develop communication skills in "Transfer of Technology" and • To understand agroforestry technologies adopted by local farmers and forestry

	related organizations, Non-Governmental Organization, etc.

Practical	Topic	
	Training attachment in wood based industry/ forest departments/ incubation centers/ KVKs or research Institutes/ NGO/ agribusiness entrepreneur, etc.(Internship with incubation centers/KVKs/University/Colleges- Either project (R & D based, field study based) or entrepreneurship based (incubation/ experiential learning).To familiarize the students with the flora, fauna and other research activities of SAUs, Research institutes, forest industries, govt. and private organization of different parts of India. To expose the students to various national / heritage monuments as part of national integration activity (Duration of study tour not more than 2 weeks).	Duration of Internship As per University Guideline

Semester VI (20 Credit Hours)

Sl. No.	Course Code	Course	Credit		Marks			Total Marks	Teaching Hours/Week		
			Theory	Practical	End Semester Exam		Internal Marks		Lec.	Tu.	Pr.
					Theory	Practical					
1	S/FST/601/MJC-13	Remote Sensing and GIS	3	1	25	15	10	50	3	NA	2
2	S/FST/602/MJC-14	Forest Resource Management, Laws and Policies	3	1	25	15	10	50	3	NA	2
3	S/FST/603/MJC-15	Wildlife and Rangeland Management	3	1	25	15	10	50	3	NA	2
4	S/FST/604/MJC-16	Tree Improvement	3	1	25	15	10	50	3	NA	2
5	S/FST/605/MN-6 (For students of other discipline)	Forest Protection	4	0	40	0	10	50	4	NA	0
Total			16	4	140	60	50	250	16	NA	8

1. S/FST/601/MJC-13: Remote Sensing and GIS (3+1)

Objective	To inculcate students regarding the concept of Remote sensing and GIS tools in forestry sector.

Theory	Topic	Lectures/ Hours
Unit I	Definition, scope, history and development of remote sensing; Electromagnetic radiation (EMR) and electromagnetic spectrum; EMR interaction with atmosphere and earth surface; Types of remote sensing; Principles and applications of optical, thermal & microwave remote sensing; Aerial photographs – types, scale, & resolution; Photo interpretation, Satellite remote sensing - platforms and sensors; Satellite systems. Indian Remote Sensing Programme. Different concepts of RS.	**15**
Unit II	Visual and digital image processing; Application of satellite based remote sensing techniques in forestry - vegetation mapping using satellite imagery; Forest cover monitoring and Forest fire damage assessment; Microwave remote sensing. Studies of different vegetation indices like NDVI. Wild life assessment.	**15**
Unit III	Introduction to GIS - Components of GIS, Hardwares and software's; Differences between GIS and conventional cartography; Spatial and non-spatial data, Integration of attribute data with spatial data. Spatial data - Raster and Vector data. Thematic over lays in GIS- topology building and calculation of area and length etc. Application of GIS in forestry – using imageries and integration with GIS data. Maps-its projection, Topo sheet and Map reading; Global Positioning System (GPS) applications in resource inventory, Global Navigation Satellite System, Galileo, IRNSS.	**15**

Practical	Preparation of base maps, thematic maps; Visual interpretation of satellite imagery; Forest cover mapping and land use mapping; Digital image processing; Introduction to various GIS and RS software; Exercises in viewing, editing, overlay. Visit to the RS and GIS labs. Using of QGIS Software to prepare different maps. Collection of different types of data through GPS.	**30**

Outcome	The students acquiring knowledge on remote sensing & GIS tools and technique, and their application related to forests and its conservation

Suggested Readings

- Campbell, J.B. (2002). Introduction to Remote Sensing-Third edition. Taylor and Francis, London
- Environment System Research Institute, (1999). GIS for Everyone. Redlands, CA:ESRI
- Jackson, M.J. (1992). Integrated Geographical Information Systems. International Journal of Remote Sensing, 13(6-7): 1343-1351
- Joseph, G. (2005). Fundamentals of Remote Sensing-Second edition. Universities Press
- Lillesand, T.M. and Kiefer,W.R.(1994).Remote sensing and Image Interpretation, Fourth edition. John Wiley & Sons, Inc., USA
- Obi Reddy, G.P. and Sarkar, D. (2012). RS and GIS in Digital Terrain Analysis and Soil Landscape Modelling. NBSS & LUP, Nagpur.
- Curran, P.J. 1985. Principles of Remote Sensing, Long man Group Ltd., England

2. S/FST/602/MJC-14: Forest Resource Management, Laws and Policies (3+1)

Objective	To understand the principles and concepts of basic forest management, normal forest, sustainable forest management and to acquire knowledge on methodology of working plan preparation. To impart knowledge on various policies and acts related to forests

Theory	**Topic**	**Lectures/ Hours**
Unit I	Definition, scope, objective and principles of forest management, organization of state forests- sustained yield-definition, principles and limitations. Sustainable forest management-criteria and indicators-Increasing and progressive yields. Silvicultural system in relation to yield	**10**

	regulation.	
Unit II	Rotation -definitions-various types of rotations- length of rotations-choice of type and kind of rotation. Normal forest-definitions basic factors of normality. Factors governing the yield and growth of forest stands-Methods of yield regulation – Yield regulation in regular and irregular forests. Working plan-preparations- objectives and uses-forest maps and their uses. Joint forest management-concept and principles- Modern tools in forest management. Forest management for environment, Soil and water conservation.	**10**
Unit III	Necessity of a Forest policy in a country. National forest policies- scope and importance -Indian judicial system- Legal definitions, application of penal code to forests, general principles of criminal law, legal principles of punishment, criminal procedure code, the law of evidence and the Indian Evidence Act, 1872 as applied to forestry matters. Indian Forest Act, 1927 general provisions, Code of Civil procedure, 1908. Forest (Conservation) Act, 1980.	**15**
Unit IV	Scope and importance of major forest laws of regional, national and international significance. Study of West Bengal forest Act, Law and Rule. Wildlife protection act'1972. Biological Diversity bill 2002-discussion of court verdicts on issues of utmost importance to conservation. National Green Tribunal (NGT) its role in forest protection/conservation	**10**
Practical	Visit to different forest divisions to study the various stand management aspects including thinning, felling and sale of timber. Study forest organizational setup and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Field visit to JFM operational areas. Study the different field exercises for data collection for working plan. Writing new proposal for fire management plan.	**30**

Outcome	The students will gain knowledge on forest management, working plan preparation and sustainable forest management concepts. The students will gain knowledge on policies, acts and criminal procedures related to forests and its conservation

Suggested Readings

- Balakathiresan, S. 1986. Essentials of forest management. Natraj Publishers. Dehradun.
- Negi, S.S. 1988. Forest working plan. B.S.M. Pal Singh, Dehradun
- Ramprakash, 1986. Forest Management. IBD Distributors, Dehradun
- Chaturvedi, A.N. (2011). Forest Policy and Law. KhannaBandhu Publishers, Dehradun.
- Negi, S.S. (1997). Forest Policy and Law, IBD, Dehradun.
- Dutta, R. and Yadav, B. (2012).Supreme Court on Forest Conservation. Universal Law Publishing Co., New Delhi, India
- ErnakulamShetty, B. J. (1985). A Manual of Law for Forest Officers, Sharda Press, Mangalore
- Takwani, C. K. T and Thakker, M. C. (2012). Takwani Criminal Procedure. Lexis Nexis Butter

warths Wadhwa, Nagpur,

3. S/FST/603/MJC-15: Wildlife and Rangeland Management (3+1)

Objective	To develop basic understanding on Reptiles, Aves and Amphibians & their ecology, behavior and the habitat. To develop basic understanding on Wildlife and their habitat this is influencing forest ecosystem. The course aims to improve the knowledge of the Grass, grassland and grazing behavior of animals and their management.

Theory	Topic	Lectures/ Hours
Unit I	Wildlife – Definition - Types - Free living, Captive, domesticated and feral animals. History of Wildlife studies in India; Classification of Indian Mammals, Basic requirements of wildlife – food, water, shelter, space, limiting factors; Food chain, Food web, Ecological pyramids; Wildlife Ecology: Biotic factors, Biological basis of wildlife, Productivity; Effect of light and temperature on animals; Wildlife Habitat: Niche, Territory, Home Range, Territoriality, Edge, Cruising Radius, Carrying Capacity; Animal behavior and adaptation; Habitat Improvement: Food, Water, Shelter improvement, Human wildlife conflict.	**15**
Unit II	Definition, History of wildlife management and conservation in India; values of wildlife. Zoogeographic regions of the world. Major biomes of the world –Biogeographic zones of India. Habitat requirements of animals. Red Data Book and red listing, IUCN revised red list categories. Wildlife census-Sample and total counts-Purpose, techniques. Direct and indirect methods of population estimation. Statistical analysis. Telemetry-transmitters, receivers, analysis of data, visual tagging and marking.	**10**
Unit III	Zoos and safari parks. Captive breeding for conservation. Central Zoo Authority of India. Wildlife (Protection) Act, 1972. Special projects for wildlife conservation- Project Tiger and Musk Deer Project. Introduction and reintroduction of species. Wild Animals Protected areas concept, wildlife sanctuaries and national parks, biosphere reserves, major protected areas of India.	**5**
Unit IV	Definition, scope and importance – cattle and fodder resources of India, grassland types of India and their distribution – ecological status of Indian grasslands – principles of grassland management for maximizing forage yield and quality. Feeding habit and grazing behavior of range animals. Carrying capacity – definition, method of calculation. Establishment and	**15**

	management of grasslands. Storage of fodder – silage and hay – methods of preparation – hay banks, Fodder trees and shrubs, Forest grazing.	
Practical	Exercise on the census methods - direct method, indirect method. Direct and indirect methods of studying food habits of different wildlife. Studying habitat management and manipulation techniques. Wildlife damage and control: Questionnaire survey. Wildlife photography. Field identification of major birds of West Bengal. Bird watching and drawings. Study of feathers, beak and leg types of different groups of birds. Study of the nest and eggs of birds. Different snake identification methods. Snake rescue techniques and release in natural habitat, Snakebite and its management, Study of role of nearby NGOs in Herpetofauna / snake conservation.	**30**

Outcome	The students will gain knowledge on wildlife management and conservation in India. The student also gains practical knowledge on different wildlife population estimation techniques. The students will gain knowledge on wildlife, Indian Mammals, Wildlife Ecology and Basic requirements of wildlife.

Suggested Readings

- Sastry, N.S.R. and C.K. Thomas. 2005. Livestock Production Management, Kalyani Publishers, New Delhi.
- Singh R.V. 1982. Fodder trees of India. Oxford and IBH New Delhi.
- Ward H.M. 1980. Grasses. A handbook for use in the field and laboratory, Scientific Pub., Jodhpur
- Berwick, S.H. and Saharia, V.B. 1995. Wildlife Research and Management. Oxford University Press, New Delhi.
- Dasmann, R.F. 1982. Wildlife Biology. Wiley Eastern Ltd. New Delhi.
- Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA.
- International Zoo Books, Published by New York Zoological Society, New York
- Krebs C & Davis N. 1978. Introduction to behavioral ecology. Oxford University Press
- Mathur R. 1985. Animal Behaviour. Oxford University Press
- Menon V. 2014. Indian Mammals: A field guide. Hachette. 528p.
- Mittermeier, RA Rylands, AB and Wilson DE. 2013. Handbook of the Mammals of the World Volume 3. Lynx Edicions. 952.
- Prater, S.H. (1971). The Book of Indian Animals. Oxford University press, Bombay. 324p.
- Wilson, DE Mittermeier RA. 2009. Handbook of the Mammals of the World- Volume 1. Lynx Edicions. 728.

- Wilson, DE Mittermeier RA. 2011. Handbook of the Mammals of the World- Volume 2. Lynx Edicions. 886.
- International Zoo Books, Published by New York Zoological Society, New York
- Krebs C & Davis N. 1978. Introduction to behavioral ecology. Oxford University Press of Wildlife Management, Justice Home, Allahabad.
- Lever, C. 1985. Naturalised mammals of the world. John Wiley, London
- Mills, L.S. 2013. Conservation of Wildlife Populations Demography, Genetics and Management (Ed.2). Wiley-Blackwell.
- Rajesh, G. 1995. Fundamentals Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA.
- Sawarkar B. Wildlife Management. Wildlife Institute of India. Dehra Dun
- Wildlife Institute of India (2004)Compendium on the notes on the course Captive management of Endangered Species. Wildlife Institute of India. Dehra Dun
- Wodroffe, G. 1981. Wildlife conservation and modern zoo. Saiga Publishing Co., England
- Zoos Print and Zoo Zen, Published by Zoo Outreaches Organization, Coimbatore
- Ali, S. and Ripley, D.S. 1990. A compact Handbook of Birds of Indian subcontinent. Oxford University press, Bombay.
- CT. Kentwood D. Wells. 2007. The Ecology and Behavior of Amphibians. The University of Chicago Press, Chicago.
- Daniel, J C. 2002. The Book of Indian Reptiles. Bombay Natural History Society, Bombay, 141pp.
- Das, I. 2002. A photographic guide to Snakes and other reptiles of India. New Holland Publishers (UK) Ltd.

4. S/FST/604/MJC-16: Tree Improvement (3+1)

Objective	To develop a balanced and broad understanding of concepts and techniques related to tree breeding and tree improvement strategies

Theory	Topic	Lectures/ Hours
Unit I	Tree Breeding – Tree Improvement – History and development –its relation to other disciplines of forestry. Essential of Tree improvement – Tree Breeding – Objectives – Advantages – Disadvantages – Limitations. Important tree breeding program in the Global and India – ICFRE and State Agricultural and Forestry Universities. Introduction – Domestication. World collections – Centre of origin of cultivated species.	**10**
Unit II	Exotic forest species – Advantages – Problems. Reproductive systems – Devices of pollination control – Anthesis – Pollination – Self-pollination and cross pollination – Variation and its uses. Breeding methods – Introduction – Selection - Mass selection - Pure line selection – Plus tree selection – Comparison tree selection. Hybridization – Mutation – Biotechnology based tree breeding. Hybrid – Hybridization – Genetic consequences – Gene character – Relationship -	**20**

	Segregation – Recombination of genes. Hybrid vigour – Heterosis – Luxuriance. Tree hybrids developed in Global and India – Natural hybrids – Definition – Occurrence – Reasons determination of natural hybrids. Hybrids in trees – Crossing in trees – Problems and perspectives – Crossing hybrids and hybrid breakdown – Hybrid nomenclature in trees – Future of hybrids in applied tree improvement.	
Unit III	Mating design – Types – Advantages and disadvantages. Heritability - Genetic gain – Genetic advance. Genetic tests – Provenance test – Seed source evaluation test – Progeny test – Clonal test.	**5**
Unit IV	Experimental design – RBD – Procedure and Protocol – Released tree varieties of regional and national importance. Varietal registration (PPVFRA) – Definition – Breeder's variety – Famer's variety – Traditional variety – Tribal varieties – Essentially derived varieties. Descriptors – development˘ validation. DUS test – Definition, need and importance.	**10**
Practical	Floral biology and phonological observations in some important species. Pollen morphology. Estimation of pollen sterility and viability. Emasculation and hybridization in forest tree species. Different breeding methods–flowchart-observations in provenance trial. Estimation of phenotypic and genotypic coefficient of variation, estimation of genetic advance, heritability and GCA, Exercise in plus tree selection – recording data – design and observation in teak, sal, eucalyptus seed orchard.	**30**

Outcome	The students will gain theoretical and practical knowledge on seed orchard, seed production area, tree selection, hybridization and other tree improvement techniques.

Suggested Readings

- Surendran, C., Sehgal, R.N. and Parmathma, M. (Eds.) (2003). A text book of Forest Tree Breeding. ICAR, New Delhi.
- Wright, J. (2012). Introduction to Forest Genetics. Elsevier.
- Zobel, B. and Talbert, J. (2003). Applied Forest Tree Improvement. Blackburn Press.
- Bruce Zobel and John Talbert.1984.Applied Forest Tree Improvement. John Wiley and Sons, NewYork.pp504
- Parthiban, K.T., N.Krishna Kumar and P.S.Devanand. 2020. Tree Breeding and Improvement – Theory and Technology. Scientific Publishers (India), Jodhpur, India (ISBN No.: 978-93-89412-83-3)
- Allied T.L. White and Adams (2010). Forest Genetics.Bedell P. E. (2007). Tree Breeding for Genetic Improvement of Tropical Tree Species (1st Ed).

4. S/FST/605/MN-16: Forest Protection (4+0) (For students of other discipline)

Objective	Develop the understanding of forest disturbances. Enlighten the management of biotic and a biotic disturbances to forest

Theory	Topic	Lectures/ Hours
Unit I	Introduction–Importance of protection in Indian Forestry–classification of injurious agencies. Injury to forest due to fires, causes and character of forest fires– fire prevention activity– fire suppression – fire fighting equipments – fire control policy and objectives. Fire fighting in other countries. Injury to forest due to man, lopping – cutting for fuel wood – Encroachment-different types, control of encroachment illegal felling of trees-method of control legislation. Forest weeds and weed management, management of woody climbers, parasites and epiphytes.	**20**
Unit II	Importance of Forest Pathology, tree disease classification, Principles of tree disease management, Causes and symptoms- losses due to forest tree diseases, root diseases (wilt, root- and butt rot), stem diseases (heart rots, stem blisters, rusts, stem wilt, cankers, pink diseases, gummosis, water blister) and foliar diseases (rust, powdery mildew, leaf spot, leaf and twig blight, abnormal leaf fall, needle blight etc.) Etiology, symptoms, mode of spread, epidemiology and management, including chemical, biological, cultural and silvicultural practices. Nursery diseases and their management. Disease due to physiological causes. Abiotic diseases.	**20**
Unit III	Forest Entomology in India. Methods and principles of pest control: Mechanical, physical, silvicultural, legal, biological and chemical. Principles and techniques of Integrated Pest Management in forests. Classification of forest pests: types of damages and symptoms; factors for outbreak of pests. Nature of damage and management: Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest and Plantation forest species. Insect pests of freshly felled trees, finished timbers and their management.	**20**

Outcome	At the end of the course, the students are expected to gain knowledge on forest fire, weeds, and basic concepts of forest pathology such as causal agents, symptoms, host parasite relationship of trees and logs and gain knowledge on management practices.

Suggested Readings

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- Johnson, A.E and Miyanishi, K. (2001). Forest Fires: Behavior and Ecological Effects. Academic Press.
- Khanna, L.S. (1988). Forest Protection. KhannaBandhu, Dehradun.206p.
- Lenka, D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi
- Luna, R.K. (2007). Principles and Practices of Forest Fire Control.International Book Distributors, Dehradun.466p.
- Mavi, H.S. (1994) Agrometerology. Oxford &IBH, New Delhi
- Mohanan, C. (2011). Macro fungi of Kerala, KFRI, Peechi.p.597
- Negi, S.S. (1999). Handbook of Forest Protection. International Book Distributors.271p.
- Pathak, V.N., Khatri, N.K. and Manish Pathak. (2000). Fundamentals of Plant Pathology. Eds. Agribios (India), Jodpur. 356 p.
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- Singh, R.S (2002).Introduction Principles of Plant Pathology. Oxford & IBH, New Delhi.
- Varshney, M.C. and Pillai, P.B. (2003) Textbook of Agrometeorology. ICAR, New Delhi.