

COURSE CURRICULUM

for

**Undergraduate Degree Programme
in Forestry**

B.Sc. (Hons.) Forestry

(As per Fifth Dean Committee Recommendations)



FACULTY OF AGRICULTURE
Jawaharlal Nehru Krishi Vishwa Vidyalaya
Jabalpur, Madhya Pradesh

COURSE CURRICULUM
B.Sc. (Hons.) Forestry Degree Programme
(As per V Dean Committee Recommendations)

Under
10+2+4 System



FACULTY OF AGRICULTURE
Jawaharlal Nehru Krishi Vishwa Vidyalaya
Jabalpur, Madhya Pradesh



COURSE CURRICULUM

B.Sc. (Hons.) Forestry Degree Programme

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कुलपति

Dr. Pradeep Kumar Bisen
Vice Chancellor



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कृषि नगर, आधारताल, जबलपुर ४८२ ००४ (म.प्र.)

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FOREWORD

I am happy to learn that course curriculum of B.Sc. (Hons.) Forestry degree programme has been restructured as per Fifth Dean's Committee recommendations of the ICAR, New Delhi. The new unified and improved course curriculum with certain modifications has ample opportunity to broaden the scope and potential for employment of forestry graduates. It is hoped that the detail course content of curriculum will be very meaningful and useful for students as well as for teachers.

The course curriculum compiled and published by Dean Faculty of Agriculture, JNKVV, Jabalpur and faculty of Department of Forestry deserves all appreciation for the introduction and implementation of new course curriculum.

I wish that the teachers and students will work with full devotion and sincerity for the successful implementation of this course curriculum.

(P.K. Bisen)



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PREFACE

The new syllabus of of B.Sc. (Hons.) Forestry degree programme has been implemented as per the recommendations of Fifth Dean's Committee of the ICAR, New Delhi. The course curriculum has been modified to meet the job requirements of the State.

The redefined courses in the frontier areas will equip our forestry graduates to meet the challenges of the coming century. It is not only the course curriculum that has been revised but the academic regulations have also been improved to meet the all India standard of forestry education.

Emphases have also been given on field practical and hands-on training. The last semester is devoted to internship programme which will make our graduates self confident and also suitable for private and public sector jobs in the field of forestry.

Appreciable efforts have been made by Dr. S.D. Upadhyaya, Professor and Head, Department of Forestry and his team during the preparation of new course curriculum is duly acknowledged.

(P.K. Mishra)



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PREFACE

The course curriculum of B.Sc. (Hons.) Forestry degree programme has been revised and unified as per recommendations of the Fifth Deans Committee of ICAR. The Course Curriculum has been given fine tuning by including experimental learning, envisaged for various courses. The new courses in the frontier areas will equip forestry in the upcoming subject areas for the sector.

The course curriculum is expected to meet the changing demands of forestry professionals and Forestry based Industries in coming future. Emphases have also been given on field practical and hands-on training. The course curriculum has been modified to meet the job requirements of the State.

The efforts made by Dr. S.D. Upadhyaya, Professor and Head, Department of Forestry and his team during the preparation of new course curriculum are appropriately acknowledged.

(R.M. Sahu)



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आचार्य एवं विभागाध्यक्ष

ACKNOWLEDGEMENT

In order to give full effect to the usefulness of forestry education, the new course curriculum of B.Sc. (Hons.) Forestry is implemented as per recommendations of the ICAR Fifth Dean's Committee from the academic session 2016-17. The course curriculum has been modified to meet the job requirements of the State and this will better equip the students to meet the complex challenges of the forestry sector in times to come. The entire course curriculum in a booklet form will enable the teachers and students to prepare themselves well in advance for the new courses to be offered. The ever increasing population and rapid decrease in forest cover is creating environmental, ecological and economic disturbances with irreversible consequences, which need to be taken care of through producing quality human resources in Forestry sector.

The suggestions given by Hon'ble Vice Chancellor, Dr. P.K. Bisen, Dean Faculty of Agriculture, Dr. P.K. Mishra and Dean, College of Agriculture, Jabalpur Dr. R.M. Sahu, during the preparation of this course curriculum is duly acknowledged.

I appreciate the active participation, suggestions and contributions of entire faculty members of the Department of Forestry.

S.D. Upadhyaya

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No country can improve its quality of the life and slandered of living unless its human resources are wedded to its national resources

Pandit Jawaharlal Nehru
The First Prime Minister of India

The greatest services which can be rendered by any country is to add a useful plant to its culture.

Thomas Jefferson

There is pleasure in the pathless woods There is society where non intrudes
Love not the man less but nature more

Lord Bryon

All wilderness is finer than tameness, in God's wilderness lies the hope of the world.

John Muir

Forest are green oceans are blue keep the earth clean for me and you

Indira Gandhi

Plant a tree, grow a flower, let's give Mother Earth back her power

APJ Abdul Kalam

INTRODUCTION

India is bestowed with biotically rich and diverse flora and fauna due to large and distinct variations in physiographic, attitude and climatic conditions. The faulty and poor management practices, organizational bottlenecks led to degradation of rich, diverse and unique flora and fauna while few are at extinction state. Moreover, the increasing demands on forest as grazing grounds and for forest based products namely wood, fuel and fodder, have accelerated the rate of degradation, erosion of forest soil and biodiversity. Thus, today India is left with only 19% forest cover, which as per National Forest Policy 1988, it should be 33% of the geographical area. Massive deforestation, increased industrialization and use of fossil fuel have resulted in the accumulation of carbon in the atmosphere and loss of rich genetic species and ecosystem biodiversity.

Madhya Pradesh is truly unique State of natural resources and physical landscape with a land area of 3.08 lakh square kilometrer to approx 1/3 of the total area of the State. For Madhya Pradesh, forest has special importance because major portion of the State population is tribals (approx 35% of the total population), whose economic and social development is linked with the forest. Tribal development cannot make headway without proper development of forests. Biological diversity in this State is under threat because of high pressure of growing population on land, unregulated grazing in the forest area, slash and burn agriculture, increased demand for forest products (fuel wood, fodder, timber poles, pulp, medicine, oil etc.) for domestic and industrial use. Thus, forestry sectors need intensive input (technical as well as economical) to increase the production of forest produce which will ultimately led to tremendous reduction in imports and increase in exports.

It has now been realized that the forests and vegetation cannot be managed by one sector alone. The knowledge and concerned participation of various forest dependent sectors, farming and the people inhabiting in and around forest area is of utmost importance. Such realization can be achieved only by the understanding changes in the forestry technology and finally developing appropriate educational programmes to address the future challenges in the forestry. The universities, dedicated to the development of forestry education, should formulate curricular and courses for imparting education and promoting post graduate research and professional excellence. It is with this objective ICAR Accreditation Committee has proposed and recommended the uniform course and credits for updating the forestry education in the country. Moreover, the courses have been framed by considering the present and future needs of the professionals.

FOREST EDUCATION IN INDIA

Forestry education in State Agricultural Universities is only two decades old although scientific forestry programmes to train forestry professionals were started as early as 1864. Year 1985 saw the inception of undergraduate forestry education in the country at YSPUHF, Solan and PDKV, Akola. This was followed by GBPUAT, Pantnagar and TNAU, Coimbatore in 1986. JNKVV, Jabalpur and OUAT, Bhubaneshwar in 1987 and NAU, Navsari in 1988.

Later on few more SAUs also started this programme and currently fifteen colleges/Departments of Forestry in SAUs are offering this programme. The first major exercise for developing uniform curricula was undertaken in February 1993 during a national workshop on 'Forestry Course Curriculum in India' at YSPUHF, Nauni Solan, HP. In order to prepare the forestry graduates to deal with the emerging issues and challenges in forestry sector, the present curricula revision exercise has been undertaken. The revisions are aimed at introducing newer concepts and delete obsolete and overlapping course contents.

BRIEF ABOUT FORESTRY DEPARTMENT

During the 6th five year plan period, Department of Forestry was established at JNKVV, Jabalpur under the faculty of agriculture on 4th November 1981. Financial assistance to the department under the budget head, 'Starting of undergraduate and postgraduate Department of Forestry' during the remaining period of the VI five year plan (i.e. 1982-83 to 1984-85) was provided by ICAR, New Delhi. In view of the shortage of trained manpower in the forestry sector, ICAR considered the expansion of forestry education and research in selected State Agricultural Universities during the VII plan period (1985-90) with the objective of getting professionally trained manpower for education and research in tree crop improvement, silviculture and the management of forests estates on sustainable basis. ICAR selected 13 State Agricultural Universities of India including JNKVV, Jabalpur for starting B.Sc. (Forestry) degree programme of four year duration, during the academic year 1985-86. In accordance with the approval of ICAR, New Delhi, Department of Forestry, JNKVV, had initiated the B.Sc. (Forestry) programme in the year 1987-88 with annual intake capacity of 15 students. Now the annual intake capacity is of 35 students. The formal creation of the Department of Forestry has been made by JNKVV on 9th April 2001.

At present, "This is the only department in JNKVV which has been imparting B.Sc. (Forestry), M.Sc. (Forestry) / Ph.D. (Forestry) degree under the faculty of agriculture.

During the year 2009-10, improved and standardized forestry syllabus at under graduate /post graduate levels, B.Sc. (Forestry)/M.Sc. (Forestry), was adopted by this department as recommended by Fourth Dean Committee on Agricultural Education (including forestry education) in India, ICAR, New Delhi and ICFRE, Dehra Dun.

DEPARTMENT – MISSION, MANDATE, VISION AND FUTURE TRUST

Mission: Integrated responsibilities for Forestry Teaching, Research and Extension.

Mandate:

- Quality human resources development in the area related to forestry fields and natural resource management.
- Need based research in forestry/ Agro forestry for improving the Socio-economic status of state farmers/ tribal
- Dissemination of forestry/ Agro forestry technology to farmers/ tribal through various extension programs.

Vision: Department of forestry sees millions of poor marginal and small farmer's access to forestry/ agroforestry innovations that will improve their livelihood and help sustain the state environment.

Objectives:

- Get professional trained manpower for education and research in the management of forests estate on sustainable basis.
- Equip forestry graduates with current trends and requirements of forestry.
- Enable forestry graduates to help in forestry development and taking forestry entrepreneurship ahead.
- Enable them to help in environmental protection, value addition of forestry products and make forestry globally competitive.

Future thrust

- Increasing flexibility in curriculum.
- Initiating new courses
- Expanding services courses
- Enhancing communication skills of students
- Establishing and maintaining recruitment goals
- Strengthening existing undergraduate and postgraduate programmes
- Starting M.Sc. (Forestry) programmes in three more disciplines of forestry
- Increasing funding levels
- Opening of Faculty of Forestry
- Forestry training to non-trained teachers

Requirement for B.Sc. (Forestry) Degree Programme

- | | |
|------------------------------|---------------------------------|
| ▪ Duration of Programme | 4 Years (8 semesters) |
| ▪ Eligibility | 10+2 (PCMB) |
| ▪ Mode of Admission | Entrance Test - PAT |
| ▪ Examination and Evaluation | Internal (50%) + External (50%) |
| ▪ Medium | English |
| ▪ Grading | 10 point scale |
| ▪ Total Credits | 181 (85+96) |

DEPARTMENT WISE DISTRIBUTION OF COURSES

1. Silviculture and Agroforestry (SA)

Code	Subject	Credit
ITF	Introduction to Forestry	2+0
DND	Dendrology	2+1
SIE	Silviculture	2+1
PAF	Principles of Agroforestry	2+1
FME	Forest Mensuration	2+1
FM	Forest Management	2+1
SIT	Silviculture of Indian Trees	2+1
FHW	Forest Hydrology and Watershed Management	2+1
ELU-I	Experiential Learning	0+5
PFT	Plantation Forestry	2+1
ELU-II	Experiential Learning	0+5
FWE	Forestry Work Experience (Student READY, FWE)	0+20
ASM	Agroforestry Systems and Management	2+1
PWD	Project Work & Dissertation	0+10
	Total	20+49=69

2. Forest Biology and Tree Improvement (FBT)

Code	Subject	Credit
PPY	Plant Physiology	2+1
PCG	Plant Cytology and Genetics	1+1
TIM	Tree Improvement	2+1
STN	Seed Technology & Nursery Management	2+1
ELU I	Experiential Learning	0+5
ELU II	Experiential Learning	0+5
FWE	Forestry Work Experience (Student READY, FWE)	0+20
FBL	Forest Biotechnology	2+1
PWD	Project Work & Dissertation	0+10
	Total	9+45=54

3. Natural Resource Management (NRM)

Code	Subject	Credit
IAH	Introduction to Agronomy and Horticulture	2+1
GAS	Geology & Soils	2+1
FPN	Forest Protection	2+1
EDM	Environmental Studies and Disaster Management	2+1
FSE	Forest Survey & Engineering	2+1
SBF	Soil Biology & Fertility	2+1
FEC	Forest Ecology & Biodiversity	2+1
RLM	Rangeland and Livestock Management	1+1
CSE	Climate Science	2+1
ELU-I	Experiential Learning	0+5
FLP	Forest Laws, Legislation and Policies	2+0
GMT	Geomatics	1+2
RUF	Recreation & Urban Forestry	1+1
REG	Restoration Ecology	1+1
ELU-II	Experiential Learning	0+5
FWE	Forestry Work Experience (Student READY, FWE)	0+20
FIP	Forest Inventory and Yield Prediction	1+1
PWD	Project Work & Dissertation	0+10
	Total	23+54=77

4. Forest Products and Utilization (FPU)

Code	Subject	Credit
WAN	Wood Anatomy	2+1
WPU	Wood Products & Utilization	2+1
EMA	Ethnobotany, Medicinal and Aromatic Plants	2+1
WST	Wood Science and Technology	2+1
LAE	Logging and Ergonomics	1+1
ELU –I	Experiential Learning	0+5
NTP	Non-Timber Forest Products	2+1
CFP	Certification of Forest Products	2+0
ELU –II	Experiential Learning	0+5
FWE	Forestry Work Experience (Student READY, FWE)	0+20
PWD	Project Work & Dissertation	0+10
	Total	13+46=59

5. Wildlife Sciences (WLS)

Code	Subject	Credit
WBY	Wildlife Biology	2+1
OH	Ornithology & Herpetology	2+1
ELU-I	Experiential Learning	0+5
ELU-II	Experiential Learning	0+5
FWE	Forestry Work Experience (Student READY, FWE)	0+20
WLM	Wildlife Management	1+1
PWD	Project Work & Dissertation	0+10
	Total	5+43=48

6. Basic and Social Science (BS)

Code	Subject	Credit
ICT	Information and Communication Technology	1+1
CPD	Communication Skills and Personality Development	1+1
PBT	Plant Biochemistry	1+1
FEB/BMS	Forest Botany/Basic Mathematics	1+1
PED-I	Physical Education-I	0+1*
NCC-I/NSS-I	NCC-I/NSS-I	0+1*
SMD	Statistical Methods & Experimental Designs	2+1
PED-II	Physical Education-II	0+1*
NCC-II/NSS-II	NCC-II/NSS-II	0+1*
PED-III	Physical Education-III	0+1*
NCC-III/NSS-III	NCC-III/NSS-III	0+1*
FTA	Forest Tribology & Anthropology	2+0
STS	Study Tour of State Forest	0+1*
FEF	Forest Extension & Community Forestry	2+1
EBM	Entrepreneurship Development & Business management	1+1
FEM	Forest Economics and Marketing	2+1
AIT	Agricultural informatics	2+1
ELU-I	Experiential Learning	0+5
ELU-II	Experiential Learning	0+5
AST	All India Study Tour	0+3*
FWE	Forestry Work Experience (Student READY, FWE)	0+20
	Total	15+49=64

Experiential Learning Modules

Code	Subject	Credit
FP	Production and Marketing of high value forest produce	0+5
SA/FB	Raising Quality Planting Materials for forest regeneration	0+5
FB/NR/WL	Apiculture/Sericulture	0+5
BS/WL	Ecotourism	0+5
WL	Wild Animal Health Management	0+5

Forestry Work Experience (FWE)

Orientation	(10 days)	0+1
Forest Range Training Programme	(50 days)	0+12
Industrial placement	(20 days)	0+3
Weapon Training and First-Aid Training	(5+3=8 days)	0+1
Socio-economic Surveys and Village Attachment	(20 days)	0+2
Report writing and presentations	(12 days)	0+1
Total	(120 days)	0+ 20

SEMESTER WISE COURSES DISTRIBUTION

Semester I (12+9=21 Credit Hours including 2 Non-Credit)

S.No.	Paper Code	Course	Credit
1.	B0901	Dendrology	2+1
2.	B0902	Introduction to Agronomy and Horticulture	2+1
3.	B0903	Geology & Soils	2+1
4.	B0904	Information and Communication Technology	1+1
5.	B0905	Communication Skills and Personality Development	1+1
6.	B0906	Plant Biochemistry	1+1
7.	B0907	Introduction to Forestry	2+0
8.	B0908	Physical Education-I	0+1*
9.	B0909	NCC-I/NSS-1	0+1*
10.	B0910/ B0911	Basic Mathematics / Forest Botany	1+1
		TOTAL	12+9

Semester II (13+9=22 Credit Hours including 2 Non-Credit)

S.No.	Paper Code	Course	Credit
1.	B0912	Plant Physiology	2+1
2.	B0913	Plant Cytology and Genetics	1+1
3.	B0914	Theory and Practice of Silviculture	2+1
4.	B0915	Wood Anatomy	2+1
5.	B0916	Wildlife Biology	2+1
6.	B0917	Forest Protection	2+1
7.	B0918	Statistical Methods & Experimental Designs	2+1
8.	B0919	Physical Education-II	0+1*
9.	B0920	NCC-II/NSS-II	0+1*
		TOTAL	13+9

Semester III (14+9=23 Credit Hours including 2 Non-Credit)

S.No.	Paper Code	Course	Credit
1.	B0921	Environmental Studies and Disaster Management	2+1
2.	B0922	Forest Survey & Engineering	2+1
3.	B0923	Soil Biology & Fertility	2+1

4.	B0924	Forest Ecology & Biodiversity	2+1
5.	B0925	Tree Improvement	2+1
6.	B0926	Principles of Agroforestry	2+1
7.	B0927	Forest Mensuration	2+1
8.	B0928	Physical Education-III	0+1*
9.	B0929	NCC-III/NSS-III	0+1*
		TOTAL	14+9

Semester IV (15+8=23 Credit Hours including 1 Non-Credit)

S.No.	Paper Code	Course	Credit
1.	B0930	Forest Management	2+1
2.	B0931	Silviculture of Indian Trees	2+1
3.	B0932	Wood Products & Utilization	2+1
4.	B0933	Ethnobotany, Medicinal and Aromatic plants	2+1
5.	B0934	Ornithology & Herpetology	2+1
6.	B0935	Seed Technology & Nursery Management	2+1
7.	B0936	Rangeland and Livestock Management	1+1
8.	B0937	Forest Tribology & Anthropology	2+0
9.	B0938	Study Tour of State Forest	0+1*
		TOTAL	15+8

Semester V (12+12=24 Credit Hours)

S.No.	Paper Code	Course	Credit
1.	B0939	Forest Hydrology and Watershed Management	2+1
2.	B0940	Climate Science	2+1
3.	B0941	Wood Science and Technology	2+1
4.	B0942	Logging and Ergonomics	1+1
5.	B0943	Forest Extension & Community Forestry	2+1
6.	B0944	Entrepreneurship Development & Business Management	1+1
7.	B0945	Forest Economics and Marketing	2+1
8.	B0946	Experiential Learning	0+5
		TOTAL	12+12

Semester VI (11+11=22 Credit Hours)

S.No.	Paper Code	Course	Credit
1.	B0947	Plantation Forestry	2+1
2.	B0948	Forest Laws, Legislation and Policies	2+0
3.	B0949	Geometrics	1+2
4.	B0950	Recreation & Urban Forestry	1+1
5.	B0951	Restoration Ecology	1+1
6.	B0952	Non-Timber Forest Products	2+1
7.	B0953	Certification of Forest Products	2+0
8.	B0954	Experiential Learning	0+5
		TOTAL	11+11

Semester VII (0+23=23 Credit Hours including 3 Non-Credit)

S.No.	Paper Code	Course	Credit
1.	B0955	Forestry Work Experience	0+20
2.	B0956	All India Study Tour	0+3*
		TOTAL	0+23

Semester VIII (8+15=23 Credit Hours)

S.No.	Paper Code	Course	Credit
1.	B0957	Forest Inventory and Yield Prediction	1+1
2.	B0958	Forest Biotechnology	2+1
3.	B0959	Agroforestry Systems and Management	2+1
4.	B0960	Wildlife Management	1+1
5.	B0961	Agricultural Informatics	2+1
6.	B0962	Project Work & Dissertation	0+10
		TOTAL	8+15
		Grand Total	85+96=181

DETAILED SYLLABUS

I. SILVICULTURE AND AGROFORESTRY (SA)

1. Introduction to Forestry

2 (2+0)

Theory

Forests - definitions, role, benefits - direct and indirect. History of Forestry - definitions, divisions and interrelationships. Classification of forests - High forests, coppice forests, virgin forest and second growth forests, pure and mixed forests - even and uneven aged stands. Forest types of India- classification. Agroforestry - farm forestry, social forestry, joint forest management - concepts, programmes and objectives. Important acts and policies related to Indian forests. Global warming - forestry options for mitigation and adaptation - carbon sequestration. Important events/dates related to forests and environment - themes and philosophy.

Introduction to world forests - geographical distribution and their classification, factors influencing global forests distribution - productivity and increment of world forests. Forest resources and forestry practices in different regions of the world - Western Europe, North America, Central Africa, Australia, Central America, Russia, Japan, and China. General problems of forest development and economy. Forest based industries in the developed and developing countries. Trade patterns of forest based raw materials. Recent trends in forestry development in the world. National and international organizations in forestry.

Suggested readings

- Beazley, M. 1981. The International Book of Forest. Mitchell Beazly Publishers, London.
- Champion, H, G and Seth, S.K. 1968. Forest types of India, revised survey of forest types of India, GOI Press, New Delhi, 404p.
- Grebner, D.L., Bettinger, P and Siry, J.P. 2012. Introduction to Forestry and Natural Resources. Academic Press. 508p (Google eBook).
- Khanna, L.S. 1989. Principles and Practice of Silviculture. Khanna Bandhu, New Delhi, 473p.
- Mather, A.S. 1990. Global forest resources. Belhaven, London.
- Persson, R. 1992. World forest resources. Periodical experts, New Delhi.
- Westoby, J. 1991. Introduction to World Forestry. Wiley, 240p.

2. Dendrology

3 (2+1)

Theory

Introduction – importance and scope of dendrology, Principles and systems of plant classification systems. Detailed study of Bentham and Hooker natural system, its advantages and disadvantages. Plant Nomenclature – objectives, principles and International Code of

Botanical Nomenclature. Role of vegetative morphology in identification of woody forest flora. Peculiarities of bole, general form of woody trunk and deviations like buttresses, flutes, etc. Morphology and description of barks of common trees. Characteristics of blaze, bark colour, exudations etc. Morphology of leaf, different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts. Detailed study of the families- diagnose the features- floral variations- distribution and economic importance- systematic position as per Bentham & Hooker System of classification - *Magnoliaceae*, *Annonaceae*, *Guttiferae*, *Dipterocarpaceae*, *Malvaceae*, *Sterculiaceae*, *Tiliaceae*, *Rutaceae*, *Meliaceae*, *Sapindaceae*, *Anacardiaceae*, *Leguminosae*, *Rhizophoraceae*, *Combretaceae*, *Myrtaceae*, *Rubiaceae*, *Sapotaceae*, *Apocyanaceae*, *Bignoniaceae*, *Lamiaceae*, *Lauraceae*, *Euphorbiaceae*, *Orchidaceae*, *Palmae* and *Graminae*. Brief description of the families- *Bombacaceae*, *Santalaceae*, *Casuarinaceae*.

Practical

Morphological description of plant parts and method of collection of plants. Techniques of preparing herbarium specimens. General study of herbarium. Dissection of flowers-makings ketches - construction of floral diagrams of one species of the following families : *Annonaceae* and *Guttiferae*, *Dipterocarpaceae* and *Malvaceae*, *Sterculiaceae* and *Tiliaceae*, *Rutaceae* and *Meliaceae*, *Sapindaceae* and *Anacardiaceae*, *Leguminosae* - *Papilionaceae*- *Mimosae* - *Caesalpiniaceae*, *Rhizophoraceae*, *Combretaceae*, *Myrtaceae*, *Rubiaceae*, *Sapotaceae*, *Apocyanaceae* and *Bignoniaceae*, *Lamiaceae*, *Euphorbiaceae*, *Santalaceae* and *Casuarinaceae*, *Orchidaceae*, *Graminae* and *Pinaceae*.

Suggested readings

- Ashok Kumar (2001). *Botany in Forestry and Environment*. Kumar Media (P) Ltd. Gandhinagar, Gujarat.
- Bor N. L. (1990). *Manual of Indian Forest Botany*. Periodical Expert Book Agency. New Delhi.
- Brandis. D. Revised by R. D. Jakarti (2010). *Indian Trees*. Dehradun.
- Charles McCann. (1966). *100 Beautiful Trees of India*. D. B. Taraporevala Sons & C. Pvt. Ltd. Mumbai. (Available online PDF)
- Eric A. Bourdo Jr. (2001). *The Illustrated Books of Trees. A Visual Guide to 250 species*. Published by Salamander Books Pvt. Ltd. London. (Available online PDF)
- Father H. Santapau. (1966). *Common Trees*. (Available online PDF)
- Gurucharan Singh. (2000). *Plant Systematics*. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Hardin, W., Harrar, E.S., and White, F.M. (1995) *Textbook of Dendrology* (8th Edition). McGraw-Hill Companies, London

- Jain S. K. and R. R. Rao. (1977). *Handbook of Field and Herbarium Methods*. Today and Tomorrow's Printers and Publishers. New Delhi.
- Lawrence, G.H.M.(1967).Taxonomy of Vascular Plants. Oxford & IBH, New Delhi.
- Mishra. S. R. (2010). *Textbook of Dendrology*. Discovery Publishing House Pvt. Ltd. New Delhi.
- Naqshi. R. (1993). *An Introduction to Botanical Nomenclature*. Scientific Publishers. Jodhpur.
- Pandey S. N. and S. P. Mishra. (2008). *Taxonomy of Angiosperms*. Ane Books India, New Delhi.
- Parker. R. N. (1933). *Forty Common Indian Trees and How to know them*. (Available online PDF)
- Pradip Krishnen (2013). *Jungle Trees of Central India*. Published by Penguin Books India Pvt. Ltd. New Delhi.
- Randhawa. M. S. (1957). *Flowering Trees in India*. Sree Saraswati Press Ltd. Kolkatta.
- Rendle, A.B.(1979). Classification of flowering plants. Vol. I & II CUP–VIKAS
- Sahni. K. C. (2000). *The Book of Indian Trees*. Bombay Natural History Society. Mumbai.
- Tewari D. N. (1992). *Tropical Forestry in India*. International Book Distributors, Dehradun.

3. Silviculture

3 (2+1)

Theory

Definitions: Forests and Forestry- Silviculture objectives and scope of silviculture - relation with other branches of Forestry Silvics. Site factors - climatic, edaphic, physiographic, biotic and their interactions. Trees and their distinguishing features, growth and development. Root growth- fine root/functional root production- Direct and indirect benefits- biophysical interactions- trees and buffering functions- C sequestration potential of forests. Silvicultural systems-definition, scope and classification. Systems of concentrated regeneration - systems of diffused regeneration - accessory systems - Clear felling systems - Shelterwood system - Selection system and its modifications - Coppice systems - Culm selection system in Bamboo, Canopy lifting system in Andaman. Silvicultural systems followed in other countries

Regeneration of forests – objectives - ecology of regeneration- natural and artificial regeneration. Natural regeneration- seed production, seed dispersal, germination and establishment, requirement for natural regeneration, advance growth, coppice, root sucker, regeneration survey, natural regeneration supplemented by artificial regeneration. Artificial regeneration - object of artificial regeneration - advantages. Factors governing the choice of regeneration techniques. Tree planting- Sowing v/s planting different kinds of pits- tending and cultural operations- weeding- kinds of weeding- release operations- singling, cleaning– liberation cutting

Practical

Acquaintance with modern silvicultural tools. Visits to different forest areas/types. Study of forest composition. Visiting plantations raised by forest department, Exercise on nursery practice- seed collection, seed pre-treatment- nursery stock preparation- field preparation- marking, alignment and stacking, pit making-planting, various tending operations- weeding, cleaning, singling, pruning, pollarding, lopping, and thinning- fertilization in trees-plant protection and sanitation measures.

Suggested readings

Baker, F.S.1950. Principles of Silviculture, Mc Graw Hill, N.Y.

Champion, H.G. and Trevor, G.1936. Hand book of Silviculture, Cosmo Publication, NewDelhi

Daniel, T. W., Helms, J.A., Baker, F.S. 1970. Principles of Silviculture, McGraw Hill, N.Y.

Duryea, M.L. and Landis, T.D. (eds.) 1984. Forest Nursery Manual: Production of bareroot seedlings. Martinus Nijhoff/Dr W. Junk Publishers. The Hague/ Boston/ Lancaster, 386 p.

Dwivedi. A.P. 1993. Text book of Silviculture. International Book Distributors.

Evans, JE. 1982. Plantation Forestry in the Tropics. The English Language Book Society and Clarendon Press–Oxford

Gunter, S., Weber, M, M Stimm, B and Mosandl, R. 2011. Silviculture in the Tropics. Springer- Verlag- Berlin.

Haig, I. T. Huberman, M. A. and Aung Din, U. 1986. Tropical Silviculture, Vol. I and II.

Food and Agriculture Organization of the United Nations Rome and Periodical Experts Book Agency, D-42, Vivek Vihar, Delhi–110032.

Khanna, L.S. 1989. Principles and Practice of Silviculture. Khanna Bandhu, 7 Tilak Marg, Dehra Dun

Kostler, J. 1956. Silviculture. International Book Distributors, P.O. Box 4. DehraDun

Lal, J.B. 2003. Tropical Silviculture, New Imperatives : New Systems, International Book Distributors, P.O. Box 4. Dehra Dun

Smith, D.M. 1986. The Practice of Silviculture, Edn 8. New York, John Wiley.

4. Principles of Agroforestry

3 (2+1)

Theory

Overview of the Agriculture scenario – its structure and constraints. Concept of sustainable agriculture and land use management. Paradigm shift in Agriculture development- impacts of

green revolution – Agrobiodiversity – significance, threats and conservation strategies. Agroforestry – definition and scope – rising demands of fuel wood, fodder and timber. Social, ecological, and economic reasons for agroforestry. History of agroforestry. Components of Agroforestry- Provisioning and regulator services of agroforestry- Nutrient cycling, Soil improvement, Increased production and productivity, Microclimate amelioration and carbon sequestration – Tree-crop interaction in agroforestry– Definition, kind of interaction – Positive interactions- complimentary - compatibility - mutualism, commensalism - Negative interactions – allelopathy and competition-Interaction management - Aboveground and belowground interactions- Manipulation of density, space, crown and roots. Tree Management – structure and growth of trees, crown and root architecture, agroforestry practices to minimize negative interaction – coppicing, thinning, pollarding and pruning – crop planning and management –selection of suitable crops –management of nutrients, water and weeds – Classification of agroforestry systems – National Agroforestry Policy 2014—National and International organizations in Agroforestry.

Practical

Visit to social / Urban / Community forestry plantations and study their impact on socio – economic status of rural people- Traditional agroforestry systems in the country and visits to some of the local agroforestry systems. Agroforestry systems in different agroecological zones- their structural and functional features. Visit to on farm agroforestry models. Studies on fodder banks and live fences. Studies on light and below ground interactions in agroforestry systems- MPTs and Nitrogen fixing trees in agroforestry- Studies on allelopathy- Design & Diagnostics exercise in agroforestry- Land capability classification of various topographic regions- Visit to industrial plantations.

Suggested readings

Huxley, P.A. 1983 (eds). Plant Research and Agroforestry, ICRAF, Nairobi, Kenya.

Huxley, P. 1999. Tropical Agroforestry. Wiley: 384p.

Kumar, B.M. and Nair, P.K.R (eds). 2011. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. Advances in Agroforestry 8. Springer Science, The Netherlands: 307p

Michael, P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Pub. Co. New Delhi.

Nair, P.K.R, Rao MR, and Buck, L.E (eds), 2004. New Vistas in Agroforestry: A Compendium for the 1st World Congress of Agroforestry, Kluwer, Dordrecht, The Netherlands.

Nair, P.K.R. 1993. An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Nair, P.K.R. Agroforestry Systems in the Tropics. Springer. 680p.

Nair, P.K.R., Kumar, B.M. and Vimala D. N. 2009. Agroforestry as a strategy for carbon sequestration. *J. Plant Nutr. Soil Sci.* 172: 10–23.

Pathak P.S. and Ram Newaj (eds.) 2003. *Agroforestry: Potentials and Opportunities*. Agrobios, Jodhpur.

5. Forest Mensuration

3 (2+1)

Theory

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

Practical

Determination of pace length- Measurements of diameter-girth and basal area of trees using Callipers, Tape, Ruler, Penta Prism Tree Calliper etc. Measurement of height using non instrumental method- Preparation and use of simple height measuring instruments- Christens Hypsometer-Smithies Hypsometer- Modified Smithies Hypsometer-Measurement of tree height using instrumental methods- Abneys level- Haga altimeter- Relaskop- Clinometer- Blumeleiss Hypsometer-Laser Hypsometer- Volume determination of standing and felled trees. Exercise on Stump analysis. Exercise on stem analysis-Annual ring counting using ring borer. Preparation of volume tables- local volume table.

Suggested readings

Chaturvedi, A.N and L.S. Khanna. 2011. *Forest Mensuration and Biometry* (5th edition). Khanna Bandhu. Dehra Dun. 364 pp.

Forest Mensuration: A Handbook for Practitioners. 2006. Forestry Commission Publications. 330 pp.

Husch, B., Beers, T.W. and Kershaw, J. J.A. 2002. *Forest Mensuration* (4th edition). John Wiley & Sons, Nature.456 pp.

Laar, V. A. and Akca, A. 2007. *Forest Mensuration. Managing Forest Ecosystems*. Vol.13. Springer.384pp.

Manikandan, K. and Prabhu, S. 2012. *Indian Forestry*. Jain Brothers. New Delhi. 590 pp.

West, P.W. 2009. *Tree and Forest Measurement* (2nd edition). Springer. 192pp.

5. Forest Management

3 (2+1)

Theory

Definition, scope, objective and principles of forest management, organization of state forests-sustained yield-definition, principles and limitations. Sustainable forest management-criteria and indicators-Increasing and progressive yields- Rotation -definitions-various types of rotations-length of rotations-choice of type and kind of rotation. Normal forest-definitions basic factors of normality. Factors governing the yield and growth of forest stands-Working plan-preparations-objectives and uses-forest maps and their uses. Joint forest management-concept and principles- Modern tools in forest management. Introduction to the concept of forestry as a common property resource- Definition, Scope and necessity of community forestry- Forests and man- Forestry in support to agriculture, animal husbandry and horticulture – development of cottage industry in rural environment-NFP 1988 and the importance of people in forest conservation. Community forest management, Community forest development, social economical and environmental aspects, Community forest development through NGOs, civil societies, citizen groups- Gender dimensions in Community forest management. Social Forestry- definition –NCA report of 1976- need and purpose-Social Forestry for – fodder production – fuel wood – leaf manure –timber production. Integrated rural development approach – with proper marketing facility – employment generation in raising, tending and harvesting of tree crops. Place of social forestry in the national forest policy of India-role of forest department.

Practical

Visit to different forest divisions to study the various stand management aspects including thinning, felling and sale of timber. Study forest organizational set up and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Field visit to JFM operational areas. Study the different field exercises for data collection for working plan.

Suggested readings

- Balakathiresan, S (1986). Essentials of Forest Management, Nataraj Publishers, Dehradun.
 Bhattacharya P., Kandya A.K. and Krishna Kumar (2008). Joint Forest Management in India, Aavishkar Publisher, Jaipur.
- Desai, V. (1991). Forest Management in India–Issues and Problems. Himalaya Pub. House, Bombay. Edmunds, Dand Wollenberg, E (2003). Essentials of Forest Management, Natraj Publishers, DehraDun.
- Jerome L Cutteretal (1983). Timber Management: A Quantitative Approach. John Wiley and Sons
- National Working Plan Code (2014). MoEF, New Delhi.
- Ramprakash, (1986). Forest Management, IBD, Dehradun.

Recknagel, A and Bentley. J. (1988). Forest Management. IBD, Dehradun.

Trivedi, P, R and Sudarshan, K,N. (1996). Forest Management. Discovery publications, NewDelhi.

7. Silviculture of Indian Trees

3 (2+1)

Theory

Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices pest and diseases and economic importance of the following tree species of India. Broadleaved species: *Tectona grandis*, *Shorea robusta*, *Dalbergia latifolia*, *Dalbergia sissoo*, *Anogeissus spp*, *Terminalia spp.*, *Santalum album*, *Swietenia macrophylla*, *Albizia spp*, *Pterocarpus marsupium*, *Gmelina arborea*, *Pterocarpus santalinus*, *Azadirachta indica*, *Hopea parviflora*, *Lagerstroemia microcarpa*, Bamboos, reeds and rattan, *Quercus spp*. Conifers: *Abies pindrow*, *Picea smithiana*, *Cedrus deodara*, *Pinus roxburghii*, *Pinus wallichiana*. Fast growing MPTs: Tropical pines, *Eucalyptus spp*, *Casuarina equisetifolia*, *Leucaena leucocephala*, *Ailanthus triphysa*, *Grevillea robusta*, *Pongamia pinnata*, *Melia dubia*, *Acacia spp*, *Populus spp*.

Practical

Study the morphological description and field identification characteristics of trees, seeds and seedlings. Phenology, Collection of seeds. Planting and stand management practices of *Tectona grandis*, *Dalbergia latifolia*, *Santalum album*, *Swietenia macrophylla*, eucalypts, acacias, bamboos, fast growing MPTs etc. Study the silviculture of trees in response to light, fire, drought, frost, root suckering, coppicing and pollarding, etc. Visit various problem areas and study on species suitability. Visit forest plantations and other woodlots. Study the planting density and stand management regimes for various end uses such as timber, pulpwood, plywood, cottage industries etc.

Suggested readings

Bebarta, 1999. Teak: Ecology, Silviculture, Management and profitability, IBD, Dehra Dun

Champion, H.G. and A.L. Griffith. 1989. Manual for General Silviculture for India ICFRE booklets on tree species

Kadambi, K. 1993. Silviculture and Management of teak. Nataraj Publishers, Dehra Dun. p. 137.

Lamprecht H 1989. Silviculture in the Tropics. GTZ, GmBH, FRG

Troup, RS 1922. Silviculture of Indian Trees, Vol. 1-4, Revised and Enlarged Edition, Forest Research Institute and Colleges, Dehra Dun, 1975.

Renuka, C., Pandalai, R.C. and Mohanan, C. 2002 Nursery and silvicultural techniques for rattan, Kerala Forest research Institute.

8. Forest Hydrology and Watershed Management

3 (2+1)

Theory

Importance and scope of Hydrology. Definitions. Hydrological cycle. Energy and water balance equations precipitation- rain and snow hydrology. Interception, infiltration, evaporation and transpiration- paired water sheds, surface water, run off processes and hydrograph. Soil water energy concept, movement, availability and measurement. Watershed management- an approach for sustainable productivity-principles and practices- Methods for water conservation- water harvesting techniques. Role of trees in water conservation- natural terracing- species suitability- Recharging of water springs. Forest treatment and water yield. Application of GIS in watershed delineation.

Practical

Study of hydrological equipment; Measurement and analysis of rainfall data; Estimation of runoff using rational formula; Preparation, use and analysis of hydrograph; Measurement of evaporation by different methods; Visit to forest watersheds to study the effect of forest treatment on hydrological properties. Assessment of the impact of watershed treatments such as afforestation/restocking, assisted regeneration etc. on the watershed functioning- field layout- regeneration assessment- interpretation of results.

Suggested readings

- Bennet, H. H. 1965. Elements of Soil conservation. Mc Graw Hill Book Co. Inc. New York
- Dhruva Narayana V. V. 1993. Soil and Water Conservation Research in India, ICAR, New Delhi
- Dhruva Narayana V. V., G. Sastry and U. S. Patnaik. 1997. Watershed Management. Indian Council of Agricultural Research, New Delhi, 176 p
- Gurmail Singh et al., 1988. Manual of Soil and Water Conservation. Oxford IBH Publishing Co. New Delhi
- Hamilton L. S. 1983. Tropical Forested Watersheds: hydrologic and soils response to major uses or conversions. International Book Distributors, Dehra Dun
- Hamilton, L.S. (ed.). 1983. Forest and Watershed Development and Conservation in Asia and the Pacific. International Book Distributors, Dehra Dun
- Hewlett, JD and Nutter, WL 1969. An Outline of Forest Hydrology. University of Georgia Press, Athens 132p
- Hudson, N. 1981. Soil Conservation. BT Batsford Limited, London 324 p.
- Lal R. 2000. Integrated Watershed Management in the Global Ecosystem. CRC Press, London
- Michael, A.M. 2008. Irrigation theory and practice, Vikas Publishing House Pvt Ltd. 768p

- Morgan, R.P.C. 1988. Soil Erosion and Conservation. English Language Book Society, Longman, London
- Murthy, V.N.N. 1983. Land and Water Management Engineering, Kalyani Publishers, New Delhi.
- Rama Rao, M.S.V. 1962. Soil Conservation in India, ICAR, New Delhi
- Riedl, O. and Zachar, D. 1984. Forest Amelioration. Elsevier, Amsterdam
- Satterlund, DR. 1972. Wildland Watershed Management. The Ronald Press Company, New York
- Seshagiri Rao, K. V. 2000. Watersheds, Comprehensive Development. B. S. Publications, Hyderabad
- USDA 1961. A Manual on Conservation of Soil and Water. Oxford and IBH Publishing Company

8. Plantation Forestry

3 (2+1)

Theory

Plantations-definition and scope. History of plantations, Development of plantation forestry, Plantation organization and structure, Land and plantation development. Plantation planning- National and regional planning-project appraisal and project implementation- feasibility studies. Plantation silviculture - Choice of species- Plantation establishment- Plantation maintenance- Nutrition in plantations- use of fertilizers- Major pest and disease in plantations- sanitation and control measures. Dynamics of stand growth- CCF-MCA- stand density management in plantations- Thinning regimes- improvement fellings, Site quality evaluation, stand basal area- site index concept in plantation forestry- plantation productivity assessment- growing stock assessment- MAI, sustainability of plantations. Plantation records- plantation journal. Industrial plantations- paper and pulp wood- match wood, plywood plantations- Plantations yielding NTFPs- Energy plantation- high density short rotation plantations- petro crops- avenue plantations- Plantations as potential carbon sinks carbon sinks- Economic factors in plantation development- social and cultural considerations.

Practical

Study the tools and materials for plantation establishment- Visit small and large plantations- study their management and functioning- Exposure to plantation project preparation- economic evaluation and feasibility studies of plantation projects. Study of planting operations- study of tending techniques- Planting methods and techniques of different types of plantations including energy plantations, canal bank plantations - pulp wood plantations- study of Forest Development Corporation plantations-road side plantations plantation planning- Plantation journal- Choice of species for plantations-economic considerations in plantation- Study of govt. vs. pvt. plantations.

Suggested readings

- Bowen, G.D., E. K. S. Nambiar, E.K.S 1984. Nutrition on Plantation Forests. Academic Press, 1984 -Nature - 516 pages
- Evans, J. 1992. Plantation Forestry in the Tropics, 2nd edition. Oxford, UK, Clarendon Press.
- Evans, J. and Turnbull, J.W. 2004. Plantation Forestry in the Tropics: The Role, Silviculture and Use of Planted Forests for Industrial, Social, Environmental and Agroforestry Purposes. OUP Oxford, 467p.
- Krishnapillay.B. 2000. Silviculture and Management of teak plantations. Unasyuva. 201. Vol 51. 14-21p
- Nambiar, E.K.S. and Brown, A.G. 1997. Management of Soil, Nutrients and Water in Tropical Plantation Forests. Australian Centre for Internat. Agricultural Research. 571p.
- Nambiar, E.K.S., Cossalter, C and Tiarks.A. 1998. Site Management and Productivity in Tropical Plantation Forests. Workshop Proceedings, South Africa.
- Suzuki, K., Ishii, K., Sakurai, S. and Sasaki, S. 2006. Plantation Forestry in the Tropics. Springer Tokyo.

9. Agroforestry Systems and Management

3 (2+1)

Theory

Land use and land capability classification- overview of agroforestry around the world – agroforestry systems in India. Classification of agroforestry systems – structural, functional, agroecological, socio-economic and physiognomic basis. Agrosilvicultural systems – Improved fallows in shifting cultivation – soil dynamics in shifting cultivation – Taungya systems – Alley cropping –structural and functional attributes. Multipurpose trees and shrubs on farmlands, agricultural fields- Plantation crop combinations- commercial crops under shade of planted trees and natural forests- Windbreaks & Shelterbelts. Silvopastoral systems – protein banks, Live fence of fodder trees and hedges, trees and shrubs in pastures. Pastoral silviculture systems- grassland and tree management in the humid, arid and semi- arid regions. Agrosilvopastoral systems – tropical home gardens –structural and functional attributes. Other systems – apiculture, sericulture and mixed woodlots. Major Agroforestry practices in different agroecological zones of India- arid and semi arid regions- agroforestry practices for wasteland reclamation. Agroforestry practices for salt affected soils – Agroforestry practices for wetlands and waterlogged areas. Non-wood forest products based agroforestry – Soil fertility improvement and water conservation through agroforestry. Socio-economic analysis of various agroforestry systems.

Practical

Study the desirable characteristics of trees/shrubs/grasses for various agroforestry programmes. Assessment of standing stock of tree species in various agroforestry systems

such as homegardens. Survey of agroforestry practices in local/adjoining areas. Field observations to characterize the structural, functional and economic attributes of the following agroforestry systems and practices- agrosilviculture systems, silvopastoral systems, pastoral silviculture systems, agrosilvopastoral systems, shelterbelts and windbreaks, live fences; fodder trees and protein banks. Exercise on Diagnosis and Design of agroforestry systems and practices. Assessment of productivity of tree crop combinations. Studying resource partitioning in agroforestry systems - water, light and nutrients. Analysis of soil and plant samples for organic carbon N, P and K.

Suggested readings

Huxley, PA 1983 (ed). *Plant Research and Agroforestry*, ICRAF, Nairobi, Kenya.

Huxley, P. 1999. *Tropical Agroforestry*. Wiley: 384p.

Kumar, B. and Nair, P.K.R. (eds). 2006. *Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry*. Volume 3 in the Book Series “Advances in Agroforestry”. Springer Science, the Netherlands

Kumar, B.M. 2011. Species richness and aboveground carbon stocks in the homegardens of central Kerala, India. *Agriculture, Ecosystems and Environment*. 140: 430–440

Kumar, B.M. and Nair, P.K.R. 2004. The enigma of tropical homegardens. 2004. *Agroforestry Systems*. 61: 135–152.

Kumar, B.M. and Nair, P.K.R (eds). 2011. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. *Advances in Agroforestry* 8. Springer Science, The Netherlands: 307p

Michael P. 1984. *Ecological Methods for Field and Laboratory Investigations*. Tata McGraw-Hill Pub. Co. New Delhi.

Mohan, S., Nair, P.K.R., Long, A.J. 2007. An Assessment of Ecological Diversity in Homegardens: A Case Study from Kerala State, India. *Journal of Sustainable Agriculture*. Volume 29, Issue 4: 135-153.

Nair, P.K.R, Rao MR, and Buck LE (eds), 2004. *New Vistas in Agroforestry: A Compendium for the 1st World Congress of Agroforestry*, Kluwer, Dordrecht, The Netherlands.

Nair, PKR 1993. *An Introduction to Agroforestry*. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Nair, P.K.R. *Agroforestry Systems in the Tropics*. Springer. 680p.

Nair, P.K.R., Kumar, B.M. and Vimala D. N. 2009. Agroforestry as a strategy for carbon sequestration. *J. Plant Nutr. Soil Sci*. 172: 10–23.

Pathak P.S. and Ram Newaj (eds.) 2003. *Agroforestry: Potentials and Opportunities*. Agrobios, Jodhpur.

II. FOREST BIOLOGY AND TREE IMPROVEMENT (FB)

1. Plant Physiology

3 (2+1)

Theory

Introduction to tree physiology. Photosynthesis - C₃, C₄ and CAM plants - Photorespiration - Factors affecting photosynthesis. Respiration - energetic of dark respiration. Plant-water relations, Concept of water potential, ascent of sap and water balance. Stomatal physiology - stomatal conductance – resistance. Mineral nutrition - macro-micro nutrients - Arnon's criteria of essentiality – deficiency. Plant growth regulators – classification. Tree structure, Growth and development - growth kinetics. Growth regulation and co-ordination - Plant growth analysis -Canopy architecture. Forest Biomes. Light interactions models of forest canopies - Sun plants and shade plants - shade tolerance. Temperature - temperature influence on forest development - energy budgets - low and high temperature - Physiological adaptations for high temperature - chilling injury. Water stress - Mechanism of drought tolerance and drought resistances - Physiological basis of drought avoidance and tolerance. Water relations of forest trees – Transpiration from forest canopies – Evapo-transpiration models of forest stands - Water use efficiency of forest stands. Salinity stress its effects on tree growth. Resistance to salinity. Forest and microclimate . Carbon balance and dry matter production in forest trees - Dry matter production and partitioning – source/ sink - GPP and NPP of forest stands -Carbon cycling - Nutrient dynamics and plant growth – Nutrient cycling of C,N,P,S.

Practical

Preparation of solutions. C₃ and C₄ leaf anatomy. Estimation of transpiration using porometer. Estimation of photosynthesis using IRGA. Extraction and estimation of chlorophyll in plants. Estimation of stomatal index. Demonstration of plasmolysis. Estimation of water potential in plants using Plant water status console. Estimation of leaf area of plants. Plant growth analysis – RGR, NAR, and LAR - specific leaf area and leaf weight ratio - LAI - CGR – LAD etc... Measurement of moisture stress tolerance parameters in trees - membrane stability, chlorophyll stability, proline content, wax and cuticle thickness. Measurement of relative water content, leaf water potential, osmotic potential. Measurements of stomatal resistance/stomatal conductance under varying stress condition. Observation on tree architecture of important species

Suggested readings

Hopkins, W.G. and Huner, N.P.A. (2008) Introduction to plant physiology. Wiley.

Kramer, P.J. and Kozlowski, T.T. (1979). Physiology of Woody Plants. John Wiley and sons. New York

Larcher, W. (2003). Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups. Springer Science & Business Media

- Lambert, Chapin, F.S. and Pons, T.L. (1998). *Plant Physiological Ecology*. Springer Scientific+ Business Media inc. Newyork.
- Landsberg, J.J (1986). *Physiological Ecology of Forest Production*. Academic Press Inc., London
- Landsberg, J.J and Gower, S.T (1997). *Applications of Physiological Ecology to Forest Management*. Academic Press Inc., London.
- Nobel P. S. (2005). *Physicochemical and Environmental Plant Physiology*. Elsevier Academic Press, Amsterdam
- Salisbury, F. B. and Ross, C. W. (2004) . *Plant Physiology*. Thomson Asia Ptd, Ltd. Singapore.
- Taiz, L. and Zeiger, E. (2010) 5th edition *Plant Physiology*. Sinauer Associates, Inc., Massachusetts

2. Plant Cytology and Genetics

2 (1+1)

Theory

History of genetics. Mendel's principles of inheritance – segregation – independent assortment. Cell – structure and functions. Cell organelles. Cell reproduction – mitosis – meiosis and its significance. Chromosome theory of inheritance. Modification to Mendelian inheritance – multiple alleles – codominance – gene interaction – epistasis – pleiotrophy – polygenic inheritance – penetrance and expressivity – cytoplasmic inheritance. Linkage and crossing over – cytological consequence of crossing over. Detection of linkage and linkage maps. Chromosomal aberrations-numerical and structural. Structure of DNA and types and its replication. Chromosomes – its structure and function. Fine structure of gene; Gene expression and their functions. RNA its structure function and types. Gene action – protein synthesis. Mutation, its classification and uses.

Practical

Study of fixatives and stains. Preparation of slides showing various stages of mitosis. Preparation of slides showing various stages of meiosis. Working out problems related to monohybrid cross, dihybrid cross, independent assortment, linkage, gene mapping, probability and chi-square, multiple alleles etc.

Suggested readings

- Fletcher, H. and Hickey, I. (2012). *Genetics*. Garland Science,
- Garner, E. J., Simmons, M. J. and Sunstad, P. D. (2008). *Principles of Genetics* (8th edn.). Wiley India (P.) Ltd., Daryaganj, New Delhi.
- Gupta P. K. (1999). *Cytogenetics* Rastogi Publishers, Meerut
- Strickberger, M.W. (1996). *Genetics* (3rd edn.). Mac Millan Publishing Co., New Delhi

Tamarin, R. (2002). Principles of Genetic (7th Ed). Tata McGraw-Hill Education.

White, T.L., Adams, W.T., and Neale, D.B. (2007). Forest Genetics. CABI

3. Tree Improvement

3 (2+1)

Theory

Introduction – history and development of tree improvement – its relation to other disciplines of forestry. Reproduction in forest trees. Anthesis and pollination – their importance in tree breeding. Incompatibility and sterility. Quantitative inheritance. Relevance in forestry. Genetic, environmental and interaction components of variation - heritability and genetic advance. Genetic basis of tree breeding. Natural variability in trees – types and importance.- forces that change variability. Exotic forestry. Provenance testing. Selection- seed production areas–seed orchards. Progeny trial and improvement of seed orchards. Combining ability and genetic gain – Hybridization in trees – back cross breeding, heterosis breeding. Breeding for resistance to insect pest's diseases, air pollution and for wood properties. Vegetative propagation and clonal forestry. Conservation of forest tree germplasm. Recent techniques in tree improvement. Mutation breeding; Ploidy breeding. Breeding objectives and concepts of breeding in self pollinated, cross pollinated and vegetatively propagated crops. Breeding of important tree species. Breeding procedures for development of hybrids, / varieties of various crops. DUS testing, Concepts of Geographical indications. Artificial hybrids in trees-crossing in trees-problems and perspectives-crossing hybrids and hybrid breakdown. Hybrid nomenclature in trees- Future of hybrid in applied tree improvement.

Practical

Floral biology and phonological observations in some important species. Pollen morphology. Estimation of pollen sterility and viability. Emasculation and hybridization in forest tree species. Different breeding methods – flow chart. Recording observations in provenence trial. Estimation of phenotypic and genotypic coefficient of variation. Estimation of genetic advance, heritability and GCA. Exercise in plus tree selection – recording data – design and observation in teak, eucalyptus seed orchard.

Suggested readings

Allied T.L. White and Adams (2010). Forest Genetics. Bedell P. E. (2007). Tree Breeding for Genetic Improvement of Tropical Tree Species (1st Ed).

Surendran, C., Sehgal, R.N. and Parmathma, M. (Eds.) (2003). A text book of Forest Tree Breeding. ICAR, New Delhi.

Wright, J. (2012). Introduction to Forest Genetics. Elsevier.

Zobel, B. and Talbert, J. (2003). Applied Forest Tree Improvement. Blackburn Press.

4. Seed Technology & Nursery Management

3 (2+1)

Theory

Importance of seed in present day forestry, seed and fruit development, seed dispersal. Planning seed collection-Collection of immature fruits - Methods of seed collection. Fruit and seed handling - maintaining viability and identity- special precautions for recalcitrant seeds. Seed processing- operations prior to extraction-pre-cleaning, methods of extraction- operations after extraction- cleaning, grading and control of moisture level- factors affecting drying of orthodox seeds. Seed storage- definition- purpose, recalcitrant seeds- Harrington's rule of thumb, seed maturity- parental and annual effects. Storage condition and ageing of seeds. Storage methods - Storage containers. Seed dormancy- types of dormancy, treatments for breaking exogenous and endogenous dormancy. Seed dressing and pelleting. Seed testing - definition- ISTA rules. Sampling- seed weight- moisture- authenticity- seed health. Germination testing- germination equipment- conditions for selected species. Germination evaluation- germination testing in nursery. Indirect tests of viability. Seed Act and Seed Certification.

Introduction and scope of Forest nursery. Nursery establishment - site selection – planning, and layout of nursery area. Types of forest nursery, types of nursery beds, preparation of beds, fumigation. Methods of seed sowing and mulching, seedling growth and development, pricking, weeding, hoeing, rotation, organic matter supplements and cover crops, mycorrhizae, fertilization, shading, pruning, root culturing techniques, lifting windows, grading, packaging. Storing and transportation. Containerised nursery technique - advantages, disadvantages - root deformations - container designs and types/root trainers and rooting media. Conditions/practices affecting survival and early growth, acclimating containerised stock, field handling of containerised stock, planting techniques for containerized stock. Planting bare-root seedlings: advantages, disadvantages. Methods for field handling and planting bare-root stock. Containerised nursery technique- Type and size of containers. Merits and demerits of containerized nursery. Root trainer techniques- Preparation of ingredient mixture. Study of important nursery pests and diseases and their control measures. Nursery practices for some important tree species. Target seedling concept.

Practical

Identification of seeds of tree species; Seed maturity tests; Physical purity analysis; Determination of seed moisture; Seed germination test; Hydrogen peroxide test; Tetrazolium test for viability; Seed vigour and its measurements; Methods of breaking dormancy in tree seeds; Testing membrane permeability; Study of seed collection and equipments; Planning of seed collection; Seed collection; Seed extraction; Visit to seed production area and seed orchard; Visit to seed processing unit/testing laboratory; Study of seed sampling equipments. Preparation of production and planning schedule for bare root and containerized nurseries. Nursery site and bed preparation. Pre-sowing treatments. Sowing methods of small, medium,

and large sized seeds. Mother beds and transplant bed preparation- Pricking and transplanting of in transplant beds. Intermediate nursery management operations. Preparation of ingredient mixture. Filling of containers. Visit to tree nurseries.

Suggested readings

- Agrawal, R.L. 1986. Seed Technology. Oxford - IBH Publishing Co. New Delhi
- Ahuja, P.S. et al. 1989. Towards developing "Artificial Seeds" by shoot and root encapsulation. In: Tissue Culture and Biotechnology of Medicinal and Aromatic Plants. CIMAP, Lucknow, India, P. 22-28.
- Bewely, J.D and Black, M. 1985. Seed- Physiology of development and germination
- Bose, T.K; Mitra, S.K. and Sadhu, M.K. 1986 Propagation of tropical and sub tropical Horticultural crops. Naya Prakash, Calcutta
- Chin, H.F. and Roberts, E.H. 1980. Recalcitrant Crop Seeds. Tropical Press Sdn. Bhd. Kuala Lumpur - 22-03, Malaysia
- Duryea, M.L. and Landis, T. D. (eds.) 1984. Forest Nursery Manual: Production of Bareroot Seedlings. Martinus Nijhoff/ Dr. W. Junk Publishers, The Hague/Boston/Lancaster for Forest Research Laboratory, Oregon State University, Corvallis, 386 p.
- Evans, J. 1982. Plantation Forestry in the Tropics. The English Language Book Society and Clarendon Press - Oxford. 472p.
- Hartmann, H.T and Kester, D.E. 1968. Plant propagation – principles and practice prentice – Hall of India Private Limited, New Delhi.
- ISTA. 1993. International Rules for Seed Testing Rules. International Seed Testing Association, Zurich, Switzerland, 1993.
- 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.
- Liegel, L.H. and Venator, R. 1987. A Technical Guide for Forest Nursery Management in the Carribean and Latin America. Gen. Tech. Rep. SO-67, New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 156p.
- May, J.T., Belcher, Jr. E. W., Cordell, C.E., Filer, Jr. T. H., David South, and Lantz. C. W. 1985. Southern Pine Nursery Handbook, USDA Forest Service, Southern Region, Cooperative Forestry
- Mehta, A.R and Bhatt, P.N. 1990. Hand book of plant tissue and all cultures. Academic book centre, Ahmedabad
- Napier, I. and Robbins, M. 1989. Forest Seed and Nursery Practice in Nepal. Nepal-UK Forestry Research Project, Kathmandu
- Prakash, R. 1990. Propagation Practices of Important Indian Trees. International Book Distributors, Dehra Dun.

5. Forest Biotechnology

3 (2+1)

Theory

Concepts and history of Plant Biotechnology: Scope and importance in tree Improvement: Totipotency and Morphogenesis, Nutritional requirements of in-vitro cultures; Techniques of in-vitro cultures, Micro propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture; Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications in tree improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants. their applications, achievements and bio-safety regulations, Blotting techniques – DNA finger printing and bar coding – DNA based markers – RFLP, AFLP, RAPD, SSR, VNTRS, CAPS, SNPs, ESTs and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in tree improvement.

Practical

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoresis technique

Suggested readings

- Bajaj, Y.P.S. (Ed) (1988). *Biotechnology in Agriculture and Forestry 2. Crops 1*. Springer-Verlag, Berlin.
- Dhawan, V (2012) *Applications of Biotechnology in Forestry and Horticulture*. Springer US
- Guptha, P.K. (2000). *Elements of Biotechnology*. Rastogi publications, Meerut.
- Neumann, K.H., Kumar, A., and Sopory, S.K. (2008) *Recent Advances in Plant Biotechnology and Its Applications*. I. K. International Pvt Ltd
- Punia, M.S. (1998). *Plant Biotechnology and Molecular Biology. A laboratory manual*. Scientific Publishers, Jodhpur
- Thieman, W.J. and Palladino, M.A. (2009). *Introduction to Biotechnology, Second Edition*. Pearson Benjamin Cummings, San Fransis

III. NATURAL RESOURCE MANAGEMENT (NR)

1. Introduction to Agronomy and Horticulture

3 (2+1)

Theory

Agronomy, scope and its role in crop production-Major Field crops of India – classification, area, distribution and productivity of major Field crops. Farming and cropping systems – mono, sole and multiple cropping, relay, sequential and inter cropping. Tillage- definition-objectives – types of tillage- tillage implements – tilth - characteristics of good tilth - Soil productivity and fertility- Crop nutrition – nutrients –classification – Nutrient sources- organic manures –fertilizers – biofertilizers- Integrated Nutrient Management-Importance of water in plant growth- Soil properties influencing moisture availability – texture, structure and organic matter status-Irrigation and drainage. Weed control – definition and characteristics of weeds, classification of weeds – damages due to weeds - benefits of weeds. -Control vs prevention of weeds – methods of weed control-Classification of herbicides–Integrated weed management. Soil and its management-Definitions and importance of horticulture- Economic importance and classification of horticultural crops and their culture and nutritive value- area and production- exports and imports- fruit, vegetables, plantation and spice crops-soil and climate–principles-planning and layout- management of orchards- planting systems and planting densities- Principles and methods of pruning and training of fruit, plantation crops-use of growth regulators in horticulture crops-Horticultural zones of state and country.

Practical

Identification of field crop and tillage implements. Preparation of seed beds, identification of fertilizers and manures – mixing chemical fertilizers – calculating fertilizer requirements. Identification of green manure plants. Identification of important weeds of the region with particular reference to forest plantations. Preparation of weed herbarium. Calculations of spray volume and herbicide concentrations. Methods of application of herbicides. Identification of horticultural crops-garden tools and implements. planning and layout of orchard and plantations. Digging and filling of pits for fruit and plantation crops-planting systems, training and pruning of orchard trees-preparation and application of regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits-bearing habits and maturity standards, harvesting, grading, packaging and storage.

Suggested readings

Agrawal, R.L. 1980. Seed technology. Oxford & IBH Publishing Co., New Delhi

Balasubramanian, P and Palaniappan, S.P. 2001. Principles and Practices of Agronomy. Agro Bios (India) Ltd., Jodhpur.

Bose, T.K. 1985. Fruits of India- Tropical and subtropical. Naya Prakash, Calcutta

- Brady, N.C. and Well, R. R. 2002. *The Nature and Properties of Soils* (13th ed.). Pearson Education, Delhi.
- De, G.C. 1989. *Fundamentals of Agronomy*. Oxford & IBH Publishing Co., New Delhi
- Havlin, J. L., Beaton, J. D., Tisdale, S.L., and Nelson, W.L. 2006. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management* (7th ed.). Pearson Education, Delhi.
- ICAR 2006. *Handbook of Agriculture*, ICAR, New Delhi.
- Nair, P.K.R. 1979. *Intensive multiple cropping with coconuts in India*. Verlag Paul Pary, Berlin
- Palaniappan, S.P. 1988. *Cropping systems in the tropics - Principles and management*. Wiley Eastern Limited, New Delhi
- Randhawa, M.S. 1982. *History of agriculture in India*, Vol I, II & III. ICAR, New Delhi
- Reddy, T.Y and Reddy, G.H.S. 1995. *Principles of Agronomy*, Kalyani Publishers, Ludhiana.
- Reddy, S.R. 1999. *Principles of Agronomy*, Kalyani Publishers, Ludhiana.
- Sankaran, S. and Subbiah Mudaliar, V.T. 1991. *Principles of Agronomy*. The Bangalore Printing & Publishing Co., Bangalore
- Tisdale, S.L. et al. 1985. *Soil fertility and fertilizers*. Macmillan Pub. Co., New York

2. Geology and Soils

3 (2+1)

Theory

Introduction to geology - its significance, composition of earth's crust, soil as a natural body - major components by volume. Pedology - rocks- types – igneous, sedimentary and metamorphic, classification - soil forming minerals - definition, classification-silicates, oxides, carbonates, sulphides, phosphates-occurrence. Weathering of rocks and minerals -weathering factors -physical-chemical-biological agents involved, weathering indices. Factors of soil formation-parent material, climate, organism, relief, time. Soil forming processes-eluviations and illuviation, formation of various soils. Physical parameters- texture-definition, methods of textural analysis, Stokes law, textural classes, use of textural triangle, absolute specific gravity-definition apparent specific gravity/bulk density-factors influencing-field bulk density, relation between bulk density-particle density. Pore space-definition-factors affecting capillary and non capillary porosity- soil colour-definition-its significance - colour variable-hue, value, chroma, Munsell colour chart-factors influencing-parent material-soil moisture-organic matter. Soil structure-definition-classification-clay- prism like structure-factors influencing genesis of soil structure, soil consistency, plasticity-Atterberg's constants. Soil air-composition, factors influencing-amount of air space. Soil temperature-sources and distribution of heat-factors influencing-measurement. Chemical properties -soil colloids organic- humus-inorganic-secondary silicate-clay-hydrous oxides. Soil organic matter decomposition - concept of pH - soil acidity -nutrient availability-soil buffering capacity – a brief overview of saline, sodic and

calcareous soils. Soil water-forms-hygroscopic, capillary and gravitational-soil moisture constants-hygroscopic coefficient-wilting point-field capacity-moisture equivalent, maximum water holding capacity, energy concepts-pF scale measurement-gravimetric-electric and tensiometer methods-pressure plate and pressure membrane apparatus-Neutron probe-soil water movement-saturated and unsaturated infiltration and percolation. Elementary knowledge of soil classification – soil orders. Forest soils- characteristics- distinguishing features-changes in physical and chemical properties compared to agricultural soils.

Practical

Identification of rocks and minerals; Collection and preparation of soil samples; Soil analyses for moisture, colour, bulk density, organic matter, pH, EC; Textural analysis by hydrometer method; Study of soil profile; Study tour for identification of rocks and minerals and profile studies; Practica on introduction to Tensiometer, pressure plate and neutron probe etc.

Suggested readings

- Biswas, T.D. and Mukherjee, S. K. 1987. Test Book of Soil Science, Tata McGraw Hill Publishing Co., New Delhi
- Brady, N. C. 1990. Nature and Properties of Soils. 10th ed., Macmillan Publishing Co. Inc., New York
- Foth, H.D. and Turk, L. M. 1972. Fundamental of Soil Science. 5th edn. Wiley Eastern Pvt. Ltd., New Delhi
- Gupta, P.K. 2007. Soil, Plant, Water and Fertilizer Analysis. Published by AGROBIOS (India), Jodpur
- Indian society of soil science (ISSS). 2002. Fundamentals of Soil Science. Published by Indian Society of Soil Science, IARI, New Delhi
- Jaiswal, P.C. 2006. Soil, Plant and Water Analysis. 2nd Edn. Kalyani Publishers, Ludhiana
- Pritchett and Fisher R, F. 1987. Properties and Management of Forest Soils. John Wiley, New York.

3. Forest Protection

3 (2+1)

Theory

Introduction – Importance of protection in Indian Forestry – classification of injurious agencies. Injury to forest due to fires, causes and character of forest fires – fire prevention activity – fire suppression – fire fighting equipments – fire control policy and objectives. Fire fighting in other countries. Injury to forest due to man, lopping – cutting for fuel wood – Encroachment- different types, control of encroachment illegal felling of trees- method of control legislation. Forest weeds and weed management, management of woody climbers, parasites and epiphytes. Importance of Forest Pathology, tree disease classification, Principles of tree disease management, - Causes and symptoms- losses due to forest tree diseases, root

diseases (wilt, root- and butt rot), stem diseases (heart rots, stem blisters, rusts, stem wilt, cankers, pink diseases, gummosis, water blister) and foliar diseases (rust, powdery mildew, leaf spot, leaf and twig blight, abnormal leaf fall, needle blight etc.) Etiology, symptoms, mode of spread, epidemiology and management, including chemical, biological, cultural and silvicultural practices. Nursery diseases and their management. Disease due to physiological causes. Abiotic diseases. Forest Entomology in India. Methods and principles of pest control: Mechanical, physical, silvicultural, legal, biological and chemical. Principles and techniques of Integrated Pest Management in forests. Classification of forest pests: types of damages and symptoms; factors for outbreak of pests. Nature of damage and management: Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest and Plantation forest species. Insect pests of freshly felled trees, finished timbers and their management.

Practical

Visit to forest areas with fire damages, Studying fire registers as records, studying encroachments and problems caused due to disturbance-visit to illegally felled areas- Visit to fire station, Study and acquaint with machinery used for fire control, identification of weeds, parasites and epiphytes. Observation of symptoms in laboratory and in forests - examination of scrapings - host-parasite relationships - causal organisms of above forest diseases. Examination of cultures of important pathogens. Visit to nurseries and plantations. Insect pests of forest seeds; forest nurseries; standing trees; freshly felled trees and finished products. Survey and identification of invertebrate fauna from forest areas. Methods of isolating soil invertebrate macro and micro fauna. Insecticides and their formulations, plant protection appliances.

Suggested readings:

- Agrios, G.N. (1997). Plant Pathology. 4th Edn, Horcourt Asia Pvt. Ltd., Singapore.
- Bakshi, B.K. (1976), Forest Pathology; Principles and Practices in Forestry. Pub. Comptroller of Publications, Delhi. 400p.
- Basher, A.E.S. (1983).Forest Fires and Their Control. Gulab Primlani Amerind Publishing, New
- Boyce, J.S. (1961). Forest Pathology, 3rd edition. McGraw-Hill. New York, New York. 572 pp
- Brown, A.A and Davis, K.P. (1973). Forest Fire Control and Use. Mc Graw Hill Book Co. New York. Delhi.159p.
- Devasahayam, H.L. and Henry, L.D.C. (2009). Illustrated Plant Pathology- Basic Concepts. New India Publishing Agency
- Elton, C. S. (2000). The Ecology of Invasions by Animals and Plants. University of Chicago Press.
- Fuller, M. (1991). Forest Fires. Wiley Nature Editions, New York.

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

4. Environmental Studies and Disaster Management

3 (2+1)

Theory

Environmental studies Definition, scope and importance, Natural Resources, Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources, Ecosystems-Concept of an ecosystem, Structure and function of an ecosystem, Biodiversity and its conservation, Value, Environmental Pollution, Solid Waste Management, Social Issues, Environmental ethics, Wasteland reclamation, Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness, Environment and human health, Women and Child Welfare, Natural Disasters, Climatic change, Man Made Disasters, Disaster Management

Practical

Field work: Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain, visit to a local polluted site-Urban/ Rural/ Industrial/ Agricultural, Study and documentation of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc.

Suggested readings:

- Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
- Hodgkinson PE & Stewart M. 1991. Coping with catastrophe. Handbook of Disaster Management. Routledge.
- Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

5. Forest Survey & Engineering

3 (2+1)

Theory

Forest survey, scope and types of surveying, chain surveying, types and instruments used; Traversing, triangulation, survey stations, base line, check and tie lines; ranging of survey lines; offsets and their types; chain of slopy grounds, chaining across obstacles; cross staff surveying, Areas of irregularly bounded fields- different methods; Simpson's, trapezoidal rule; compass surveying, chain and compass traversing, magnetic and true bearing, prismatic compass, local attraction. Computation of interior angles and balancing of closed traverse. Plane table surveying; plane table and its accessories, methods of plane table surveying. Leveling: terms used types of level. Theodolite and its uses. Contour surveying buildings materials- types, strength and characteristics, site selection for building construction, forest roads- alignment, construction and drainage; retaining walls, breast wall, water ways and culverts; bridges-types, selection of site, simple wooden beam bridge, check dams, spurs, farm ponds, earth dams.

Practical

Chain surveying, compass traversing; plane table surveying, leveling, calculations of earth work for construction of forest; roads & earth dams; alignment of forest roads; preparation building plans; design of water ways; design of simple wooden beam bridge; design of retaining walls. Design of check dams.

Suggested readings

- Kanetkar, T.P. and Kulkarni, S.V. (1989). Surveying and leveling. Vidyarthi Griha Prakashan, Pune.
- Masani, N.J. (2006). Forest Engineering -without tears (2nd edition). Natraj Publishers, Dehra Dun.
- Murthy, V.V.N. (1985). Land and water management engineering. Kalyani Publishers, New Delhi.
- Parkash, R. (1983). Forest Surveying, International Book Distributor
- Punna, B.G. (1987). Surveying Vol I. Laxmi Publishers, New Delhi.
- Sahani, P.B. (1979). Text Book of Surveying Vol. I & II. Oxford and IBH, New Delhi.

6 . Soil Biology & Fertility of Forest Soil

3 (2+1)

Theory

Introduction - forest soils vs. cultivated soils, special features of forest soils, forest soil formation and vegetation development. Pedogenic processes – Podzolization and Laterization. Properties of soils under different forest ecosystems. Forest floor – stratification – types of humus. Essential nutrient elements-occurrence, availability and their functions. Diagnosis of nutrient deficiencies-visual symptoms, soil fertility evaluation methods. Site productivity and nutrient cycling in forest soils. N, P and K, macro and micronutrient fertilizers and their uses. Forest soil - biology-distribution of various microorganisms in soil ecosystem and their interaction effects. Role of microorganisms in soil fertility. Mineral transformations-carbon cycle with reference to organic matter decomposition and humus formation, Microbial degradation of cellulose & lignin. Bio-fertilizers – their importance. Nitrogen fixation-Rhizobium-tree legume symbiosis, Frankia X non-legume symbiosis, asymbiotic and associative N₂ fixation. Nitrification and denitrification in forest ecosystems. Microbial transformation of phosphorous, sulphur, and micronutrients. Mycorrhizae: types, biology and importance with specific relevance to tree crops and mobilization of phosphorus and micronutrients. Rhizosphere and phyllosphere concept. Fertility management of forest soils. Integrated nutrient management in plantation forestry.

Practical

Study of forest soil profile; Estimation of pH and EC –Organic carbon – available N, P, K, Ca, Mg, S and micronutrients – Determination of CEC and exchangeable cations; Interpretation of soil and plant analysis data for fertilizer recommendation. Basic sterilization techniques; culturing and maintenance of micro organism occurring in soil; Staining methods; Study of decomposition of forest litter by CO₂ – evolution method; Estimation of nitrification rate in soil; Isolation of legume bacteria and Azotobacter; Preparation and inoculation techniques for mycorrhizae and biofertilizers.

Suggested readings

Brady, NC. The Nature and Properties of Soils. Mac Millan Pub. Comp. New York.

Burges, A. and Raw, F. 1967. Soil Biology. Acad. Press, New York

Mengel, K. and Kirkby, A. 1978. Principles of Plant Nutrition. International Potash Institute, Switzerland

Pritchett and Fisher RF 1987. Properties and Management of Forest Soils. John Wiley, New York.

Tisdale, L. S. Nelson, L.W. and Beaton, J. D. 1985. Soil Fertility and Fertilisers. Macmillan Publishing Company, New York

Young, A. 1989. Agroforestry for Soil Conservation. CAB International, U.K.

7. Forest Ecology and Biodiversity

3 (2+1)

Theory

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

Practical

Study of ecological modifications in plants; Effects of fire on forest ecosystem; Study of population dynamics using model systems; Preparation of life tables; Study of spatial dispersion among plants; Study of Forest composition; Niche analysis; Computation of diversity indices; Measurement of diversity of plants and insects in a nearby forest; Study of succession in field and water bodies; Visit to different ecosystems.

Suggested readings

- Odum EP 1983. Basic Ecology. Saunders College Publishing, Philadelphia etc. 613p
- Misra KC 1974. Manual of Plant Ecology. Oxford & IBH Pub Co. New Delhi etc. 491p
- Michael P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata Mc Graw-Hill Pub. Co. New Delhi, 404p
- Montagnini, F and Jordan, C.F. 2005. Tropical Forest Ecology: The Basis for Conservation and Management. Springer. 295p.
- Frankel, O.H., Brown, A.H.D., Burdon, J.J. 1995. The Conservation of Plant Biodiversity. Cambridge University Press. Cambridge. 299p

8. Rangeland and Livestock Management

2 (1+1)

Theory

Definition, scope and importance – cattle and fodder resources of India, grassland types of India and their distribution – ecological status of Indian grasslands – principles of grassland

management for maximizing forage yield and quality. Feeding habit and grazing behavior of range animals. Carrying capacity – definition, method of calculation. Establishment and management of grasslands – selection of species, planting, cultural practices – liming, fertilizer application, burning, weed control, grazing and cutting intensity. Storage of fodder – silage and hay – methods of preparation – hay banks, Fodder trees and shrubs, Forest grazing.

Definition and importance of Livestock management. Important breeds of important livestock eg. Cattle, buffalo, sheep and goat. Breeding and reproductive management for higher productivity. Feeding management – types of feedstuffs available for feeding livestock, methods of feeding. Assessing nutritive value of feed and fodder, estimation of digestible nutrients and energy in feedstuffs. Principles of rationing. Prevention and control of diseases.

Practical

Study of grassland and rangelands in the area. Different tools/instruments used in livestock management; Routine management practices followed on livestock farms; Identification of feedstuffs and their nutritive value; Nutritive requirement animals; Study of housing systems and requirements; Preservation of fodder as hay, silage and leaf meal.

Suggested readings

Banerjee, G.C. 2010. A text book on Animal Husbandry, 8th Edition, Oxford and IBH New Delhi.

Holechek J.L. et al. 1989. Range Management. Prentice Hall, New Jersey

Sastry, N.S.R. and C.K. Thomas. 2005. Livestock Production Management, Kalyani Publishers, New Delhi.

Singh R.V. 1982. Fodder trees of India. Oxford and IBH New Delhi.

Ward H.M. 1980. Grasses. A handbook for use in the field and laboratory, Scientific Pub., Jodhpur

9. Climate Science

3 (2+1)

Theory

Agrometeorology – definition, aim and scope. Factors and elements of weather and climate. Composition and structure of atmosphere. Air and soil temperature regimes, atmospheric humidity, types of clouds and precipitation, hails and frost. Cyclones, anticyclones and thunder storms. Solar radiations components and effect on plant growth. Effect of weather and climate on the growth and development of crops. Climatic normal for crops and trees. Agro climatic zones of India . Evaporation and transpiration.

Climate change: Understanding climate change and its Consequences. Global warming and its effects on Forest. Forest and climate change: Vulnerability and adaptability - Evidence of forest disturbance due to climate change –Climate change influence on agro-forestry- Climate resilient forestry. Economic worth of carbon storage in forest – Forest and UN convention on

climate change - NATCOM initiatives – Decision making in emission of Green House Gases (GHG). Kyoto protocol, awareness about climate change. National action plan for climate change – Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plans on Climate Change.

Practical

Study of temperature instruments, pressure instruments, humidity instruments, wind instruments, rain instrument and wind rose. Solar radiation instruments with pyranometer. Layout of an agromet observatory and types. Measurement of wind and evaporation. Measurement of sunshine hours. Measurement of soil temperature and dew. Estimation of green house gases into atmosphere.

Suggested readings

Ghadekar, S.R. (2003) Meteorology . Agromet Publishers, Nagpur

Lenka,D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi

Mavi, H.S. (1994) Agrometeorology . Oxford & IBH, New Delhi

Rao, GSLHVP (2003) Agrometeorology, KAU, Thrissur, Kerala,

Seemann, J., Chirkov, Y.I., Lomas, J., and Primault, B. (2012) Agrometeorology. Springer Berlin Heidelberg

Varshney, M.C. and Pillai, P.B. (2003) Textbook of Agrometeorology. ICAR , New Delhi.

10. Forest Laws, Legislation and Policies

2 (2+0)

Theory

National forest policies-scope and importance- comparative analysis of all forest policies - Indian judicial system- Legal definitions, application of penal code to forests, general principles of criminal law, legal principles of punishment, criminal procedure code, the law of evidence and the Indian Evidence Act, 1872 as applied to forestry matters. Indian Forest Act, 1927 general provisions, Code of Civil procedure, 1908. Forest (Conservation) Act, 1980. Brief description about other major forest laws of regional, national and international significance. Detailed study of KFA 1961. Biological Diversity bill 2002-discussion of court verdicts on issues of utmost importance to conservation.

Suggested readings

Dutta, R. and Yadav, B. (2012). Supreme Court on Forest Conservation. Universal Law Publishing Co., New Delhi, India

Joy, P. P. (2012). Set up your criminal practice. Swamy Law House, Ernakulam

Shetty, B. J. (1985), A Manual of Law for Forest Officers, Sharda Press, Mangalore

Takwani, C. K. T and Thakker, M. C. (2012). Takwani Criminal Procedure. Lexis Nexis Butterwarths Wadhwa, Nagpur

Varghese, M. I. (2012). Treatise on Forest Laws of Kerala. Swamy Law house, Ernakulam.

11. Geomatics

3 (1+2)

Theory

Remote sensing - classification based on source: Active and passive remote sensing; Aerial and space remote sensing; Interaction of electromagnetic radiation with atmosphere and earth surface; Aerial photographs – types; Photo interpretation - Satellite remote sensing - platforms and sensors; Satellite systems. Indian Remote Sensing Programme; Visual and digital image processing; Application of satellite based remote sensing techniques in forestry - vegetation mapping using satellite imagery-NDVI; Forest cover monitoring and damage assessment; Microwave remote sensing. Introduction to GIS. Differences between GIS and conventional cartography. Spatial and non-spatial data- Integration of attribute data with spatial data. Spatial data - Raster and Vector data-Thematic over lays in GIS- topology building and calculation of area and length etc. Application of GIS in forestry – using imageries and integration with GIS data. Maps-its projection-Toposheet and Map readings. Global Positioning System (GPS) applications in resource inventory, Global Navigation Satellite System, Galileo, GLONASS, QZSS, Compass, IRNSS etc., GAGAN

Practical

Preparation maps; Visual interpretation of satellite imagery; Forest cover mapping and land use mapping. Digital image processing. Introduction to various GIS software – Q-GIS, ERDAS, Arc GIS etc. Exercises in viewing, editing, overlay. Visit to the GIS labs at State level.

Suggested readings

Campbell, J.B. (2002). Introduction to Remote Sensing-Third edition. Taylor and Francis, London

Environment System Research Institute, (1999). GIS for Everyone. Redlands, CA:ESRI

Jackson, M.J. (1992). Integrated Geographical Information Systems. International Journal of Remote Sensing, 13(6-7): 1343-1351

Joseph, G. (2005). Fundamentals of Remote Sensing-Second edition. Universities Press

Lillesand, T.M. and Kiefer, W.R. (1994). Remote sensing and Image Interpretation, Fourth edition. John Wiley & Sons, Inc., USA

Obi Reddy, G.P. and Sarkar, D. (2012). RS and GIS in Digital Terrain Analysis and Soil Landscape Modelling. NBSS & LUP, Nagpur.

12. Recreation & Urban Forestry

2 (1+1)

Theory

Forest recreation – Definition and scope – social and environmental aspects of recreation components new approaches in forest recreation. Principles and elements of landscaping - types of landscape designs formal-Persian and Mughal designs, and informal- British and Japanese. Landscape components- plant and other components- lawn, pergolas, hedges, edges, topiary, baloon, arbours, carpet beds, trees, flower beds, annuals, and climbers. Practices of landscaping-Tools and implements for landscaping. Specialized gardens-butterfly, water, bog or marsh, terrace, roof, Sunken, Indoor and rock. Planning and planting programmes in institutional and industrial complexes, roads, bridges, parking area and other structures. Urban forestry – definition and scope – uses of urban forests, Management of urban forest- Arboriculture and its importance in urban forestry.

Practical

Preparation, planning and designing the planting pattern for parks, sanctuaries and industrial complexes – familiarize with the components of landscaping – studies on the features of flowering and foliage trees suitable for avenue planting – visit to landscaped areas, parks tourist spots and centres, national parks and sanctuaries., practice planting methods.

Suggested readings

Douglar, J. Hort, R. A and Ranganadhan, S. (1982). Forest Farming. Natraj Publications, Dehradun.

Gopikumar K. (2008). Arboriculture Principles and Practices. Published by Khanna Bandhu, Dehradun

Hamm, W.E and Cale, D.N.(1987). Wild Land Recreation, John Wiley and Sons, New York .

Miller, R.W.(1988). Urban Forestry. Prentice Hall International Ltd. London

Singh, S.P. (1986). Planting of Trees. B.R. Publishing Corporation, Delhi.

Urban Forestry and Urban Greening. An International Journal aimed at presenting high-quality research with urban and peri-urban woody and non-woody vegetation and its use, planning, design, Elsevier Publications.

13. Restoration Ecology

2 (1+1)

Theory

Degraded lands: Concept, classification, status, extent and causes of degraded lands/wastelands, different types of degraded lands – physical, chemical and biological land degradation. Soil erosion- types, causes and mechanism, measures to control erosion, ravine and sand dune formation and their control measures. Salt affected soils- classes of salt affected

soils, causes, extent and their effects on plant growth and afforestation / reclamation practices. Acid soils- definition, characteristics, causes and afforestation. Water logged areas- explanation, impact on plant growth and Biodrainage techniques. Afforestation and reclamation of denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas. Desertification- definition, impact and causes, prevention and counter measures (shelter belts and wind breaks). Soil pollution- types, effects and control measures through forestry techniques. National and state level programmes on degraded lands/wasteland development. Role of Government agencies and NGO's in degraded lands/wasteland development programme.

Practical

Tree species suitable for different degraded lands. Identification and study of various degraded lands. Visit to nearby degraded lands (eroded site, ravine and sand dune, coastal area, waterlogged area, denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas) and afforestation programme.

Suggested readings:

- Anilkumar and Pandey, RN 1989. Wastelands Management in India. Ashish Publishing House, New Delhi
- Buol, S.W., Kole, F.D. and McGracken, R.J. 1975. Soil Genesis and Classification. Oxford and IBH Publ. New Delhi.
- Butler, B.E. 1980. Soil Classification for Soil Survey. Clerneder Press-Oxford Publ. Co., London.
- Gregersen, H. Draper, S. and Elz. D.(eds.) 1989. People and Trees- The Role of Social Forestry in Sustainable Development EDI Seminar Series, The World Bank, Washington, D. C. 273p
- Hegde NG 1987. Handbook of Wasteland Development. BAIF, Pune 102p.
- Hegde NG and Abhyankar 1986 (eds). The Greening of Wastelands. BAIF, Pune 204p
- IARI 1960. Soil Survey Manuel, IARI. New Delhi.
- ICAR 1977. Desertification and its Control. ICAR, New Delhi 358p.
- National Commission on Agriculture 1976. Report of the National Commission on Agriculture, Part ix,
- Prasad, V. N. 1985. Principles and Practices of Social-Cum-Community Forestry. International Book Distributors, Dehradun, 108p
- Shah, S. A. 1988. Forestry for People. ICAR, New Delhi, 147p
- Sharma, S. C., Chaturvedi R. B and Mishra O. P 1990. Utilization of Wastelands for Sustainable Development In India. Concept Publishing Co. New Delhi-59, 488p

14. Forest Inventory and Yield Prediction

2 (1+1)

Theory

Yield - In regular forests-In Irregular forests. Estimation of growth and Yield of stands - Forest Inventory - Point sampling Forest Inventory - Definition-objectives- Kinds of enumeration- Tree assessment techniques- Measurement of wood volume, tree volume & tree volume tables - Kinds of sampling -Sampling design - Kinds of sampling units- Fixed area and point sampling units - Plots, strips, topographical units - sampling intensity- Inventory designs used in India - Sampling errors and non sampling errors.- Organization of field work and conduct of enumeration - Point sampling- Concept of horizontal point sampling . Estimation of growth and yield prediction in forest stands- Stand structure - Growth of stand - Methods of predicting future growth of stands - Stand density - Canopy density -Crown competition factor- Yield tables- definition- Preparation of yield table - Application and use of yield tables - Stand table-definition and use.

Practical

Study the demarcation and alignment of plots, strips etc. Field exercise on Horizontal Field demonstration of various sampling techniques- Simple, stratified, multi stage, multiphase, non-random sampling techniques. Visit forest areas for forest enumerations- point sampling- use of wedge prism and Relaskop - Field exercise on the determination of site quality -Visit to local forest divisions and study the methods of preparation and use of yield tables. Method demonstration on the use of aerial photographs in forest inventory

Suggested Readings

- Chapman, H.H and Meyer, W.H. (2008).Manual of Forest Mensuration: Methods and Techniques. Asiatic Publishing House, New Delhi, 522p.
- Chaturvedi, A.N and L.S. Khanna. (2011). Forest Mensuration and Biometry (5th edition). Khanna Bandhu. Dehra Dun. 364 pp.
- Heindjik, D. (1975). Forest Assessment. International Book Distributors, Dehradun, 349p
- Husch, B., Beers, T.W. and Kershaw, Jr. J.A.(2002). Forest Mensuration (4th edition). John Wiley & Sons, Nature.456 pp.
- Kangas, A. and Maltamo, M. (2006). Forest Inventory: Methodology and Applications. Managing Forest Ecosystems (Vol.10).Springer.340pp.
- Philip, M.S.(1994).Measuring Trees and Forest. AB International, UK,310p
- Scott,C.T and Gove, J.H. (2002). Forest Inventory. Encyclopedia of Environmetrics (Vol 2), John Wiley & Sons. pp 814–820
- Shiver, B.D and Borders, B.E.(1996). Sampling Techniques for Forest Resource Inventory. John Wiley and Sons, New York, 356p
- Spurr, H.S.(1952).Forest Inventory. John Wiley and Sons, New York, 476p.

IV. FOREST PRODUCT UTILIZATION (FP)

1. Wood Anatomy

3 (2+1)

Theory

Introduction to wood anatomy. Classification of plant kingdom. Gymnosperms versus angiosperms. Kinds of woody plants. The plant body; a tree and its various parts. Meristems; promeristem, primary meristem, secondary meristem. Simple tissues; parenchyma, collenchyma, sclerenchyma and the vascular tissues. Parts of the primary body; typical stems and roots of dicots and monocots. Secondary growth in woody plants. Mechanism of wood formation in general, and with special reference to typical dicot stem. Ray initials and fusiform initials; anticlinal and periclinal division. Physiological significance of wood formation. The macroscopic features of wood, sapwood, heartwood, pith, early wood, late wood, growth rings, wood rays, etc. Sapwood versus heart wood, anatomical differences. Transformation of sapwood to heartwood; factors affecting transformation. Microscopic features of wood. Prosenchymatous elements, tracheids, vessels, fibers. Parenchymatous elements, parenchyma and rays, resin canals, gum canals, latex canals, infiltrants in wood. Three dimensional features of wood; transverse, tangential and radial surfaces. Elements of wood cell walls. The structure and arrangement of simple pit, bordered pits. Extractives in wood. Comparative anatomy of gymnosperms and angiosperms. Anatomical features of common Indian timbers; classification into porous and non-porous woods, ring porous and diffuse porous woods. Effect of growth rate on wood properties. Juvenile wood and mature wood.

Practical

Study of primary growth in stems of typical dicots and monocots. Study of wood formation in typical dicot stem. Study of vascular bundles in monocots. Parts of the logs (woody trunks), and the three distinctive surfaces of wood (i.e. cross, radial and tangential planes). Timber identification and its importance. Procedures for field identification of timbers. Study of physical features of wood. Study of gross features of wood. Study of anatomical features of wood, pores or vessels, different types. Study of soft tissue in timbers and their different types distributions. Study of wood rays, and their different types. Study of the non-porous woods, their physical and anatomical description. Study of infiltration and inclusions in wood. Anatomical keys and methods to use them. Dichotomous keys, punched card keys and computer aided identification. Field identification of important timbers of Kerala.

Suggested readings

Anoop, E.V., Antony, F., Bhat, K.V. Lisha, D.A. and Babu, L.C. 2005. Anatomical key for the identification of important timbers of Kerala. Kerala Agricultural University, Thrissur and Kerala State Council for Science, Technology and Environment, Thiruvananthapuram, Kerala, India. 126p.

- Hoadley, B. 2000. Identifying wood-Accurate results with simple tools. Taunton Press, Newtown, USA. 223p.
- Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.
- Rao, R. K. and Juneja, K. B. S. 1992. Field identification of fifty important timbers of India. Indian Council of Forestry Research and Education, New Forest, Dehra Dun. 123p.

2. Wood Products and Utilization

3 (2+1)

Theory

Uses of wood. Growth of wood based industry in India, effect of globalization. Importance of forest based industries in relation to Indian economy. Wood as a source of energy and chemicals, wood as raw material for industries like pulp, paper, rayon, composite woods and improved woods. Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of wood of lesser known forest species for commercial purposes. Structural uses of Timber – bridges and other super structures. Decorative uses of wood. Introduction to wood modification, its need and scope, chemical modification of wood (acetylation, reaction with isocyanates, acetates, ethers, epoxides etc.). Primary conversion; sawing and veneering. Composite wood; plywood, laminated wood, core board, sandwich board, fibre board, particle board; manufacturing process, uses and properties. Adhesives used in manufacture of composite wood. Improved wood; compressed wood, impregnated wood etc.; manufacturing process, uses and properties. Nano technology in wood. Manufacture of rayon and match. Wood carving and handicrafts. Destructive distillation of wood. Saccharification of wood. Production of wood molasses, alcohol and yeast. Biochar, technology, bioenergy concepts - short rotation crops as raw materials.

Practical

Estimation of specific gravity and calorific value of wood specimens. Maceration techniques and determination of sizes of fibres, vessels etc. Visits to various wood based industries like, plywood, packing case, match, tannins, furniture, saw mills etc. to study the manufacturing process. Visit to saw mill to study veneering and different kinds of sawing. Handicraft manufacturing unit. Visit to wood distillation unit. Visit to nearby industrial plantations.

Suggested readings

- Baldwin, R. F. 1981. Plywood manufacturing practices. Revised 2nd Ed. Miller and Freeman Publication, Inc. USA. 388p.
- FRI [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
- Hoadley, B. 2000. Understanding Wood: A Craftsman's guide to wood technology. Taunton Press. Newtown, USA. 223p.

3. Ethnobotany, Medicinal and Aromatic plants

3 (2+1)

Theory

Definition and scope of ethnobotany. Terms employed in relation to ethnobotany and its relationship with man and domestic animals. Ethnic – people and their contribution in therapeutic and ethnobotanical knowledge especially with respect to medicinal and allied aspects. Important plants and their folk uses for medicines, food, dyes, tans, etc Methods and tools in Ethnobotanical studies. Ethnobotany of tribals in Southern India. Traditional Botanical Knowledge- concepts. Major tribes of Northern, Central, North East and Andaman and Nicobar Islands. Ethnobotany of the plants from the following families. *Guttiferae* (*Clusiaceae*), *Malvaceae*, *Fabaceae*, *Mimosaceae*, *Caesalpinaceae*, *Combretaceae*, *Umbelliferae* (*Apiaceae*), *Rubiaceae*, *Asteraceae*, *Ebenaceae*, *Apocynaceae*, *Asclepiadaceae*, *Euphorbiaceae*, *Lauraceae*, *Palmaceae*, *Poaceae*, *Liliaceae*, *Coniferae*, *Santalaceae*, *Thymeliaceae*.

Definition - role of medicinal and aromatic plants in Indian economy - Important essential oil yielding plants in India - Detailed study of lemon grass, citronella, palmarosa, vetiver, japanese mint, eucalyptus, jasmine, patchouli and geranium - botany, climate and soil requirements, planting cultural and manorial practices - harvesting, curing and extraction of essential oils. Medicinal plants in India and Kerala - history, origin, area and distribution, production, botany and varieties - cultivation, extraction of active principles and their uses - uses of different medicinal plants like *Atropa*, *Cinchona*, *Rauwolfia*, *Opium*, *Sandal*, *Acorus*, *Cannabis*, *Digitalis*, *Strychnos nux-vomica*, *Aconitum*, *Neem*, *Dioscorea*, *Costus*, *Solanum* etc. Cultivation practices of medicinal plants like *Adhathoda zylanica*, *Sida cordifolia*, *Sterospermum colais*, *Plumbago zylanica*, *Tinosporacordifolia*, *Kaemferia glanga*, *Indigofera tinctoria*. Conservation packages for the medicinal plants collected in wild.

Practical

Field visit to different tribal regions to gain ethnobotanical knowledge and the inter-relation between plant and people- Survey and identification of plants used by the tribals for medicine, food and other social purposes- Collection and preparation of herbarium specimens of the above plants- Identification of medicinal and aromatic plants – propagation techniques – Harvesting and oil extraction of aromatic plants – Field visit, collection and preparation of herbarium – Visiting commercial units of medicinal plants.

Suggested readings:

- Atul, C.K. and Kapur, B.K. (1982). Cultivation and utilization of medicinal plants. RRL., CSIR, Jammu-Tawi.
- Chopra, R.N., Nayar, S.L. and Chopra, I.C. (1956). Glossary of Indian medicinal plants. CSIR, New Delhi.
- Cunningham, A. 2014. Applied Ethnobotany: "People, Wild Plant Use and Conservation". Taylor & Francis,

EIRI Board. (2007). Handbook of Medicinal and Aromatic Plants: Cultivation, Utilisation and Extraction

Ethnobotany. Principles and applications. (1997). C. M. Cotton. John Wiley and Sons Ltd. 424p.

Gunther, E. (1975). The essential oils. Robert, K Krieger Pub. Co., New York.

Jain, S.K. 2010. Manual of Ethnobotany (2nd Ed). Scientific Publishers, India, 242p.

Maheshwari, J.K. 2000. Ethnobotany and medicinal plants of Indian subcontinent. Scientific Publishers, Jodhpur, India, 672p.

4. Wood Science and Technology

3 (2+1)

Theory

Kinds of woods; hardwood, softwood, bamboos and palms, merits and demerits of wood as a raw material, the physical features of wood. Electrical, thermal and acoustic properties of wood. Mechanical properties of wood like tension, compression, bending, shearing, cleavage, hardness, impact resistance, nail and screw holding capacities. Suitability of wood for various uses based on mechanical and physical properties. Wood water relationship; shrinkage, swelling, movement, fibre saturation, equilibrium moisture content. Wood seasoning; merits, principles and types; air seasoning, kiln seasoning and chemical seasoning. Refractory classes of timbers, kiln schedules. Seasoning defects and their control. Classification of timbers based on durability. Wood preservation; principles, processes, need, types of wood preservatives (Water soluble, oil based, etc.). General idea about fire retardants and their usage. Non-pressure methods; steeping, dipping, soaking open tank process, Boucherie process. Pressure methods; full cell process, empty cell process (Lowry and Rueping). Wood machining. Sawing; techniques, kinds of saws; cross cut, edging, cudless, hand, circular and bow saws. Wood working, tools used in wood working (parting, slicing, shaping, measuring and marking tools). Various stages in wood working. Dimensional stabilization of wood by surface coating method, bulking method, impregnation of resins and polymers.

Practical

Mechanical tests on timber. Static bending, impact bending, compression parallel and perpendicular to the grain, hardness, shear, torsion, nail and screw pulling test, brittleness test and calculation of properties. Estimation of combustibility of wood using bomb calorimeter. Estimation of directional shrinkage and swelling of wood. Familiarization of non-destructive wood testing instruments. Visit to wood testing laboratories.

Suggested readings

Bowyer J. L., Shmulsky, R. and Haygreen, J. G. 2007. Forest products and wood science: An introduction. 5th Ed. Blackwell publishing, Ames, IA. 496p.

Brown, H. P. 1985. Manual of Indian wood technology. International books and periodicals supply service, New Delhi. 121 p.

FRI. [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute, Dehradun. 941p.

Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.

USDA [U.S. Department of Agriculture]. Wood handbook - Wood as an engineered material. 1999. U.S. Department of Agriculture, Forest Service. Forest Products Laboratory, Madison, WI. 508p.

5. Logging and Ergonomics

2 (1+1)

Theory

Definition and scope of logging, logging plan and execution. Location and demarcation of the area for logging and estimation of produce available for extraction. Implements used in logging operation; traditional and improved tools. Felling rules and methods, Work contracts related to felling and removing (contract system, convener systems) etc. Conversion, measurement and description of converted material. Means of transport of timber; carts, dragging, skidding, overhead transport, ropeways, skylines. Transport by road and railways. Transport by water; floating, rafting and concept of booms. Non-destructive sampling methods of wood. Grading and storage of timber in the depots for display and disposal, temporary and final storage. Timber Depots; types, lay out and management. Systems of disposal of timber. Ergonomics: definition, components and provision of energy. Requirement of energy and rest periods. Effect of heavy work, posture, weather and nutrition. Personal protective equipments, safety helmets, ear and eye protections. Accidents: causes, statistics, safety rules and first aids.

Practical

Equipments and tools used in logging operations and their uses. Instructions regarding maintenance of various records and registers in logging operations; Conversion of felled trees into logs, poles, firewood, pulpwood. Visit to local saw mills to study the equipments used and process of conversion. Measurement of logs, poles and firewood in forests and maintenance of records in relevant registers. Visit to local dumping yard (timber depot) to trace the logs delivered from different forest sites. Sorting of logs, poles and firewood in the depots according to species, quality, length and girth classes. Stacking and stock checking of different logs, poles and firewood in the depots so as to confirm that all the converted materials in the forests have reached their destination. Stacking of the lots for display and final disposal; recording of the lots for auction sale. Final disposal of the material. Visit during the auction sale in the government timber depots; Preparation of ergonomic check lists. Familiarize the e-auctioning procedure of State Forest Department. Safety rules and first aids in forestry operations

Suggested Readings

Brown, N. C. 2002. Principles and methods of harvesting of timber. Biotech books, Delhi. 430p.

- Staaf, K.A.G. and Wiksten, N.A. (1984). Tree Harvesting Techniques. Martinus Nijhoff/DR W. Junk Publishers, Netherlands.
- FRI. [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.
- GFC. [Guyana Forestry Commission]. 2002. Code of practice for timber harvest. 2nd Ed. Georgetown, Guayana. 42p.
- Hakkila, P. 1989. Utilization of residual forest biomass. Springer-verlag, Berlin. 567p.
- Jones, J. T. 1993. A guide to logging aesthetics. Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.
- Jones, J. T. 1993. A guide to logging aesthetics. Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.
- Mehta, T. 1981. A handbook of forest utilization. IBD Dehradun. 298p.
- Wakermann, A. E. 2002. Harvesting timber crops. Biotech books, Delhi. 433p.

6. Non-Timber Forest Products

3 (2 +1)

Theory

Types of markets for timber and non-timber forest produce, market locations of timber and non-timber forest produce and their features. Demand forecasts. Price determination in timber and non-timber forest produce. Economic features of specialized timber markets in terms of degree and type of competition in buying and selling, price spread, costs of marketing functions involved like pre-commercial thinning, commercial thinning, harvesting, hauling, sawing, transportation, treatment of wood, carpentry, and other processing activities involved in teakwood, rosewood, matchwood, pulpwood, sandalwood, veneers; type and degree of competition in market for services of saw mill and other intermediate wood processing industries, price spreads across different channels of marketing. Economic features of specialized markets in terms of degree and type of competition for bamboo, canes, lac, gums, resins, hides and skins. Economics of gathering medicinal plants from forests, economics of processing medicinal plants. Domestic demand and trade in timber and non-timber forest products. International demand and trade in timber and non-timber forest produce. Market inefficiencies in timber, non-timber forest produce and measures to check in efficiencies, role of cooperative societies in marketing of timber and non-timber forest produce. Economic policy and regulations of international timber trade. Essentials of World Trade Organization, GATT, Dunkel proposals, Intellectual Property Rights and Patenting. International Timber Trade Organization (ITTO) and timber certification.

Practical

Library review of studies on marketing and trade of; timber forest produce (teak, rosewood, *Terminalia* spp. *Pterocarpus* and other important timber of national importance etc.); Non-Timber Forest Produce (NTFP such as bamboo, canes, eucalypts etc.); forest based medicinal plants. Visits to timber produce and NTFP markets to collect price data and quantity sold and

to observe auctions and competitions. Analysis of price and quantitative data of timber forest produce, NTFP for examining trend; seasonal, cyclical variations. Visit to markets of forest based medicinal plants. Study of buy back arrangements in forest based medicinal plants trade. Valuation of timber and NTFP (existence value, use and option values, intrinsic value etc). Development of hypotheses to study the marketing of forest produce. Presentation of results on analysis of price and quantity. Economics of processing pulp to paper/poly fiber; wood to plywood/veneers.

Suggested readings

- Gray, J. W. 1993. Forest resource systems in developing countries. Food and agricultural organization. Rome. 259p.
- ITTO. [International Tropical Timber Organisation]. 1993. The economic linkages between international trade in tropical timber and sustainable management of tropical forests. London environmental economic centre, International Institute for Environment and Development, London, UK. 330p.
- ITTO. [International Tropical Timber Organisation]. 2012. Annual review and assessment of the world timber situation, Yogyakarta, Indonesia. 182p.
- Kula, E. 1996. The economics of forestry: Modern theory and practice. Timber press, Portland, Oregon. 182p.
- Muraleedharan, P. K. Subramanian, K. K., and Pillai, P. P. 1998. Basic readings in forest economics. Kerala Forest Research Institute and Ford Foundation, Thrissur, Kerala. 177p
- Tewari, D. N. 1995. Marketing and trade of forest produce; International Book Distributors (Book Sellers & Publishers), Dehradun, India. 140p.

7. Certification of Forest Products

2 (2 +0)

Theory

Definition of forest certification. Responsible sourcing of wood. Principal stages in the process of certification. Producer's motivation for supplying certified forest products. Key aspects of certification. Principles of sustainable forest management. Origin of certification. Organizations responsible. Legislations and policies of importance. Certification schemes in operation. Forest Stewardship Council (FSC), Programme for Endorsement of Forest Certification Schemes (PEFC) etc. CIFOR certification tool kit. Indian scenario in certification. International trade in tropical logs and sawn wood. Pros and cons of certification. Potential for certifying forests and forest products of India. Tracing illegal logging. Identification of species and region of origin. Timber tracing through genetic methods and (analysis of stable isotope ratios).

Suggested readings

- Bass, S. Introducing forest certification. 1996. A report prepared by the Forest Certification Advisory Group (FCAG) for DGVII of the European Commission. European Forest

- Institute, Discussion Paper 1. 30p. Details available at: <http://www.giz.de/Themen/de/dokumente/en-d28-innenpenent-certification-verification-forest-manage.pdf>
- Bass, S., Thornber, K., Markopoulos, M., Roberts, S. and Grieg-gran, M. 2001. Certification's Impact on forests, stakeholders and supply changes. International Institute for Environment and Development. London. 153p.
- Conroy, M. E. 2007. Branded! How the "certification revolution" is transforming global corporations. New Society publishers, Gabriola Island, BC. 354p.
- Gupta, H. S., Yadav, M., Sharma, D. K. and Singh, A. M. 2013. Ensuring sustainability in forestry: certification of forests. TERI, New Delhi. 284p.

V. SOCIAL AND BASIC SCIENCES (BS)

1. Information and Communication Technology

2 (1+1)

Theory

Introduction to computers, hard ware and soft ware, basic works of computer, operating systems. DOS, WINDOWS commands for managing files. Windows component like icons, desktop, My Computer, recycle bin, My Documents, task bar, start menu options. Familiarizing with MS OFFICE (MS Excel, MS Word, MS PowerPoint). Introductions to FOSS for OS and for work related to word processing, spreadsheet and presentation. Introduction to intra and internet and its application. Introduction to statistical packages and image processing software. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of A.V aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication.

Practical

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of fisheries data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

Suggested readings:

Norton Peter, "DOS Guide", Prentice Hall of India

Norton Peter, "Introduction to Computers", TMH

Rajaraman V, "Fundamentals of Computers", PHI

2. Communication Skills and Personality Development

2 (1+1)

Theory

Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Readings and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences. Applied Grammar: Introduction to Word Classes. Structure of the Verb in English. Uses of Tenses. Study of Voice. Use of Conjunctions and Prepositions. Sentence Patterns in English. Spoken English: Conversations of Different Situations in Everyday Life. The Concept of Stress, Stress Shift in

Words and Sentences. Words with Silent Letters and their Pronunciations. The Basic Intonation Patterns.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Readings and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations.

Suggested Readings

Carroll, B.J. 1986. English for college, Macmillan India Ltd. New Delhi

Hahn, "The Internet complete reference", TMH

Hornby, A.S. 1975. Guide to patterns and usage in English. Oxford University, New Delhi.

Quirk, R and Greenbaum, S 2002. A University grammar

3. Plant Biochemistry

2 (1+1)

Theory

Chemistry of carbohydrates— classification, mono, di and poly saccharides, anomers, epimerism, mutarotation, configuration of sugars and inversion. Chemistry of lipids— classification, simple lipids and phospholipids. Fatty acids and fat constants, lipids of chloroplast, membrane lipids. Chemistry amino acids, peptides and proteins, classification, levels of protein structure. Chemistry of nucleic acids— bases, sugars, Nucleosides and nucleotides. Structure and function of RNA and DNA. Enzymes —classification, enzyme kinetics, enzyme inhibition, allosteric enzymes, lysozymes, coenzymes. Metabolism of carbohydrates—glycolysis, TCA cycle, HMP shunt, glyoxylic acid cycle, electron transport chain. Lipids metabolism—beta oxidation and fatty acid biosynthesis. Photosynthesis —light reaction, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3 and C4 plants, CO₂ fixation, regulation of photosynthesis. Plant hormones and their mode of action.

Practical

Qualitative tests for carbohydrates, Quantitative estimation of reducing sugars by DNS method, Quantitative test for total carbohydrates by Anthrone reagent, Qualitative tests for lipids, Determination of Saponification number of oils/fats, Determination of Iodine number of fatty acids, Qualitative tests for proteins/amino acids, Estimation of protein by Lowry's method, Determination of Michaelis constant of enzymes, Estimation of RNA

Suggested readings

Conn, E.E. and Stumpf, P.K. (1989). Outlines of Biochemistry, Wiley Eastern Ltd., New Delhi

Mazur, A and Harrows, B. (1971). Text book of Biochemistry. W.B. Sanders Publications, New Delhi

Robert, C.B. (1983). Modern concepts in Biochemistry. Allyn and Bacon Inc. London

William, H.E. and Daphne, C.E. (2005). Biochemistry and Molecular Biology, Oxford University Press.

4. Forest Botany/Basic Mathematics

2(1+1)

Theory (Forest Botany)

Introduction to Allied and Applied Branches of Botany; General classification of plants – Phanerogams, Cryptogams, Angiosperms and Gymnosperms, Dicotyledons and Monocotyledons; General body organization and characters of Algae (e.g. *Chlamydomonas*), Fungi (*Mucor*), Bryophytes (*Moss*) and Pteridophytes (*Nephrolepis*); Parts of flowering plants- Root system and Shoot system, typical structure of root, stem and leaf; Functions of root, stem and leaves; Basic Structure of Flower- Essential and Non essential parts of flower; Morphology of root, stem and leaves; Morphology of Flower with emphasis on Inflorescence; Types of Phyllotaxy and Venation in leaves, types of placentation and aestivation in flower; Basic types of tissues (Structure and Function) - Dermal, Vascular and Ground tissues; Parenchyma, Sclerenchyma, Collenchyma, Chlorenchyma, Aerenchyma, Cambium, Xylem and Phloem; Types of vascular bundles in flowering plants.

Practical

Morphology of root, stem and leaves with special emphasis on underground and aerial modifications in root and stem; simple and compound leaves; types of phyllotaxy and venation (live specimens); typical structure of bisexual flower; types of inflorescence (live specimens); types of tissues with the aid of permanently mounted slides; Tissue organization in Dicot root, stem and leaves; Tissue organization in Monocot root, stem and leaves with the aid of permanent slides or study charts.

Suggested readings:

Ashok Bendre and Ashok Kumar. (1984). Textbook of Practical Botany. Vol. I and II. Rastogi Publications. Meerut. India. (Also available on Flipkart and Amazon books. Com)

Ashok Bendre and P. C. Pande. (1996). Introductory Botany. Rastogi Publications. Meerut. India.

Ashok Kumar (2001). Botany in Forestry and Environment. Kumar Media (P) Ltd. Gandhinagar, Gujarat.

Dutta. C. (1998). Botany for Degree Students. (1998). Oxford University Press. India

Dutta. C. (2000). Class Book of Botany. Oxford University Press. India

Gurucharan Singh. (2000). Plant Systematics. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

Pandey S. N. and S. P. Mishra. (2008). Taxonomy of Angiosperms. Ane Books India, New Delhi.

Pandey. P. (2012). Taxonomy of Angiosperms. S. Chand and Company Ltd. New Delhi.

5. Basic Mathematics

2(1+1)

Elementary idea of complex number. Arithmetic and Geometric progressions. Elementary idea of permutation and combinations. Matrix of a system of linear equations. Binomial theorem for positive integral index, any index and their applications, addition and subtraction formulae. A, B and C, D formulae. Sine and Cosine formulae. Inverse Trigonometric functions, ratios and their interrelationships. Limit of functions-differentiations and integrations simple applications- maxima and minima least square techniques- Introduction to matrices and determinants, special type of matrices, addition, subtraction and multiplication of matrices.

Suggested Readings

- Chatterjee S. K. (1970). *Mathematical Analysis*. Oxford & IBH.
- Frank, A. (1962). *Schaum's Outline of Theory and Problems of Matrices*. McGraw-Hill
- Frank, A. 1967. *Theory and Problems of Differential Equations*. McGraw-Hill
- Gentle JE. (2007). *Matrix Algebra: Theory, Computations and Applications in Statistics*. Springer
- Narayan, S. (1953). *A Text Book of Matrices*. S. Chand and Company.
- Parameswaran, S. (1976). *An introduction to mathematics*. Oxford & IBH Publishing Co. 172p.
- Priestley, H.A. (1985). *Introduction to Complex Analysis*. Clarenton Press
- Walter R. (1976). *Principles of Mathematical Analysis*. McGraw-Hill.

6. Physical Education-I

1(0+1)

Practical

Concept of Physical Education-Meaning, need & importance, aim, & objectives. Conditioning exercises- warming up, warming down (general & specific), and flexibility exercise. Physical Fitness exercises for speed, strength, agility, endurance and coordination. Posture & Concept - Definition, values of good posture, causes & drawbacks of bad posture, Common postural deviation, their causes and correct exercises, Kyphosis, Scoliosis, Lordosis, Knock knee & Bow legs, Flatfoot. Running ABC'S, walking ABC'S-Major games- Rules and regulations of important games, Skill development in anyone of the games- Football, Basketball & badminton. Indoor games - Participation in one of the indoor games - Shuttle badminton & table tennis. Athletic events- Rules & regulations of athletic events, Participation in any of the athletic events-Broad jump, high jump and shortput. Conduct of Health Related Physical Fitness Test (TPFP): Onemilerun/ Beep test, Sit-Up 60sec, Sit and reach, Modified pull-ups. NOTE: (one to be selected major games, indoor games and Athletic events).

7. NCC/NSS-I

1 (0+1)

NCC

Introduction to NCC, defense services, system of NCC training, foot drill, sizing, forming up in three ranks, open and close order march, dressing, getting on parade, dismissing and falling out, saluting, marching, arms drill, shoulder arm, order arm, present arm, guard of honour, ceremonial drill.

NSS

Aims and objectives of NSS. NSS logo, motto etc. Orientation of students in national problems, study of philosophy of NSS, fundamentals rights, directive principles of state policy, Village adoption.

8. Statistical Methods & Experimental Designs

3 (2+1)

Theory

Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data. Construction of frequency distribution, tables –graphic representation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve average and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and quadrilles for raw and grouped data. Dispersion: Range, standard deviation, variance, coefficient of variation for raw and grouped data. Probability: Basic concept, additive and multiplicative laws. Theoretical distributions, binominal, poisson and normal distributions, sampling, basic concepts, sampling vs. Complete enumeration parameter and static, sampling methods, simple random sampling and stratified random sampling. Tests of significance: Basic concepts, tests for equality mean, an independent and pairedt-tests, chi square tests for application of attributes and test for goodness to fit of mendalian ratios. Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of sample linear regression, tests of significance of correlation and regression co-efficient. Introduction to design of experiment- Basic principles of experimental design-replication, randomization and local control. Analysis of variance-assumptions-construction of ANOVA table-conclusions based on ANOVA. Comparisons based on means-critical difference, DMRT. Transformations of data-square root, logarithmic and angulartrans formations. Complete lyr and omised design-Layout, analysis, advantages and limitations, Randomised block design- layout, analysis, choice of no. of blocks, advantages and limitations. Latin square designs- layout, analysis, applications, advantages and limitations

Practical

Formation of frequency distribution, Diagrammatic and graphic representation. Calculation of different measures of central tendency. Computation of various measures of dispersion. Calculation of coefficient of variation-coefficients of skewness and kurtosis. Computation of

product moment correlation coefficient- rank correlation coefficient-and coefficient of concordance. Fitting of linear regression models for prediction. Simple problems on probability-fitting of binomial distribution. Fitting of poisson distribution , problems on normal distribution. Selection of simple random sample – estimation of parameters – sample size determination. Selection of stratified and om sample–equal, proportional and Neyman’s allocation in stratified sampling. Large sample tests. Small sample tests, t and F tests, Chi – square test, test of goodness of fit – test of independence of attributes in a contingency table - computation of mean – square contingency. Analysis of variance-construction of ANOVA table of one-way classified data. Analysis of variance- construction of ANOVA table of two-way classified data. Layout and analysis of CRD, Layout and analysis of RBD. Analysis of data from 2ⁿ factorial experiments in RBD. Formation of Yate's table-calculation of main effects and interaction effects. Layout and analysis of split-plot design.

Suggested readings

- Anderson, R.L. and Bancroft, T.A. (1952). Statistical Theory in Research. Mc. Graw Hill Book Co., New York.
- Cochran, W.G and Cox, G.M.(1958). Experimental designs. Wiley, New York
- Das, M.N. and Giri, N.C. (1986). Design and Analysis of Experiments. Wiley Eastern Ltd., New Delhi.
- Federer, W.T. (1955), Experimental Design. Macmillan, New York.
- Gomez, K.A. and Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons. New York.680p.
- Kempthorne, O. (1952).The design and analysis of experiments. Wiley, New York.
- Nigam A.K. and Gupta, V.K.(1979). Hand book on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.
- Panse, V. G.and P. V. Sukhatme. (1967). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.
- Petersen Roger G. (1994) Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.

9. Physical Education–II

1(0+1)

Practical

Concept of Health -Physical health, mental health, social health, spiritual health, spectrum of health. Fitness & wellness-Motor components. Regular exercises, Amount of training, Scientific way of training, Rest and relaxation, conditioning, Good posture, Heredity, Environment, Standard of living, Balance Diet, Stress &tension, Drugs, Intoxication. Means of Fitness Development- Aerobic activities, anaerobic activities, Sports & Games, Yoga, Recreational Activity. Safety Education– Swimming. Yoga-Meaning & importance of Yoga, Role of Yoga in life, Teaching of Yoga. Physical Fitness test- TPFPP Fitness test: One mile run/ Beep test, Sit-Up 60sec, Sit and reach, Modified pull-ups. Major games- Rules and regulations

of important game, Skill development in any one of the game- Hockey, Volleyball, Handball and Kho Kho. Indoor games- Participation in one of the indoor games–(Table Tennis & Badminton). Athletic events- rules & regulations of athletic events participation in any one of the athletic events-Triple jump, Discus throw and Javelin throw. NOTE: (one to be selected, major games, indoor games and Athletic events)

10. NCC-II/NSS-II

1 (0+1)

NCC-II

Weapon training – rifle bayonet, light machine gun, sten machine carbine, introduction and characteristic stripping, assembling and cleaning, loading, unloading and firing. Field craft, visual training, targets, judging distance, fire discipline and fire control orders, battle craft, field signals, description of ground, section formation, section battle drill, scouts and patrols, ambush.

NSS-II

Socio-economic structure of Indian society, population problems, brief of Five Year Plan. Functional literacy, non-formal education of rural youth, eradication of social evils, village adoption- continued.

11. Physical Education-III

1 (0+1)

Practical

Lifestyle diseases & dietary and lifestyle changes that reduce the incidence of chronic diseases. Obesity, Coronary heart diseases (CAD), ischemic stroke Diabetes Mellitus, Blood pressure, Osteoporosis. Injuries –Injuries in sports, Prevention of sports injuries. First aid training in sports- Sprain, Fractures, Burns, Snakebite, Drowning, Unconscious victim, First aid ABC, First aid CPR, Sling and Splint and carrying techniques. Yoga continuation. Major games, Rules & regulation of important games, Skill development in any one of the game-Cricket, Football, Basketball, Volley Ball and Netball. Athletic events-Rules & regulations of athletic events– participation in any one of the athletic events- short & long distance running. Any one to be selected major games and Athletics events. Adventure training- On Land– Trekking, High Altitude Trekking, Rock Climbing, Mountaineering. In water- River Crossing.

12. NCC-III/NSS-III

1 (0+1)

NCC-III

Field engineering, map readings, conventional signs, grid systems, use of service protractor, prismatic compass and its use, self defense, general principles, precautions and training, attacks and counter attacks, marching and searching, first aid, hygiene and sanitation, civil defense, leadership and NCC song.

NSS-III

Awareness programmes, consumer awareness, highlights of consumer act. Environment enrichment and conservation, health, family welfare and nutrition, village adoption-continued.

13. Forest Tribology & Anthropology

2 (2+0)

Theory

Meaning, scope and development of Anthropology. Relationships with other disciplines. Main branches of Anthropology, their scope and relevance. Human Evolution and emergence of Man. Phylogenetic status, characteristics and geographical distribution. Principles of Prehistoric Archaeology. Chronology: Relative and Absolute Dating methods. Culture, Society, Marriage, Family, Kinship, Economic and Political Organization, Social Control, Religion, Anthropological theories, Language and Communication, Research Methods in Anthropology. Race and Racism. Applications of Anthropology. Ethno-archaeology in India. Demographic profile of India. The structure and nature of traditional Indian social system. Caste system in India Definition and characteristics of a tribe. Tribes and aborigines- an anthropological perspective. Racial classification and distribution of tribes. Tribes in India and Kerala. Tribal economy. Tribals and Constitution of India Administration of tribal areas in independent India- appraisal of tribal development - problems of tribal identity and integration in the mainstream. Relation between tribes and forests- forest as their immediate environment. Forests as the means of livelihood. Girijan habitat - changes consequent to government control of forests. Forest management and tribal welfare- management conflicts and way forward. Role of forest department in tribal welfare. Role of Non wood Forest products in the economy of tribal's and Tribal cooperative societies. Social forestry and tribal welfare.

Suggested readings:

- Furer-Haimendorf, C.V. 1985. Tribes of India - the struggle for survival. OUP. New Delhi
Hasnain, N. 2007. Tribal India. New Royal Book Company
Hasnain, N. 2011. Indian Anthropology. Palaka Prakashan
Sharma, R.N. and Bakshi, S. 1984. Tribes and tribal development. Uppal Publ. House, New Delhi
Sharma, R. N., Sharma, R.K. 1997. Anthropology. Atlantic Publishers & Distributors.
Thakur, D. 1986. Socio-economic development of tribes in India. Deep and Deep Publications, New Delhi

14. Study Tour

1 (0+1*)

Practical

Study tour of one week duration in the respective States/part of India. To familiarize the students with the fauna, flora and other research activities of SAUs, Research institute, forest

industries, Govt. and private organizations of different parts of respective states/ part of India. To expose the students to various national / heritage monuments as part of national integration activity.

15. Forest Extension & Community Forestry

3 (2+1)

Theory

Forest Extension: Introduction- human behaviour and psychology. Concept, scope, principles, philosophy and objectives of extension education and forestry extension education. Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Forestry extension: process, principles and types of education, Formal, informal non-formal education. People's participation in Forestry programmes. Elements of extension education, man himself man's environment and man's created devices. Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Van Vigyan Kendras, Technology Assessment and Refinement Programme (TARP) of ICAR/ICFRE. Communication: meaning, definition, elements and selected models. Audio-visual aids: importance, classification and selection. Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA). Rural social groups, primary and secondary groups, formal, informal group, temporary, permanent groups, references group, classification of group.

Community Forestry: Introduction to the concept of forestry as a common property resource– Definition, Scope and necessity of community forestry. Forests and man: Forestry in support to agriculture, animal husbandry and horticulture – development of cottage industry in rural environment-NFP 1988 and the importance of people in forest conservation. Community forest management, Community forest development, social economical and environmental aspects, Community forest development through NGOs, civil societies, citizen groups. Gender dimensions in Community forest management. Social Forestry- definition, need and purpose, historic development. Social Forestry for fodder production, fuel wood, leaf manure, timber production, NTFPS. Integrated rural development approach with proper marketing facility, employment generation in raising, tending and harvesting of tree crops. Joint Forest management: concept, legislation, rules, importance. Case studies of JFM implementation-problems and prospects, Microplan Preparation. JFMs, FDCs, VFCs, CBOs, NGOs and co-operative societies.

Practical

Visits to study structure, functions, linkages and extension programmers of KVKs or ICFRE institutes/voluntary organizations/Mahila Mandal/Village Panchayat/Van Panchayat/ State Forest Department (Social forestry wing). Group discussion at farm homesteads. Preparing individual and village level production plans. Preparation of charts, posters and flash cards.

Participation in conducting exhibitions and method demonstrations/campaigns at the village level. Familiarization of the use of audio-visual aids. PRA exercises. Visit to village to study the community forestry components- Community reserve, organizational set up and administrative procedures in a social forestry (SF) Range, Micro plan preparation-Field visit to a JFM operational area and conduct PRA surveys. Afforestation techniques and social forestry.

Suggested readings:

- FAO (1984). Forestry extension, making it work, An international journal of forestry and forest industries, Unasylva - No. 143, Published by FAO.
- L.K. Jha and P. K. Sen Sarma, A.P.H. (2008). A Manual of Forestry Extension Education, Published by VEDAMS, P. 386 p.
- D. Sim, H. A. Hilmi (1987), Forestry Extension Methods, FAO Forestry Paper-80, P. 153.
- Jalihal, K.A. Veerabhadraiah, V. (2007), Fundamentals of Extension Education and Management in Extension, Concept Publishing Company.
- Balakathiresan, S. (1986). Essentials of forest management, Nataraj Publishers, Dehradun.
- Bullock, R. C. L. and Hanna, K.S. (2012). Community Forestry Local Values, Conflict and Forest Governance. Cambridge University Press.
- Gunter, J. (Ed.). (1973). The Community Forestry Guidebook (http://www.forrex.org/sites/default/files/forrex_series/FS15.pdf).
- Ojha, H.R., Timsina, N.P., Kumar, C., Banjade, M.R and Belcher, B. (2007). Communities, Forests and Governance: Policy and Institutional Innovations from Nepal. Adroit Publishers, New Delhi, India.
- Roy, S.B. and Chatterjee, M.(1994). Joint Forest Management. Inter India Publications
- Tiwari, K.M. (1983). Social forestry for rural development. International Book Distributors.
- Vyas, G. P.D. (2006). Community Forestry. Agrobios, India.

16. Entrepreneurship Development & Business Management

2 (1+1)

Theory

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to forestry sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of forestry inputs industry. Characteristics of Indian forestry processing and export industry. Social Responsibility of Business.

Practical

SWOT analysis, developing leadership skills, developing managerial skills, problem solving skill, supply chain management and total quality management, project planning formulation and report preparation.

Suggested readings:

Maslow, A.H (1970). Motivation and personality. Harper and Row publishers. New York.

Perelson, B and Steiner, G (1964) Human behaviour. Harcourt Brace Jovanovich, New York.

17. Forest Economics and Marketing

3 (2+1)

Theory

Economics- Meaning, definition, subject matter- Divisions of economics - Importance of economics- Forest Economics- Meaning, definition- Basic concepts - Goods, service, utility, value, price, wealth, welfare-Wants-Meaning, characteristics, classifications of wants, importance. Theory of consumption- Law of diminishing marginal utility, meaning, definition, assumption, illustration, limitations, law of equi- marginal utility-Importance. Consumer surplus- Meaning, definition, importance. Demand- Meaning, definition, kinds of demand, demand schedule, demand curve, law of Demand, extension and contraction vs increase and decrease in demand. Elasticity of demand- Types of elasticity of demand, degrees of price elasticity of demand, methods of measuring elasticity, factors influencing demand, elasticity of demand, importance of elasticity of demand–supply- meaning, supply function-Law of supply-factors influencing supply-Pricing of timber and non-timber products- Economics of timber and non-timber forest products. Forest planning–forest policy and development. Production- Meaning, factors of production-land, labour, capital, organization, entrepreneurship - Distribution-rent, wages, interest, profit- National Income-definition and concepts-.Public finance- meaning- Public resource-Meaning- sources-Taxation-types-Public expenditure-meaning, Principles-Money-meaning-evolution-Inflation: definition, types of inflation-Welfare economics- Meaning and basic concepts.

Marketing- definition – Marketing Process – Need for marketing – Role of marketing-Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agricultural produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management.

Practical

Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products. Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets.

Suggested readings

Dewett, K. K. 2005. Modern Economic Theory. S. Chand, New Delhi.

Dewett, K. K., Verma. 2004. Elementary Economic Theory, S. Chand, New Delhi

Jhingan, M. L. 2012. Macro Economic Theory. Vrinda publishers, New Delhi.

Reddy, S.S., Raghu Ram, P., Neelakanta Sastry, T.V., Bhavani, D.I 2004. Agricultural Economics. Oxford and IBH Publishers, New Delhi.

18. All India Study Tour

3 (0+3*)

Three weeks' duration

To familiarize the students with the flora, fauna and other research activities of SAUs, research institutes, forest industries, govt. and private organization of different parts of India. To expose the students to various national / heritage monuments as part of national integration activity.

19. Agricultural Informatics

3 (2+1)

Theory

Computer Programming, General Concepts, Documentation and Program Maintenance, Debugging programs, Errors. Introduction to Visual Basic, Java, Fortran, C/ C++, etc, concepts and standard input/output operations, Variables and Constants, Operators and Expressions, Flow of control, Inbuilt and User defined functions, programming techniques for agriculture/forestry.

e-Agriculture, concepts, design and development. Application of innovative ways to use information and communication technologies (IT) in agriculture/forestry. ICT for Data Collection, formation of development programmes, monitoring and evaluation of Programmes. Computer Models in agriculture/forestry: statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology, concepts, techniques, components and uses for generating valuable agri-information. Decision support systems, taxonomy, components, framework, classification and applications in agriculture/forestry, DSS, Agriculture Information/Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools.

Practical

Study of Computer Components, accessories, practice of important DOS Commands. Introduction of different operating systems such as windows, Unix, Linux, Creating, Files & Folders, File Management. Use of MS-WORD and MS Power point for creating, editing and presenting a scientific Document, Handling of Tabular data, animation, video tools, art tool, graphics, template & designs. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system.

Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web. Introduction of various programming languages such as Visual Basic, Java, Fortran, C, C++, and their components Hands on practice on writing small programmes. Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/Crop Syst/ Wofost. Preparation of Inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools. Use of smart phones and other devices in agro-advisory and dissemination of market information. Introduction of Geospatial Technology, demonstration of generating information important for Agriculture. Hands on practice on preparation of Decision Support System.

VI. WILDLIFE SCIENCES (WL)

1. Wildlife Biology

3 (2+1)

Theory

History of Wildlife studies in India; Classification of Indian Mammals, Basic requirements of wildlife – food, water, shelter, space, limiting factors; Food chain, Food web, Ecological pyramids; Wildlife Ecology: Biotic factors, Biological basis of wildlife, Productivity; Effect of light and temperature on animals; Wildlife Habitat: Niche, Territory, Home Range, Territoriality, Edge, Cruising Radius, Carrying Capacity; Animal behavior and adaptation; Habitat Improvement: Food, Water, Shelter improvement.

Practical

Visit to various protected areas and observations on the morphological, behavioral, feeding and reproductive activities of different species of wild animals in India. Various study methods on the wild animals, such as focal animal sampling, Sherman trapping, mist netting, camera trapping, for identification, determination of age and sexing of animals including the small mammals. Faecal analysis of wild animals.

Suggested readings

Berwick, S.H. and Saharia, V.B. 1995. Wildlife Research and Management. Oxford University Press, New Delhi.

Dasmann, R.F. 1982. Wildlife Biology. Wiley Eastern Ltd. New Delhi.

Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA.

International Zoo Books, Published by New York Zoological Society, New York

Johnsingh, A.J.T. and N. Manjrekar. 2014. Mammals of South Asia. Vol. I. University Press, 614p

Johnsingh, A.J.T. and N. Manjrekar. 2015. Mammals of South Asia. II. University Press, 739p

Krebs C & Davis N. 1978. Introduction to behavioral ecology. Oxford University Press

Mathur R. 1985. Animal Behaviour. Oxford University Press

Menon V. 2014. Indian Mammals: A field guide. Hachette. 528p.

Mittermeier, RA Rylands, AB and Wilson DE. 2013. Handbook of the Mammals of the World - Volume 3. Lynx Edicions. 952.

Prater, S.H. (1971). The Book of Indian Animals. Oxford University press, Bombay. 324p.

Wilson, DE Mittermeier RA. 2009. Handbook of the Mammals of the World - Volume 1. Lynx Edicions. 728.

Wilson, DE Mittermeier RA. 2011. Handbook of the Mammals of the World - Volume 2. Lynx Edicions. 886.

2. Ornithology & Herpetology

3 (2+1)

Theory

Introduction. History of ornithology in India. Origin and ancestry of birds. A brief knowledge of bird anatomy, morphology and physiology, digestive, skeletal, respiratory, excretory systems of birds. Skeleton, feathers, skin, beak and taxidermy. Thermoregulation in birds. Bird ecology and behaviour; migration and territorial behaviour, feeding, song and nests. Eggs and egg laying. Water birds, scavenger birds, frugivorous birds, pest birds, pet birds and pollinator birds. Importance of birds to different ecosystems. Birds and man. Bird watching, Bird conservation and management in India. Important Bird areas of India, Red Data Book birds of India. Wetland conservation, Ramsar sites of India. Classification of Indian birds - birds belonging to the *Orders Podicipediformes, Procellariiformes, Pelicaniformes, Ciconiiformes, Phoenicopteriformes, Anseriformes, Falconiformes, Galliformes, Gruiformes, Caradriformes, Columbiformes, Psittaciformes, Cuculiformes, Strigiformes, Caprimulgiformes, Apodiformes, Trogoniformes, Coraciformes, Upupiformes, Piciformes and Passeriformes*.

Practical

Field identification of major birds of India. Bird watching and drawings. Study of feathers, beak and leg types of different groups of birds. Study of the nest and eggs of birds. Mist netting and tagging/marketing of birds for the bird migration studies. Bird census techniques. Visit to different bird habitats.

Suggested readings

- Ali, S. and Ripley, D.S. 1990. A compact Handbook of Birds of Indian subcontinent. Oxford University press, Bombay.
- Daniel, J C. 2002. The Book of Indian Reptiles. Bombay Natural History Society, Bombay, 141pp.
- Das, I. 1995. Turtles and Tortoises of India. Oxford University Press. Bombay. 176pp.
- Das, I. 2002. A photographic guide to Snakes and other reptiles of India. New Holland Publishers (UK) Ltd.
- Grimmet, R. Inskipp T and Inskipp, I. 2003. Handbook of Birds of Indian subcontinent. Oxford University press
- Grimmet, R. Inskipp, T and Nameer, P.O. 2007. Birds of southern India, BNHS series.
- Gururaja KV. 2012. Pictorial Guide to frogs and toads of the Western Ghats. II Sc. Bangalore.
- Kazmierczak, K. and van Perlo B. 2000. A field guide to the birds of the Indian subcontinent, Yale University Press, New Haven. CT.
- Kentwood D. Wells. 2007. The Ecology and Behavior of Amphibians. Th University of Chicago Press, Chicago.

Rasmussen P C and John C. Anderton. 2012. *Birds of South Asia: The Ripley guide*. Vol. I and II, Smithsonian Institution and Lynx Edicions, Washington DC and Barcelona.

Wallace GJ and HD Mahan. 2005. *An Introduction to Ornithology*. 3rd Ed. McMillion publishing company. New York.

Whitaker, R. and Captain, A. 2004. *Snakes of India. The Field Guide*. Draco Books. Chengalpattu, Tamil Nadu, xiv+479, pls, text-figs.

William E. Duellman and Linda Trueb. 1986. *Biology of Amphibians*. John Hopkins University Press, Maryland.

Vidyarthi, L.P. and Rai, B.K. 1985. *The tribal culture of India*. Concept Publ. Co., New Delhi.

3. Wildlife Management

2 (1+1)

Theory

Definition, History of wildlife management and conservation in India; values of wildlife - aesthetic, recreational, scientific, educational, commercial, farming, technological and ecological values. Zoogeographic regions of the world – Palearctic region, Nearctic region, Oriental region, Ethiopian region, Neotropical region, Australasian region. Major biomes of the world – polar region, coniferous forests, temperate forests, tropical forests, grasslands, deserts, mountains, inland waters, oceans and oceanic islands. Bio-geographic zones of India - trans-Himalayan, Himalayan, Indian desert, semi-arid, Western Ghats, Deccan peninsula, Gangetic plain, North East India, islands, coasts. Habitat requirements of animals. Red Data Book and red listing, IUCN revised red list categories – Extinct, Extinct in the wild, Vulnerable, Near Threatened and Least concerned. Wildlife census: Purpose, techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities, block counts, road side counts, dung counts, pug mark census, water hole census, line transect- statistical analysis. Telemetry- transmitters, receivers, analysis of data, visual tagging and marking. Captive wildlife: Zoos and safari parks. Captive breeding for conservation. Central Zoo Authority of India. Wildlife (Protection) Act, 1972. Special projects for wildlife conservation. Project Tiger and Musk Deer Project. Introduction and reintroduction of species. Wildlife corridors. MAB, CITES. Wildlife Damage - Appraisal, Control and Management. Healthcare, Disease Management and Nutrition in Wild Animals Protected areas concept, wildlife sanctuaries and national parks, biosphere reserves, major protected areas of India.

Practical

Exercise on the census methods - direct method - total count, block count, water hole count, capture - recapture method, point transect, and line transect method – use of soft ware for analysis. Exercise on the census methods - indirect methods, dung count for elephants, pugmark method for larger cats and pellet count for other ungulates. Pitfall trap, mist net, Sherman trap, camera trap, and other traps to study the wildlife. Direct and indirect methods of

studying food habits of different wildlife. Studying habitat management and manipulation techniques. Wildlife damage and control: Questionnaire survey. Wildlife photography.

Suggested readings

Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA.

International Zoo Books, Published by New York Zoological Society, New York

Krebs C & Davis N. 1978. Introduction to behavioral ecology. Oxford University Press

Lever, C. 1985. Naturalized mammals of the world. John Wiley, London

Mills, L. S. 2013. Conservation of Wildlife Populations Demography, Genetics and Management (Ed.2). Wiley-Blackwell.

Rajesh, G. 1995. Fundamentals of Wildlife Management, Justice Home, Allahabad.

Sawarkar B. Wildlife Management. Wildlife Institute of India. Dehra Dun

Wildlife Institute of India (2004) Compendium on the notes on the course Captive management of Endangered Species. Wildlife Institute of India. Dehra Dun

Wodroffe, G. 1981. Wildlife conservation and modern zoo. Saiga Publishing Co., England

Zoos Print and Zoo Zen, Published by Zoo Outreaches Organization, Coimbatore

ELU-I EXPERIENTIAL LEARNING**5 (0+5)**

- Production and Marketing of high value forest produce (0+5) (FP)
- Raising Quality Planting Materials for forest regeneration (0+5) (SA/FB)
- Apiculture/Sericulture (0+5) (FB/NR/WL)
- Ecotourism (0+5) (BS/WL)
- Wild Animal Health Management (0+5) – WL

1. Production and Marketing of high value forest produce**5 (0+5)**

Project formulation, Market survey and prioritization of species. The species (imported and indigenous) that are currently available in the market has to be surveyed through personal visits to timber markets, saw mills, forest depots etc. Lesser known, but highly utilizable indigenous species of timbers will be given priority. Fast rotation timber species raised under various trials of the University will also be included to the extent possible.

Potential of different species for various end users will be determined. Timber samples have to be converted into sticks / smaller sizes / macerated through appropriate procedures such as sawing and sizing in a saw mill or maceration in a laboratory. Mechanical tests: Static bending, compressive tests-across and along the grain. Finding out safe working stresses of lesser known or exotic/new species. Wood database currently available in the department will be updated based on the test results. Project report preparation and presentation, final examination. Wood conversion in an integrated saw mill, turnery for handicrafts, joineries and furniture making. Data analysis, project report writing, presentation and final examination.

2. Raising Quality Planting Materials for forest regeneration**5 (0+5)**

Project formulation, Identification of species (grasses, trees, medicinal plants & wild fruits) for nursery raising, time of collection of plant material from selected seed sources, quantity of seed/plant material required, nursery area (open and protected), inputs required, Schedule for intercultural operation-seed treatment, sowing, weeding, fertigation, root hardening treatments. Assessment of demand in local/potential markets and institutions. Collection, Handling, Processing and Storage of planting material. Identification of superior seed sources, seed collection, treatment and storage. Vegetative propagation under controlled and ambient conditions. Collection of vegetative propagules. treatments and processing of bare-root and containerized seedlings. Project Report and Presentation, Final examination

3. Apiculture**5 (0+5)**

Project formulation, Apiculture- Scope and importance of beekeeping–Bees classification–Hives –Social organization–extraction of honey and other products. Marketing of honey and bee wax and their value addition. Cost Benefit analysis, Project Report and Presentation, Final examination.

5. Ecotourism **5 (0+5)**

Socio- economic feasibility analysis for initiating ecotourism projects. Tour planning and site development. Social engineering and natural resource management. Study of environmental and social impacts of ecotourism and mitigation strategies. Potential of ecotourism as a business.

6. Wild Animal Health Management **5 (0+5)**

Basic concepts of disease and health conditions. Review of major diseases of Indian wild mammals, birds, amphibians and reptiles. Epidemiology of disease. Disease and population dynamics. Disease transmission between domestic and wild populations. Malnutrition, starvation, dehydration as disease syndromes. Condition, health and nutritional assessment in free-ranging populations. Control of disease planning and management of wildlife health programmes. Zoonoses.

ELU-II EXPERIENTIAL LEARNING **5 (0+5)**

- Production and Marketing of high value forest produce (0+5) (FP)
- Raising Quality Planting Materials for forest regeneration (0+5) (SA/FB)
- Apiculture/Sericulture (0+5) (FB/NR/WL)
- Ecotourism (0+5) (BS/WL)
- Wild Animal Health Management (0+5) – WL

1. Production and Marketing of high value forest produce **5 (0+5)**

Project formulation, Market survey and prioritization of species. The species (imported and indigenous) that are currently available in the market has to be surveyed through personal visits to timber markets, saw mills, forest depots etc. Lesser known, but highly utilizable indigenous species of timbers will be given priority. Fast rotation timber species raised under various trials of the University will also be included to the extent possible.

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2. Raising Quality Planting Materials for forest regeneration **5 (0+5)**

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Handling, Processing and Storage of planting material. Identification of superior seed sources, seed collection, treatment and storage. Vegetative propagation under controlled and ambient conditions. Collection of vegetative propagules. Treatment and processing of bare-root and containerized seedlings. Project Report and Presentation, Final examination

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Project formulation, Apiculture- Scope and importance of beekeeping–Bees classification–Hives –Social organization–extraction of honey and other products. Marketing of honey and bee wax and their value addition. Cost Benefit analysis, Project Report and Presentation, Final examination.

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Socio- economic feasibility analysis for initiating ecotourism projects. Tour planning and site development. Social engineering and natural resource management. Study of environmental and social impacts of ecotourism and mitigation strategies. Potential of ecotourism as a business.

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Basic concepts of disease and health conditions. Review of major diseases of Indian wild mammals, birds, amphibians and reptiles. Epidemiology of disease. Disease and population dynamics. Disease transmission between domestic and wild populations. Malnutrition, starvation, dehydration as disease syndromes. Condition, health and nutritional assessment in free-ranging populations. Control of disease planning and management of wildlife health programmes. Zoo-noses.

FWE (FORESTRY WORK EXPERIENCE)

20 (0+20)

The Forestry Work Experience (FOWE) course would have the following modules.

Orientation	(10 days)	0+1
Forest Range Training Programme	(50 days)	0+12
Industrial placement	(20 days)	0+3
Weapon Training and First-Aid Training	(5+3=8 days)	0+1
Socio-economic Surveys and Village Attachment	(20 days)	0+2
Report writing and presentations	(12 days)	0+1
Total	(120 days)	0+ 20

1. Orientation

Conducting various exercises for exposing the students on the recent trends in the field of forestry, transactional analysis, personality development, soft skills etc and to prepare students for the rigours of professional life after completing B.Sc. (Hons.) Forestry programme.

2. Forest Range Training Programme

Visit to modern forest nurseries, herbal gardens and watersheds, study the felling and logging operations, timber lots and important industrial products, study working plan, enumeration, volume and yield calculation & compartment history files, study the 'CAT' (Catchment Area Treatment Plan) and FDA (Forest Development Agencies). Use of forestry equipments/instruments, Study their generation and management to important forestry tree species, Sample plots, layout studies, stump analysis, preparation of local volume Tables. Study the working of other Forestry related organizations/industries. At the Wildlife Sanctuaries/National Parks/Tiger Reserves, the students are expected to learn about the aspects related with the preparation of the Management Plans/Conservation Plans, to undertake and familiarize the various wildlife population enumeration techniques and the biodiversity assessment techniques. To undertake pilot studies on the man-animal conflict and other issues in the forest areas etc.

3. Industrial placement

Attachment with Forest Based Industries like Wood Workshop, Saw Mills, Wood Seasoning and Preservation Treatment Plants, Pulp and Paper Industries, Aromatic and Medicinal Plant Units including AMPRS, Odakkali, Oushadhi, Kottakkal, KAPL, Aluwa, Ayurdhara, etc. Carpentry, bamboo and reed crafts, other Wood Products Industries, rubber, NWFP etc. Works to be undertaken includes study the nature of industrial and business organization—structure, raw material—collection and processing of raw-material, hands on practicals, production and management process, marketing and financial management.

4. Weapon Training and First-Aid Training:

Hands on training in the handling of various kinds of weapons and their operation, limitations and precautions during their use. Getting basic knowledge on different first aid practices which

are required in case of field emergencies, like snake bite, animal attack, poachers and accidents. Also to learn about the first aid to be given to wild animals in distress and volunteering in rural health services.

5. Socioeconomic surveys and village attachment

Data collection, use of PRA techniques with respect to village profile including socio-economic and cultural status, farm technology used, homesteads, agroforestry, biodiversity etc., Bench Mark survey of planter sources (cropping pattern, homesteads, agroforestry, biodiversity, yield system etc.), Schedule development, tabulation, analysis and preparing plan of work. Understanding local forestry and other village level institutions (Panchayat, Village Forest Committees, corporations, youth/ women groups etc.), People's participation in developmental programmes with special reference to forestry. Exercises on the use of extension methods and teaching aids for Transfer of Technology.

6. Report writing and presentation

Compilation of the work/experience detailing the objectives, places and persons visited, work done, experiences/skills gained and suggestions for improvement of training. Presentation of the report before faculty. The assessment will be based on Project Report evaluation and viva-voce.

PW Project Work & Dissertation (PWD)

10 (0+10)

This course shall provide the B.Sc. (Hons.) Forestry students an understanding of the principles and procedures of the experimental design, layout, analysis and interpretation of data and technical writing. Each student shall work on a specific research project to be identified with the help of the supervising teacher. They shall also prepare and present a proposed plan of work (PPW) specifying the objectives and procedures of the study and present the same before an audience consisting of faculty and students. The research work will be conducted leading to the preparation of a project report in the format and style of M.Sc. Thesis. Evaluation will be done based on the quality of work, quality of report and its presentation before an audience consisting of faculty and students.

The course curriculum has been designed keeping in view the demands of emerging areas and removing obsolete courses. Accordingly, new courses on Forest Engineering, Fundamentals of Horticulture, Introductory Agroforestry, Principles of Forest Economics, Project Planning and Evaluation, Business Management, Communication Skills and Information Technology have been incorporated. Courses on Mathematics (for Biology students) and Introductory Biology (for Maths Students) have been made credit courses while course on Structural & Spoken English has been made non-credit. It is also proposed that SAUs will have freedom for 25-30% variation in course content suiting the regional needs if felt necessary by Academic bodies.

The forest is a peculiar organized of unlimited kindness and benevolence that makes no demands for sustenance and extends generously the products of its life activity; it provides protection to all beings, offering shade even to the exe man who destroys it.



**Jawaharlal Nehru Krishi Vishwa Vidyalaya
Jabalpur, Madhya Pradesh**

