

# PG Program Committee Recommendations

## POST GRADUATE PROGRAMME

### 1. PG DEGREE NOMENCLATURE

As per 5<sup>th</sup> deans committee, the PG degree nomenclature is made uniform in all colleges as follows:

- M.Sc degree Nomenclature:
1. M.Sc. Forestry (Silviculture & Agroforestry)
  2. M.Sc. Forestry (Forest Biology & Tree Improvement)
  3. M.Sc. Forestry (Natural Resource Management)
  4. M.Sc. Forestry (Forest Products & Utilization)
  5. M.Sc. Forestry (Wildlife Sciences)

### 2. NUMBER OF SEATS: 24

<b>M.Sc. Forestry(2 Years)</b>		
<b>Sl.No.</b>	<b>Discipline</b>	<b>Seats</b>
1	Silviculture & Agroforestry	6
2	Forest Biology & Tree Improvement	6
3	Natural Resource Management	6
4	Forest Products & Utilization	4
5	Wildlife Sciences	2
<b>Total</b>		<b>24</b>

### 3. ELIGIBILITY FOR ADMISSION:

1. B.Sc. Forestry ( 4 years programme)
2. The applicants who appeared for ICAR- AIEEA-PG entrance examination 2020 are only eligible for admission into F.C.R.I.
3. The candidate must have secured a minimum OGPA of 7.0 out of 10.00 in Bachelor's Degree Programme. However, for SC/ST candidates, minimum OGPA is 6.50.

### 4. SYSTEM OF TEACHING AND EVALUATION

Semester system of instruction and internal/external evaluation will be followed.

### 5. APPLICATION FEE

<b>Masters Degree programme</b>			<b>Application fee (Rs.)</b>
General category			2000
Scheduled	Caste / Scheduled	Tribe	1000

### 6. PROCEDURE FOR APPLYING:

Prescribed application form has to be filled online at the college website [www.F.C.R.I.ts.in](http://www.F.C.R.I.ts.in) By uploading the required documents and paying the application fee online on or before the stipulated time period.

## 7. RESERVATION:

- a) **Reservations for local & non-local candidates: 85% seats are reserved for local candidates and 15 % seats shall be in open category**
- b) **Reservation for SC/ST and BC candidates:** 15%, 6% and 29% of the seats shall be reserved for the candidates belonging to SCs, STs and BCs respectively.
- c) **Reservation for special category candidates:** Seats are reserved as per Govt. norms. (Physically Handicapped-3%; NCC & Sports -0.5%; PAC-2%)
- d) 1/3 seats shall be filled with women candidates

## 6. CRITERIA FOR SELECTION

- a) The selection shall be based on the academic record at Under Graduate level and performance in the entrance test conducted by ICAR through AIEEA PG – 2020 and the weight age shall be in the ratio of **50:50**. Based on the overall merit rank the candidate is allowed to take admission for M.Sc Forestry considering the availability of seat at that merit through a process of counseling.

(i) Candidates will be ranked on the basis of aggregate marks obtained as follows.

ICAR Entrance test.....	50
Academic Merit .....	50
(based on marks / grades obtained for degree examination)	
<b>Total</b>	<b>100</b>

**Note:** In case of a tie, marks in entrance test shall be considered for tie breaking. When still there is a tie the academic merit shall be considered. For further tie breaking date of birth shall be considered and older candidate shall be preferred.

- b) The admission shall be on the basis of Counseling. The merit list of eligible candidates shall be displayed on college website. The counseling will be held at F.C.R.I., Mulugu, Hyderabad on the specified date. Selected candidates shall submit necessary certificates (in original), pay the prescribed fee in full and secure the admission. Failure to do so entails forfeiture of claim for seat. The date of registration will be announced on the counseling day.

## 7. CERTIFICATES/DOCUMENTS NEEDED:

Following documents shall be enclosed to the application. (Candidates are advised to enclose only copies of the certificates):

- ICAR-AIEEA-PG 2020 –Entrance Marks / Rank card

- Memoranda of marks (all years) obtained at the qualifying (B.Sc. level) examination or transcript.
- Provisional/degree certificate of the qualifying examination.
- Social Status Certificates issued by the competent authority, in case of candidates belonging to BC / SC/ STs.
- Certificate regarding achievements in NCC / NSS / Sports & Games
- Date of birth certificate
- Certificate towards physical disability, if any
- Aadhaar Card or Passport or Ration card or voters ID card for identity purpose
- Conduct certificate from the head of the institute last attended.
- Originals of the above certificates should be submitted at the time of admission.

**8.** Candidates who are selected for admission should submit the following certificates/documents in original at the time of admission in addition to the originals of the certificates listed above.

- i. Transfer Certificate from the College/Institution where the candidate last studied;
- ii. Students selected for admission into PG courses shall pay the entire fee at the time of counseling itself.
- iii. Migration certificate in case of selected candidates from other universities

**9.** The candidates who fail to submit provisional/degree certificate of qualifying examination will not be allowed for the counseling.

#### **10. FINANCIAL ASSISTANCE:**

The Institute does not offer any financial assistance to the post-graduate students.

#### **11. GENERAL:**

- a) PG students should not register for any other degree/diploma programme concurrently on regular or part-time basis in any other University/Educational Institution.
- b) Those who joined M.Sc. in F.C.R.I. but could not complete the requirement or withdrawn from M.Sc. courses for not maintaining minimum OGPA and willing to apply again shall appear for Entrance exam conducted by ICAR for that year and seek admission afresh.
- c) All admissions shall be deemed as provisional and subject to further scrutiny. The admission shall be liable for cancellation without notice at any stage during the study

of the students if it is found that this admission is in any way repugnant to the rules/regulations or invalid by reason of incorrect or false information furnished by the applicants or their parents/guardians at the time of admission. Any cancellation of admission shall not exclude penal action under the relevant criminal law. The Institute reserves to itself the right to cancel or vary any of these rules without notice.

d) Hostel accommodation shall be provided.

## **12. FEES:**

The fee structure is given at **Annexure - I**

**Note:** Fees once paid will not be refunded on any account.

## **ANNEXURE - I**

**FEES:** The following fees are payable by the candidates selected for admission into M.Sc. course for the Academic Year 2020-21

## FEE STRUCTURE FOR M.SC. FORESTRY 2020

S.No	FEE PARTICULARS	FCRI (Rs)
<b>Admission Fee</b>		
1.	Admission Fee (at the time of admission)	1500
2.	Identity Card (at the time of admission)	100
3.	Academic Regulation & Course Catalogue (at the time of admission)	250
4.	Thesis Guidelines	200
5.	Alumni Fund (in the final semester of study)	600
6.	Thesis Evaluation Fee (in the final semester of study)	2000
7.	Migration Certificate Fee	250
<b>Sub Total::</b>		<b>4900</b>
<b>Semester Fee</b>		
8.	Tuition Fee (per semester)	8000
9.	Registration Fee (Per semester)	1500
10.	Library Fee (per semester)	1000
11.	Examination Fee (per semester)	2500
12.	Laboratory Fee (per semester)	3500
13.	Hostel Room Rent (per semester / per head)	2500
14.	Sports & Games Fee (per semester)	2000
15.	Hostel Establishment Charges	4800
16.	Medical Fee (per semester)	125
17.	Student activities (per semester)	300
18.	Student welfare Scheme (per semester)	125
19.	Inter College / Inter University Sports, Games & Cultural meet fee (per semester)	600
<b>Sub Total::</b>		<b>26950</b>
<b>Refundable Fee payable at the time of admission</b>		
20.	Library Deposit at the time of Admission	2000
21.	Laboratory Deposit at the time of Admission	3000
22.	Hostel Deposit at the time of Admission	5000
23.	Mess Deposit at the time of Admission	5000
<b>Sub Total</b>		<b>15000</b>
	Seat Cancellation Fee– for General	2000
	for SC / ST / PH	1000

**Note:** The Selected candidates shall pay the entire fee at the time of admission on the day of counseling itself approximately Rs.46,250/- (Rupees Forty Six Thousand Two Hundred and Fifty Only).

Description	FCRI
In 1 <sup>st</sup> Semester (Semester fee+ admission fee)	31250 (excluding deposit of Rs 15000/-)
Only 1 <sup>st</sup> sem fee	26350
2,3, & 4 <sup>th</sup> Semester	26350

**Fee for all the certificates of PG Program from the academic year 2020-21**

<b>S.No</b>	<b>Item</b>	<b>Amount</b>
1	Bonafide studentship certificate	100/-
2	Conduct Certificate	100/-
3	Transfer Certificate	150/-
4	Certificate verification charges	500/-

**Fee for the issue of duplicate certificates of PG Program from the academic year 2020-21**

<b>S.No</b>	<b>Item</b>	<b>Amount</b>
1	Bonafide certificate(duplicate)	250/-
2	Conduct Certificate(duplicate)	300/-
3	Transfer Certificate(duplicate)	200/-

## **PG Course Structure**

As per the approval from the governing board and academic council in 2016, Forest college and Research Institute will start the PG programmes from academic year 2020 onwards.

The M.Sc. Forestry degree will be offered in five disciplines such as Agro-forestry and Silviculture, Forest Biology and Tree Improvement, Forest Resource Management, Forest Products and Utilization and Wildlife Sciences. The institute is well equipped with the needed infrastructure such as classrooms, well equipped laboratories and field labs.

The proposed department-wise course structure and full length syllabus for M.Sc. Forestry 2 year program to be adopted from August 2020 onwards is given below

## 1. DEPARTMENT OF SILVICULTURE & AGROFORESTRY

CODE	COURSE TITLE		CREDITS
<b>A. CORE COURSES (22 credits) (Semester-I)</b>			
MFC 501	SILVICULTURE		2+1
MFC 502	FOREST BIOMETRY		1+1
MFC 503	FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES		2+1
MFC 504	FOREST ECOLOGY AND BIODIVERSITY CONSERVATION		2+1
MFC 505	FOREST RESOURCE MANAGEMENT AND ECONOMICS		1+1
MFC 506	FOREST SOIL FERTILITY AND NUTRIENT MANAGEMENT		2+1
MFC 507	APPLIED TREE IMPROVEMENT		2+1
MFC 508	TREE SEED TECHNOLOGY		2+1
<b>Total Credits</b>			<b>14+8=22</b>
<b>B. SPECIALIZATION COURSES (12 Credits) (Semester-II)</b>			
SAF 511	AGROFORESTRY SYSTEMS		2+1
SAF 512	PLANTATION FORESTRY		2+1
SAF 513	CLIMATE CHANGE AND CONSERVATION SILVICULTURE		2+1
SAF 514	FRUIT PLANTS, TREES & SHRUBS FOR AGROFORESTRY		2+1
SAF 515	MODERN NURSERY TECHNOLOGY		1+1
SAF 516	BIOFERTILIZERS PRODUCTION TECHNOLOGY		1+1
<b>Total Credits</b>			<b>12</b>
<b>C. SUPPORTING COURSES (5 Credits) (Semester-II)</b>			
STA 501	DESIGN OF EXPERIMENTS		1+1
STA 502	REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM		2+1
STA 503	APPLIED STATISTICAL METHODS		1+1
STA 504	COMPUTER APPLICATIONS IN STATISTICS		0+1
<b>Total Credits</b>			<b>5</b>
<b>D.</b>	SAF 591	MASTER'S SEMINAR (Semester-III)	1+0
<b>E.</b>	SAF 599	MASTER'S RESEARCH(Semester-II, III & IV)	0+20
<b>F</b>		NON-CREDIT COURSES (6)	-
<b>G</b>		COMPREHENSIVE EXAMINATION (WRITTEN & ORAL)	-
<b>Total Credits</b>			<b>60</b>

## 2. DEPARTMENT OF TREE BREEDING & IMPROVEMENT

CODE	COURSE TITLE	CREDITS	
<b>A. CORE COURSES (22 credits) (Semester-I)</b>			
MFC 501	SILVICULTURE	2+1	
MFC 502	FOREST BIOMETRY	1+1	
MFC 503	FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES	2+1	
MFC 504	FOREST ECOLOGY AND BIODIVERSITY CONSERVATION	2+1	
MFC 505	FOREST RESOURCE MANAGEMENT AND ECONOMICS	1+1	
MFC 506	FOREST SOIL FERTILITY AND NUTRIENT MANAGEMENT	2+1	
MFC 507	APPLIED TREE IMPROVEMENT	2+1	
MFC 508	TREE SEED TECHNOLOGY	2+1	
<b>Total Credits</b>		<b>14+8=22</b>	
<b>B. SPECIALIZATION COURSES (12 Credits) (Semester-II)</b>			
FBT 511	BREEDING METHODS IN FOREST TREES	2+1	
FBT 512	QUANTITATIVE GENETICS IN FOREST TREE BREEDING	2+1	
FBT 513	PHYSIOLOGY OF WOODY PLANTS	2+1	
FBT 514	REPRODUCTIVE BIOLOGY OF FOREST TREES	2+1	
FBT 515	BIOTECHNOLOGY APPROACHES IN FORESTRY	2+1	
FBT 516	CLONAL FORESTRY	1+1	
FBT 517	TISSUE CULTURE IN FOREST TREES	2+1	
<b>Total Credits</b>		<b>12</b>	
<b>C. SUPPORTING COURSES (5 Credits) (Semester-II)</b>			
STA 501	DESIGN OF EXPERIMENTS	1+1	
STA 502	REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM	2+1	
STA 503	APPLIED STATISTICAL METHODS	1+1	
STA 504	COMPUTER APPLICATIONS IN STATISTICS	0+1	
<b>Total Credits</b>		<b>5</b>	
<b>D</b>	FBT 591	MASTER'S SEMINAR (Semester-III)	1+0
<b>E</b>	FBT 599	MASTER'S RESEARCH (Semester-II, III & IV)	0+20
<b>F</b>		NON-CREDIT COURSES (6)	-
<b>G</b>		COMPREHENSIVE EXAMINATION (WRITTEN & ORAL)	-
<b>Total Credits</b>		<b>60</b>	

### 3. DEPARTMENT OF FOREST PRODUCTS & UTILIZATION

CODE	COURSE TITLE	CREDITS	
<b>A. CORE COURSES (22 credits) (Semester-I)</b>			
MFC 501	SILVICULTURE	2+1	
MFC 502	FOREST BIOMETRY	1+1	
MFC 503	FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES	2+1	
MFC 504	FOREST ECOLOGY AND BIODIVERSITY CONSERVATION	2+1	
MFC 505	FOREST RESOURCE MANAGEMENT AND ECONOMICS	1+1	
MFC 506	FOREST SOIL FERTILITY AND NUTRIENT MANAGEMENT	2+1	
MFC 507	APPLIED TREE IMPROVEMENT	2+1	
MFC 508	TREE SEED TECHNOLOGY	2+1	
<b>Total Credits</b>		<b>14+8=22</b>	
<b>B. SPECIALIZATION COURSES (12 Credits) (Semester-II)</b>			
FPU 511	WOOD IDENTIFICATION TECHNIQUES	0+2	
FPU 512	GENERAL PROPERTIES OF WOOD	1+1	
FPU 513	WOOD SEASONING & PRESERVATION	2+1	
FPU 514	PULP & PAPER TECHNOLOGY	2+1	
FPU 515	WOOD MODIFICATION & COMPOSITE WOOD	2+1	
FPU 516	MEDICINAL CHEMISTRY & PROCESSING OF MEDICINAL & AROMATIC PLANTS	2+1	
<b>Total Credits</b>		<b>12</b>	
<b>C. SUPPORTING COURSES (5 Credits) (Semester-II)</b>			
STA 501	DESIGN OF EXPERIMENTS	1+1	
STA 502	REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM	2+1	
STA 503	APPLIED STATISTICAL METHODS	1+1	
STA 504	COMPUTER APPLICATIONS IN STATISTICS	0+1	
<b>Total Credits</b>		<b>5</b>	
<b>D</b>	FPU 591	MASTER'S SEMINAR (Semester-III)	1+0
<b>E</b>	FPU 599	MASTER'S RESEARCH (Semester-II, III & IV)	0+20
<b>F</b>		NON-CREDIT COURSES (6)	-
<b>G</b>		COMPREHENSIVE EXAMINATION (WRITTEN & ORAL)	-
<b>Total Credits</b>		<b>60</b>	

#### 4. DEPARTMENT OF FOREST RESOURCE MANAGEMENT

CODE	COURSE TITLE	CREDITS	
<b>A. CORE COURSES (22 credits) (Semester-I)</b>			
MFC 501	SILVICULTURE	2+1	
MFC 502	FOREST BIOMETRY	1+1	
MFC 503	FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES	2+1	
MFC 504	FOREST ECOLOGY AND BIODIVERSITY CONSERVATION	2+1	
MFC 505	FOREST RESOURCE MANAGEMENT AND ECONOMICS	1+1	
MFC 506	FOREST SOIL FERTILITY AND NUTRIENT MANAGEMENT	2+1	
MFC 507	APPLIED TREE IMPROVEMENT	2+1	
MFC 508	TREE SEED TECHNOLOGY	2+1	
<b>Total Credits</b>		<b>14+8=22</b>	
<b>B. SPECIALIZATION COURSES (12 Credits) x(Semester-II)</b>			
FRM 511	ECOSYSTEM SERVICES AND ACCOUNTING	1+1	
FRM 512	RESTORATION ECOLOGY	2+0	
FRM 513	MANAGEMENT OF INSECT PESTS AND DISEASES IN PLANTATIONS	2+1	
FRM 514	FOREST MANAGEMENT	2+1	
FRM 515	FORESTS AND PEOPLE	2+0	
FRM 516	FOREST HYDROLOGY	1+1	
FRM 517	FOREST ECOSYSTEM ASSESSMENT AND MANAGEMENT	2+1	
<b>Total Credits</b>		<b>12</b>	
<b>C. SUPPORTING COURSES (5 Credits) (Semester-II)</b>			
STA 501	DESIGN OF EXPERIMENTS	1+1	
STA 502	REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM	2+1	
STA 503	APPLIED STATISTICAL METHODS	1+1	
STA 504	COMPUTER APPLICATIONS IN STATISTICS	0+1	
<b>Total Credits</b>		<b>5</b>	
<b>D</b>	FRM 591	MASTER'S SEMINAR (Semester-III)	1+0
<b>E</b>	FRM 599	MASTER'S RESEARCH(Semester-II, III & IV)	0+20
<b>F</b>		NON-CREDIT COURSES (6)	-
<b>G</b>		COMPREHENSIVE EXAMINATION (WRITTEN & ORAL)	-
<b>Total Credits</b>		<b>60</b>	

## 5. DEPARTMENT OF WILDLIFE SCIENCES

CODE	COURSE TITLE	CREDITS	
<b>A. CORE COURSES (22 credits) (Semester-I)</b>			
MFC 501	SILVICULTURE	2+1	
MFC 502	FOREST BIOMETRY	2+1	
MFC 503	FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES	2+1	
MFC 504	FOREST ECOLOGY AND BIODIVERSITY CONSERVATION	2+1	
MFC 505	FOREST RESOURCE MANAGEMENT AND ECONOMICS	2+1	
MFC 506	FOREST POLICY AND LAWS AND INTERNATIONAL CONVENTIONS	2+0	
MFC 507	TREE IMPROVEMENT	2+1	
MFC 508	FORESTS AND PEOPLE	2+0	
<b>Total Credits</b>		<b>16+6=22</b>	
<b>B. SPECIALIZATION COURSES (12 Credits) (Semester-II)</b>			
WLS 511	FUNDAMENTALS OF CONSERVATION BIOLOGY	2+1	
WLS 512	ADVANCES IN WILDLIFE MANAGEMENT	2+1	
WLS 513	ECOTOURISM - CONCEPTS AND MODERN APPROACHES	2+1	
WLS 514	WILDLIFE AND HABITAT ECOLOGY	2+1	
WLS 515	ETHNO BIOLOGY AND TRIBAL WELFARE	1+1	
<b>Total Credits</b>		<b>12</b>	
<b>C. SUPPORTING COURSES (5 Credits) (Semester-II)</b>			
STA 501	DESIGN OF EXPERIMENTS	1+1	
STA 502	REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM	2+1	
STA 503	APPLIED STATISTICAL METHODS	1+1	
STA 504	COMPUTER APPLICATIONS IN STATISTICS	0+1	
<b>Total Credits</b>		<b>5</b>	
<b>D</b>	WLS 591	MASTER'S SEMINAR (Semester-III)	1+0
<b>E</b>	WLS 599	MASTER'S RESEARCH (Semester-II, III & IV)	0+20
<b>F</b>		NON-CREDIT COURSES (6)	-
<b>G</b>		COMPREHENSIVE EXAMINATION (WRITTEN & ORAL)	-
<b>Total Credits</b>		<b>60</b>	

## F. NON-CREDIT COMPULSORY COURSES

Six courses (PGS 501-PGS 506) are of general nature and are compulsory for Master's programme.

Code	Course Title	Credits
PGS 501	LIBRARY AND INFORMATION SERVICES	0+1
PGS 502	TECHNICAL WRITING AND COMMUNICATIONS SKILLS	0+1
PGS 503 (e-Course)	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1+0
PGS 504	BASIC CONCEPTS IN LABORATORY TECHNIQUES	0+1
PGS 505 (e-Course)	AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES	1+0
PGS 506 (e-Course)	DISASTER MANAGEMENT	1+0

## G. COMPREHENSIVE EXAMINATION (Qualifying Exam)

After completion of all major courses (for M.Sc. students) excluding seminars a qualifying / comprehensive examination comprising of both written and oral components will be conducted. In order to be eligible to appear for the comprehensive / qualifying examination, the student should have secured an OGPA of 6.50.

## H. PATTERN OF EVALUATION OF COURSES

S.No.	Exam Type	Marks
1	Mid-term Examination	30
2	Practical Examination	20
3	Final Semester Examination	50
	<b>Total</b>	<b>100</b>

In order to pass in a course, a PG student should secure a minimum of 50% of marks in both theory and practical in semester final examination.

### (i) Mid Semester Evaluation:

Two mid semesters will be conducted each after 50% of the syllabus is over..

### (ii) Non Credit compulsory courses Evaluation:

The performance in non credit compulsory courses will be evaluated on the basis of attendance which shall not be less than 75%.

There shall be continuous evaluation of students in non credit courses having practical only. It shall contain 50% class work (which includes regular class work, record, observations etc. 25% for assignments (term papers related to practicals and 25% for final examination. A student shall get a minimum of 50% in regular class work and 50% in final examination to be qualified as satisfactory. If he / she fails to get 50% overall it is recorded as unsatisfactory. If a student records Unsatisfactory by securing less than 50% in final examination he / she shall not register the course but shall appear for final examination to get satisfactory performance.

In case of non credit compulsory course, having only theory component, the student shall maintain minimum 75% attendance, the periodical examination carries 30%, assignments / term paper 20% and final examination shall carry 50% weightage. This shall be reduced to 100% and to be graded as satisfactory, the student shall obtain a minimum of 50%, and should have obtained at 50% in final theory examination. If fails to secure a minimum of 50%, he / she shall be awarded unsatisfactory and shall appear for the examination as and when it is conducted and shall get qualified for getting satisfactory grade.

### **(iii) Comprehensive Examination Evaluation**

The written qualifying examination for M.Sc. shall be common and held for all the students majoring in the discipline at the same time. The question paper shall cover all the major courses. It is proposed to obtain the question papers from outside the campus, the detailed lecture outlines in the major courses shall be sent to the external examiner nominated by Dean, F.C.R.I. and the question paper shall be obtained by Dean/controller of examinations.

The pattern of question paper shall consist of part A and part B. In part A, 12 short note questions shall be given, where each question carries 4 marks, out of which student has to attempt 10 questions (approx. 8 minutes per question- 80 minutes). Part B contain 8 questions of 10 marks each, out of which 6 questions to be answered (approx). 15 minutes per question- 90 minutes).

The question paper shall carry questions from all the major courses of M.Sc. In addition, in part B one question shall be of general nature covering the subject. This question shall be compulsory for all the students. In addition, the student shall answer 5 questions, thus totally six questions in part B. A student should get a minimum of 65% in M.Sc. to be eligible to appear for oral qualifying examination. If a student fails to secure a minimum of 65 % he/she is deemed to have failed in written examination and shall appear after three months from the date of announcement of results. If a student fails for the second time also then the decision of Dean shall be final.

## **Minimum Credit Requirements**

<b>S. No.</b>	<b>Subject</b>	<b>Master's programme</b>
1	Major (Core)	22
2	Minor (Specialization)	12
3	Supporting	05
4	Seminar	01
5	Research	20
	<b>Total Credits</b>	<b>60</b>
	Compulsory Non Credit Courses	-
	Comprehensive Examination	-

## **PROPOSED FULL LENGTH SYLLABUS**

### **CORE COURSES**

#### **1. MFC 501**

#### **SILVICULTURE**

**2+1**

#### **Objective**

To provide knowledge about Forest ecosystem concept, stand dynamics- forest succession, productivity and vegetation forms and natural regeneration of tree species.

#### **Theory**

##### **UNIT-I**

Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of world's forest vegetation.

##### **UNIT-II**

Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation & water relationship, mineral nutrients and temperature.

##### **UNIT-III**

Natural regeneration of species and types including uneven aged silviculture. Intermediate treatments.

##### **UNIT-IV**

Site quality and factors affecting it - direct and indirect measures of site quality- site index - stand density- stand density indices - Reineke's stand density index. Crown- competition method - Maximum Crown Area - Crown Competition Factor.

#### **Practicals**

Visit to forest areas to study forest composition, classification, factors of locality, site quality, form and growth of forest trees- study plant succession- study stand density changes on productivity- thinning effects.

#### **Suggested Readings**

- Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH.

- Dwivedi AP. 1993. *A Text Book of Silviculture*. International Book Distributors, Dehradun.
- Khanna LS. 1996. *Principle and Practice of Silviculture*. International Book Distributors.
- Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture- Applied Forest Ecology*. John Wiley & Sons.

## 2. MFC 502

## FOREST BIOMETRY

1+1

### Objective

To develop understanding of students about tree measurements, forest inventory and yield concepts

### Theory

#### UNIT-I

Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands. Preparation of volume & its application, yield and stand tables.

#### UNIT-II

Forest inventory, Sampling methods adopted in forestry, Use of GPS in forest inventory.

#### UNIT-III

Measurement of stand density. Simulation techniques.

#### UNIT-IV

Growth and yield prediction models – their preparation and applications.

### Practical

Calculations of volume of felled as well as standing trees., Volume table preparation., Application of sampling procedures., Handling of GPS., preparation of yield and stand table.

### Suggested Readings

- Chaturvedi AN & Khanna LS. 1994. *Forest Mensuration*. International Book Distributor.
- Ram Parkash 1983. *Forest Surveying*. International Book Distr.
- Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestry*. McGraw-Hill.
- Simmons CE. 1980. *A Manual of Forest Mensuration*. Bishen Singh Mahender Pal Singh, Dehradun.

## 3. MFC 503

## FOREST PRODUCTS – CHEMISTRY AND INDUSTRIES

2+1

### Objective

The course will equip the students regarding wood based industries. How it is affecting the economy of the country such as match and splint, sports and pencil making, besides this

wood extracts resins and gums, katha, tannis and various type of non timber products. Practical will make them aware regarding extracting method of different products of wood.

### **Theory**

#### **UNIT-I**

Importance of forest based industries in relation to Indian economy. Chemistry in relation to forest products.

#### **UNIT-II**

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.

#### **UNIT-III**

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

#### **UNIT-IV**

Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth). Chemical nature and uses of volatile oils, tannins, katha and cutch. Chemical nature and uses of important forest based dyes and pigments.

### **Practical**

Estimation of cell wall contents – Hemicellulose and lignin, Extraction of essential oils, resins, tannins, Acetylation of wood, Visit to nearby forest based industries.

### **Suggested Readings**

- Anonymous. 1981. *Wealth of India*. CSIR.
- Anonymous. 2007. *Year Book of Forest Products*. FAO. Dwivedi AP. 1993. *Forestry in India*. Surya Publ.
- Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
- Krishnamurthy T. *Minor Forest Products of India*. Oxford & IBH.

**4. MFC 504**

**FOREST ECOLOGY AND BIODIVERSITY CONSERVATION**

**2+1**

### **Objective**

To develop understanding of students about ecological aspects of forest, conservation of forest resources & biodiversity, consequences of depleting biodiversity and sustainable use of biodiversity.

## **Theory**

### **UNIT-I**

Advanced topics in forest ecology including forest population, forest community dynamics, forest community structure and analysis, forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity; Hierarchy issues in ecology.

### **UNIT-II**

Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserve). Global warming and forests. Green House Effect and its consequences. Ozone depletion. Conservations laws and acts.

### **UNIT-III**

Forest genetics resources of India: timber and non timber species. Survey exploration and sampling strategies. Documentation and evaluation of forests genetical resources (FGR), *in situ* and *ex situ* conservation of gene resources.

### **UNIT-IV**

Biological diversity and its significance to sustainable use. Handling and storage of FGR. Intellectual property rights. Quarantine laws and FGR exchange.

## **Practical**

Study of forest community structure and its successional status, Estimation of productivity of forest ecosystem, Trip to different regions of the state to study forest vegetation, Collection and preservation of specimen, Methods of vegetation analysis, Measurement of biomass and productivity, Quantification of litter production and decomposition, Visit to national parks, wildlife sanctuaries, botanical gardens and arboreta.

## **Suggested Readings**

- Anonymous 2006. *Report of the National Forest Commission*. Govt. of India. Dhyani SN. 1994. *Wildlife Management*. Rawat Publ.
- Huxley P. 1999. *Tropical Agroforestry*. Blackwell.
- Khan TI & Al-Azmi DN. 1999. *Global Biodiversity Conservation Measures*. Pointer Publ.
- Kimmins JP. 1976. *Forest Ecology*. MacMillan.
- Nautiyal S & Koul AK. 1999. *Forest Biodiversity and its Conservation Practices in India*. Oriental Enterprise.
- Ramakrishnan PS. 1992. *Shifting Agriculture and Sustainable Development*.
- Man and Biosphere Series. The Parthenon Publ. Group.

**Objective**

To develop understanding of students about forest resource management and economics management decisions, natural and environmental resource accounting.

**Theory****UNIT-I**

Application of microeconomics in solving forest resource problems. Emphasis on forest products demand and supply analysis, forest products marketing, forest capital theory.

**UNIT-II**

Inter-regional and international trade in forest products. Impact of economics and physical variables upon forest appraisal and management decisions. Externalities and property rights.

**UNIT-III**

Natural and environmental resource accounting –methods and implications.

**UNIT-IV**

Application of operations research tools in evaluating forest management alternatives in public and private forest planning.

**Practical**

Exercises on estimation of demand and supply functions; biodiversity valuation, valuation of non-marketed forest products. Exercises on financial and economic appraisal of forestry projects. Exercises on marketing of forest products and international trade competitiveness. Computer applications for using programming techniques in evaluating forest management alternatives.

**Suggested Readings**

- FAO 1986. *Guidelines to Practical Project Appraisal*. Natraj Publ.
- Kerr JM, Marothia DK, Singh K, Ramaswamy C & Beritley WR. 1997. *Natural Resource Economics : Theory and Applications in India*. Oxford & IBH.
- Nautiyal JC. 1988. *Forest Economics – Principles and Applications*. Natraj Publications, Dehradun.
- Sharma LC. 1980. *Forest Economics, Planning and Management*.
- International Book Distributors, Dehradun.

**Objective**

To teach basics of soil fertility evaluation, techniques of soil fertility evaluation, plant nutrients, integrated approach of plant nutrition, and environmental quality.

**Theory****UNIT-I**

Historical aspects of soil fertility, essential plant nutrients: criteria of essentiality, classification, functions, deficiency and toxicity symptoms, beneficial elements. Carbon cycle in nature, carbon stocks, sequestration, greenhouse effects, different carbon pools in soil and their role in maintaining soil quality and productivity;

soil organisms and their role in soil fertility.

**UNIT-II**

Transformations and dynamics of major- and micro-nutrients in soils and their availability to plants. Nutrient interactions in soils and plants: Concept, different types of interaction, interaction-among essential plant nutrients, law of minimum and maximum.

**UNIT-III**

Soil fertility evaluation: Different approaches, soil and plant tests, biological tests, hidden hunger, critical nutrient concentration- concept and determination (graphical and statistical procedures), critical nutrient range, diagnosis recommendation and integrated system (DRIS)

**UNIT-IV**

Integrated nutrient management (INM): Concept, objectives and components; organic farming: principles, practice and its impact on soil processes; precision farming: concept and practices.

Organic manures including compost, farmyard manure, green manure and crop residues.

**Practicals**

Soil and plant sampling and processing for chemical analysis; determination of soil pH, total and organic carbon in soil; chemical analysis of soil for total and available nutrients (major and micronutrients); analysis of plants for essential elements (major and micronutrients)

**Suggested-Readings**

- Brady, N.C. and Weil, R.R. 2002. *The Nature and Properties of Soils*. 13th Edition. Pearson Education, New Delhi.
- Epstein, E. and Bloom, A. 2005. *Mineral Nutrition of Plants: Principles and Perspectives*. Second edition. Sinauer Associates

- Fageria, N.K., Baligar, V.C. and Jones, C.A. 1991. *Growth and Mineral Nutrition of Field Crops*.
- Goswami, N.N., Rattan, R.K., Dev, G., Narayanasamy, G., Das, D.K., Sanyal, S.K., Pal, D.K. and Rao, D.L.N. 2009. *Fundamentals of Soil Science*. Second Edition. Indian Society of Soil Science, New Delhi.
- Havlin, J. L., Beaton, J. D., Tisdale, S. L. and Nelson W. L. 2006. *Soil Fertility and Fertilizers*(7thEdn.) Prentice Hall, New Delhi
- Prasad, R. and Power, J.F. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press, Boca Raton.
  - Stevenson, F.J. (Editor) 1982. *Nitrogen in Agricultural Soils*. Soil Science Society of America, Madison, Wisconsin, USA.
  - Stevenson, F.J. 1986. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulfur and micronutrients*. John Wiley and Sons, New York. Sumner, A.M.E. (Editor) 2000. *Handbook of Soil Science*. CRC Press, Boca Raton, USA.

**7. MFC 507**

**APPLIED TREE IMPROVEMENT**

**2+1**

### **Objective**

To acquaint the students about general principles of tree breeding with examples of important trees.

### **Theory**

#### **UNIT-I**

General concept of forest tree breeding, tree improvement and forest genetics. Reproduction in forest trees, dimorphism pollination mechanisms. Pollen dispersion distances, pollinators and their energetics. Attractants for pollinators. Pollen handling forced flowering for seed orchard manipulation. Pollination mechanisms.

#### **UNIT-II**

Variation in trees importance and its causes. Natural variation as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races. Selective breeding methods- mass, family, within family, family plus within family. Plus tree selection for wood quality, disease resistance and agroforestry objectives. Selection strategies and choice of breeding methods and progress in selective breeding in forest trees. Indirect selection for biotic and abiotic stresses.

### **UNIT-III**

Progeny and clone testing. Seed orchards – type, functions and Importance. Estimating genetic parameters and genetic gain. Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples – teak, sal, shisham, eucalypts, acacias, pines and poplars.

### **UNIT-IV**

Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Hardy-weinberg law, null hypothesis, Wohlund's Principle. Biotechnology in tree improvement. Mutation breeding.

### **Practical**

Floral biology, modes of reproduction and modes of pollination in forest trees. Estimating pollen viability. Controlled pollination and pollen handling. Visit to species, provenance and progeny trials. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Visit to seed orchards.

### **Suggested Readings**

- Mandal AK & Gibson GL. (Eds). 1997. *Forest Genetics and Tree Breeding*. CBS.
- Surendran C, Sehgal RN & Paramathma M. 2003. *Text Book of Forest Tree Breeding*. ICAR Publ.
- White JW. 1976. *Introduction to Forest Genetics*. Academic Press.
- Zobel BJ & Talber J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

### **Objective**

To impart knowledge and develop understanding about tree seed development, harvesting, processing, storage, dormancy, germination of tropical, sub-tropical and temperate species, their testing and certification.

## **Theory**

### **UNIT-I**

Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems, limiting factors in tree propagation and afforestation.

### **UNIT-II**

Reproductive biology in seed plants - development and maturation of seed bearing organs and seeds - morphology of fruit and seed - seed dispersal - ecological fruit and seed types - seasonality and periodicity of flowering and fruiting - reproductive age - influence of external factors on seed production. Seed structure and chemical composition – development and maturation – germination – breakdown of storage products – endogenous hormonal regulation – effect of stimulators and inhibitors– dormancy – its causes and breakage specific problems of seeds of woody plants.

### **UNIT-III**

Modes of seed dispersal. Determining optimal harvest maturity indices. Factors influencing choice of collection methods. Methods of seed collection and processing, storage methods – loss of viability during storage. Dormancy and pre-treatment. Germination and seedling establishment and seed testing techniques.

### **UNIT-IV**

Quality seed production technologies - seed certification. Eco-physiological role of seed storage. Classification of seed storage potential. Factors affecting seed longevity. Pre-storage treatment. Physiological change during ageing. Viability and vigor. Storage of orthodox, recalcitrant and pre-storage intermediate seeds, Fumigation and seed treatment.

## **Practical**

Identification of forest seeds. Seed sampling, different storage methods, Seed quality testing-purity, viability and germination, collection and processing of seeds/ fruit. Tests of viability

viz., cutting, hydrogen peroxide, excised embryo, tetrazolium, seed health testing primarily to the presence or absence of disease-caused organisms such as fungi, bacteria, virus and animal pests, recording, calculation and use of results of seed treatment.

### **Suggested Readings**

- Baldwin, H.I. 1942. Forest Tree Seed of the North Temperate Regions. Periodical Experts Book Agency, Delhi.
- Chin, H. F. and Roberts, E. H. 1980. Recalcitrant crop seeds. Tropical Press Sdn. Bhd. Malaysia.
- Hong, T. D. and Ellis, R. H. 1996. A protocol to determine seed storage behaviour. IPGRI Technical Bulletin No. 1. (J. M. M. Engels and J. Toll, vol. Eds.) International Plant Genetic Resources Institute, Rome, Italy.
- Khullar, P. et. al. 1992. Forest seed. ICFRE, New Forest, Dehra Dun.
- Leadem, C.L. 1984. Quick Tests for Tree Seed Viability. B.C. Ministry of Forests and Lands, Canada.
- Schmidt, L. 2000. Guide to handling of tropical and subtropical forest seed.
- DANIDA Forest Seed Centre, Denmark. STA. 1993. International Rules for Seed Testing. International Seed Testing Association, Zurich, Switzerland.
- Willan, R. L. 1985. A guide to forest seed handling. FAO Forestry Paper 20/2, DANIDA Forest Seed Centre, Denmark and FAO, Rome.

## **DEPARTMENT OF SILVICULTURE & AGROFORESTRY**

**SAF 511**

**AGROFORESTRY SYSTEMS**

**2+1**

### **Objective**

To impart knowledge on the concept of agroforestry land use including diagnosis & design methodologies.

### **Theory**

#### **UNIT-I**

Agroforestry objectives, importance, potential and impediments in implementation. Land capability classification and land evaluation.

#### **UNIT-II**

Overview of global agro-forestry systems, shifting cultivation, taungya system,

multiple and mixed cropping, alley cropping, shelter-belts and windbreaks, energy plantations and homestead gardens. Productin potential of different silvi-pasture system.

### **UNIT-III**

Concepts of community forestry and social forestry, linear strip plantations.

### **UNIT-IV**

Diagnosis and Design – Trends in Agroforestry systems research and development.

#### **Practical**

Survey and analysis of land use systems in the adjoining areas. Design and plan of suitable models for improvement.

#### **Suggested Readings**

- Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH. Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer. Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer.
- Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF.
- Thampan PK. 1993 . *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.
- Young A. 1997. *Agroforestry for Soil Management*. CABI.

**SAF 512**

**PLANTATION FORESTRY**

**2+1**

#### **Objective**

To acquaint with various aspects of production, integrated nutrient and irrigation management and ecological factors in raising forest plantations.

#### **Theory**

##### **UNIT-I**

Role of plantation forestry in meeting the wood demand – Plantation forestry in India and abroad, Purpose of plantation, Factors determining scale and rate of plantation, Land suitability and choice of plantation species

##### **UNIT-II**

Production technology for quality planting stock, preliminary site preparation for establishing plantation, Planting programme, time of planting, planting pattern, spacing, plating method.

### **UNIT-III**

Nutritional dynamics and irrigation of plantation, Mechanization in plantation, Protection and after care of plantation, Pruning and thinning of plantation for quality wood production, Rotation in plantation, Failure of plantations, Impact of interaction and integration of plantation forestry, Protective Afforestation, afforestation of inhospitable sites, Ecological factors and long term productivity, Sustainable yield from plantation.

### **UNIT-IV**

Case studies in plantations of Eucalyptus, Casuarina, Poplars, Acacias, Pine, Silver Oak, Gmelina, Teak, Sandal, Bamboo, etc. Wasteland Plantation, Industrial Plantation.

### **Practical**

Analysis of plantation problems in Asia and India – Preparation of plantation calendar – Preliminary arrangement for a plantation programme – Planting geometry and calculation of planting stock – Study of different cultural operations and site preparation for plantation – Studies on wood based industries – Problems and prospects – Management of Eucalyptus, Casuarina, Teak, Sal, Poplar, Acacias and Bamboo plantations – Production technology for energy plantations – INM in plantations – Irrigation and plantations – Economics of pulpwood, timber and energy plantations.

### **Suggested Readings.**

- Dwivedi AP. 1993. *Forestry in India*. Surya Publ.
- Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press, Oxford.
- Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.
- Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.
- Ram Prakash, Chaudhari DC & Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors.

## **SAF 513 CLIMATE CHANGE AND CONSERVATION SILVICULTURE (2+1)**

### **OBJECTIVE**

To understand the climate and its impact and climate change mitigation through forestry options

## **THEORY**

### **UNIT-I: CLIMATE CHANGE SCENARIO**

Climate change during 20<sup>th</sup> century – Understanding climate change – Consequences of climate change – Global warming effects on Forest. Deforestation  
- Global scenario - Impact of climate change.

### **UNIT-II: CLIMATE CHANGE ON BIODIVERSITY AND FOREST DEGRADATION**

Evidence of forest disturbance due to climate change – Climate change and forest biodiversity – Carbon sequestration with forest and land use change – Climate change influence on agroforestry.

### **UNIT-III SILVICULTURE AND SUSTAINABILITY FOR CLIMATE CHANGE**

Silviculture and sustainability-criteria and indicators for sustainable plantation forestry in India-CIFOR guidelines. Silvicultural and stand management strategies for carbon sink maximization and source minimization. Adaptive silviculture for climate change. Impacts of 'No Green Felling' on stand productivity and health. Restoration forestry-silvicultural treatments for habitat restoration, catchment area treatments, enrichment planting

### **UNIT-IV: CLIMATE RESILIENCE AND CONSERVATION SILVICULTURE**

Climate resilience - definition - resilient forestry - concept - practices and models - resilient forestry practices for different land use systems - Silviculture of old growth stands and sacred grooves- their ecological significance and biodiversity values. Carbon sequestration potential of Trees Outside forests (TOFs), home gardens and urban forests. Silvicultural strategies for conservation of disturbed forest and tree species

### **UNIT V: GLOBAL AGREEMENTS AND NATIONAL INITIATIVE FOR CLIMATE CHANGE**

International climate negotiation, UNFCCC, IPCC, CoP :LULUCF, REDD++ and CDM. National action plan for climate change – Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plans on Climate Change.

## **PRACTICAL**

Climate communication- Case studies on important climate change effect on forest- Predicting carbon sequestration potential in trees- Evaluating plantation carbon and soil carbon. Developing carbon sequestration models for plantation and natural forest.

Assessment of invasive species in forest and plantation due to climate change. Estimating un seasonal fire and climate change consequences in forest. Estimation of green house gases - NO<sub>x</sub>, SoX, Co and Co<sub>2</sub> gases. Green house gas on tress. Estimating dust sink potential of trees. Designing urban forestry model for pollution abatement

## **SAF 514                      FRUIT PLANTS, TREES AND SHRUBS FOR AGROFORESTRY    2+1**

### **Objective**

To make students familiar with trees and shrubs (fruit, fodder and small timber) suitable for Agorforestry.

### **Theory**

#### **UNIT-I**

Introduction, importance of woody elements in agro-forestry systems, their role in biomass production. Suitability of species for different purposes. Multipurpose trees in agro-forestry systems. Fodder from trees/shrubs and their nutritive value propagation techniques.

#### **UNIT-II**

Fruits crop and their need and relevance in Agroforestry fruits tree suitable for various assemblage and then planting plan in different agro climatic situation and Agroforestry system. Modification in tending and pruning floor. Fertilit y management, yield and quality improvement.

#### **UNIT-III**

Role of nitrogen fixing trees/ shrubs. Choice of species for various agro climatic zones for the production of timber, fodder, fuel wood, fibre, fruits, medicinal and aromatic plants.

#### **UNIT-IV**

Generic and specific characters of trees and shrubs for Agroforestry. Generic and specific characters of trees and shrubs for agro-forestry.

### **Practical**

Field survey and acquaintance with specialized features of trees, shrubs and fruit species and varieties for Agroforestry. Planting plans including wind breaks. Training and pruning of tree, shrubs and fruit trees for enhancing production in Agroforestry system.

### **Suggested Readings**

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford & IBH. Nair PKR, Rai MR & Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer. Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer. Ong CK & Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF. Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation. Young A. 1997. *Agroforestry for Soil Management*. CABI.

**SAF 515**

**MODERN NURSERY TECHNOLOGY**

**1+1**

### **Objective**

To impart knowledge on modern nursery techniques about types of nursery, vegetative propagation, use of green house, mist chamber and fertilizer use. **Theory**

### **UNIT-I**

Introduction and importance of nursery. Types of nurseries. Bare root, containerized and vegetatively produced nursery.

### **UNIT-II**

Bare root nursery- nursery soil and water management, bed preparation, pre sowing seed treatments, seed sowing and intermediate operations viz., pricking, watering, fertilization, weeding and hoeing. Physiology and nursery environment interaction affecting seedling growth. Root culturing techniques. Lifting windows, grading, packaging and storing and out- planting.

### **UNIT-III**

Containerized nursery - Type and size of container including root trainers, selection of growing medium.

### **UNIT-IV**

Types of green house and mist chamber for propagation. vegetative propagation - importance, selection of superior phenotype, methods of propagation viz. cutting, budding, grafting and layering. Factors affecting rooting of cuttings. Structures, media fertilizers, sanitation and containers, source selection and management in vegetative propagation.

### **Practical**

Introduction and identification of modern equipments and tools used in nursery. Pre-sowing seed treatments. Preparation of nursery beds and growing media for containerized nursery. Sowing of seed and other intermediate nursery management operations. Preparation and planting of cuttings. Use of vegetative propagation methods such as budding, grafting and layering. Precaution required in vegetative propagation, use of plant bio-regulators for rooting Maintenance of nursery records. Identification of nursery insects and diseased and their control measures. Visit to nurseries.

### **Suggested Readings**

- Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu. Dwivedi AP. 1993. *Forestry in India*. Suya Publ.
- Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.
- Ram Prakash, Chaudhari DC & Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors.

**THEORY****UNIT-I**

Different important beneficial Microorganisms. Introduction and Scope of Biofertilizers. Types and classification of Biofertilizers. Total Biofertilizer production in India and Telangana state.

**UNIT-II**

Different Nitrogen Biofertilizers. Symbiotic & Non Symbiotic Nitrogen fixation. Nodule formation, Competitiveness, Quantification of Nitrogen fixed. Associative and Free living Nitrogen fixation. Cynobacterial Biofertilizers. Phosphate solubilizing Bacteria and Fungi. Mechanism and solubilization of phosphorus. Phosphate mobilizing microorganisms. VAM in detail. Potassium and Zinc Biofertilizers – Types of solubilization, different mechanism utilized by bacteria.

**UNIT-III**

Plant Growth Promoting Biofertilizers (PGPR) different mechanisms direct and indirect methods, advantages. Production Technology; Strain selection, Sterilization, Growth and Fermentation. Mass production of different carrier and liquid based biofertilizers.

**UNIT-IV**

FCO specifications and quality control of biofertilizers. Biofertilizers – Storage, shelf life and marketing. Factors influencing the efficacy of Biofertilizers. Bioremediators and its related Microbes Different types : Different organisms utilized for Bioremediation. Application technology for seeds, seedlings, tubers, setts etc

**PRACTICALS**

Handling of instruments in the laboratory. Isolation of Nitrogen fixing organism: *Rhizobium*. Isolation of Nitrogen fixing organism: *Azotobacter*. Isolation of Phosphate solubilizing microorganisms from soil sample. Isolation of Potassium solubilizing microbes from soil sample. Isolation of Zinc solubilizing microbes from soil sample. Preservation and pure cultures development. Study of Nitrogen fixing Activity by ARAMethod. Production of Indole Acetic Acid (IAA). Production of Siderophores. Preparation of different Carrier based

Biofertilizers. Preparation of different Liquid based Biofertilizers. Study the Quality parameters of Biofertilizers. Application of biofertilizers in the nurseries. Visit to Biofertilizer unit,

### **Suggested Readings:**

- Subbha Rao, N. S. Biofertilisers in Agriculture and Forestry. 1993 (3<sup>rd</sup> ed). International Science Publishers.
- Bikas, R. P and Santi, M. M. Recent Trends in Biofertilizers. 2016. I. K International Publishing House.
- Mahendra Rai. 2006. Hand book of Microbial Biofertilizers. CRC Press Publishers.
- Guar. A. C. 2014. Biofertiliser in Sustainable Agriculture. ICAR Publishers. New Delhi.
- Kannaiyan, S. Kumar K and Govindarajan, K. 2004. Biofertilisers Technology. Scientific Publishers (India).

## **DEPARTMENT OF TREE BREEDING & IMPROVEMENT**

**FBT 511**

**BREEDING METHODS IN FOREST TREES**

**2+1**

### **OBJECTIVE**

To impart the state of art breeding technology and methods to professional forestry graduates and to develop skill and expertise on tree breeding

### **THEORY**

#### **UNIT-I: CONCEPTS OF BREEDING**

Genetic constitution of tree population – half sib – full sib – families in trees, Hardy – Weinberg equilibrium, changes in gene frequency, Migration, mutation, Essentials of tree improvement - Variations in natural stand, Selection for different traits

#### **UNIT-II: GENERAL BREEDING METHODS**

Genetic basis of breeding self and cross pollinated trees – Different breeding methods – Plant introduction – Pure line, mass and progeny selection – Breeding Methods adopted – Selection from even aged stand, individual check tree method – Regression selection system, mother

tree system, subjective grading system - Hybridization in self pollinated crops, Selection procedures with hybridization, Hybridization in cross pollinated crops – Back cross method – Heterosis breeding

### **UNIT-III: SPECIAL BREEDING METHODS**

Mutation breeding – Polyploidy breeding – Transgenic breeding – Molecular breeding – Breeding for biotic and abiotic stress – Breeding for quality traits.

### **UNIT-IV: MATING DESIGNS**

Genetic testing programmes – Mating systems and Mating designs, Incomplete pedigree designs, Complete pedigree designs Experimental designs, Genotype and environmental interactions, Mating systems - types of mating system – population improvement-recurrent selection – disruptive selection – breeding procedure – merits and demerits

### **UNIT V: BREEDING METHODS FOR TREE GENETIC RESOURCES**

Breeding methods and systems for tropical trees (Teak, Sal, Eucalyptus, Casuarina, Sandal , Dalbergia, Neem, Jatropha and Subabul) – Temperate trees like Oak, Pine, Poplar, Salix.

### **PRACTICAL**

Half-sib, full-sib family in trees. Grading system of plus trees in natural stands. Mating designs, complete designs – nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs – open pollinated mating and polycross mating design. Selection for biotic and abiotic stresses.

### **SUGGESTED READINGS**

#### **Text Books**

1. Mahabal Ram.2014. Plant Breeding Methods. PHI Learning Private Limited. New Delhi.
2. G. S. Chahal, S. S. Gosal.2002. Principles and Procedures of Plant Breeding: Biotechnological and conventional Approaches. Alpha Science International Ltd. UK.
3. Izak Bos, Peter Caligari.2008. Selection Methods in Plant Breeding. Springer.
4. Wright JW. 1976 Introduction to Forest Genetics. Academic Press.
5. FAO. 1985. Forest Tree Improvement, FAO. Publi.
6. Faulkner R. 1975. Seed Orchard Forestry. Commission Bull. No. 34.
7. Khosla PK. 1981. Advances in Forest Genetics. Ambika Publ., New Delhi.

8. Mandal AK & Gibson GL. (Eds.) 1997. Forest Genetics and Tree Breeding.
9. Surendran C, Sehgal RN & Paramathama M. (Eds.). 2003. A Text Book of Forest Tree Breeding. ICAR.
10. Zobel BJ & Talbert J. 1984. Applied Forest Tree Improvement. John Wiley & Sons.
11. Zobel BJ, Wyk GV & Stahl P. 1987. Growing Exotic Forests. John Wiley & Sons.

### **Journals**

1. Frontiers in Crop Improvement
2. International Journal of Forestry and Crop Improvement
3. Electronic Journal of Plant Breeding
4. SABRAO Journal of Breeding and Genetics

### **SUGGESTED WEBSITES**

[www.csiro.au](http://www.csiro.au)

[www.env.for.nic.in](http://www.env.for.nic.in)

## **FBT 512 QUANTITATIVE GENETICS IN FOREST TREE BREEDING 2+1**

### **Objective**

To impart knowledge in the field of biometry as applied to breeding, population, provinces and making experiment in forest genetics and tree breeding.

### **THEORY**

#### **UNIT-I: HISTORY AND PRINCIPLE OF QUANTITATIVE GENETICS**

History and Principles - Developments of quantitative genetics - Mating systems - Arithmetic Mean, Range, Standard deviation, Variance, Standard error, Coefficient of variation, Test of significance, Null Hypothesis - Analysis of variance, Co-variance - Experimental designs, Principles, Replication, Randomization, Local Control. Types of Experimental designs, Experimental Error, Correction factor, Critical differences  
 – RBD (Method). First degree statistics, Second degree statistics, Third degree statistics.

#### **UNIT-II: VARIABILITY AND BIOMETRICAL TECHNIQUES**

Selection – objective – types- Selection theory – Models – Single and two locus models – Selection differential - Nature of Gene Action - Dominance and Epistatic - Biometrical

Techniques used for assessing the variability in germplasm collection various types of variability – Significance --  $D^2$  statistics – metroglyph analysis – Principal Component Analysis – Molecular Diversity Analysis – Merits & Demerits – Association analysis – Correlation coefficient – Simple correlation – Types of correlation – Discriminant functions – Implications in plant breeding

### **UNIT-III: HERITABILITY AND POPULATION GENETICS**

Heritability, Types of heritability – methods of estimation of heritability – Estimation of combining ability – Biometrical analysis – Interpretation of results – Merits & Demerits – Population Genetics – Hardy-Weinberg equilibrium – Hardy-Weinberg law – Proof – Applications of the Hardy-Weinberg law – Test of Hardy-Weinberg equilibrium – Mating frequencies – Non-dominance – Co-dominance – Snyder's ratio, importance and its effect over random mating in succeeding generations.

### **UNIT-IV: BIOMETRICAL APPROACHES FOR QUANTITATIVE GENETICS**

Biometrical approaches – Diallel analysis – Hayman's graphical approach (or) Griffings Numerical approach, Merits & Demerits – Line x Tester analysis – Path analysis Merits, Demerits, Application in Plant Breeding – Heterosis, Factors affecting heterosis, Genetic basis of heterosis – Estimation of heterosis – Adaptation, Types of adaptation, causes of adaptation. Factors affecting adaptability– Inbreeding and Inbreeding depression

### **UNIT V: STABILITY STUDIES**

Types of interactions, Models of stability analysis – Different types of Model – Eberhart & Russell Model. – Uses of stability analysis – Comparison of stability, combining ability & Heritability analysis.

### **PRACTICAL**

Problems on multiple factor inheritance – Hardy – Weinberg Law – Extension of H- W-L – Calculating Allelic frequency using H – W – L -. H-W-L – Problems – Migration. – Correlation coefficient in tree species – Test of significance of Correlation coefficient in tree species – Analysis of Metroglyph Indices in tree species –  $D^2$  Analysis in *Eucalyptus*, Teak, Neem – Path Analysis in *Eucalyptus*, Teak, Neem – Diallel analysis – Graphical approach – in *Eucalyptus* – GCA and SCA effects in *Eucalyptus* – Top Cross analysis, Line x Tester analysis, Stability analysis, Discriminate analysis, Generation Mean analysis in tree species

## Suggested Readings

- FAO. 1985. *Forest Tree Improvement*, FAO Publi.
- Faulkner R. 1975. *Seed Orchard Forestry*. Commission Bull. No.34.
- Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.
- Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi. Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.
- Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.
- Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.
- Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.
- Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

**FBT 513**

**PHYSIOLOGIES OF WOODY PLANTS**

**2+1**

### OBJECTIVE

To acquaint students about the concepts of physiology for understanding its use in increasing productivity of forest stands

### THEORY

#### UNIT-I: TREE PHYSIOLOGY, GROWTH AND DEVELOPMENT

Introduction – Tree physiology – Growth – phases of growth – growth curve – factors affecting growth- Wood formation - Plant cell as a structural and functional unit. Organization of cells and tissues – morphogenesis.

#### UNIT-II: PLANT MORPHOLOGY AND FUNCTIONS

Structure of leaves, stem wood, bark and roots in trees. Functions and process in plant growth and development - Photosynthesis – structure of photosynthetic tissues and organs – enzyme, energetics and factors influencing photosynthesis. Photorespiration – its mechanisms and significance – factors affecting photorespiration.

#### UNIT-III: RESPIRATION AND TRANSPIRATION

Respiration – mechanisms – enzymes, energetics and factors influencing respiration. Respiratory quotient - Water relations of trees – absorption – ascent of sap. Translocation

of solutes – Phloem loading and phloem transport. Transpiration – Mechanisms and factors influencing – regulating transpiration – anti transpirants.

#### **UNIT-IV: PLANT NUTRITION AND PHYTOHORMONES**

Mineral nutrition – Mineral salt absorption and translocation – deficiency and toxicity of mineral nutrients. Diagnosis of mineral deficiency- The enzymes – nomenclature and classification – structure and composition – Mode of action. Phytohormones – Auxins, GA, Cytokinins, ABA, Ethylene. Biosynthesis and biochemical activity of . Plant hormones. Synthetic plant growth regulators. Growth retardants.

#### **UNIT V: PLANT METABOLISM**

Nitrogen fixing trees - Nitrogen metabolism. N<sub>2</sub> fixation – physical and biological. Nitrogen assimilation – Amino acid and protein synthesis - Fat metabolism. Carbohydrate metabolism.

#### **PRACTICAL**

Preparation of growth curves of different tree seedlings - Study of structure of leaves - Measurement of photosynthesis- Observing structure of plant cells and leaves in C<sub>3</sub> and C<sub>4</sub> species - Studying stomata in different tree species and working out stomatal frequency - Measurement of stomatal size in different tree species - Estimation of transpiration rates in different trees - Isolation and estimation of chlorophyll - Observing xylem vessel size variation in tree species - Estimation of plant water status by different methods - the effect of growth promoters on germination - Growth analysis - RGR, NAR and CGR- Nutrient deficiency symptoms in tree seedlings.

#### **SUGGESTED READINGS**

##### **Text Books**

1. Paul. J. Kramer and T.T. Kozlowski. 1979. Physiology of Woody Plants. Academic Press, New York.
2. Raghavendra, A.S. 1991. Physiology of Tree John Wiley & Sons, Inc, New York.
3. Larcher, W. 2004. Physiological Plant Ecology. Springer - Verlag, New York.
4. Longman, K.A. and Jenik, 1987. Tropical Forest and its Environment ELBS, London
5. Taiz. L and Zeiger. E.,2008. Plant Physiology. Publishers: Sinauer Associates, Inc., Massachusetts, USA.

6. Hopkins WG & Huner NPA.2004.*Introduction to Plant Physiology*. JohnWiley & Sons.
7. Guillermo Goldstein, Louis S. Santiago. 2016. *Tropical Tree Physiology: Adaptations and Responses in a Changing Environment*. Springer.
8. Satish C Bhatla, Manju A. Lal. 2018. *Plant Physiology, Development and Metabolism*. Springer.

### **Journals**

1. Annals of Plant Physiology
2. Annual Review of Physiology
3. Indian Journal of Plant Physiology
4. American Journal of Physiology - Cell Physiology

### **SUGGESTED WEBSITES**

1. <http://www.plantphys.org>
2. <http://www.Biologie.Uni-hamburg.de/b-online>
3. [www.genfys.slu.se /](http://www.genfys.slu.se/)
4. [www.mpcer.nau.edu / ug / forest. html](http://www.mpcer.nau.edu/ug/forest.html)

**FBT 514**

**REPRODUCTIVE BIOLOGY OF FOREST TREES**

**2+1**

### **Objective**

To impart the knowledge of reproduction in forest tree species and to make them understand the mechanism of breeding, sex expression.

### **Theory**

#### **UNIT-I**

#### **CONCEPTS OF REPRODUCTIVE BIOLOGY**

Reproductive Biology – Introduction – Concepts – Importance – Mode of reproduction – types – Tropical trees – Temperate trees – Crop characteristics - growth and development (both vegetative and reproductive) - Application of reproductive biology in tree breeding - Floral morphology and types of flowers- floral initiation and breeding systems.

## **UNIT-II**

### **FLORAL BIOLOGY AND POLLINATION MECHANISMS**

Floral Measurement and prediction of flowering-Juvenility and vernalization - Floral diversity and pollination. Mode of pollination - Cross pollinated crops and self pollinated crops - Mechanisms and significance - Pollination syndromes and their evolution; Plant - Pollinator systems, Diversity of pollination syndromes in selected plant families. Sex expression, monoecy, dioecy and its evolution.

## **UNIT-III**

### **MATING DYNAMICS AND LIMITATIONS**

Environmental effects on sex expression. Floral attractants and rewards; Biology of floral and extra floral nectaries; Examples of plant insect interactions involving pollination. Floral characteristics of the main pollination syndromes- Mating system dynamics in Forest trees - Factors affecting different mechanisms - Mechanisms promoting high levels of Out-Crossing - self incompatibility - Factors leading to unusually low levels of out crossing - Factors that prevent or limit self-fertilization.

## **UNIT-IV:**

### **PLANT-POLLINATION INTERACTIONS, GENE FLOW AND SEED DISPERSAL**

Environmental effects on sex expression - Plant-pollination interactions, Pollinator energetic and nectar production, Pollen travel within and between plants - pollination efficiency, reproductive efficiency, Distance of pollen travel, pollen transport and pollen viability. Fertilization in hard wood trees - Double fertilization - Seed formation in angiosperms fertilization in soft wood trees - Cone formation in softwood trees. Seed dispersal - Benefits of seed dispersal - types of dispersal - consequences of seed dispersal - Gene flow- Barrier to gene flow - Gene flow between species (Genetic pollution) - Models of gene flow - Gene flow mitigation.

### **Practical**

Sex expression in forest trees. Out crossing mechanisms in forest trees. Measurement of pollen flow in wind-pollinated and insect-pollinated species. Pollen viability and fertility. Seed dispersal mechanism.

### **Suggested Readings**

- FAO. 1985. *Forest Tree Improvement*, FAO Publi.
- Faulkner R. 1975. *Seed Orchard Forestry*. Commission Bull. No.34.

- Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.
- Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.
- Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.
- Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.
- Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.
- Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.
- Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

**FBT 515**

**BIOTECHNOLOGY APPROACHES IN FORESTRY**

**2+1**

**Objective:**

To imbibe an understanding of scope, potential and techniques in forest biotechnology and to prepare them for experimentation in the discipline.

**Theory**

**UNIT-I**

Historical development of biotechnology; scope of biotechnology in forestry; different methods of biotechnology related to forestry

**UNIT-II**

Plant tissue culture and response pattern; application of plant tissue culture in tree improvement.

**UNIT-III**

In vitro selection and micro propagation in forestry for conservation; gene regulation, genetic engineering techniques; basis of operation in DNA manipulation;

**UNIT-IV** Transgenic plants; molecular markers and its application in forestry; modification of plant species to practically desired products; biodegradation of forestry wastes through genetically engineered microbes.

**Practical**

Biochemical techniques: Preparation of buffers and reagents, Principle of centrifugation, Chromatographic techniques Gel electrophoresis- agarose and PAGE (nucleic acids and proteins); PCR and optimization of factors affecting PCR. Dot blot analysis; Southern

hybridization; Northern hybridization; Western blotting and ELISA; Radiation safety and non-radio isotopic procedure.

### **Suggested Readings**

Bajaj YPS. (ed). 1988. Biotechnology in Agriculture and Forestry. Springer-Verlag. Gupta PK. 2000. Elements of Biotechnology. Rastogi Pub. Kumar S and Singh MP. 2008. Plant Tissue Culture. APH Pub. Mandal AK and Gibson GL. (ed.). 1997. Forest Genetics and Tree Breeding. CBS. Punia MS. 1998. Plant Biotechnology and Molecular Biology. Scientific Pub. Singh BS and Singh MP. 2007. Fundamental of Plant Biotechnology. Sodesh Serial Pub. Srivastava PS, Narula A and Srivastava S. (ed.). 2004. Plant Biotechnology and Molecular Markers. Anamaya Pub.

**FBT 516**

**CLONAL FORESTRY**

**(1+1)**

**Objective:** To impart the state-of-the-art clonal technologies and to develop scientific skill of clonal propagation technologies to augment the productivity. .

### **THEORY**

#### **UNIT-I: CONCEPTS AND METHODS**

Clonal Forestry – definition - Basic concepts in clonal forestry –operational use – advantages of clonal forestry- constraints – Selection of Plus Trees – Propagation methods- auto and hetero propagation methods – rooting of cutting, grafting, layering, budding- micro-clonal propagation methods

#### **UNIT-II: POTTING MEDIA AND PGR**

Potting media – components and characteristics – peat, vermiculite, perlite, styrofoam, soil, sand, –characteristics of potting media – physical and chemical characteristics– Plant growth substances – Auxins – cytokinins – gibberellins – ethylene – preparation of powder and liquid formulations – Applications in clonal multiplication.

#### **UNIT-III: PROPAGATION STRUCTURES**

Establishment of hardening chamber/shade house– Factors controlling propagation– Biotic and abiotic factors –Maintenance - Performance and cause factors – Hardwares in clonal propagation – Root trainers – types – advantages and limitations.

## **UNIT-IV: CLONAL MULTIPLICATION AND EVALUATION**

Mini garden – Concepts – Method of establishment – Hedge garden - Management of mini and hedge clonal garden – Clonal Multiplication Area (CMA) – Clonal Testing Area (CTA) – Designs of clonal evaluation – Amplified clonal test

## **UNIT V: CLONAL PLANTATIONS**

Clonal plantation establishment- management strategies – Problem and constraints in clonal forestry – Tophophysis – Plagiotrophic and orthotrophic response – Tophophysis – Cyclophysis – Periphysis - Role of corporate sectors in clonal forestry – Forest development corporation – Experience. Economics of clonal forestry.

## **PRACTICAL**

Clonal nursery – Study of propagation methods -- Propagation Chambers – Mist chamber – Green house – Cost of establishment – Root trainer technology – Establishment of low cost polytunnels – Cost of establishment and management – Establishment of CMA and CTA – Clonal evaluation – Visit to corporate sectors – Pest and disease management in clonal garden – Clonal hedge management – clonal propagation techniques for timber( teak, rosewood, Red sander, Sissoo) pulpwood and energy (*Eucalyptus*, *Casuarina*, *Leucaena*), TBOs (Neem, Pungam, *Simarouba*, Mahua) and other alternate industrial wood (*Melia*, *Gmelina*, *Ailanthus*, kadamba) species – contract tree farming and corporate social responsibilities.

## **SUGGESTED READINGS**

### **Text Books**

1. Ahuja and Libby. 1986. Clonal Forestry. Martinus Nijhoff Publishers, Dordrecht.
2. Parthiban K.T., M.Paramathma., K.S.Neelakantan, K.S., 2004. Clonal Forestry. TNAU Publications, Coimbatore. Pp: 209.
3. Ahuja. M.R. 1993. Micropropagation of Woody Plants. Springer.
4. Hartman, H.T., D.E. Kester, F.T. Davies and R.L. Geneve. 1997. Plant Propagation – Principles and Practices. Prentice- Hall of India Pvt. Ltd., New Delhi. P 770
5. Zobel, B. and J. Talbert. 1984. Applied Forest Tree Improvement. John Wiley and Sons, New York. P 505.
6. Landis, T.D., R.W. Tinus, S.E. Mc Donald and J.P. Barnett. 1990. Containers and

growing media. Vol. 2. The container Tree Nursery Manual. Agriculture Handbook. 674. Washington, D.C., USDA Forest Service. P 88.

7. Surendran,C., K.T .Parthiban, K.Vanagamudi and S. Balaji, 2000 .Vegetative propagation of trees- Principles and Practices. .FC&RI Publication, Mettupalayam.

### **Journals**

1. Electronic Journal of Plant Breeding
2. Frontiers in Crop Improvement
3. Breeding Science
4. Biotechnology Journal International (British Biotechnology Journal)
5. Asian Biotechnology and Development Review

### **SUGGESTED WEBSITES**

1. [www.forestrycentre.com](http://www.forestrycentre.com)
2. [www.studentsguide.in](http://www.studentsguide.in)
3. [www.clonalforestry.com](http://www.clonalforestry.com)

**FBT 517**

**TISSUE CULTURE IN FOREST TREES**

**2+1**

Objective To develop faculties of students to explore and analyze the propagation techniques in vitro and to provide knowledge in the field with principles, techniques and progress achieved in the discipline.

### **Theory**

#### **UNIT-I**

Tissue culture-principles as applied to forest tree species, history, development, fields of application, progress and prospects with special reference to tree crops. Culture conditions. Stages of micro propagation. In vitro propagation via enhanced release of auxiliary buds. Somatic organogenesis and somatic embryo genesis, leaf diseases, embryoid and synthetic seed production.

#### **UNIT-II**

Problems and Progress in in vitro propagation of tree crops. In vitro pollination and fertilization for distant hybridization. Somaclonal variation – factors influencing – exploitation for crop improvement. Haploid culture and production of homodiploids, Protoplast isolation, culture and regeneration; Protoplast fusion for somatic hybridization and its application.

### **UNIT-III**

Techniques for direct gene transfer to protoplasts. Need of in vitro conservation. Short and medium term conservation. Long term storage, cryo-preservation, freeze preservation, significance of liquid nitrogen, prefreezing treatments – use of cryo-protectants, dry freezing, incubation.

### **UNIT-IV**

Alteration/modifications in cell components during cryo-preservation. Recalcitrant species. Thawing and reculture. Survival of freeze preserved cells/tissues. Clonal fidelity and karyotype stability of cryopreserved cultures and regenerates. Use of biochemical and molecular markers for testing the stability, Protocol development.

### **Practical:**

Preparation and storage of stock solutions, preparation of culture media. Collection, handling and pre-treatment of explants. Micro-propagation of tree species via different routes. Ex vitro establishment of plantlets. Production of somatic embryos. In vitro pollination and fertilization. Protoplast isolation and culture. Haploid culture. Components and preparation of culture medium. Collection, handling and surface sterilization of explants. Inoculation and incubation. Preparation of in vitro cultures for short, medium and long term preservation. Practicing different protocols for conservation. Thawing and reculture. Assessing the stability of regenerates. Manipulation of culture media and conditions for prolonging the culture period. Essential features of tissue culture laboratories.

### **Suggested Readings**

Bajaj YPS. (ed.). 1988. Biotechnology in Agriculture and Forestry. Springer Verlag. Gupta PK. 2000. Elements of Biotechnology. Rastogi Pub. Kumar S and Singh MP. 2008. Plant Tissue Culture. APH Pub. Mandal AK and Gibson GL. (ed.). 1997. Forest Genetics and Tree Breeding. CBS. Punia MS. 1998. Plant Biotechnology and Molecular Biology. Scientific Publ. Singh BS and Singh MP. 2007. Fundamental of Plant Biotechnology. Sodesh Serial Publ. Srivastava PS, Narula A and Srivastava S. (ed.). 2004. Plant Biotechnology and Molecular Markers. Anamaya Pub.

## **DEPARTMENT OF FOREST PRODUCTS & UTILIZATION**

## **Objective**

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

## **Practical**

Planes of wood, Physical characteristics of important woods, Identification of different types of cells and tissues. Anatomical studies of reaction wood. Identification of different types of cells and tissues. Anatomical studies of reaction wood. Classification of timber using dichotomous and perforated card keys. Modern timber identification techniques.

## **Suggested Readings**

- Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
- Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.
- Sharma LC. 1977. *Development of Forests and Forest-based Industries*.
- Bishen Singh Mahender Pal Singh, Dehradun.
- Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.
- Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

**FPU 512**

**GENERAL PROPERTIES OF WOOD**

**1+1**

## **Objective**

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

## **Theory**

### **UNIT-I**

Wood density, thermal, electrical and acoustics of wood.

### **UNIT-II**

Mechanics and Rheology of wood, elasticity, plasticity and creep (tensile compression and bending strength)

### **UNIT-III**

Toughness, torsion, shear, hardness and abrasion strength.

## **UNIT-IV**

Acoustic and acousto-ultrasonics, based non-destructive evaluation technique.

### **Practical**

Determination of wood density, study of thermal, electrical and acoustic properties of wood.

Determination of tensile and bending properties of wood.

### **Suggested readings**

- Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
- Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.
- Sharma LC. 1977. *Development of Forests and Forest-based Industries*.
- Bishen Singh Mahender Pal Singh, Dehradun.
- Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.
- Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

**FPU 513**

**WOOD SEASONING AND PRESERVATION**

**2+1**

### **Objective**

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

### **Theory**

## **UNIT-I**

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

## **UNIT-II**

Defects of timber- natural, seasoning defects, defects due to external agencies, machining

defects. Effect of defects on utilization.

### **UNIT-III**

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

### **UNIT-IV**

Wood preservation : preservatives and treatment processes. Advantages and safety concern of wood preservatives.

#### **Practical**

Determination of moisture content and swelling coefficients of different woods. Comparative studies on air and kiln dried woods. Analysis of decayed wood for physical and chemical parameters. Treatment of wood with different types of preservatives.

#### **Suggested Readings**

- Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
- Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.
- Sharma LC. 1977. *Development of Forests and Forest-based Industries*. Bishen Singh Mahender Pal Singh, Dehradun.
- Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun. Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

**FPU 514**

**PULP AND PAPER TECHNOLOGY**

**2+1**

**Objective:**To acquaint with the resources and processes for making pulp and paper.

#### **Theory**

##### **UNIT-I**

Raw materials used in pulp and paper industries and its characteristics and handling

##### **UNIT-II**

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

##### **UNIT-III**

Recycled fibers, supplementary pulp treatment and additive. Paper making, paper drying, calendaring, reeling, external sizing, coating etc.

#### **UNIT-IV**

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

#### **Practical**

Study of raw materials techniques and pulp yield, making of paper and its quality determination, visit to nearby paper industry.

#### **Suggested Readings**

- Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
- Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.
- Sharma LC. 1977. *Development of Forests and Forest-based Industries*.
- Bishen Singh Mahender Pal Singh, Dehradun.
- Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.
- Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

### **FPU 515 WOOD MODIFICATION AND COMPOSITE WOOD**

**2+1**

#### **Objective**

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

#### **Theory**

#### **UNIT-I**

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

#### **UNIT-I**

Wood impregnation and compregnation, heat stabilization, wood densification.

#### **UNIT-III**

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

#### **UNIT-IV**

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

#### **Practical**

Use of different adhesives in plywood, study of composite boards, study of antishrink efficiency of wood treated with different chemicals impregnation and compregnation of

wood with chemicals.

### **Suggested Readings**

- Mehta T. 1981. *A Handbook of Forest Utilization*. Periodical Expert Book Agency.
- Rao KR & Junaja KBS. 1992. *Field Identification of 50 Important Timbers of India*. ICFRE, Dehradun.
- Sharma LC. 1977. *Development of Forests and Forest-based Industries*.
- Bishen Singh Mahender Pal Singh, Dehradun.
- Trotter H. 1982. *Manual of Indian Forest Utilization*. FRI & College, Dehradun.
- Wadoo MS. 1992. *Utilization of Forest Resources*. IDRIS Publ.

## **FPU 516 MEDICINAL CHEMISTRY & PROCESSING OF MEDICINAL & AROMATIC PLANTS 2+1**

### **Objective**

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

### **Theory**

#### **UNIT-I**

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

#### **UNIT-II**

Primary and Secondary plant metabolites and their therapeutic uses of phytoconstituents such as gums, anthraquinones, steroidal and triterpenoidal glycosides, phenolic compounds, lipids, alkaloids and terpenoids.

#### **UNIT-III**

Basic principles of extracting different phytoconstituents.

#### **UNIT-IV**

Post harvest processing-drying, grading and storage. Extraction of essential oils and their storage.

### **Practical**

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

### **Suggested Readings**

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

- Chadha KL & Gupta R.. 2006. *Advances in Horticulture*. Vol. XI.
- *Medicinal and Aromatic Plants*. Malhotra Publ. House.
- Gupta AK & Sharma M. 2008. *Reviews on Indian Medicinal Plants*. ICMR. Gupta AK, Tandon N & Sharma M. 2008. *Quality Standards of Indian Medicinal Plants*. ICMR.
- Johnson CB & Franz C. 2005. *Breeding Research on Aromatic and Medicinal Plants*. International Book Distr.
- Sharma R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publ.

## **DEPARTMENT OF FOREST RESOURCE MANAGEMENT**

**FRM 511**

**ECOSYSTEM SERVICES AND ACCOUNTING**

**1+1**

**Aim:** To introduce students to the concept of ecosystem services, which is increasingly recognized as a useful concept for decision-making, and provide an overview of the suite of methods that are used to quantify them.

### **THEORY**

#### **UNIT-I-INTRODUCTION**

Introduction to Ecosystem goods and Services- Importance of Ecosystem services-Definition of Ecosystem services- Millennium Ecosystem Assessment- Classification of ecosystem services -Provisioning-regulating-cultural-Supporting services; Market and non-market goods and services- Conceptual Framework of Interactions between Biodiversity, Ecosystem Services, Human Well-being, and Drivers of Change

#### **UNIT-II ASSESSING ECONOMIC VALUE**

Basics of Economics -demand-Supply curve, NPV, Opportunity costs cost-benefit analysis. Significance and need of valuation of ecosystem services-Environmental cost -Benefit analysis(CBA)-Environmental damage assessment-Natural capital accounting(Green GDP)- Assessing value- Total Economic value(TEV)-Use value and Non use value; Direct use and indirect use values; Existence value ,Bequest value and Option values.

#### **UNIT-III VALUATION METHODS FOR ECOSYSTEM SERVICES- I**

Classification of valuation methods-Evaluation methods of ecosystem services for use values: Direct market valuation methods-Revealed preference methods: Market price method-

Production function method- Cost-based methods; Random utility and travel cost methods- Hedonic pricing method-Strengths and challenges of each method

#### **UNIT-IV VALUATION METHODS FOR ECOSYSTEM SERVICES- II**

Evaluation methods of ecosystem services for both use and non-use values- Stated preference methods-Contingent valuation- Conjoint analysis- Biodiversity as nonmonetary evaluation approach-Benefit transfer approach- Strengths and challenges.

#### **UNIT-V PAYMENTS AND POLICIES**

Payment for Ecosystem services- Review of Case studies of valuation of different ecosystems such as Forest reserves,Urban ecosystems,wetlands, watershed, agrobiodiversity in India and abroad -National and International policies governing valuation and accounting.

#### **PRACTICALS:**

Flow chart of Ecosystem goods and services – Methods of valuation of Ecosystem services- Market based methods and Non-market based methods-Valuation of direct use value and indirect use value of ecosystem services of different ecosystems: Forests, Urban landscapes, Watersheds, Agro biodiversity and wetlands.

#### **REFERENCES:**

##### **Books**

- Bouma and Van Beukering (2015) Ecosystem services: from concept to practice, Cambridge University Press
- Ruhl, Kraft, and Lant (2007) The Law and Policy of Ecosystem Services, Island Press
- The Economic, Social and Ecological Value of Ecosystem Services: A Literature Review Final report for the Department for Environment, Food and Rural Affairs January 2005
- Valuation of Forest Ecosystem Services in Uttarakhand Himalaya ñ IIFM, Bhopal- May 2007
- Compensating states that maintain forests at the expense of their own development..... Valuation of forests in India- Comptroller and Auditor general of India Report.
- Green National Accounts in India A Framework A Report by an Expert Group Convened by the National Statistical Organization Ministry of Statistics and Programme Implementation Government of India

- TEEB D1. 2009. The Economics of Ecosystems and Biodiversity for National and International Policy Makers.

**Websites:**

- Ecosystem Marketplace: <http://www.ecosystemmarketplace.com>
- Forest Carbon Portal: <http://www.forestcarbonportal.com>
- Watershed Connect: <http://watershedconnect.org>
- SpeciesBanking.Com: <http://www.speciesbanking.com>
- Ecosystem Marketplace Community Portal:  
<http://community.ecosystemmarketplace.com> Ecosystem Commons:  
<http://ecosystemcommons.org>
- Natural Capital Project: <http://naturalcapitalproject.org>
- The Ecosystem Services Partnership: <http://www.fsd.nl/esp/>
- Millennium Ecosystem Assessment: <http://www.maweb.org/en/index.aspx>
- IPBES: <http://www.ipbes.net>
- World Bank, Wealth Accounting and the Valuation of Ecosystem Services (WAVES):  
<http://www.wavespartnership.org/waves/>
- World Resources Institute, Mainstreaming Ecosystem Services Initiative (MESI):  
<http://www.wri.org/project/mainstreaming-ecosystem-services>

**Objective:**

To give insights into the forestry and agroforestry options for productivity enhancement in problem soils.

**Theory****UNIT-I**

Sustainability of land use systems- soil conservation and sustainability-forestry for soil conservation- soil restoration- need and reclamation of degraded soils, flood prone areas. Mine spoils and ravines- selection of species and techniques - forestry for maintenance of soil fertility, ecological balance and conservation of biodiversity.

**UNIT-II**

Phytoremediation to cleanup metals pesticides, solvents, explosives crude oil, polyaromatic hydrocarbons, landfill leachates, and salt affected soils. Treating metal contaminants - phytoextraction, rhizofiltration and phytostabilization. Treating organic contaminants - phytodegradation, rhizodegradation and phytovolatilization. Hydraulic control of contaminants. Riparian corridors or buffer strips as applications of phytoremediation.

**UNIT-III**

Agricultural non-point source (NPS) pollutants to watercourses. Riparian buffers as bioassimilation strategy to remove nutrients, sediment, organic matter, pesticides, bacteria and pathogens, and other pollutants from surface runoff and groundwater. Multispecies riparian buffer. Species and management considerations.

**UNIT-IV**

Forestry for maintenance of soil fertility, ecological balance and conservation of biodiversity. Management innovation in forestry and agroforestry systems of the tropics.

**Suggested Reading:**

Garrett, Rieteveld, Fisher: 2000 North American Agroforestry, ASA, Madison, USA. Buck, Lassoie, Fernandes 1999. Agroforestry in Sustainable Agri. Systems, CRC Press. Gordon and Newman: 1997 Agroforestry Systems in the Temperate Zone, CAB Int'l. Nair, P.K.R., Rao, M.R. and Buck L.E. (eds.) 2004. New Vistas in Agroforestry. A Compendium for the 1st World Congress of Agroforestry. Kluwer Academic Publishers, Dordrecht, The Netherlands McDicken and Vergara: 1990 Agroforestry. Wiley, New York Mayer, P.M., Reynolds, S.K., McCutchen, M.D., Canfield, T.J., 2007. Meta-analysis of nitrogen removal in riparian buffers. Journal of Environmental Quality 36, 1172-1180. Schultz, R.C., Isenhardt, T.M., Simpkins, W.W.,

Colletti, J.P. 2004. Riparian forest buffers in agroecosystems - lessons learned from the Bear Creek Watershed, central Iowa, USA. *Agroforestry Systems* 61, 35-50.

## **FRM 513      MANAGEMENT OF INSECT PEST AND DISEASES IN PLANTATIONS 2+1**

### **OBJECTIVE**

To impart knowledge about the various measures involved in the management of insects and diseases in forest plantations.

### **THEORY**

#### **UNIT-I: INSECT PESTS**

Biology – Nature of Damage – Insect pests of nursery and plantations – Eucalyptus – Ailanthus – Teak – Neem – Sal – Melia - Kapok – Poplar - Subabul – Kadam- Dalbergia sissoo - D.latifolia- Pterocarpus

#### **UNIT-II: INTEGRATED PEST MANAGEMENT**

Economic Threshold Level – Economic Injury Level – Principles and methods of IPM – physical – mechanical – cultural – host plant resistance – chemical – biological control – predators – parasitoids – microbial control – use of attractants and repellents – Male sterility techniques – Pheromones – Biotechnological approaches – Insecticide Formulations – Application methods – plant protection appliances

#### **UNIT-III: DISEASES**

Diseases of nursery and plantations – disease symptoms – Eucalyptus -- Ailanthus – Teak – Neem -- Sal – Melia – Sisoo – Pungam – Syzygium- Pterocarpus- Ficus

#### **UNIT-IV: INTEGRATED DISEASE MANAGEMENT**

Principles – Exclusion – Eradication – Protection – Management methods – cultural – chemical – contact and systemic fungicides – biocontrol agents – biotechnological approaches – Disease Interaction and Management

#### **UNIT V: OTHER PESTS**

Rodents and their management – Birds – Nematodes – Mites - Cultural and biological

methods of nematode management – forest plant quarantine

## **PRACTICAL**

Collection and identification of insects and non-insects – Inspection and collection of damaged material showing insect damage – Identification and use of plant protection equipments – preparation of different concentrations of pesticides – Identification of important diseases in forest nurseries and plantations – preparation of fungicidal concentrations and their use in controlling nursery and plantation – nematodes identification.

## **SUGGESTED READINGS**

### **Textbooks**

1. Bakshi, B.K. 1976. Forest Pathology. Principles and Practices in Forestry. Controller of Publications, New Delhi.
2. Ferraz, L.C. and D. Brown. 2002. An Introduction to nematodes - Plant Nematology. Pensoft Publishers. 221 pp.
3. Speight, M.R. and F.R. Wylie. 2001. Insect Pests in Tropical Forestry. CABI International, Wallingford, United Kingdom.

### **Reviews / Journals / E-Journal**

1. Annual Review of Entomology
2. Crop Protection
3. Indian Journal of Entomology
4. Indian Forester
5. Entomological Science
6. Agricultural and Forest Entomology
7. Journal of Forest Research

## **SUGGESTED WEBSITES**

1. [www.nysaes.cornell.edu/ent/biocontrol](http://www.nysaes.cornell.edu/ent/biocontrol)
2. [www.forestryimages.org/insects.cfm](http://www.forestryimages.org/insects.cfm)
3. [www.fs.fed.us/r6/nr/fid/wid.shtml](http://www.fs.fed.us/r6/nr/fid/wid.shtml)
4. [www.forestpests.org/](http://www.forestpests.org/)
5. <http://nfdp.ccfm.org/compendium/insects/index>
6. [http://forestry.about.com/od/insects/Insects\\_of\\_Trees\\_in\\_North\\_America.htm](http://forestry.about.com/od/insects/Insects_of_Trees_in_North_America.htm)

**Objective :**

To provide knowledge about forest management, ecosystem management, productive and protective management, sustained yield, yield prediction, site quality evaluation, stand density & forest valuation.

**Theory****UNIT-I**

Forest management – an art and science – importance of forest management in relation to industries and agricultural management – areas and objectives of management- productive and protective management- complimentary and competitive strategies -Balanced management and Priority issue management strategies- tangible and intangible aspects of management – complexity and multiplicity – quality attributes. management strategies according to old and new policies.

**UNIT-II**

Sustained yields – progressive sustained yield –yield regulation -rotation – principles and practices – physical, silvicultural, technical. Income, problem solving rotation –normal forest – growing stock and increment. Increment percentage-Yield prediction and regulation in different types of forests – various methods, Von-Mentals formula and its modifications – Massons method, Brandis method – Howards, Burmas, Smithies, Simmonds - methods merits and demerits.

**UNIT-III**

Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies.

**UNIT-IV**

Forest valuation and appraisal in regulated forests. Practical: Visit to selected forest areas to study the management practices. Preparations of new working plan for a selected range or division by incorporating all modern management strategies including market demand, price fluctuations etc.

**Suggested Readings**

- Bentley, J., Recknagel, A.B. 1985. Forest Management, International book distributors, Dehra Dun.
- Edmunds, D and Wollenberg, E 2003. Local Forest Management, Earthscan Publications, London.
- Fugomori, T. 2003. Ecological and Silvicultural strategies for sustainable forest management. Elsevier, Amsterdam
- Kathiresan, 1986. Essentials of Forest Management, Natraj Publishers, Dehra Dun.
- Pulparambil, J (2002) Forest Management – an HRD approach. Uppal Publishing House, New Delhi
- Raison, R.J., Brown, A.J and Flimn, P.W. Criteria and Indicator for sustainable Forest Management. CABI, Publications, UK.
- Smith DM, Larson BC, Ketty MJ and Ashton PMS. 1997. The Practices of Silviculture- Applied Forest Ecology. John Wiley & Sons.

**FRM 515**

**FORESTS AND PEOPLE**

**2+0**

### **Objective**

It will help students to understand socio-economic, cultural and ecological relationship between forests and people. It will acquaint students with the role of people in forest management through analysis of need dependence and traditional interactions between forests and society.

Theory

### **UNIT-I**

Forests and its importance, forest societies, interactions between forests and people, importance of forests in traditional farming systems, livestock economy and forests, social and cultural factors of forest management, man in ecosystem in relation to ecophilosophy.

### **UNIT-II**

Afforestation programmes and forest conflicts, wildlife and human conflicts, peoples movement in forest conservation like Chipko Movement, Gender dimension of forest management, tribals and forests. Pastoralists and their dependence on forests. Forests and economic security of tribals.

### **UNIT-III**

Management of Commons and Common Property Resources (CPRs) and open access resources, forest management and sustainable livelihood strategies, forests and food security, eco-tourism and local development, land use change and forestry.

#### **UNIT-IV**

Forest rights, customary rights of people, community participation, biodiversity and ethnobotany, Joint Forest Management, global environmental change and land use; dams, forests and resettlement of tribals and non-tribals – case study, poverty alleviation and forests, tourism and forest management, role of NGOs and other CBOs community based organization in forest management.

#### **Suggested readings**

- Annamalai R. 1999. Participatory Learning Action and Microplanning for JFM.
- Dean SFRC, Coimbatore. FAO. 1978. Forestry for Local Community Development.
- FAO Publ. Shah SA. 1988. Forestry for People. ICAR.
- Tiwari KM. 1988. Social Forestry and Rural Development. International Book Distr.
- Vyas GPD. 1999. Community Forestry. Agrobios.

**FRM 516**

**FOREST HYDROLOGY**

**1+1**

#### **Theory**

#### **UNIT-I**

Review of basics: Terminologies; Hydrological Cycle and its components; Rainfall-Runoff relationship; Hydrograph and its types; Distribution of global water resources; Subsurface distribution of water; Hydrological properties of water; Water-bearing earth formations (aquifer and types); Water quality and suitability; Groundwater flow – Darcy's Law.

#### **UNIT-II**

Resources inventory soil, land, water and Biota. Soil survey and land use planning –soil types, fertility, productivity, erosion and conservation practices. Water resource development, water availability, pressurized irrigation, crop water requirements and water use efficiency.

#### **UNIT-III**

Forests as a natural resource and its characteristics; Forest trees; Environmental functions of forests; Forests and precipitation (forest interception; relation between forests and depth of precipitation); Forests and drainage; Forests and evapotranspiration; Forest runoff processes; Forests and, stream-flow quantity and quality; Forests and stream sediment; Forests and flooding.

#### **UNIT-IV**

Climate change – definition and its detection; Impact of climate change on water resources (impact on groundwater-level and depletion, -recharge, -quality); Arid zone hydrology – Introduction; Characteristics of arid zones; Thumb Rule; Groundwater Management – Basic concepts; Instruments and Institutions for groundwater management; Basic tools of groundwater management; Artificial recharge and groundwater recharge estimation; Groundwater quality management; Integrated Water Resources Management (IWRM).

**Practical:** Rain water budgeting – run off and soil loss, infiltration, soil moisture, deep percolation and ground water recharge, rainfall measurements hydrograph. Techniques for measuring subsurface flow on hill slopes. Field study of hill slope flow processes.

#### **Suggested readings:**

- David Keith Todd and Larry W. Mays – Groundwater Hydrology (3<sup>rd</sup> edition) – Wiley Publishers, 2004.
- Fetter, C. W. – Applied Hydrogeology (4<sup>th</sup> edition) – Pearson Education, 2014.
- Ven Te Chow, David Maidment and Larry Mays – Applied Hydrology (2<sup>nd</sup> edition), McGraw Hill, 2013.
- Mingteh Chang – Forest Hydrology, An Introduction to Water and Forests (2<sup>nd</sup> edition) – CRC Press, 2012.
- Devendra M. Amatya, Thomas M. Williams, Leon Bren and Carmen de Jong (Editors) – Forest Hydrology (Processes, Management and Assessment) – CAB International, 2016.
- Baumer 1989. Agroforestry for watershed management. ICRAF, Kenya
- Dhruva Narayana VV 1993. Soil and water conservation research in India, ICAR, New Delhi
- Dutta SK. 1986. Soil Conservation and Land Management. International Book Distributors, Dehra Dun. Hamilton IS. 1987. Forest and Watershed Development and Conservation in Asia and the Pacific. International Book Distributors, Dehra Dun.

- Hamilton IS. 1988. Tropical Forest Watersheds. Hydrologic and Soil Response to Major Uses of Conservation. International Book Distributors, Dehra Dun.
- Hewlett, JD and Nutter, WL 1969. An outline of forest hydrology. University of Georgia Press, Athens. Moorthy VVN. 1990. Land and Water Management. Kalyani Publishers.
- Morgan 1984. Soil Conservation. Nataraj Pub, Dehra Dun.
- Murty JVS 1995. Watershed Management in India. Wiley Eastern, New Delhi.
- Oswal MC. 1999. Watershed Management (For Dryland Agriculture), Associated Publishing Co., New Delhi.
- Rajora R. 1998. Integrated Watershed Management. Ravat Publ., New Delhi.
- Rama Rao. 1980. Soil Conservation. Standard Book Depot, Bangalore.
- Satterlund, DR. 1972. Wildland watershed management. The Ronald Press Company, New York.

## **FRM 517 PRINCIPLES AND PRACTICES OF ARBORICULTURE 1+1**

### **Objective**

To understand various techniques adopted for cultivation of trees and their utilization in landscaping and avenue planting.

### **Theory**

#### **Unit 1**

Scope of arboriculture- Tree forms, shapes and architecture-arboriculture for soil improvement and soil conservation, for domestic and industrial produces, trees and environmental pollution control abatement- arboriculture for employment generation.

#### **UNIT-II**

Avenue planting of trees species selection and planting methods, shade, water and nutrient management sprayers and dusters low volume and high volume sprayers, vapourizers, aerosols.

#### **UNIT-III**

Planting and management of timber, ornamental flowering and foliage trees, multipurpose, medicinal and fruit trees

## **UNIT-IV**

Designing and landscaping of parks and other public areas-landscaping with trees-principles and practices Social awareness and social concern of tree planting

### **Practical:**

Visit to arboretums and botanical gardens maintained by various institutes-Study the different forms and shapes of trees, explain tree architecture-make diagrams and sketch, study the role of trees in environmental amelioration.

### **Suggested reading**

- Ahuja, M.R and Libbey, W.J 1993. Clonal Forestry. Springer-Verlag, London
- Doornbos, M., Saith, A and White, B. 2000. Forest – Nature, People, Power. Blackwell Publishers, Massachusetts, USA.
- James, N.D.G. 1989. The Arboriculturists Companion. Basel Blackwell Ltd. Oxford.
- Sagwal, S.S. 1994. Trees on Marginal Hands. Scientific Publishing Company, Jodhpur.

## **FRM 518 FOREST ECOSYSTEM ASSESSMENT AND MANAGEMENT 2+1**

### **UNIT-I: Introduction**

Applications of remote sensing technique in forest resources; Introduction of Forest Resources and its Management, Use of Multispectral & Temporal Remote Sensing data, GIS and GPS in Forest Studies, Identification and classification of forest type and forest density, Quantification of forest resources, Wildlife Management, Identification of suitable site for Afforestation and assessing the Bio-diversity and Forest Carbon Dynamics, Social Forestry

### **UNIT-II: Forest Mapping and Monitoring**

Natural Vegetation: Geographical distribution, types, extent and status of vegetation of the World, Asia-Pacific and India. Global forest resources assessment (FRA), Hierarchical forest cover classification scheme (FAO, NRSC, LCCS, FSI and others), Spectral properties of vegetation, factors affecting spectral reflectance. Aerial Photointerpretation: Forest information extraction from aerial photographs. Satellite image interpretation: On-screen and digital methods-based image interpretation for forest type and density mapping/monitoring. Spectral vegetation indices, phenology as discriminant for vegetation

differentiation, growth and green wave, Forest change detection using time series data, Forest biophysical parameters retrieval: Hyperspectral remote sensing for species/community delineation, Microwave remote sensing in forestry, LiDAR remote sensing for tree height determination, Biophysical spectral response-based forest canopy density (FCD) mapping.

### **UNIT-III: Forest Informatics**

Fire ecology, Global and national issues, Fire detection and scar mapping, Fire risk assessment and modelling, Indian National Forest Fire Response Assessment and Support System (INFFRASS), Wildlife habitat: Concept of protected areas, Protected areas in India, Project Tiger, Project Elephant, wildlife corridors, Habitat suitability models and modelling, Wildlife Information System (WILIS) Biodiversity Information System (BIS), Indian Bioresource Information System (IBIN)

### **UNIT-IV: Forest Ecosystem Analysis**

Forest Ecology: Forest ecosystems principles and concepts, Structural components, Functional analysis, Biogeochemical cycles, Carbon pools and fluxes assessment, Landscape ecology: Landscape concept, Landscape characterization, Landscape matrices, Landscape and ecosystem analysis, Forest, environment & climate: Forest, environment and climate change impacts on forests and biodiversity, Habitat/species loss, Environmental planning and management: Environmental policy and strategy, Environmental impact assessment and monitoring, Wetland monitoring and conservation planning, Agenda-21 and sustainable development planning, Biodiversity legislation, Biodiversity conservation planning

### **Practicals:**

Familiarization with RS data types, Spectral properties of vegetation, Forest mapping & measurement using aerial photographs, Visual image interpretation, Digital image interpretation & Spectral vegetation indices, Forest change detection using time series data, Hyperspectral image interpretation, Microwave image interpretation, LiDAR data processing, Forest canopy density mapping, Spatial database generation on forest/fuel type and extent mapping, forest canopy density mapping, slope, aspect and elevation data generation, road, rail and settlements data generation, water body types and distribution mapping, Stock Mapping for Working Plan preparations, Forest fire risk modelling/danger rating using Landsat, ASTER, MODIS data.

## References:

### Books and Reports

1. Anonymous, 2009. State of Forest Report 2009. Forest Survey of India, Dehradun, India.
2. Anonymous, 2009. State of the World's Forests 2009. FAO, Rome
3. Champion, H.G. and Seth, S.K. 1968. A Revised Survey of the Forest Types of India. Manager of Publications, Govt. of India, New Delhi.
4. Collinson, A.S. 1988. Introduction to World Vegetation, 2nd Edn. Academic Division of Unwin Hyman Ltd., London. 37
5. Mueller-Dombois, D. and Ellenberg, H. 1974. Aims and Methods of Vegetation Ecology. Wiley, New York.
6. Jensen, J.R. 2007. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edn. NJ: Prentice Hall.
7. Brooks, T.M., Mittermeier, R.A., Fonseca, G.A.B., Gerlach, J., Hoffmann, M., Lamoreux, J.F., Mittermeier, C.G., Pilgrim, J.D. and Rodrigues, A.S.L. 2006. Global biodiversity conservation priorities. *Science* 313: 58-61.
8. Detwiler, R.P. and Hall, C.A.S. 1988. Tropical Forests and the Global Carbon Cycle. *Science* 239(4835): 42-47.
9. Goldammer J.G. 1999. Forests on fire. *Science* 284(5421): 1782-1783.
10. Gupta, S., Singh, S., Agarwal, S. And Roy, P.S. (2006). Degradation of Tropical Evergreen Forests In Mokokchung, Nagaland, India –A Geospatial Approach. *International Journal of Ecology and Environmental Sciences* 32(4): 345-356.
11. Kushwaha, S.P.S., Khan, A., Habib, B., Quadri, A. and Singh, A. 2004. Evaluation of sambar and muntjak habitats using geostatistical modelling. *Current Science* 86(10): 1390-1400.
12. Rands, M.R.W., Adams, W.M., Bennun, L., Butchart, S.H.M., Clements, Andrew, Coomes, David, Entwistle, A., Hodge, I., Kapos, V., Scharlemann, J.P.W., Sutherland, W.J., and Vira B. 2010. Biodiversity conservation: challenges beyond 2010. *Science* 329: 1298-1303.
13. Santilli, M., Moutinho, P., Schwartzman, S., Nepstad, D., Curran, L. and Nobre, C. 2005. Tropical deforestation and the Kyoto Protocol. *Climatic Change* 71(3): 267-276.
14. Thakur, A.K., Singh, G., S. Singh and Rawat, G.S. (2011). Impact of Pastoral Practices on Forest Cover and Regeneration in the Outer Fringes of Kedarnath Wildlife Sanctuary, Western Himalaya. *J. Indian Soc. Remote Sensing* 39(1): 127-134.
15. Odum, E.P. 1975. Fundamentals of Ecology. W.B. Saunders, Philadelphia.
16. Forman, R.T.T. and Godron, M. 1986. Landscape Ecology. John Wiley & Sons, New York.

17. Magurran, A.E. 2004. Measuring Biological Diversity. Blackwell Publishing, Oxford, UK.
18. Millennium Ecosystem Assessment 2005. Ecosystems and Human Well-Being: Synthesis. Island Press, Washington, DC.
19. Singh, J.S., Singh, S.P. and Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.
20. Richards, J.F. and Flint, E.P. 1994. Historic Land Use and Carbon Estimates for South and Southeast Asia 1880–1980. In: Daniel, R. C. (ed.), ORNL/CDIAC-61, NDP-046, Oak Ridge National Laboratory, Tennessee, U.S.A., 326 pp.

## **DEPARTMENT OF WILDLIFE SCIENCES**

### **WLS 511 FUNDAMENTALS OF CONSERVATION BIOLOGY 2+1**

#### **Objective:**

To provide knowledge about the various aspects of Conservation Biology such as biological diversity, design of protected areas network etc

#### **Theory**

##### **UNIT-I**

Introduction to Conservation Biology, Conservation of biodiversity, Patterns and processes; concepts of biodiversity, levels of biodiversity, patterns of losses.

##### **UNIT-II**

Conservation Genetics, Management and conservation of genetic variation in natural populations.

##### **UNIT-III**

Ex-situ conservation. Demographic issues, Population viability analysis, ecological restoration,

##### **UNIT-IV**

Designing conservation reserve, Management to meet conservation goal; Control of invasive species, scales of management (on population level, habitat and landscape) of management and cultural context.

#### **Practical:**

Seminar based discussion and paper analysis. Calculations of degree of inbreeding, MVP sizes, PHVA, etc. Evaluation of existing protected areas from the point of view of principles of conservation biology.

#### **Suggested reading**

- Primack, R.B. 1993. Essentials of Conservation Biology.
- Soiner, MA. Piank, E.R. 1981. Competition and niche theory. In Theoretical Ecology. May (ed). Pielou, E.C. 1975. Ecological Diversity. Wiley Interscience Pub.
- Hunterer, M.L. 1996. Fundamentals of Conservation Biology. Blackwell

**WLS 512**

**ADVANCES IN WILDLIFE MANAGEMENT**

**2+1**

**Objective:**

To acquaint about the wildlife management aspects

**Theory**

**UNIT-I**

History of wildlife management and conservation in India, Zoogeographic regions of the world, major biomes of the world, biogeographic zones of India.

**UNIT-II**

IUCN revised red list categories, Red Data Book and red listing, Wildlife census, radio telemetry in wildlife studies. Captive wildlife: Zoos and safari parks. Captive breeding for conservation. Central Zoo Authority of India. Wildlife (Protection) Act, 1972.

**UNIT-III**

Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Captive breeding and reintroduction of threatened species. MAB, CITES, TRAFFIC.

**UNIT-IV**

Human-wildlife conflicts, Wildlife health management, Protected area network of India, wildlife sanctuaries, national parks, biosphere reserves, world heritage sites, ramsar sites etc

**Practical**

Exercise on the census methods, use of soft ware for analysis of census data. Pitfall trap, mist net, Sherman trap, camera trap, and other traps to study the wildlife.

**Suggested readings**

- Berwick, S.H. and Saharia, V.B. 1995. Wildlife Research and Management. OUP, New Delhi.481pp.
- Dasmann, R.F. 1982. Wildlife Biology.
- Rajesh, G. Fundamentals of Wildlife Management, Justice Home, Allahabad.
- Reena Mathur. 1985. Animal Behaviour.
- OUP Sawarkar B. Wildlife Management. WII.
- Sukumar, R. Asian Elephant. Ecology and Management. OUP Cambridge.

- Wildlife Institute of India 2004. Compendium on the notes on the course Captive management of Endangered Species. WII. 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

## **WLS 513      ECOTOURISM - CONCEPT AND MODERN APPROACHES      2+1**

### **Objective**

To acquaint about the impact of tourism on ecology.

### **Theory**

#### **UNIT-I**

Eco tourism - study history of tourism, identify various forms of tourism and evolution of ecotourism. Dimensions of tourism and essential conditions for tourism to occur. Differences between tourism components. Mass tourism versus ecotourism.

#### **UNIT-II**

Sustainable use, Understand dimensions of ecotourism and the criteria to qualify for ecotourism. Quebec declaration. Different forms of ecotourism like hard and soft ecotourism. Ecotourism indicators and conceptual differences between developing and developed countries.

#### **UNIT-III**

Organized tours and Free Independent Travelers. World Tourism Organization. Problems with definition of ecotourism and criticisms.

#### **UNIT-IV**

International organizations and NGOs promoting ecotourism. Sociological implications of eco-tourism.

### **Practical**

Students should make detailed reference on the various forms of Ecotourism in the World. Visit to various ecotourism areas and identify the tourism components- suggest modifications. Exercises on the blending of local cultural and sociological heritage with the various forms of ecotourism. Debate on the concept to reach the most viable. Once they agree on a concept, then the debate. Problems on common property resources and facilitate group discussion for recommendations. Discuss the merits and demerits of the recommendations. Evaluation and monitoring of the various ecotourism activities of the region. Identify an area where ecotourism in vogue- Identity the various ecosystem activities in the selected area,

evaluate in terms of economic feasibility, ecological adaptability and social acceptance. Climate change and its influence on carbon economy. Study the carrying capacity and impact of ecotourism activity on the ecosystem, suggest recommendation to overcome the ill effects of ecotourism.

### **Suggested Readings**

- Baker CP. 1996. World Travel: A Guide to International Eco Journeys. Warner Books.
- Honey M. 1998. Ecotourism and Sustainable Development. Iceland Press.
- Luck M and Kirstges T. 2002. Global Ecotourism Policies and Case Studies. Channel View Publ.
- Neale G. 1999. Green Travel Guide. Earthscan.

## **WLS 514                      WILDLIFE AND HABITAT ECOLOGY      (2+1)**

### **Objective**

To provide knowledge about the ecological aspects of wild animals and their habitat which in turn help the conservation of wild animals

### **Theory**

#### **UNIT-I**

Demographic and life history parameters, evolution of life history parameters: r & K selection, allometry, aging and sexing, life tables, methods of estimation of life history parameters, population dynamics: exponential, logistic and other forms of growth of population, density dependent and independent growth, population ecology of plants, population simulation, predator-prey systems, carrying capacity, population estimation methods: relative, absolute measures and age/sex composition. Preparation of sampling designs for population estimation.

#### **UNIT-II**

Community Ecology - Definitions and nature of communities - Energy & materials flux through communities; Productivity; Intra and inter-specific competition and mutualism; Community structure, organization and stability (guilds, resource partitioning, niche, competitive exclusion); measures of diversity and richness, edge, ecotones, interspersions and juxtaposition

#### **UNIT-III**

Physical and anthropogenic factors influencing terrestrial habitats. Habitat degradation and fragmentation. Successional changes and wildlife habitat. Inventory, evaluation and

monitoring of wildlife habitat - Measuring wildlife habitat, availability, quality, palatability of graze and browse. **UNIT-IV**

Inventory of unique habitats and their distribution, Animals signs as indicators of habitat use, use of map overlay approach in habitat evaluation. Monitoring changes in habitat parameters, use and availability of habitat resources.

### **Practicals**

Seminars and discussion of relevant published literature; Simulation (stochastic and deterministic) modeling of populations. Calculations of energy and productivity. Analysis of species diversity. Comparison of several techniques for quantitative habitat survey and mapping. Evaluating habitat availability and utilization. Field visits for habitat evaluation, visit to wetland areas and demonstration of habitat quantification techniques.

### **Suggested Readings:**

- Berry RJ and Hallen A. 1989. Animal Evolution, William Colliasn & Soni.
- Grover SP and Gupta. SK.1998, An introduction to Animal Behaviour. Bishansingh Mandra Pal Singh
- John A Cock. 1985. Animal Behavior an Evolutionary Approach. Sinavier Associates. Massachusetts.
- Reena Mathur 2000. Animal Behavior. Rastogi Publication
- Slater. RJB.1984. An introduction to Ethology. Cambridge University press.
- Stanley H. Anderson. 1990. Managing our Wildlife resource. Prentice Hall. New Jersey.
- Elton C.S.1927. Animal ecology, Sidgwick and Jackson, London.

**WLS 515**

**ETHNOBIOLOGY AND TRIBAL WELFARE**

**1+1**

### **Objective**

To acquaint with tribals of Indian with particular emphasis on the tribals, their problems and welfare issues

### **Theory**

## **UNIT-I**

Ethnobiology - definition, Ethno botany, Ethno zoology, definition of tribe, main features. General economic, political and social structure, Racial classification, concepts of race, family, class, heirship, Principles of social grouping and social control. Cultural traditions, customs, ethos, beliefs and practices.

## **UNIT-II**

Important tribes of India. Important tribes of Telangana. Tribal economy, features, occupational characteristics, interdependence with forests, role of NWFP in the life of tribes. Tribes and Forest policies - Rights and concessions and fall out. Constitutional safeguards for the welfare of tribes. Problems faced by tribes of India - Indebtedness and land alienation.

## **UNIT-III**

Role of tribes in Forest and PA management. Tribal development schemes and problems in implementation. Legal provisions to safeguard tribal interests. Ethnic conflicts between tribes and non tribes. Voluntary organizations and tribal development. Tribal research - priorities and back drop. The continuity and changes in culture of tribe and future of tribal society.

## **UNIT-IV**

Tribals and JFM, Indigenous knowledge and tribal development, Ethno medicinal practices and traditional wisdom, Bio piracy of medicinal plants, Bio imperialism and bio prospecting. Tribal development and five year plans. Commercial forestry and indigenous people. Shifting cultivation and tribes. Tribes and forest development works, Eco development through tribal development – Important case studies of Protected areas and conservation reserves in India and Telangana. Human rights and tribes.

## **Practical**

Visit to different tribal colonies to understand problems faced by them, Conduct surveys to evaluate the life standards. Visit to different development organizations and NGO's implementing tribal welfare schemes and study about research aspects of Indian tribes. Visit Vana Samrakshana Samiti (VSS) of tribes and understand their role in forest management.

## **Suggested readings**

- Maheshwari K. 1998. Ethnobotany in S Asia. Scientific publishers

- Pushpangathan et al. 1997. Conservation and Ecological Economics of biodiversity. Longman.
- Ramprasad Sangupta. 2001. Ecology and Economics. OUP

### **SUPPORTING COURSES**

**STA 501**

**DESIGN OF EXPERIMENTS**

**1+1**

#### **Objective**

Designing an experiment is an integrated component of research in almost all sciences. The students would be exposed to the concepts of Design of Experiments so as to enable them to understand the concepts involved in the basic principles of designing an experiment, collection of data, analysis and interpretation.

#### **THEORY**

##### **UNIT-I: PRINCIPLES OF EXPERIMENTATION**

Basic concepts – terminology in experimental designs – experiment – treatment – experimental unit – blocks – experimental error – principles – randomization, replication and local control – error control – selection of experimental material – uniformity trials – determination of optimum plot size – maximum curvature method.

##### **UNIT-II: ANOVA AND MEAN COMPARISONS**

Analysis of variance – assumptions in analysis of variance – effects of failure of assumptions – identification and remedies – Data transformation – logarithmic, angular and square root transformations – multiple comparisons – critical difference (least significant difference) and Duncan's multiple range test (DMRT).

##### **UNIT-III: SINGLE FACTOR EXPERIMENTS**

Designs for laboratory and field experiments – single factor experiments – Completely Randomised Design (CRD) with equal and unequal replications – layout of CRD – analysis of CRD – advantages and disadvantages of CRD – Randomised Block Design (RBD) – layout of RBD – analysis of RBD – advantages and disadvantages of RBD – efficiency of RBD over CRD – missing plot technique in RBD (one and two missing observations) – analysis of covariance (RBD) – multi- observation data.

##### **UNIT-IV: FACTORIAL EXPERIMENTS**

Concept of factorial experiments – factor – levels of a factor – simple, main and interaction effects – advantages and disadvantages of factorial experiments – symmetrical and asymmetrical factorial experiments – comparison of single factor experiments and factorial

experiments –  $2^n$  factorial experiments – analysis using regular method (RBD) – Yates algorithm – asymmetrical factorial experiment (up to 3 factors).

### **UNIT V: DESIGNS FOR FACTORIAL EXPERIMENTS**

Split-plot design – lay out – analysis – advantages and disadvantages – strip plot design – layout – analysis – advantages and disadvantages – split-split-plot design – layout – analysis.

### **PRACTICAL**

Determination of optimum plot size using uniformity trial – analysis of CRD with equal and unequal replications – comparison of means – analysis of RBD and calculating the efficiency of a design – analysis of RBD with log, square root and angular transformation of data – missing plot techniques in RBD with one and two missing observations – analysis of covariance in RBD – analysis of multi observation data (sampling in RBD) – symmetrical factorial experiment (RBD) – Yates algorithm – regular method – asymmetrical factorial experiment (RBD) – split-plot design – strip plot design – split-split plot design.

## **STA 502 REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM 2+1**

### **Objective**

To acquaint with the use of imageries, GIS and simulation in forest survey and management.

### **Theory**

#### **UNIT-I**

The use of aerial photography, satellite imagery and geographic information system for the collection, storage and spatial analysis for geo- referenced forest resources data and information.

#### **UNIT-II**

The integration of spatial data analysis systems with knowledge-based systems and/or simulation systems for the development of information/decision support systems for forest management;

#### **UNIT-III**

Satellite systems; satellite imageries – techniques, uses and limitation;

#### **UNIT-IV**

Future prospects of remote sensing in India; softwares used in remote sensing ; GIS versus remote sensing; GIS Software used in forestry and environments; Analysis of data; Application of GIS in forestry.

## **Practical**

Uses of various photogrammetry instruments, recognition and identification of objects on photography, compilation of maps and their interpretation, Hands on practice on remote sensing and GIS, software.

## **Suggested Readings**

- Burrough PA. 1990. *Principles of GIS for Land Resources Assessment*.
- Oxford & IBH.
- Lillsand TM. 1989. *Remote Sensing and Image Interpretation*. John Wiley. Narayanan LRA. 1999. *Remote Sensing and its Application*. Universities Press (India) /Orient Longman.
- Sharma NK. 1986. *Remote Sensing and Forest Survey*. International Book Distr.

## **STA 503 APPLIED STATISTICAL METHODS 1+1**

### **OBJECTIVE**

The students would be exposed to concepts of statistical methods and statistical inference that would help them in understanding the importance of statistics. It would also help them in understanding the concepts involved in computation, analysis and interpretation.

### **THEORY**

#### **UNIT-I: SAMPLING THEORY AND ESTIMATION**

Sampling theory – population – finite and infinite population – parameter – sample – statistic – sampling – need for sampling – probability sampling – simple random sampling (SRS) – methods of selection of SRS – lottery method and random number table method – non-probability sampling – purposive and judgment sampling – sampling distributions – standard error and its uses – Estimation theory – estimate – estimator – types of estimation – point estimation – properties of good estimators – unbiasedness, consistency, efficiency and sufficiency – interval estimation – confidence limits – confidence interval.

#### **UNIT-II: TEST OF HYPOTHESIS**

Test of significance – null and alternative hypothesis – Type I and Type II errors – critical region – level of significance – degrees of freedom – large sample test – tests for significance of means and proportions for large samples – small sample test – t- test – testing the significance of single mean – testing the significance of two means for independent and paired samples – F-test for equality of two variances –  $\chi^2$  test for goodness of fit and test for independence of attributes – test for equality of several variances (Bartlett's test).

### **UNIT-III: CORRELATION ANALYSIS**

Bivariate distribution – simple correlation – meaning – assumptions – positive and negative correlation – scatter diagram – computation of correlation coefficient – properties of correlation coefficient – testing and interpretation of correlation coefficient – coefficient of determination – Fisher's Z-transformation – testing several correlation coefficients – Spearman's rank correlation (with and without ties).

### **UNIT-IV: SIMPLE LINEAR REGRESSION ANALYSIS**

Regression – simple linear regression – meaning – assumptions – fitting of simple linear regression equation of  $y$  on  $x$  – properties of regression coefficient – testing and interpretation of regression coefficient and intercept.

### **UNIT V: MULTIPLE LINEAR REGRESSION ANALYSIS**

Multiple linear regression – assumptions – difference between simple and multiple linear regression – standardised and partial regression coefficients – fitting of multiple linear regression equation – testing the regression coefficients – interpretation of regression coefficients – multiple correlation – coefficient of multiple determination ( $R^2$ ) – interpretation of  $R^2$  – selection of variables – stepwise regression approach – multicollinearity – applications of dummy variables.

### **PRACTICAL**

Interval estimation for means and proportion – large sample test – Z test – tests for significance of means and proportions for large samples – small sample test – t-test – testing the significance of single mean – testing the significance of two means for independent and paired samples – F-test for equality of two variances – chi square test for goodness of fit and test for independence of attributes – test for equality of several variances (Bartlett's test) – Simple correlation – computation of correlation coefficient – properties of correlation coefficient – testing and interpretation of correlation coefficient – coefficient of determination – Fisher's Z-transformation – testing several correlation coefficients – Spearman's rank correlation (with and without ties) – Simple linear regression – fitting of simple linear regression equation of  $y$  on  $x$  – testing and interpretation of regression coefficient and intercept – Multiple linear regression – fitting of multiple linear regression equation – testing the partial regression coefficients – interpretation of regression coefficients.

### **SUGGESTED READINGS**

1. Rangaswamy, R, 2009, A text book of Agricultural Statistics, New Age International (P) Ltd., New Delhi.

2. Gupta. S.P, 2005, Statistical Methods, Sultan Chand & Sons, New Delhi.
3. K.P. Dhamu and K. Ramamoorthy, 2007, Statistical Methods, Agrobios (India), Jodhpur.
4. S.C. Gupta & V.K. Kapoor, 2006, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi.
5. Sahu P.K, 2007, Agriculture and Applied Statistics-I, Kalyani Publishers, Ludhiana.
6. D.C. Sanchetti & V.K. Kapoor, 2007, Statistics (Theory, Methods and Application), Sultan Chand & Sons, New Delhi.
7. G. Nageswara Rao, 2007, Statistics for agricultural sciences, BS Publications, Hyderabad
8. E.V. Divakara Sastry, 2007, Essentials of Agricultural Statistics, Pointer Publishers, Jaipur.
9. Murray R. Spiegel and Larry J. Stephens, 2007, Schaum's Outline of Theory and Problems of Statistics, McGraw–Hill, New Delhi.

#### **SUGGESTED WEBSITES**

1. <http://www.statistics.com/resources/glossary/>
2. [www.statsoft.com](http://www.statsoft.com)
3. [http://www.iasri.res.in/ebook/EB\\_SMAR/index.htm](http://www.iasri.res.in/ebook/EB_SMAR/index.htm)
4. [www.stats.gla.ac.uk/steps/glossary/index.html](http://www.stats.gla.ac.uk/steps/glossary/index.html)
5. <http://davidmlane.com/hyperstat/>
6. <http://www.stattrek.com/>
7. <http://www.businessbookmall.com/Statistics Internet Library.htm>
8. <http://www.stat-help.com/>

**STA 504**

**COMPUTER APPLICATIONS IN STATISTICS**

**0+1**

#### **OBJECTIVE**

This course is meant for exposing the students in the usage of various statistical packages like Ms. Excel, SYSTAT and SAS for analysis of data. It would provide the students hands on experience in the analysis of their research data. This course is useful to the students of all disciplines.

#### **PRACTICAL**

Operating system – windows – MS Excel – statistical functions – measures of central tendency – mean, median, mode, geometric mean, harmonic mean – quartiles and percentiles – measures of dispersion – range, quartile deviation, mean deviation, standard

deviation, variance and coefficient of variation – skewness and kurtosis – finding critical values of t, F and  $\chi^2$ .

Statistical data analysis using MS Excel – descriptive statistics – independent and paired t-tests – F test for testing the equality of variances – large sample test for comparing two means – correlation coefficient – simple linear regression analysis – multiple linear regression analysis.

Design of experiments – using AGRES / IRRISTAT – Completely Randomised Design (CRD) – Randomised Block Design (RBD) – factorial experiments – symmetrical and asymmetrical series – split plot design – split-split plot design – data transformation – log transformation – square root transformation – angular transformation.

## **SUGGESTED READINGS**

### **Text Books**

1. Sharma. K.V.S., 2010, Statistics Made Simple: Do it yourself on PC, Prentice Hall of India, New Delhi.
2. Sanjay Saxena, 2003, A first course in Computers, Vikas Publishing House (P) Ltd., New Delhi.
3. Gene Weisskopf, 2000, ABC's of Excel.
4. Ramesh Babu and Samyuktha, 2003, Computer Practice – I, V.R.B. Publications.
5. SYSTAT User's guide and User's manual.
6. SAS User's guide and User's manual.

### **SUGGESTED WEBSITES**

1. <http://www.iasri.res.in/ebook/EBADAT/index.htm>
2. [http://www.iasri.res.in/ebook/EB\\_SMAR/index.htm](http://www.iasri.res.in/ebook/EB_SMAR/index.htm)
3. <http://www.statistics.com/resources/glossary/>
4. [www.statsoft.com](http://www.statsoft.com)
5. <http://www.exceltip.com/>
6. <http://www.baycongroup.com/el0.htm>
7. <http://office.microsoft.com/training/training.aspx?AssetID=RC100620751033>