

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

FOR

M.Sc. (FORESTRY) FOREST RESOURCE MANAGEMENT



**Dept. of Natural Resource
Management & Env. Sci.
College of Forestry
Sam Higginbottom University of
Agri., Tech. & Sci. (SHUATS)
Prayagraj (Allahabad), U.P., India**

M.Sc. FORESTRY (FOREST RESOURCE MANAGEMENT)

Course work

1. Major courses (20 credits)

Course Code	Title of the Course	L	T	P	Total Credits	Semester
FRM-501*	Forest Biometry and Management	2	0	1	3	I
FRM-502	Ecology and Management of Forest Soils	2	0	1	3	II
FRM-503*	Remote Sensing and Geographical Information System in Natural Resource Management	2	0	1	3	I
FRM-504	Land Use Planning and Watershed Management	2	0	1	3	II
FRM-505*	Forest Resource Economics	1	0	1	2	I
FRM-506*	Forest Ecosystem Services and Valuation	2	0	1	3	II
FRM-507	Environmental Impact Assessment and Auditing	1	0	1	2	I
FRM-508*	Forest Policy, law and International Conventions	2	0	0	2	II
FRM-509	Global Climate Change Impact, Mitigation and Adaptation	2	0	0	2	I
FRM-510*	Participatory Approaches in Forest Resource Management	1	0	1	2	II
FRM-511	Management of Tree Insect-Pests and Diseases	2	0	1	3	I
FRM-512	Forest Ecology, Biodiversity and Management	2	0	1	3	II
	Total Credits	21	0	10	31	

2. Minor courses (8 credits)

Courses from Silviculture and Agroforestry or Forest Biology and Tree Improvement or Forest Products and Utilization or Environmental Science

3. Supporting courses (6 credits)

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

4. Common Courses (5 credits)

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

5. Seminar (1 credits)

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

6. Research (30 credits)

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

*Compulsory Core Courses

Course Title : Forest Biometry and Management

Course Code : FRM-501

Credit Hours : 2+1

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

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.

Practical

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

Suggested Reading

- Chaturvedi A.N 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 Blackwell.
- Laar A Van and Akca A. 2007. *Forest Mensuration*. Springer, Netherlands.

- Loctsch 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.

Theory

Sl. No.	Topic	No. of Lecture(s)
1.	Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands	2
2.	Preparation of volume tables and their application	2
3.	Preparations of Yield and stand tables, their application	2
4.	Forest Inventory, Sampling methods adopted in Forestry, Kinds of enumeration, Kinds of sampling Advantages of sampling, Sampling design, Sampling Intensity and Sampling errors. Use of aerial Photography in Forest Inventory	5
5.	Use of GPS in Inventory	2
6.	Principles of forest management, scope and object of forest management	2
7.	Ecosystem management, development of forest management in India Site quality evaluation and importance: Site Index, Methods of site quality evaluation, Methods of determining past growth of stands Canopy Density, Crown Competition Factor	2 4
8.	Stand Density Measurement: Measure of stand density, Absolute measures of stand density, Stand density index, Stand density versus stocking	4
9.	Forest Valuation and appraisal in regulated forests	3
10.	Growth and yield prediction models- their preparation and applications	4
11.	Simulation techniques	2
	Total	36

Practical

Sl. No.	Topic	No. of Practical(s)
1.	Calculations of volume of felled as well as standing trees	3
2.	Volume table preparation	4
3.	Application of sampling procedures	3
4.	Handling of GPS	2
5.	Preparation of yield and stand table	4
	Total	16

Course Title : Ecology and Management of Forest Soils

Course Code : FRM-502

Credit Hours : 2+1

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.

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* 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.

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.

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 Ferility*. Black well.

Theory

Sl. No.	Topic	No. of Lecture(s)
1.	Forest soils – distinguishing features – soils and vegetation development	3
2.	Physical and chemical properties- Types and properties of soils under different forest ecosystems	3
3.	Forest floor: Organic horizons and litter dynamics	3
4.	Humus – types- organic matter decomposition-mineralization and immobilization of organic matter	4
5.	Nutrient cycling, significance of C:N ratio, soil pH	3
6.	Forest soil biology, soil fauna, nitrogen fixation. Rhizobium-tree legume symbiosis. <i>Frankia</i> x non-legume symbiosis	4
7.	Nitrification and denitrification in forest ecosystems. Mycorrhizal associations in forest soils	3
8.	Nursery soils, problem soils, mineral nutrition, acidic deposition effects	5
9.	Effect of forest fire and management interventions of forest soils	4
	Total	32

Practical

Sl. No	Topic	No.of Practical (s)
1.	Study of the soil profile	1
2.	Mechanical analysis of soil	3
3.	Determination of pH, EC, organic carbon	2
4.	Determination of CEC	2
5.	Determination of available N, P, K, Ca, Mg and S	3
6.	Determination of micro-nutrients-Cu, Zn, Mn and Fe	2
7.	Manurial schedules for different soils	3
	Total	16

Course Title :Remote Sensing and Geographical information System
in Forest resource management

Course Code : FRM-503

Credit Hours : 2+1

Aim of the course

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

Theory

Unit I

Satellite remote sensing and recent developments in geomatics, different satellite missions 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.

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 of forest biomass and carbon map, fire affected areas assessment, preparation of change detection map, classification of LULC using ERDAS and Arc GIS softwares.

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.
- Lillesand 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.

Theory

Sl. No.	Topic	No. of Lecture(s)
1.	Remote sensing: Introduction, definition, brief history, fundamental principle of RS, Stages of RS, Classification of RS: Active and Passive RS- based on source of energy and wavelength; Aerial and space remote sensing, Merits and limitations of RS. Recent developments in geomatics. Different satellite missions of India and abroad	8
2.	Remote sensing platforms-ground aerial and space platforms, satellite orbits, Resolution- spatial, spectral, radiometric and temporal; Scanning systems- whisk broom and push broom scanners; Sensor system-MSS, ETM, MSS, LISS, etc.	6
3.	Image analysis: Definition, visual image analysis, digital image analysis, elements of image analysis and steps in digital imageprocessing. Agencies involved in remote sensing	4
4.	Application of RS in forestry: Vegetation cover classification and mapping-NDVI, SAVI, EVI, status and monitoring, species identification, social and agro-forestry applications, growing stock estimation, biodiversity characterization, wildlife habitatsuitability mapping, biomass and carbon mapping, etc.	6
5.	Geoinformatics and GIS meaning, objectives, elements of GIS- software, hardware, data ware, human ware, processes involved in GIS, Raster data, vector data, thematic overlay building. Application of GIS to forest resource management	5
6.	GPS: Global Positioning System-meaning, principles, applications, GNSS, IRNS, GAGAN, etc.	3
	Total	32

Practical

Sl. No	Topic	No. of Practical(s)
1.	Thematic layers build up, overlaying and their integration using ERDAS and ArcGIS Software package	4
2.	Interpretation of satellite data and digital image processing	4
3.	Preparation of thematic maps	3
4.	Preparation forest biomass and carbon map, fire affected areas assessment, preparation of change detection map, classification of	5

Course Title : Land Use Planning and Watershed Management

Course Code : FRM-504

Credit Hours : 2+1

Aim of the course

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

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.

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.

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.

Theory

Sl. No.	Topic	No. of Lecture(s)
1.	Land use Planning: concepts and techniques; Agro-ecological regions/ sub-regions of India	3
2.	Factors affecting land use; soil and land use survey through remote sensing technique	3
3.	Interpretation of soil resource map for land use planning	2
4.	Land evaluation methods and soil-site suitability evaluation for different crops	4
5.	Watershed management concept- objectives, characterization, planning, execution, community participation and evaluation	5
6.	Developing economically and ecologically sustainable agroforestry systems for watersheds; water harvesting and its efficient use; rehabilitation of watersheds	4
7.	Suitable tree planting techniques in watersheds	2
8.	Suitable trees/ shrubs and grasses for watersheds for different	2

	agroclimatic regions	
9.	Watershed management cases studies	4
10.	Drought and flood mapping and its relevance in designing sustainable cropping systems	3
	Total	32

Practical

Sl. No.	Topic	No. of Practical(s)
1.	Study of Agro-ecological regions/ sub-regions of India	2
2.	Soil and land use survey through remote sensing technique	2
3.	Interpretation of soil resource map for land use planning; land evaluation methods and soil-site suitability evaluation for different crops	3
4.	Watershed characterisation, planning, execution, community participation and evaluation. Suitable tree planting techniques in watersheds	3
5.	Suitable trees/ shrubs and grasses for watershed for different agro-climatic regions. Watershed management cases studies	3
6.	Drought and Flood mapping and its relevance in designing sustainable cropping systems	3
	Total	16

Course Title : Forest Resource Economics

Course Code : FRM-505

Credit Hours : 1+1

Aim of the course

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

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.

Unit III

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.

Practical

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

Suggested Reading

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

Theory

Sl. No.	Topic	No. of Lecture(s)
1.	Principles of microeconomics and its application in forest resource management	3
2.	Demand, supply and marketing of forest products. Theory of capital and application in forest resource management	3
3.	Domestic and international trade in forest products	1
4.	Impact of socio-economic variables on forest appraisal and management decisions. Externalities and property rights	3

5.	Forest and environmental resource accounting –methods and implications.	3
6.	Application of operational research tools in evaluating forest management alternatives in public and private forest planning and valuation	3
Total		16

Practical

Sl. No	Topic	No. of Practical(s)
1.	Exercises on estimation of demand and supply functions	4
2.	Biodiversity valuation, valuation of non-marketed forest products	3
3.	Exercises on financial and economic appraisal of forestry projects Exercises on marketing of forest products and international trade competitiveness	6
4.	Computer applications for using programming techniques in evaluating forest management alternatives	3
Total		16

Course Title : Forest Ecosystem Services and Valuation

Course Code : FRM-506

Credit Hours : 2+1

Aim of the course

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.

Theory

Unit I

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.

Unit II

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.

Unit III

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.

Practical

IPBES and MEA assessment; Valuation methods- direct and indirect; Case studies of PES in India and Abroad; Case studies on certification and geographical indications, FSC.

Suggested Reading

- Alavalapati JRR, Shrestha RK, Stainback GA and Matta JR. 2004. *Agroforestry development: An environmental economic perspective*. Agroforestry Systems.
- Huxley P. 1999. *Tropical Agroforestry*. Blackwell.
- Jain SK and Singh P. 2000. *Economic Analysis of Industrial Agroforestry: Poplar (Populus deltoides) in Uttar Pradesh (India)*. Agroforestry Systems.
- Jeffers JNR. 1978. *An Introduction to System Analysis with Ecological Application*. Edward Arnold.
- Jose S. 2009. *Agroforestry for Ecosystem Services and Environmental Benefits: an Overview*. Agroforestry Systems.
- Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, Netherlands.
- Paulo ELD and Nunes. 2014. *Handbook on the Economics of Ecosystem and Biodiversity*. E-book. Sander J, Nicolas D and Hans K. 2014
- *Ecosystem Services: Global Issues and Local Practices*. First Edition. Elsevier Publications.
- Schroth G and Sinclair F. 2003. *Tree Crops and Soil Fertility: Concepts and Research Methods*, CABI, Wallingford, UK.
- Young A. 1997. *Agroforestry for Soil Management*. 2nd ed. CABI, Wallingford, UK.

Theory		
Sl. No.	Topic	No of Lecture(s)
1.	Ecosystem Services (ES) basics, importance, history of ES and natural capital, classification of ES-provisioning, regulating, supporting and cultural services	3
2.	Status and changes of ecosystem services, drivers of change of ecosystem services	2
3.	International conventions and charters on ES-Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) and Millennium Ecosystem Services (MEA) Assessment– an overview	3
4.	Linkages among biodiversity, ecosystem services and human well being	2
5.	Quantification of Ecosystem Services-direct and indirect approaches. Ecological Economics: Valuation of ES, need for valuation	4
6.	Use values and Non-Use values- direct value, indirect value, optional value, bequest value, existence value	2
7.	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.	6
8.	Case studies of valuation of ES in India and abroad. Challenges in valuation of ES	2
9.	Governance and policy issues in ecosystem services	2
10.	Payment for ecosystem services (PES), mechanisms of benefit sharing, eco-certification, Geographic Indications, Forest Stewardship Council, Landscape labelling	3
11.	National and International initiatives in PES and on-going programs	3
Total		32

Practical		
Sl. No.	Topic	No. of Practical(s)
1.	IPBES and MEA assessment	3

2.	Valuation methods- direct and indirect	3
3.	Case studies of PES in India and Abroad	4
4.	Case studies on certification and geographical indications, FSC	4
Total		16

Course Title : Environmental Impact Assessments and Auditing

Course Code : FRM-507

Credit Hours : 1+1

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 EIA legislation and other statutory obligations.

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.

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 agroindustries.

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.

Theory

Sl. No.	Topic	No of Lecture(s)
1.	Origin of EIA and historical perspective, scope and purpose of EIA. Key merits of environmental assessment in regulating the state of environment	1
2.	Global experience in EIA; Comparative review of EIA systems in different countries and regions. Salient features of EIA legislation and other statutory obligations	2
3.	Environmental decision making in India Environmental clearance procedures and national requirements	2

4.	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)	2
5.	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)	2
6.	Introduction to various impact assessment methods: checklist, matrices, networks, indices and weight scaling techniques and their scope and limitations	2
7.	Prediction and assessment of impact on the land, air, water, noise, biological and socioeconomic environments	2
8.	Mitigation: definitions and hierarchy of measures including avoidance, reduction, rectification and compensation enhancement approaches	2
9.	Principles and concepts of offsets, type of offsets	2
	Total	17

Practical

Sl. No.	Topic	No. of Practical(s)
1.	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)	8
2.	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	8
	Total	16

Course Title : Forest Policy, Law and International Conventions

Course Code : FRM-508

Credit Hours : 2+0

Aim of the course

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

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.

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*. NatrajPubl.The Biodiversity Act,2002.

- Wilson B, Van Kooten GC, Vertinsky I, Arthur L. 1998. *Forest policy—International case studies*. CABI publishing, UK.

Theory		
Sl. No.	Topic	No. of Lecture(s)
1.	Forest policy – Relevance and scope, National Forest Policy –1894, 1952 and 1988	2
2.	Forest laws; Indian Forest Act –1927, general provision and detailed study	3
3.	Forest Conservation Act 1980	2
4.	Wildlife Protect Act 1972	2
5.	Important Forest Rules and Guidelines.; Indian evidence act applied to forestry matters, Legal definitions; objectives of species forest laws	2
6.	History of environmental policy in India	1
7.	Constitutional and legislative provisions—constitutional provisions and the environment	2
8.	Environmental protection and fundamental rights, Digest of environmental <i>legislation</i> (Interpretation of environmental statutes,	2
9.	Environmental protection Act 1986	2
10.	Biodiversity Act 2002	2
11.	Schedules tribes (Recognition of forest rights) Act 2007	1
12.	Judicial remedies and procedures, public interest litigations, Intellectual Property Rights (Patents, Copyrights, Trade mark, Trade secrets), freedom of information, and right to know	4
13.	Important case studies and landmark judgments. Case studies of different forests divisions/ areas of India	3
14.	International conventions of forestry issue. e.g. Role of international treaties like CITES, IUCN, RAMSER, CBD, etc.	3
Total		32

Course Title : **Global Climate Change Impact, Mitigation and Adaptation**

Course Code : **FRM-509**

Credit Hours : **2+0**

Aim of the course

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

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 CO₂ on growth, physiological processes, productivity and quality of different vegetation types, soil health, water availability, insect pest dynamics, crop production, milk and inland 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; modeling 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 CO₂ fertilization on productivity, recent techniques for assessing the impact of elevated CO₂ on tree species.

Suggested Reading

- *Climate Change: Challenges To Sustainable Development in India*. 2008. Research Unit (Larrdis) RajyaSabha 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.

Theory

Sl. No.	Topic	No. of Lecture (s)
1.	Definition and concept of climate change and variability; global warming and dimming	2
2.	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 agroecosystems, source and sinks of GHG	4
3.	Warming potential and contribution of greenhouse gases to global warming, greenhouse effect; monitoring of greenhouse gases	4
4.	Impact assessment of rise in atmospheric temperature and CO ₂ on growth, physiological processes, productivity and quality of different forest types, soil health, water availability, insect pest dynamics, cropweed competition, milk and inland and marine fish production	4
5.	Climate change and loss of biodiversity; spatial and temporal changes in forest and plantation productivity and agricultural production in context of climate change	3
6.	Adaptation and mitigation options to climate change; carbon sequestration; modeling climate change and its impact on forests	4
7.	International summit, conferences, protocols and negotiations on climate change; clean development mechanism; carbon trading, credits, footprints	3
8.	Government strategies and policies on climate change management	3
9.	Recent techniques for assessing the impact of high temperature on tree species and crops, recent techniques for assessing the impact of CO ₂ fertilization on productivity, recent techniques for assessing the impact of elevated CO ₂ on tree species	5
	Total	32

Course Title: Participatory Approaches in Forest Management

Course Code: FRM-510

Credit Hours : 1+1

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.

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.).

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.

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.

Theory

Sl. No.	Topic	No. of Lecture(s)
1.	Participatory approaches- Participatory planning-Participatory data collection, research and project preparation	2
2.	Participatory implementation- group approaches for implementation of projects and programmes; Participatory monitoring; Participatory evaluation- Concurrent and ex-post evaluation; Peoples' participation- community mobilization	2
3.	Concept of Social Research, Traditional methods of doing research, Action Research and Participatory Research	2
4.	Impact assessment of rise in atmospheric temperature and CO ₂ on growth, physiological processes, productivity and quality of different forest types, soil health, water availability, insect pest dynamics, crop-weed competition, milk and inland and marine fish production	2
5.	Scope and importance of qualitative data. Construction and Methods of Data Collection. Different types of Sampling	1
6.	Interview Techniques. Qualitative methods-Sociometry, Case Studies, observation, coding and content analysis	2
7.	Participatory Methods of Data Collection-Concept and Need of Data, Information, Appraisal; Various methods of Data Collection, Interpretation of Qualitative and Quantitative Data	1
8.	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	2
9.	Objectives of PRA. The Logic and merits of the PRA. Challenges/ constraints of PRA. Major methods of PRA. The fundamental	2

concepts of PRA. Principles of PRA

10.	Operational guidelines for organizing PRA at village level. PRA and PLA – Concept, Methods, Tools, Interpretation and Techniques.	1
11.	Other relevant participatory approaches like RRA, PANR, etc. Emerging tools used for PRA (ICT, GIS, GPS, etc.)	1
Total		16

Practical

Sl. No	Topic	No. of Practical(s)
1.	Visit to selected forest areas to undertake and understand various participatory research methods	8
2.	Including participatory rural appraisal techniques like social mapping, resource mapping, Venn diagrams, transect walk, time lines, etc.	8
Total		16

Course Title : Management of Tree Insect Pests and Diseases

Course Code : FRM-511

Credit Hours : 2+1

Aim of the course

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

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.

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.

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 Pathol Microb.
- Sinclair W and Howard HL. 2005. *Diseases of Trees and Shrubs*.
- Speight MR. 2000. *Insect Pest in Tropical Forestry*. Rose Willey Publications.

Theory

Sl. No.	Topic	No. of Lecture(s)
1.	Concepts and terminologies in forest entomology	1
2.	Insect pest induced loss assessments in different forest nursery seedling	2
3.	Insect pest induced loss assessments in different forest plantations	2
4.	Principles of integrated pest management	2
5.	Insect attractants and repellents, male sterility techniques	2
6.	Important insect pests of nurseries	1
7.	Important insect pests of plantation trees, avenue trees and their management	3
8.	Insect pests of seeds of forest trees and their management.	1
9.	Concepts and terminologies forest pathology	2

10.	Disease induced loss assessments in different forest nursery seedlings and plantations	2
11.	Principle methods of tree disease management	2
12.	Integrated forest protection	2
13.	Development of disease management system	2
14.	Important diseases of forest nurseries and their management	3
15.	Important diseases of forest plantations and avenue trees and their management	3
16.	Mycoflora of seeds and their management	2
Total		32

Practical

Sl. No	Topic	No. of Practical(s)
1.	Collection and identification of insect pests and non-insect pests	2
2.	Inspection and collection of insect damaged plant specimens	3
3.	Preparations of different pesticides. Application of pesticides	3
4.	Collection, preservation and identification of tree diseases, forest nursery and plantation	3
5.	Isolation and characterization of tree pathogens	2
6.	Preparation of fungicidal solutions; <i>In-vitro</i> efficacy and <i>In vivo</i> efficacy assessments	3
Total		16

Course Title : Forest Ecology, Biodiversity and Management

Course Code : FRM-512

Credit Hours : 2+1

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.

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.

Practical

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

Suggested 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: Characterization, Utilization and Management*. CAB International, Wallingford.

Theory

Sl. No	Topic	No. of Lecture(s)
1.	Introduction to forest ecology, forest population, forest community dynamics, forest community structure and analysis	2
2.	Forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity; Hierarchy issues in ecology	2
3.	Biodiversity-an overview; genetic, species and ecosystem diversity; determinants of biodiversity. Higher plant diversity, species richness and endemism	2
4.	Managing plant genetic resources: Basic science issues – genetic vulnerability and crop diversity, crop diversity-institutional responses, in situ conservation of genetic resources	3
5.	The science of collecting genetic resources, the science of managing genetic resources, using genetic resources	2
6.	Biotechnology and germplasm conservation	1
7.	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	4
8.	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	4

9.	Managing plant genetic resources: policy issues (exchange of genetic resources: quarantine, IPR; genetic resources: assessing economic value; conflicts over ownership, management and use	4
10.	National and international treaties/ legislations: CBD, IT-PGRFA, GPA, PVP and FR Act, Biodiversity Act, etc.)	4
11.	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	4
Total		32

Practical

Sl. No	Topic	No. of Practical(s)
1.	Introduction to forest ecology, forest population, forest community dynamics, forest community structure and analysis	2
2.	Forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity; Hierarchy issues in ecology	2
3.	Biodiversity-an overview; genetic, species and ecosystem diversity; determinants of biodiversity. Higher plant diversity, species richness and endemism	2
4.	Managing plant genetic resources: Basic science issues – genetic vulnerability and crop diversity, crop diversity-institutional responses, in situ conservation of genetic resources	3
5.	The science of collecting genetic resources, the science of managing genetic resources, using genetic resources	2
6.	Visit to national parks, wildlife sanctuaries, botanical gardens and arboreta	3
Total		16

Course Title : Experimental Designs

Course Code : MAS-815

Credit Hours : 2+1

Theory

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

Practical

Analysis of variance, Randomized Block Design.

Suggested Readings

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

Theory

Sl. No	Topic	No of Lecture(s)
1	Analysis of variance	2
2	Definition and assumptions	2
3	One way classification	2
4	Two-way classification	2
5	Sampling Techniques	2
6	Simple random sampling	2
7	Stratified random sampling	2
8	Systematic sampling	2
9	Design Experiments	2
10	Randomized Block design	2

11	Latin Square design	2
12	Factorial design (2^2 , 2^3 , 3^2 , 3^3 factorials)	3
13	Some P x Q experiments	3
14	Split Plot Experiments	2
	Balanced Incomplete Block design	2
	Total	32

Practical

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

Course Title : Statistical Methods

Course Code : MAS-511

Credit Hours : 2+1

Theory

Statistical Methods- Measures of Skewness and Kurtosis, standard error of mean, Coefficient of variation. Theory of Probability- Definitions, Additions and Multiplication rules of Probability, Conditional Probability. Probability distributions- Normal, Binomial and Poisson distributions. Correlation and Regression- Simple correlation, Rank correlation, Regression Coefficient, Multiple and Partial Correlation, Regression lines between two variables, Multiple Regression. Tests of Significance- X^2 - test, t - test one sample, two sample t - tests, paired t-test, F - test, Fisher's 2- transformation.

Practical

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

Suggested Readings

- Ostle, B. and. Mensing, R.W. 1964. Statistics in Research.
- Goulden, C.H. 2007. Method of Statistical Analysis.

- Snedecor, G.W. and Cochran, W.G. 1989. Statistical Methods.
- Steel, R.G. and Torrie, J.H. 1980. Principles and Procedures of Statistics (with special reference to Biological Sciences).
- Rangaswamy, R. 2010. A Text Book of Agricultural Statistics.
- Chandel, S.R.S. 2014. A Text Book of Agricultural Statistics.
- Cochran, W.G. and Cox, G.M. 1992. Experimental Designs.

Theory

Sl. No	Topic	No of Lecture(s)
1	Statistical Methods: Measures of Skewness and Kurtosis	1
2	Standard error of mean	1
3	Coefficient of variation	1
4	Theory of Probability- Definitions	1
5	Additions and Multiplication rules of Probability	2
6	Conditional Probability	2
7	Probability distributions: Normal, Binomial and Poisson distributions	2
8	Correlation and Regression, Simple correlation	2
9	Correlation and Regression, Simple correlation	2
10	Rank correlation	2
11	Regression Coefficient	2
12	Multiple and Partial Correlation	1
13	Regression lines between two variables	1
14	Multiple Regression	2
15	Tests of Significance- χ^2 - test	2
16	t- test one sample	2
17	Two sample t- tests	2
18	Paired t-test, F- test	2
19	Fisher's 2- transformation	2
	Total	32

Practical

Sl. No	Topic	No of Practical(s)
1	Coefficient of variation	2
2	SE of mean	1

3	Skewness and Kurtosis	2
4	Fitting of Normal	2
5	Binomial and Poisson distribution	1
6	Simple Correlation	2
7	Multiple and Partial Correlation with three variables only	2
8	Regression lines between two variables	2
9	X^2 , t and F- tests	2
	Total	16

Course Title : Computer Orientation

Course Code : CSIT-701

Credit Hours : 2+1

Theory

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

Practical

Demo session on computer & its components, I/O devices, Memory, CPU, MS DOS-Internal DOS Command- md, cd, dir, time, del, type, edit, copy, exit, path, prompt, rem, ren, ver. External DOS Commands- attrib, backup, chkdsk, diskcomp, diskcopy, doskey, format, label, xcopy, move, tree, undelete, Windows- Login, Desktop, Icons & Folders, Taskbar, Changing Desktop properties, My computer, My Network places, Recycle bin, My Documents, Control panel, Application Software- MS Word- Getting familiar with various tool bars. Tables and Columns, Mail merge. MS Excel- Working with Spreadsheets, Mathematical & Statistical functions, Generating Charts, Creating Macros. MS Access- database table, forms, reports MS Power Point- Designing slides, Adding animation tools to slides, C programming- Programs illustrating use of print f () and scan f () statements, practicing with decision making statements like IF, IF-ELSE, Nested IF,ELSE-IF, Ladder, Switch, Goto, Working with loops, Illustration of Arrays, Designing programs to demonstrate concept of functions, Internet- Website, website,

browser, URL, Surfing, Searching, creating mail accounts. A glance over statistical packages like SPSS, MATLAB etc.

Suggested Readings

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

Theory

Sl. No	Topic	No of Lecture(s)
1	Information Concepts	2
2	Data and Information	2
3	Information System: Application, Elements, types	1
4	Computers basics- Definition, Characteristics & Application of Computers	1
5	Computer Hardware: I/O devices, Memory, CPU	1
6	Software Concepts	2
7	Operating System- DOS	2
8	Windows	2
9	Application Software - MS Word, MS Excel, MS Access, MS Power Point, Adobe Reader	3
10	Computer Programming-Algorithm & Flowchart	2
11	Introduction to 'C' Language , History	2
12	Input & Output Statements	1
13	Variables & Constants	1
14	Expressions & Operators	1
15	Control Statements	1
16	Branching Statements (if, if-else, Nested if)	1
17	Looping Statements (while, do-while, for)	1
18	Functions & Arrays	2
19	Internet Concepts & Search Engine	2
20	Application of statistical packages	2
Total		32

Practical

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

NON-CREDIT COURSE CONTENTS

Course Title : Library and Information Services

Course Code : PGS- 501

Credit Hours : 0+1

Objective

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

Practical

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

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

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

Course Title : Technical Writing and Communication Skills

Course Code : PGS- 502

Credit Hours : 0+1

Objective

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

Practical

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

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

Suggested Readings

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

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

Practical

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

Course Title : Intellectual Property & Its Management in Agriculture

Course Code : AEAB-503

Credit Hours : 0+1

Objective

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

Practical

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

Suggested Readings

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

Practical

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

Course Title : Basic Concepts in Laboratory Techniques

Course Code : SAF-515

Credit Hours : 0+1

Objective

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

Practical

Safety measures while in Lab, Handling of chemical substances, Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes washing, drying and sterilization of glassware, Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution, Handling techniques of solutions, Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-

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

Suggested Readings

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

Practical

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

Course Title : Agricultural Research, Research Ethics and Rural Development

Course Code : AEAB-505

Credit Hours : 0+1

Objective

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

Practical

Unit- I

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

Unit- II

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

Unit- III

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

Suggested Readings

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

Practical

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

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