

**Restructured and Revised Syllabus of PG Programme  
M.Sc. FORESTRY IN FOREST RESOURCE MANAGEMENT**

**Course Contents**

| <b>Semester 1</b>              |   |               |                 |                                  |                  |
|--------------------------------|---|---------------|-----------------|----------------------------------|------------------|
| <b>Code</b>                    | <b>Title</b>  | <b>Theory</b> | <b>Internal</b> | <b>Practical/<br/>Term Paper</b> | <b>Total</b>     |
| <b>Major Courses</b>           |   |               |                 |                                  |                  |
| SOA/FCMC/501                   | Forest Biometry and Management  | 60 (2)        | 20              | 20 (2+1)                         | 100 (3)          |
| SOA/FCMC/502                   | Ecology & Management of Forest Soils  | 60 (2)        | 20              | 20 (2+1)                         | 100 (3)          |
| SOA/FCMC/503                   | Remote Sensing and Geographical Information System in Natural Resource Management | 60 (2)        | 20              | 20 (2+1)                         | 100 (3)          |
| SOA/FCMC/504                   | Land Use Planning and Watershed Management  | 60 (2)        | 20              | 20 (2+1)                         | 100 (3)          |
| <b>Supporting Course</b>       |   |               |                 |                                  |                  |
| SOA/FESC/511A                  | General Statistical Methods and Computer Application                              | 60 (2)        | 20              | 20 (2+1)                         | 100 (3)          |
| <b>Common Courses</b>          |   |               |                 |                                  |                  |
| SOA/FECC/01                    | Library and Information Services  | -             | 40              | 60 (0+1)                         | 100 (1)          |
| SOA/FECC/02                    | Technical Writing & Communication Skills  | -             | 40              | 60 (0+1)                         | 100 (1)          |
| SOA/FECC/03                    | Intellectual Property & Its Management in Agriculture                             | 60            | 40              | - (1+0)                          | 100 (1)          |
| SOA/FECC/04                    | Basic Concepts in Laboratory Techniques   | -             | 40              | 60 (0+1)                         | 100 (1)          |
| SOA/FECC/05                    | Agricultural Research, Research Ethics & Rural Development Programmes             | 60            | 40              | - (1+0)                          | 100 (1)          |
| <b>Total Marks and Credits</b> |   |               |                 |                                  | <b>1000 (20)</b> |
| <b>Semester II</b>             |   |               |                 |                                  |                  |
| <b>Major Courses</b>           |   |               |                 |                                  |                  |
| SOA/FCMC/505                   | Forest Resource Economics   | 60            | 20              | 20 (1+1)                         | 100 (3)          |
| SOA/FCMC/506                   | Forest Ecosystem Services and Valuation   | 60            | 20              | 20 (2+1)                         | 100 (3)          |
| SOA/FCMC/507                   | Environmental Impact Assessment and Auditing                                      | 60            | 20              | 20 (1+1)                         | 100 (2)          |
| <b>Minor Courses</b>           |   |               |                 |                                  |                  |
| SOA/FEMC/01                    | Silviculture  | 60            | 20              | 20 (2+1)                         | 100 (3)          |
| SOA/FEMC/02                    | Agroforestry System   | 60            | 20              | 20 (2+1)                         | 100 (3)          |
| SOA/FEMC/03                    | Climate Change and Conservation Silviculture                                      | 60            | 40              | 20 (2+0)                         | 100 (2)          |
| <b>Supporting Courses</b>      |   |               |                 |                                  |                  |
| SOA/FCSC/511B                  | Experimental Designs  | 60            | 20              | 20 (2+1)                         | 100 (3)          |
| <b>Total Marks and Credits</b> |   |               |                 |                                  | <b>700 (20)</b>  |
| <b>Semester III</b>            |   |               |                 |                                  |                  |
| SOA/FCMC/509                   | Global Climate Change Impact, Mitigation and Adaptation                           | 60            | 40              | - (2+0)                          | 100 (2)          |
| SOA/FCMC/508                   | Forest Policy, Law and International Conventions                                  | 60            | 40              | - (2+0)                          | 100 (2)          |
| SOA/FCMC/511                   | Management of Tree Insect-Pests and Diseases                                      | 60            | 20              | 20 (2+1)                         | 100 (3)          |
| SOA/FCMC/512                   | Forest Ecology, Biodiversity and Management                                       | 60            | 20              | 20 (2+1)                         | 100 (3)          |
| SOA/FCMC/591                   | Master's Seminar  | -             | -               | 100 (1)                          | 100 (1)          |
| SOA/FCMC/599A                  | Research Review (Master Thesis)   | -             | -               | 100 (7)                          | 100 (7)          |
| <b>Total Marks and Credits</b> |   |               |                 |                                  | <b>600 (19)</b>  |
| <b>Semester IV</b>             |   |               |                 |                                  |                  |
| SOA/FEMC/510                   | Participatory Approaches in Forest Resource Management                            | 60            | 20              | 20 (1+1)                         | 100 (2)          |
| SOA/FE/599B                    | Master's Research (Thesis)  | -             | -               | 100 (23)                         | 100 (23)         |
| <b>Total Marks and Credits</b> |   |               |                 |                                  | <b>300 (25)</b>  |

## SEMESTER I

### MAJOR COURSES

#### **SOA/FCMC/501 - FOREST BIOMETRY AND MANAGEMENT**

| I – Title                      | II - Code    | III - Credit Hours | Theory | Internal | Practical | Total   |
|--------------------------------|--------------|--------------------|--------|----------|-----------|---------|
| Forest Biometry and Management | SOA/FCMC/501 | 2+1                | 60     | 20       | 20        | 100 (3) |

#### **IV – Aim of the Course**

To provide knowledge about forest management, ecosystem management, site quality evaluation, stand density and forest valuation, tree measurements, forest inventory and yield concepts

#### **V. Theory**

##### **Unit I**

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

##### **Unit II**

Forest inventory, Sampling methods adopted in forestry, Use of GPS in forest inventory. Measurement of stand density. Simulation techniques.

##### **Unit III**

Principles of forest management; scope and object of forest management, ecosystem management, development of forest management in India. Site quality evaluation and importance. Stand density measurement.

##### **Unit IV**

Forest valuation and appraisal in regulated forests.

##### **Unit V**

Growth and yield prediction models – their preparation and applications.

#### **VI. Practical**

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

#### **VII. Suggested Reading**

- Chaturvedi AN and Khanna LS. 1994. *Forest Mensuration*. International Book Distributor.
- Davis LS and Johnson KN. 2005. *Forest Management*. Waveland Press.
- Husch B, Miller CI and Beers TW. 2003. *Forest Mensuration*. John Wiley.
- John AK, Ducey MJ, Beers TW and Husch B. 2017. *Forest Mensuration*. Wiley Blackwel.
- Laar A Van and Akca A. 2007. *Forest Mensuration*. Springer, Netherlands.
- Loetsch I and Haller KE. 1964. *Forest Inventory* Vol. and Vol II. BLV Verlagsgesellschaft, München, Germany.
- Michael S Philip. 1994. *Measuring Forests and Trees*. CAB International.
- Prodan M. 1968. *Forest Biometrics*. Pergamn Press.
- Ram Parkash. 1983. *Forest Surveying*. International Book Distr.
- Sharpe GW, Hendee CW and Sharpe WE. 1986. *Introduction to Forestry*. McGraw-Hill.
- Simmons CE. 1980. *A Manual of Forest Mensuration*. Bishen Singh Mahender Pal Singh, Dehradun.

**SOA/FCMC/502 - ECOLOGY AND MANAGEMENT OF FOREST SOILS**

| I – Title                              | II - Code    | III - Credit Hours | Theory | Internal | Practical | Total   |
|--|--------------|--------------------|--------|----------|-----------|---------|
| Ecology and Management of Forest Soils | SOA/FCMC/502 | 2+1                | 60     | 20       | 20        | 100 (3) |

**IV – Aim of the Course**

To impart information on the soil types and properties of soils under different forest ecosystems, chemical and biological dimensions of soil fertility, and forest soil fertility evaluation and management.

**IV. Theory**

**Unit I**

Forest soils – distinguishing features, soils and vegetation development, physical and chemical properties- Types and properties of soils under different forest ecosystems.

**Unit II**

Forest floor – Organic horizons- litter dynamics- humus – types- organic matter decomposition-mineralization and immobilization of organic matter- nutrient cycling significance of C:N ratio, soil pH.

**Unit III**

Forest soil biology – soil fauna – nitrogen fixation – rhizobium-tree legume symbiosis *Frankia* x non-legume symbiosis, nitrification and denitrification in forest ecosystems. Micorrhizal associations in forest soils.

**Unit IV**

Nursery soils, problem soils, mineral nutrition, acidic deposition effects, fire effects and management interventions of forest soils.

**VI. Practical**

- Study of the soil profile;
- Mechanical analysis;
- Determination of pH;
- Organic C, CEC and available,
- Micro and macro nutrients;
- Manurial schedules for different soils.

**VII. Suggested Reading**

- Brady NC and Weil RR. 2007. *The Nature and Properties of Soils*. 14th Ed., Prentice
- Fisher RF and Binkley D. 2000. *Ecology and Management of Forest Soils*. John Wiley & Sons, Inc. New York. Hall, New Jersey.
- Stevenson FJ and Cole MA. 1999. *Cycles of soil; Carbon, Nitrogen, Phosphorus, Sulphur, micronutrients*. John Wiley & Sons Inc. New York.
- Tisdale LS, Nelson LW and Beaton JD. 1985. *Soil Fertility and Fertilizers*. Macmillan Publishing Company, New York.
- Troeh FR and Thompson LM. 2005. *Soils and Soil Fertility*. Black well.

**SOA/FCMC/503 - REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM IN FOREST RESOURCE MANAGEMENT**

| I – Title  | II - Code    | III - Credit Hours | Theory | Internal | Practical | Total   |
|--|--------------|--------------------|--------|----------|-----------|---------|
| Remote Sensing and Geographical information System in Forest resource management | SOA/FCMC/503 | 2+1                | 60     | 20       | 20        | 100 (3) |

**IV – Aim of the Course**

To impart practical knowledge to the students on geomatics and its application in natural resource management

## V. Theory

### Unit I

Satellite remote sensing and recent developments in geomatics, different satellite emissions of India and abroad. Spatial and spectral resolution of different data products and applications.

### Unit II

Geo-referencing of topo-sheets and satellite imageries, Satellite Image Interpretation, Digital Image Processing (DIP)-image registration, image enhancement, classification, supervised and unsupervised classification.

### Unit III

RS softwares, Application of Remote Sensing in forest resource management-landuse and land cover mapping, vegetation mapping and change detection, forest biomass and carbon mapping and monitoring, forest damage assessment (pests and diseases, mining, fire), forest fire risk zonation and mapping, Watershed delineation and mapping, wildlife habitat assessment, etc.

### Unit IV

GIS for the collection, storage and spatial analysis for geo-referenced forest resources data and information. Integration of spatial data analysis systems with knowledge-based systems and/ or simulation systems for the development of information/decision support systems for forest management. GIS application in FRM.

## VI. Practical

- Thematic layers build up, overlaying and their integration using ERDAS and ArcGIS software package;
- Interpretation of satellite data and digital image processing;
- Preparation of thematic maps;
- Preparation forest biomass and carbon map, fire affected areas assessment, preparation of change detection map, classification of LULC using ERDAS and Arc GIS softwares.

## VII. Suggested Reading

- A Preliminary Overview. *Journal of Latin American Geography*.
- Bolstad P. 2005. *GIS Fundamentals: A first text on Geographic Information Systems, Second Edition*. White Bear Lake, MN: Eider Press.
- Buzai GD and Robinson D. 2010. *Geographical Information Systems in Latin America, 1987-2010*.
- Campbell JB and Randolph HW. 2011. *Introduction to Remote Sensing*. Fifth Edition, The Guild Press, New York.
- Chang K. 2007. *Introduction to Geographic Information System, 4th Edition*. McGraw Hill.
- Elangovan N. 2006. *GIS Fundamentals, applications and implementation*. New India Publ. Agency, New Delhi.
- Gurugnanam B. 2009. *Geographic Information System*. New India Publ. Agency, New Delhi.
- Harvey and Francis. 2008. *A Primer of GIS, Fundamental geographic and cartographic concepts*. The Guilford Press.
- Jackson MJ. 1992. *Integrated Geographical Information Systems*. International Journal of Remote Sensing.
- Joseph G. 2005. *Fundamentals of Remote Sensing*, Second edition. Universities Press.
- Lilles and TM and Kiefer WR. 1994. *Remote sensing and Image Interpretation*, Fourth edition. John Wiley & Sons, Inc., USA.
- Reddy AM. 2014. *Text book of Remote Sensing and Geographic Information System*. 4th edition, BS Publication, Hyderabad.

**SOA/FCMC/504 - LAND USE PLANNING AND WATERSHED MANAGEMENT**

| I – Title                                  | II - Code    | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total   |
|--|--------------|--------------------|--------|----------|--------------------------|---------|
| Land Use Planning and Watershed Management | SOA/FCMC/504 | 2+1                | 60     | 20       | 20 (2+1)                 | 100 (3) |

**IV – Aim of the Course**

To develop understanding of students about land use planning and watershed management. Developing sustainable agroforestry systems/ techniques in watershed.

**V. Theory****Unit I**

Land use Planning: Concepts and techniques; Agro-ecological regions/ sub-regions of India; factors affecting land use; soil and land use survey through remote sensing techniques.

**Unit II**

Interpretation of soil resource map for land use planning; land evaluation methods and soil-site suitability evaluation for different crops.

**Unit III**

Watershed management concept- objectives, characterization, planning, execution, community participation and evaluation.

**Unit IV**

Developing economically and ecologically sustainable agroforestry systems for watersheds; water harvesting and its efficient use; rehabilitation of watersheds. Suitable tree planting techniques in watersheds. Suitable trees/ shrubs and grasses for watershed for different agro-climatic regions.

**Unit V**

Watershed management cases studies. Drought and flood mapping and its relevance in designing sustainable cropping systems.

**VI. Practical**

- Study of Agro-ecological regions/ sub-regions of India;
- Soil and land use survey through remote sensing technique;
- Interpretation of soil resource map for land use planning; land evaluation methods and soil-site suitability evaluation for different crops;
- Watershed characterisation, planning, execution, community participation and evaluation. Suitable tree planting techniques in watersheds;
- Suitable trees/ shrubs and grasses for watershed for different agro-climatic regions.
- Watershed management cases studies;
- Drought and Flood mapping and its relevance in designing sustainable cropping systems.

**VII. Suggested Reading**

- Michael AM and Ojha TP. 1966. *Principles of Agricultural Engineering*, Jain Brothers, Jodhpur.
- Michael AM. 2008. *Irrigation Theory and Practice*. Vikas Publishing House Pvt Ltd.
- Murthy JVS. 1998. *Watershed Management*. New Age International, New Delhi.
- Murthy VVN. 1985. *Land and water management engineering*. Kalyani Publishers, New Delhi.
- Narayana DVV, G Sastry and US Patnaik. 1997. *Watershed Management*. Indian Council of Agricultural Research, New Delhi.
- Narayana DVV. 1993. *Soil and Water Conservation Research in India*, ICAR, New Delhi.
- Singh G et al. 1988. *Manual of Soil and Water Conservation*. Oxford IBH Publishing Co. New Delhi.
- Subramanya K. 2006. *Engineering Hydrology*, Tata McGraw Hill publication.
- USDA. 1961. *A Manual on Conservation of Soil and Water*. Oxford and IBH Publishing Company.

## SUPPORTING COURSES

### SOA/FESC/511A – GENERAL STATISTICAL METHODS AND COMPUTER APPLICATIONS

| I – Title   | II – Code     | III - Credit Hours | Theory | Internal | Practical | Total   |
|---|---------------|--------------------|--------|----------|-----------|---------|
| General Statistical Methods and Computer Applications | SOA/FESC/511A | 2+1                | 60     | 20       | 20        | 100 (3) |

#### IV – Aim of the Course

This course is meant for students who do not have sufficient background of statistical methods. The students would be exposed to concepts of general statistical methods and statistical inference that would help them in understanding the importance of statistical methodology. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation of results.

#### V – Theory

##### Unit I

Review of probability. Random variable and mathematical expectation. Discrete and continuous probability distributions, viz., Binomial, Poisson and Normal distributions.

##### Unit II

Correlation and regression, Rank correlation, Non-linear regression, Partial and multiple correlation coefficient, Intra class correlation, Multiple linear regression.

##### Unit III

Introduction to theory of estimation, Testing of statistical hypothesis: chi-square, t and F distributions. Tests of significance based on chi-square, t and F tests. Large sample tests, Fisher Z transformation.

##### Unit IV

Analysis of variance: One way and two way classification. Design of Experiments: Basic Principles of design of experiments, Completely Randomised Design, Randomised Block Design, Latin Square Design. Elementary idea of factorial experiments. Estimation of genetic parameters from ANOVA table.

##### Unit V

Non-parametric tests: Sign test, Wilcoxon test, Mann-Whitney U-test, Wald Wolfowitz run test, Median test, Kruskal- Wallis test. MS Excel, Introduction to computer softwares.

#### VI – Practical

- Random variable and mathematical expectation;
- Fitting of distributions, viz., Binomial, Poisson, Normal;
- Correlation and regression;
- Non-linear regression
- Multiple linear regression;
- Testing of hypothesis based on chi square, t and F tests. Large sample tests. Completely Randomised Design, Randomised Block Design, Latin Square Design and Factorial experiments. Non-parametric tests. Exercises based on computer software.

#### VII – Suggested Reading

- Aggarwal BL. 1996. Basic Statistics. Wiley Eastern Limited, New Age International Ltd.
- Bansal ML, Singh S, Singh TP and Kumar R. 2004. Statistical Methods for Research Workers. Kalyani Publishers.
- Chandel SRS. 2014. A Handbook of Agricultural Statistics. Achal Prakashan.
- Goon AM, Gupta MK and Dasgupta B. 1968. Fundamentals of Statistics, vol I, II. The World Press, Calcutta.
- Snedecor GW and Cochran WG. 1980. Statistical Methods. East West Press.

## **COMMON COURSES**

### **SOA/FECC/01 - LIBRARY AND INFORMATION SERVICES**

| I - Title                        | II - Code   | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total   |
|----------------------------------|-------------|--------------------|--------|----------|--------------------------|---------|
| Library and Information Services | SOA/FECC/01 | 0+1                | -      | 40       | 60                       | 100 (1) |

#### **IV. Objective**

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

#### **Practical**

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

### **SOA/FECC/02 - TECHNICAL WRITING AND COMMUNICATIONS SKILLS**

| I - Title                                   | II - Code   | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total   |
|---|-------------|--------------------|--------|----------|--------------------------|---------|
| Technical writing and communications skills | SOA/FECC/02 | 0+1                | -      | 40       | 60                       | 100 (1) |

#### **Objective**

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

#### **Practical (Technical Writing)**

- Various forms of scientific writings- theses, technical papers, reviews, manuals, etc.;
- Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
- Writing of abstracts, summaries, précis, citations, etc.;
- Commonly used abbreviations in the theses and research communications;
- Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations;
- Writing of numbers and dates in scientific write-ups;
- Editing and proof-reading;
- Writing of a review article;
- Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks);
- Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription;
- Accentual pattern: Weak forms in connected speech;

- Participation in group discussion;
- Facing an interview;
- Presentation of scientific papers.

### Suggested Readings

1. Barnes and Noble. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language.
2. Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
3. Collins' Cobuild English Dictionary. 1995.
4. Harper Collins. Gordon HM and Walter JA. 1970. Technical Writing. 3rd Ed.
5. Holt, Rinehart and Winston. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6th Ed. Oxford University Press.
6. James HS. 1994. Handbook for Technical Writing. NTC Business Books.
7. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
8. Mohan K. 2005. Speaking English Effectively. MacMillan India.
9. Richard WS. 1969. Technical Writing.
10. Sethi J and Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
11. Wren PC and Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

## SOA/FECC/03 -INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

| I - Title   | II - Code   | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total   |
|---|-------------|--------------------|--------|----------|--------------------------|---------|
| Intellectual Property and its Management in Agriculture | SOA/FECC/03 | 1+0                | 60     | 40       | No Practical             | 100 (1) |

### Objective

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

### Theory

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

### Suggested Readings

1. Erbisch FH and Maredia K. 1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
2. Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
3. Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
4. Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
5. Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
6. Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium



on Law and Policies. Daya Publ. House. The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; The Biological Diversity Act, 2002.

#### SOA/FECC/04 - BASIC CONCEPTS IN LABORATORY TECHNIQUES

| I - Title                               | II - Code   | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total   |
|---|-------------|--------------------|--------|----------|--------------------------|---------|
| Basic Concepts in Laboratory Techniques | SOA/FECC/04 | 0+1                | -      | 40       | 60                       | 100 (1) |

#### Objective

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

#### Practical

- Safety measures while in Lab;
- Handling of chemical substances;
- Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets;
- Washing, drying and sterilization of glassware;
- Drying of solvents/ chemicals;
- Weighing and preparation of solutions of different strengths and their dilution;
- Handling techniques of solutions;
- Preparation of different agro-chemical doses in field and pot applications;
- Preparation of solutions of acids;
- Neutralisation of acid and bases;
- Preparation of buffers of different strengths and pH values;
- Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath;
- Electric wiring and earthing;
- Preparation of media and methods of sterilization;
- Seed viability testing, testing of pollen viability;
- Tissue culture of crop plants;
- Description of flowering plants in botanical terms in relation to taxonomy.

#### Suggested Readings

1. Furr AK. 2000. CRC Hand Book of Laboratory Safety. CRC Press.
2. Gabb MH and Latchem WE. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.

#### SOA/FECC/05 - AGRICULTURAL RESEARCH, RESEARCH ETHICS & RURAL DEVELOPMENT PROGRAM.

| I - Title   | II - Code   | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total   |
|---|-------------|--------------------|--------|----------|--------------------------|---------|
| Agricultural Research, Research Ethics & Rural Development Program. | SOA/FECC/05 | 1+0                | 60     | 40       | No Practical             | 100 (1) |

#### Objective

To enlighten the students about the organization and functioning of agricultural research systems at national

and international levels, research ethics, and rural development programmes and policies of Government.

**Theory**

**UNIT I**

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

**UNIT II**

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

**UNIT III**

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

**Suggested Readings**

1. Bhalla GS and Singh G. 2001. Indian Agriculture - Four Decades of Development. Sage Publ.
2. Punia MS. Manual on International Research and Research Ethics. CCS Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives. Mittal Publ.
4. Singh K. 1998. Rural Development - Principles, Policies and Management. Sage Publ.

**SEMESTER II**

**MAJOR COURSES**

**SOA/FCMC/505 – FOREST RESOURCE ECONOMICS**

| I – Title                 | II - Code    | III - Credit Hours | Theory | Internal | Practical | Total   |
|---------------------------|--------------|--------------------|--------|----------|-----------|---------|
| Forest Resource Economics | SOA/FCMC/505 | 1+1                | 60     | 20       | 20        | 100 (2) |

**IV – Aim of the Course**

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

**V. Theory**

**Unit I**

Principles of microeconomics and its application in forest resource management. Demand, supply and marketing of forest products. Theory of capital and application in forest resource management.

**Unit II**

Domestic and international trade in forest products. Impact of socio-economic variables on forest appraisal and management decisions. Externalities and property rights.

|   |
|---|
| <p><b>Unit III</b><br/>Natural and environmental resource accounting –methods and implications. Application of operational research tools in evaluating forest management alternatives in public and private forest planning and valuation.</p>   |
| <p><b>VI. Practical</b></p> <ul style="list-style-type: none"> <li>• Exercises on estimation of demand and supply functions;</li> <li>• Biodiversity valuation, valuation of non-marketed forest products;</li> <li>• Exercises on financial and economic appraisal of forestry projects;</li> <li>• Exercises on marketing of forest products and international trade competitiveness;</li> <li>• Computer applications for using programming techniques in evaluating forest management alternatives.</li> </ul>  |
| <p><b>VII. Suggested Reading</b></p> <ul style="list-style-type: none"> <li>• FAO. 1986. <i>Guidelines to Practical Project Appraisal</i>. Natraj Publ.</li> <li>• Kerr JM, Marothia DK, Singh K, Ramaswamy C and Beritley WR. 1997. <i>Natural Resource Economics: Theory and Applications in India</i>. Oxford and IBH.</li> <li>• Nautiyal JC. 1988. <i>Forest Economics – Principles and Applications</i>. Natraj Publications, Dehradun.</li> <li>• Sharma LC. 1980. <i>Forest Economics, Planning and Management</i>. International Book Distributors, Dehradun.</li> </ul> |

### SOA/FCMC/506 – FOREST ECOSYSTEM SERVICES AND VALUATION

| I – Title                               | II – Code    | III - Credit Hours | Theory | Internal | Practical | Total   |
|---|--------------|--------------------|--------|----------|-----------|---------|
| Forest Ecosystem Services and Valuation | SOA/FCMC/506 | 2+1                | 60     | 20       | 20        | 100 (2) |

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| <b>IV – Aim of the Course</b>   |
| To impart knowledge ecosystem services, natural capital, nature's contribution to people, global science perception on ecosystem services, quantification and valuation tools, governance, challenges and policy issues. To develop an understanding of students on the concepts of Ecological-Economics and importance of Green Economy. |

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| <p><b>V. Theory</b></p> <p><b>Unit I</b><br/>Ecosystem Services (ES) basics, importance, history of ES and natural capital, classification of ES-provisioning, regulating, supporting and cultural services and their status and changes, drivers of change of ecosystem services, international conventions and charters on ES-Inter-governmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Millennium Ecosystem Services(MEA) Assessment– an overview. Linkages among biodiversity, ecosystem services and human well being.</p> <p><b>Unit II</b><br/>Quantification of ecosystem services-direct and indirect approaches. Ecological Economics: Valuation of ES, need for valuation. Use values and Non-Use values direct value, indirect value, optional value, bequest value, existence value. Valuation methods-Market price based approach such as stumpage value method, productivity and cost based approaches such as replacement cost method and surrogate market and stated preference approaches such as stumpage value method, Hedonic Pricing Method, Contingent Valuation Method, Travel Cost Method, etc., Case studies in India and abroad. Challenges in valuation of ES.</p> <p><b>Unit III</b><br/>Governance and policy issues in ecosystem services, Payment for ecosystem services (PES), mechanisms of benefit sharing, eco-certification, Geographic Indications, Forest Stewardship Council, Landscape labelling. National and International initiatives in PES and on-going programs.</p> |
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| <b>VI. Practical</b>   |
| <ul style="list-style-type: none"> <li>• IPBES and MEA assessment;</li> <li>• Valuation methods- direct and indirect;</li> <li>• Case studies of PES in India and Abroad;</li> <li>• Case studies on certification and geographical indications, FSC.</li> </ul>   |
| <b>VII. Suggested Reading</b>  |
| <ul style="list-style-type: none"> <li>• Alavalapati JRR, Shrestha RK, Stainback GA and Matta JR. 2004. <i>Agroforestry development: An environmental economic perspective</i>. Agroforestry Systems. Huxley P. 1999. <i>Tropical Agroforestry</i>. Blackwell.</li> <li>• Jain SK and Singh P. 2000. <i>Economic Analysis of Industrial Agroforestry: Poplar (Populus deltoides) in Uttar Pradesh (India)</i>. Agroforestry Systems.</li> <li>• Jeffers JNR. 1978. <i>An Introduction to System Analysis with Ecological Application</i>. Edward Arnold.</li> <li>• Jose S. 2009. <i>Agroforestry for Ecosystem Services and Environmental Benefits: an Overview</i>. Agroforestry Systems.</li> <li>• Nair PKR. 1993. <i>An Introduction to Agroforestry</i>. Kluwer, Netherlands.</li> <li>• Paulo ELD and Nunes. 2014. <i>Handbook on the Economics of Ecosystem and Biodiversity</i>. E-book.</li> <li>• Sander J, Nicolas D and Hans K. 2014. <i>Ecosystem Services: Global Issues and Local Practices</i>. First Edition. Elsevier Publications.</li> <li>• Schroth G and Sinclair F. 2003. <i>Tree Crops and Soil Fertility: Concepts and Research Methods</i>, CABI, Wallingford, UK.</li> <li>• Young A. 1997. <i>Agroforestry for Soil Management</i>. 2nd ed. CABI, Wallingford, UK.</li> </ul> |

#### SOA/FCMC/507 – ENVIRONMENTAL IMPACT ASSESSMENTS AND AUDITING

| I – Title                                     | II - Code    | III - Credit Hours | Theory | Internal | Practical | Total   |
|---|--------------|--------------------|--------|----------|-----------|---------|
| Environmental Impact Assessments and Auditing | SOA/FCMC/507 | 1+1                | 60     | 20       | 20        | 100 (2) |

#### IV – Aim of the Course

To provide a detailed knowledge on the environmental impact assessment and its importance. Also this course enables the students to know salient features of EI Legislation and other statutory obligations.

#### V. Theory

##### Unit I

Origin of EIA and historical perspective, scope and purpose of EIA; Key merits of environmental assessment in regulating the state of environment. Global experience in EIA; Comparative review of EIA systems in different countries and regions. Salient features of EIA legislation and other statutory obligations. Environmental decision making in India Environmental clearance procedures and national requirements.

##### Unit II

Flow charts showing key steps; Methodological approaches and tools for key stages in the process: Screening (classification of developments and stage to determine the level of EIA, exclusion and inclusion lists of projects, different approaches to screening) Scoping (scoping steps, guidance and tools, and stakeholder involvement), Impact prediction and evaluation (approach for baseline development and methods of impact identification-checklists, Matrices, Networks).

##### Unit III

Introduction to various impact assessment methods: checklist, matrices, networks, indices and weight scaling techniques and their scope and limitations · Prediction and assessment of impact on the land, air, water, noise, biological and socioeconomic environments Mitigation: definitions and hierarchy of measures including

avoidance, reduction, rectification and compensation enhancement approaches, principles and concepts of offsets, type of offsets.

**Unit IV**

EIA administration and practice. Cost and benefits of evaluation of EIA; understanding strengths and limitation of EIA. EIA standards; risk assessment; potential impact to water and air pollution.

**VI. Practical**

- Methodological approaches and tools for key stages in the process: Screening(classification of developments and stage to determine the level of EIA, exclusion and inclusion lists of projects, different approaches to screening) Scoping (scoping steps, guidance and tools, and stakeholder involvement);
- Impact prediction and evaluation (approach for baseline development and methods of impact identification-checklists, Matrices, Networks), EIA of development projects, EIA of restored mine lands, Undertaking an EIA: case studies for agro-industries.

**VII. Suggested Reading**

- Anjanayulu Y. 2002. *EIA Methodologies*. BSP BS publication Lawrence and Dravid P. 2003. *EIA Practical Solutions to Recurrent problems*.
- Morgan RK. 1988. *EIA- A methodological Perspective*. Kluwer Academic Publishers.
- Patnaik and Naba Kumar. 2000. *Environmental Audit-A Perspective, Environment Management and Audit*, Deep and Deep Publication Pvt. Ltd., New Delhi.
- Pramanik AK. 2002. *Environmental Audit and Indian Scenario, Environmental Accounting and Reporting*, Deep and Deep Publications Pvt. Ltd., New Delhi.
- Selvam M. 2002. *The Need for an Environmental Audit, Environmental Accounting and Reporting*, Deep and Deep Publications Pvt. Ltd., New Delhi.
- Smith LG. 1993. *Impact Assessment and Sustainable Resource Management*, John Wiley & Sons. New York.
- Shrivastava AK. 2003. *Environment Auditing*. APH Publishing.

**MINOR COURSES**

**SOA/FEMC/01 – SILVICULTURE**

| I – Title    | II – Code   | III - Credit Hours | Theory | Internal | Practical | Total   |
|--------------|-------------|--------------------|--------|----------|-----------|---------|
| Silviculture | SOA/FEMC/01 | 2+1                | 60     | 20       | 20        | 100 (3) |

**IV – Aim of the Course**

To understand stand growth, development and provide knowledge regarding the application of silvicultural principles for the production and protection benefits from the forests.

**V. Theory**

**Unit I**

Forest ecosystems- Introduction to tropical/ temperate silviculture. Role of silviculture in forest and wild land management, major forest formations classification, distribution, composition and structure. Vegetation dynamics- species richness-diversity indices. Vegetation forms of India and their productivity. Forest ecosystem-structure and functioning, community development, competitive interactions in forest communities, forest succession, concepts and models of succession-Connell-Slatyer models, climax theories, tolerance.

**Unit II**

Ecophysiology of tree growth- effect of radiation and water relationship, mineral nutrients and temperature. Forest stand development – stand development, even aged and uneven-aged stands, age and site quality. Tree architecture and its role in stand management.

**Unit III**

Stand density determination-stand density indices-stand density management density management diagram, silvicultural treatments involved- thinning as a stand management tool, objectives of thinning, effects on growth and yield, thinning effect on economic yield of stands. Forest site quality evaluation-direct and indirect methods.

**Unit IV**

Treatment analysis-silvicultural regimes- factors influencing choice of regimes, use of system analysis to determine regimes, models for evaluating silvicultural alternatives, development of silvicultural regimes to suit management objectives, optimum management strategies, silvicultural prescriptions for maximum production regime.

**I. Practical**

Visit to forest areas to study forest composition, classification, factors of locality, site quality, form and growth of forest trees- study plant succession- study stand density, changes on productivity- thinning effects; Forestry– Silviculture and Agroforestry 527

**II. Suggested Reading**

- Daniel TW, Helms JA and Baker FS. 1979. Principles of Silviculture. McGraw-Hill Book Company. Julius E. 1992. Plantation Forestry in the Tropics. Oxford University Press.
- Khanna LS. 1996. Principle and Practice of Silviculture. International Book Distributors.
- Khanna LS. 2015. Theory and Practice of Indian Silviculture Systems. Bio-Green Publisher.
- Lamprecht. 1986. Silviculture in the Tropics. Verlag Paul Parey, Hamburg und Berlin.
- Nyland RD, Laura S, Kenefic, Kimberly K, Bohn and Susan LS. 2016 Silviculture: Concepts and Applications (III edition), Kindle Edition, USA.
- Pascal. 1988. Wet Evergreen Forests of the Western Ghats.
- Shepherd KR. 1986. Plantation Silviculture. Springer.
- Smith DM, Larson BC, Ketty MJ and Ashton PMS. 1997. The Practices of Silviculture- Applied Forest Ecology. John Wiley & Sons.

**SOA/FEMC/02 – AGROFORESTRY SYSTEMS**

| I – Title            | II – Code   | III - Credit Hours | Theory | Internal | Practical | Total   |
|----------------------|-------------|--------------------|--------|----------|-----------|---------|
| Agroforestry Systems | SOA/FEMC/02 | 2+1                | 60     | 20       | 20        | 100 (3) |

**IV – Aim of the Course**

To impart knowledge on the concept of agroforestry as a sustainable land use including diagnosis and design methodologies; overview of agroforestry and case studies.

**V. Theory**

**Unit I**

Agroforestry: objectives, importance, potentials and limitations for implementations. Land capability classification and land evaluation. Basis of classification of agroforestry systems and principles, indigenous vs. exotic, intraspecific variations, crown architecture of tropical/ temperate trees. Ideotype concept for selection of multipurpose trees. Nitrogen fixing trees. Overview and case studies of different agroforestry systems.

**Unit II**

Structural and functional attributes of agroforestry systems, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, silvopastoral systems, shelter-belts and windbreaks, energy plantations and home gardens.

**Unit III**

Role of trees in soil productivity and conservation– micro-site enrichment- litter and fine root dynamics, Nitrogen fixation and nutrient pumping. Soil productivity and management in agroforestry.

**Unit IV**

Community forestry and social forestry, linear strip plantations. Unit V Trends in agroforestry systems research and development, Diagnosis and Design –PRA-RRA tools in agroforestry problem diagnosis.

**Unit VI**

Climate Change mitigation and adaptation through agroforestry- climate negotiations- LULUCF- agroforestry options.

**VI. Practical**

- Survey and analysis of land use systems in the adjoining areas;
- Study of tree crown architecture;
- Design and plan of suitable models for improvement;
- PRA-RRA tools in agroforestry problem diagnosis.

**VII. Suggested Reading**

- Buck LE, Lassoie, Fernandes ECM 1999. Agroforestry in Sustainable Agri. Systems. CRC Press.
- Kumar BM and Nair PKR. 2006. Tropical Homegardens: A Time-Tested Example of Sustainable Agroforestry. Springer publication.
- Kumar BM and Nair PKR. 2013. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges (Advances in Agroforestry). Springer publication.
- Nair PKR and Latt 1998. Directions in Tropical Agroforestry Research. Kluwer.
- Nair PKR, Rai MR and Buck LE. 2004. New Vistas in Agroforestry. Kluwer Forestry–Silviculture and Agroforestry 533
- Nair PKR. 1993. An Introduction to Agroforestry. Kluwer Academic Pub.
- Ong CK and Huxley PK. 1996. Tree Crop Interactions – A Physiological Approach. ICRAF.
- Peter Huxley. 1999. Multiple Cropping with Woody and Non-Woody Plants. John Wiley and Sons Ltd, Oxford, United Kingdom.
- Tejwani KG. 1994. Agroforestry in India. Oxford & IBH Publishing Co. Pvt Ltd.
- Thampan PK. 1993. Trees and Tree Farming. Peekay Tree Crops Development Foundation.
- Young A. 1997. Agroforestry for Soil Management. CABI.

**SOA/FEMC/03 - CLIMATE CHANGE AND CONSERVATION SILVICULTURE**

| I – Title                                    | II – Code   | III - Credit Hours | Theory | Internal | Practical    | Total   |
|--|-------------|--------------------|--------|----------|--------------|---------|
| Climate Change and Conservation Silviculture | SOA/FEMC/03 | 2+0                | 60     | 40       | No practical | 100 (2) |

**IV – Aim of the Course**

To understand the scenario of climate change and international treaties on climate change, adaptive silviculture for climate change mitigation, silviculture for conservation of ecosystems.

**V – Theory****Unit I**

Global climate change-factors involved, green house gases, potential threats, global carbon cycle and C-budget, carbon sequestration. Forests and climate change: Forest responses and vulnerabilities to climate change mitigation. Status of forests in global climate change. Harnessing Forests for Climate Change Mitigation, International climate negotiation, UNFCCC, IPCC, CoP: LULUCF, REDD++ and CDM.

**Unit II**

Silviculture and sustainability-criteria and indicators for sustainable plantation forestry in India-CIFOR guidelines. Silvicultural and stand management strategies for carbon sink maximization and source minimization. Adaptive silviculture for climate change.

**Unit III**

Disturbance- natural and anthropogenic, short and long term impacts and their implications. Fire loss estimation in forests. Deforestation and degradation trends at global, national and regional levels. Mega development projects, Road widening projects and conservation of native and threatened species, management and rehabilitation plans.

**Unit IV**

Impacts of 'No Green Felling' on stand productivity and health. Restoration forestry silvicultural treatments for habitat restoration, catchment area treatments, enrichment planting, Analog forestry for site productivity and carbon value. Expanding forest and tree cover area- TOF sector in India.

**Unit V**

Role of canopy in regulating functional inputs to stand: canopy and forest continuum, Continuous Cover Forestry. Silviculture of old growth stands and sacred grooves their ecological significance and biodiversity values. Carbon sequestration potential of Trees Outside forests (TOFs), homegardens and urban forests.

**VII – Suggested Reading**

- Anderson P and Palik B. 2011. Silviculture for Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center.

**SUPPORTING COURSES****SOA/FCSC/511B - EXPERIMENTAL DESIGNS**

| I - Title            | II – Code     | III - Credit Hours | Theory | Internal | Practical | Total   |
|----------------------|---------------|--------------------|--------|----------|-----------|---------|
| Experimental Designs | SOA/FCSC/511B | 2+1                | 60     | 20       | 20        | 100 (3) |

**IV - Aim of the Courses**

This course is meant for students who do not have sufficient background of statistical methods. The students would be exposed to concepts of general statistical methods and statistical inference that would help them in understanding the importance of statistical methodology. It would also help them in understanding the concepts involved in data presentation, analysis and interpretation of results.

**V – Theory****Unit I**

Analysis of variance: One way and two way classification. Design of Experiments: Basic Principles of design of experiments, Completely Randomised Design, Randomised Block Design, Latin Square Design. Elementary idea of factorial experiments. Estimation of genetic parameters from ANOVA table.

**Unit II**

Non-parametric tests: Sign test, Wilcoxon test, Mann-Whitney U-test, Wald Wolfowitz run test, Median test, Kruskal- Wallis test. MS Excel, Introduction to computer softwares.

**VI. Practical**

- Random variable and mathematical expectation;
- Fitting of distributions, viz., Binomial, Poisson, Normal;
- Correlation and regression;
- Non-linear regression
- Multiple linear regression;
- Testing of hypothesis based on chi square, t and F tests. Large sample tests. Completely Randomised Design, Randomised Block Design, Latin Square Design and Factorial experiments. Non-parametric tests. Exercises based on computer software.

**VII. Suggested Reading**

- Aggarwal BL. 1996. Basic Statistics. Wiley Eastern Limited, New Age International Ltd.



- Bansal ML, Singh S, Singh TP and Kumar R. 2004. Statistical Methods for Research Workers. Kalyani Publishers.
- Chandel SRS. 2014. A Handbook of Agricultural Statistics. Achal Prakashan.
- Goon AM, Gupta MK and Dasgupta B. 1968. Fundamentals of Statistics, vol I, II. The World Press, Calcutta. Snedecor GW and Cochran WG. 1980. Statistical Methods. East West Press.

### SEMESTER III

#### SOA/FCMC/509 - GLOBAL CLIMATE CHANGE IMPACT, MITIGATION AND ADAPTATION

| I – Title   | II – Code    | III - Credit Hours | Theory | Internal | Practical    | Total   |
|---|--------------|--------------------|--------|----------|--------------|---------|
| Global Climate Change Impact, Mitigation and adaptation | SOA/FCMC/509 | 2+0                | 60     | 40       | No Practical | 100 (2) |

#### IV – Aim of the Course

To impart knowledge on climate change and different mitigation and adaptation strategies and also on international initiatives on climate change.

#### V. Theory

##### Unit I

Definition and concept of climate change and variability; global warming and dimming; science and politics of climate change and international conventions; evidence, scenario and causes of climate change. Greenhouse gases and mechanism of their production and emission from various agro-ecosystems, source and sinks of GHG; warming potential and contribution of greenhouse gases to global warming, greenhouse effect; monitoring of greenhouse gases.

##### Unit II

Impact assessment of rise in atmospheric temperature and CO<sub>2</sub> on growth, physiological processes, productivity and quality of different vegetation types, soil health, water availability, insect pest dynamics, crop production, milk and in land and marine fish production; climate change and loss of biodiversity; spatial and temporal changes in forest and plantation productivity and agricultural production in context of climate change.

##### Unit III

Adaptation and mitigation options to climate change; carbon sequestration; modelling climate change and its impact on forests. International summit, conferences, protocols and negotiations on climate change; clean development mechanism; carbon trading, credits, footprints and govt. strategies and policies on climate change management.

##### Unit IV

Recent techniques for assessing the impact of high temperature on tree species and crops, recent techniques for assessing the impact of CO<sub>2</sub> fertilization on productivity, recent techniques for assessing the impact of elevated CO<sub>2</sub> on tree species.

#### VI. Suggested Reading

- *Climate Change: Challenges to sustainable Development in India*. 2008. Research Unit (Larrdis) Rajya Sabha Secretariat, New Delhi.
- Reddy KR and Hodges HF. *Greenhouse Gas Emission from Agricultural System*, Published by IPCC- USEPA *Climate change and global crop productivity* Ed. CABI Publishing.
- IPCC Assessment Report. 2007. *Climate Change Journal Climate Change: Source, Impact and Policy*, Proceeding of 2nd World Climate Conference. Ed. by J Jager and HL. Ferguson, Cambridge University Press.
- Houghton J. *Global Warming* (4th), Cambridge Press.
- Robert M, Clausen and Henry L Gholz. *Carbon and Forest Management*. School of Forest Resources and Conservation. University of Florida, Gainesville, FL 32611, USA.

### SOA/FCMC/508 - FOREST POLICY, LAW AND INTERNATIONAL CONVENTIONS

| I – Title  | II – Code    | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total   |
|--|--------------|--------------------|--------|----------|--------------------------|---------|
| Forest Policy, Law and International Conventions | SOA/FCMC/508 | 2+0                | 60     | 40       | No Practical             | 100 (2) |

#### IV – Aim of the Course

To develop understanding of students about forest policy and laws and international conventions

#### V. Theory

##### Unit I

Forest policy – Relevance and scope; National Forest Policy – 1894, 1952 and 1988

##### Unit II

Forest laws; Indian Forest Act 1927, general provision and detailed study; Forest Conservation Act, 1980, Wildlife Protect Act, 1972 Important Forest Rules and Guidelines; Indian evidence act applied to forestry matters, Legal definitions; objectives of species forest laws.

##### Unit III

History of environmental policy in India. Constitutional and legislative provisions—constitutional provisions and the environment, Environmental protection and fundamental rights, Digest of environmental *legislation* (Interpretation of environmental statutes, Environmental protection Act, 1986; Biodiversity Act, 2002, Schedules tribes (Recognition of forest rights), Act, 2007. Judicial remedies and procedures, public interest litigations, Intellectual Property Rights (Patents, Copyrights, Trade mark, Trade secrets), freedom of information, and right to know.

##### Unit IV

Important case studies and landmark judgments. Case studies of different forests divisions/areas of India. International conventions of forestry issue. e.g. Role of international treaties like CITES, IUCN, RAMSER, CBD, etc.

#### VI. Suggested Reading

- Divan S and Rosencranz A. 2002. *Environmental Law and Policy in India*. Oxford University Press, New Delhi.
- *Indian Forest Acts* (with short notes)1975. Allahabad Law Agency.
- Jha LK. 1994. *Analysis and Appraisal of India's Forest Policy*. Ashish Publ. House.
- *National Forest Policy 1952*. Ministry of Food and Agriculture, New Delhi.
- *National Forest Policy 1988*. Ministry of Environment and Forests, New Delhi.
- Negi SS. 1985. *Forest Law*. Natraj Publishers.
- Saharia VB. 1989. *Wildlife Law in India*. Natraj Publ.The Biodiversity Act,2002.
- Wilson B, Van Kooten GC, Vertinsky I, Arthur L. 1998. *Forest policy —International case studies*. CABI publishing, UK.

### SOA/FCMC/511 - MANAGEMENT OF TREE INSECT PESTS AND DISEASES

| I – Title                                    | II – Code    | III - Credit Hours | Theory | Internal | Practical | Total   |
|--|--------------|--------------------|--------|----------|-----------|---------|
| Management of Tree Insect Pests and Diseases | SOA/FCMC/511 | 2+1                | 60     | 20       | 20        | 100 (2) |

#### IV – Aim of the Course

To provide and understanding to the students on management of insect pests and Restructured and diseases and aspects related to INM.

#### V. Theory

##### Unit I

Principles and methods of integrated pests management; Insect attractants and repellents; male sterility techniques.

##### Unit II

Important insect pests of nurseries, plantations, avenue trees and their management. Insect pests of seeds of forest trees and their management.

##### Unit III

Principles of tree disease. management; Integrated forest protection; development of disease management system.

##### Unit IV

Important diseases of nurseries, plantations and avenue trees and their management, Mycoflora of seeds and their management.

#### VI. Practical

- Collection and identification of insect pests and non-insect pests;
- Inspection and collection of insect damaged plant specimens;
- Preparations of different pesticides;
- Application of pesticides;
- Collection, preservation and identification of tree diseases, forest nursery and plantation;
- Isolation and characterization of tree pathogens;
- Preparation of fungicidal solutions; *In-vitro* efficacy and *In vivo* efficacy assessments.

#### VII. Suggested Reading

- Agrios GN. 2005. *Plant Pathology*. Elsevier Acad. Press. Singapore.
- Butin H. 1995. *Tree Diseases and Disorders*. Oxford Univ. Press, New York.
- Evane JW. 1989. *Insect Pest and their Control*. Samir Book Center, New Delhi (India).
- Gonthia P and Nicolotti G. 2013. *Infectious Forest Diseases*. CABI, UK. Guy Watson., 2013, Tree Pests and Diseases.
- Pathak H, Maru S, Satya HN and Silawat SC. 2015. *Fungal Diseases of Trees in Forest Nurseries of Indore, India*. J Plant PatholMicrob.
- Sinclair W and Howard HL. 2005. *Diseases of Trees and Shrubs*.
- Speight MR. 2000. *Insect Pest in Tropical Forestry*. Rose Willey Publications.

#### SOA/FCMC/512 - FOREST ECOLOGY, BIODIVERSITY AND MANAGEMENT

| I – Title                                   | II – Code    | III - Credit Hours | Theory | Internal | Practical | Total   |
|---|--------------|--------------------|--------|----------|-----------|---------|
| Forest Ecology, Biodiversity and Management | SOA/FCMC/512 | 2+1                | 60     | 20       | 20        | 100 (2) |

#### IV – Aim of the Course

This course would enable the students to understand the aspects related to forest ecosystem and its dynamics. As well it provides the knowledge on biodiversity conservation in natural forests and agro-ecosystems, policy issues, IPR, etc.

## V. Theory

### Unit I

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

### Unit II

Biodiversity-an overview; genetic, species and ecosystem diversity; determinants of biodiversity. Higher plant diversity, species richness and endemism. Managing plant genetic resources: Basic science issues – genetic vulnerability and crop diversity, crop diversity-institutional responses, *in situ* conservation of genetic resources, the science of collecting genetic resources, the science of managing genetic resources, using genetic resources, biotechnology and germplasm conservation, etc.

### Unit III

Complementary strategies for plant biodiversity conservation. *In situ* conservation of wild species in nature reserves, *in situ* conservation components, factors influencing conservation value, national plan for *in situ* conservation. *In situ* conservation of Forest and agro-biodiversity on-farm: importance of on-farm conservation initiatives, overview of the types of information necessary in the design of an on-farm conservation programme.

### Unit IV

Managing plant genetic resources: policy issues (exchange of genetic resources: quarantine, IPR; genetic resources: assessing economic value; conflicts over ownership, management and use; national and international treaties/ legislations: CBD, IT-PGRFA, GPA, PVP and FR Act, Biodiversity Act, etc.). International instruments concerning agro-biodiversity, Agenda 21, convention on biological diversity (CBD), FAO and global system of PGR, the International Treaty on Plant Genetic Resources for food and agriculture (ITPGR), Global Plan of Action, TRIPS agreement and IPR protection of life forms.

## VI. Practical

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

## VII. Suggested Reading

- Bonneuil, Christophe and Jean-Baptiste F. *The Shock of the Anthropocene: The Earth, History and Us*. London; Brooklyn, NY: Verso, 2016. (Chapter 1: Welcome to the Anthropocene).
- Brush SB. 1999. *Genes in the Field: On-farm Conservation of Crop Diversity*. Lewis Publishers, Boca Raton, Florida, USA.
- Chandna RC. 2002: *Environmental Geography*, Kalyani, Ludhiana.
- Cunningham WP and Cunningham MA. 2004: *Principles of Environmental Science: Inquiry and Applications*, Tata Macgraw Hill, New Delhi.
- Engels JMM. 1995. *In Situ Conservation and Sustainable Use of Plant Genetic Resources For Food and Agriculture in Developing Countries*. IPGRI/ DSE.
- Jarvis D, Staphit B and Sears L. 2000. *Conserving Agricultural Biodiversity in Situ: A Scientific Basis for Sustainable Agriculture*. IPGRI, Rome, Italy.
- Maxted N, Ford-Lloyd BV and Hawkes JG. 1997. *Plant Genetic Conservation: The In Situ Approach*. Chapman & Hall, London.
- Wood D and Lenne J. 1999. *Agrobiodiversity: Characterisation, Utilization and Management*. CAB International, Wallingford.

**SOA/FCMC/591 – MASTER’S SEMINAR**

| I – Title   | II – Code    | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total   |
|---|--------------|--------------------|--------|----------|--------------------------|---------|
| Master’s Seminar  | SOA/FCMC/591 | 0+1                | --     | --       | 100                      | 100 (1) |
| <ul style="list-style-type: none"> <li>Concerned department will organize in house seminars about pre-discussion of the master thesis topics.</li> <li>Departmental committee will discuss and finalize synopsis of master thesis through ppt. presentation.</li> </ul> |              |                    |        |          |                          |         |

**SOA/FCMC/599A – RESEARCH REVIEW (MASTER THESIS)**

| I – Title   | II – Code     | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total   |
|---|---------------|--------------------|--------|----------|--------------------------|---------|
| Research Review<br>(Master Thesis)  | SOA/FCMC/599A | 0+7                | --     | --       | 100                      | 100 (7) |
| <ul style="list-style-type: none"> <li>Mid-term progress will be presented by each student by ppt. presentation.</li> <li>Master thesis review work will be presented by each student.</li> </ul> |               |                    |        |          |                          |         |

**SEMESTER IV****SOA/FEMC/510 – PARTICIPATORY APPROACHES IN FOREST MANAGEMENT**

| I – Title   | II – Code    | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total   |
|---|--------------|--------------------|--------|----------|--------------------------|---------|
| Participatory<br>Approaches in Forest<br>Management | SOA/FEMC/510 | 1+1                | 60     | 20       | 20                       | 100 (2) |

**IV – Aim of the Course**

To inculcate knowledge and skills in students to employ participatory tools and techniques for effective planning, implementation, monitoring and evaluation of forestry projects, to efficiently carry out forest resource management and to effectively resolve conflicts by adopting participatory techniques.

**V. Theory****Unit I**

Participatory approaches- Participatory planning- Participatory data collection, research and project preparation; Participatory implementation- group approaches for implementation of projects and programmes; Participatory monitoring; Participatory evaluation- Concurrent and ex-post evaluation; Peoples’ participation community mobilization.

**Unit II**

Concept of Social Research, Traditional methods of doing research, Action Research and Participatory Research. Scope and importance of Qualitative Data. Construction and Methods of Data Collection. Different types of Sampling. Interview Techniques. Qualitative methods-Sociometry, Case Studies, observation, coding and content analysis.

**Unit III**

Participatory Methods of Data Collection-Concept and Need of Data, Information, Appraisal; Various methods of Data Collection, Interpretation of Qualitative and Quantitative Data. Origin of Participatory Methods, FSA, Rapid Rural Appraisal. Key informants, selection of key informants. Semi-structured interviews, Question guide/

checklist and other relevant methods and their applications in forestry and natural resource management.

**Unit IV**

Objectives of PRA. The Logic and merits of the PRA. Challenges/ constraints of PRA. Major methods of PRA. The fundamental concepts of PRA. Principles of PRA. Operational guidelines for organizing PRA at village level. PRA and PLA – Concept, Methods, Tools, Interpretation and Techniques. Other relevant participatory approaches like RRA, PANR, etc. Emerging tools used for PRA (ICT, GIS, GPS etc.).

**VI. Practical**

Visit to selected forest areas to undertake and understand various participatory research methods including participatory rural appraisal techniques like social mapping, resource mapping, Venn diagrams, transect walk, time lines, etc.

**VII. Suggested Reading**

- Kothari CR. 1992. *Research Methodology- Methods and Techniques*. Wiley Eastern Limited New Delhi.
- Narayanasamy N. 2008. *Participatory Rural Appraisal: Principles, Methods and Application*.
- Robert C. 1981. *Rapid Rural Appraisal Rationale and Repertoire*. IDS Discussion Paper, No.155, IDS, Sussex.
- Sabarathnam VE. 2002. *R/ R/ PRA for Agriculture*. Vamsaravath Publishers, Hyderabad.

**SOA/FE/599B – MASTER RESEARCH (THESIS)**

| I – Title                   | II – Code   | III - Credit Hours | Theory | Internal | Practical/<br>Term Paper | Total    |
|-----------------------------|-------------|--------------------|--------|----------|--------------------------|----------|
| Master Research<br>(Thesis) | SOA/FE/599B | 0+23               | --     | --       | 100                      | 100 (23) |

Evaluation of the master thesis shall be as follows:

- |                            |          |
|----------------------------|----------|
| 1. Periodical presentation | 20 Marks |
| 2. Viva-Voce               | 20 Marks |
| 3. Thesis evaluation       | 60 Marks |

Evaluation of the thesis shall be done by one external and one internal examiner.