Detailed syllabus of Ph.D. (Forestry) Silviculture and Agroforestry

Major Courses (Gradial Courses)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	SAF-601	Credit	3(2+1)
Year/Sem	Year 1; Semester - I	L-T-P	2-0-2
Course name	QuantitativeSilviculture (Compulsory Core Course)		

Course Objectives:

1. Toacquaint the studentswithforeststandgrowthandyield.
2. To understand the quantitative techniques used for evaluating site quality.
3. To measure the stand density.
4. To predict forestgrowthandyield.
5. To learn about Nursery management practices.
6. To assess the existingforestgrowthandyieldsimulators.

UNITS I (Total Topics- 6 and Hrs- 8)

Principlesoftreeandstandgrowthandyield.Habitattypes; site quality; siteindex.
Growth functions – empirical, exponential, allometry and Backman's growth functions. Growth pattern and growth increment curve. Growth cycle and phases.Quantifying site quality: Methods – tree and stand height data, periodic heightgrowth.Techniques– guidecurves,differenceequations,parameterprediction.

UNIT II (Total Topics -8 and Hrs-8)

Stand density and stocking, measures of density: –3/2 power rule of self-thinning, pointdensity, competition indices. Control of growing stock to achieve specific managementobjectives – growth-growing stock relations, Full site occupancy, Onset of competitiveinteractions.Langsaeter'shypothesis,standdensityindexandtechniquesfortranslatingthisunderstandingintorationaldensitymanagementregimes

UNIT- III (Total Topics -8 and Hrs-6)

Techniques: stand density management diagrams and stocking charts. Constructionand use of stand density management diagrams. Designing density managementregimestosuitspecificmanagementobjectives

UNIT-IV (Total Topics -8 and Hrs-8)

Predicting growth and yield: normal and empirical yield tables, stand growth andyield equations, stand table projections. Simulation models: whole-stand models,size-classdistributionmodels,singletree/distanceindependentanddistance-dependentmodels,processmodels,linkageofmodelsatdifferentlevels.Evaluation,calibration,verification,andvalidationofforestgrowthandyieldpredictionsystems.IntroductiontoexistingforestgrowthandyieldsimulatorS.

Practical (Total Experiments-8 and Hrs-16)

Assessment of growth characteristics; Preparation of growth and increment curves; Site quality assessment, Stand density diagrams; Growth prediction models; Yield simulation techniques.

Course Outcomes (CO)

- SAF-601-CO-1 Remembering Techniques– guidecurves,differenceequations,parameterprediction.
- SAF-601-CO-2 Understanding various growth functions.
- SAF-601-CO-3 Applying Growthpredictionmodels.
- SAF-601-CO-4 Analyzing. Growth cycle and phases.
- SAF-601-CO-5 Evaluation Forestgrowthandyieldpredictionsystems.
- SAF-601-CO-6 Designing density managementregimestosuitspecificmanagementobjectives.

Suggested readings:

- ClutterJL,FortsonJC,PienaarLV,BristerGHandBaileyRL.1992.TimberManagement:AQuantitativeApproach.KriegerPublishingCompany.
- DavisLSandJohnsonKN.1987.ForestManagement.3rdEd.McGraw-Hill.EvansJ.1982.PlantationForestryintheTropics.ClarendonPress.
- JohnsonPS,ShifleySRandR.Rogers.2009.Self-thinningandStandDensity.TheEcologyandSilvicultureofOaks.CABI,Cambridge,MA.
- LunaRK.1989. PlantationForestry inIndia. International Book distributors.
- VanclayJK.1994.ModelingForestGrowthandYield:ApplicationtoMixedTropicalForests.CABInternational.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	2	3	-	-	-	1	1	1	1	2	1
CO-2	2	3	3	1	2	-	2	3	-	1	1
CO-3	3	3	2	2	-	-	1	2	2	-	3
CO-4	2	3	2	1	3	2	1	-	-	1	-
CO-5	-	3	3	-	2	3	3	3	3	2	2
CO-6	3	2	2	3	-	1	2	-	1	1	2
Average	2.0	2.8	2.8	1.1	1.1	1.1	1.6	1.5	1.1	1.1	1.5

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
SAF-601	QuantitativeSilviculture	2	0	2	20	10	20	50	100	3(2+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	SAF602	Credit	2(2+0)
Year/Sem	Year 1; Semester - II	L-T-P	2-0-0
Course name	AgroforestryResearchandManagement (Compulsory Core Course)		

Course Objectives:

1. To remember various agroforestry system for production and protection purpose.
2. Tounderstand the refinement of theagroforestrysystems.
3. To apply various Agroforestry models increase landuse system.
4. To analyze managementpracticesandtheirintegrationfordevelopingsuitableagroforestrysystems.
5. To evaluate Carbon and nutrient dynamics in agroforestry- carbon sequestration
6. To create a working plan of capacity building of farmer and farm forest associations.

UNITS I (Total Topics- 6 and Hrs- 8)

Recenttrendsinagroforestryresearchanddevelopment.Agroforestrylandusesystems and their salient features. Research designs and analysis in agroforestry.Multi-functionality of agroforestry systems-multiplicity of products and services,foodandnutritionalsecurity,livelihoodsecurity,genderrelatedaspects.Constraintsinagroforestryresearch–researchprioritization

UNIT II (Total Topics -8 and Hrs-8)

Studyofsystemsspecification,prioritizingpotentialinterventionsandtechnologyspecifications;spaceandtimerelatedconsiderations. Introductiontoon-farmandon-stationresearchexperiments.Biomassproductionandallocationpatterns-changesthoroughagroforestryinterventions

UNIT- III (Total Topics -8 and Hrs-6)

Belowgrounddynamics-roleoffinerootsinagroforestryproductivity.Treehusbandrypracticesinagroforestryforproductivityoptimization.Soil-sitesustainabilityandenvironmentalresourcesharing.Site-speciescompatibility.Competition,predation,mutualism,commensalisms.Simulationmodelingofagroforestrysystems. Carbon and nutrient dynamics in agroforestry- carbon sequestration- carbon credits- mitigatory and adaptive roles of agroforestry in the climate negotiations and agroforestry,context of climate change

UNIT-IV (Total Topics -8 and Hrs-8)

Management of multifunctional agroforestry – sustainability, links with UNFCCC, UNCCD and UNCBD. Carbon conservation, sequestration, and substitution functions of agroforestry trees. Domestication of useful species and crafting market regimes for the products derived from agroforestry and ethno-forestry systems. Contract fuel wood schemes, small-scale nursery enterprises, charcoal policy reform, novel market information systems, facilitating and capacity building of farmer and farm forest associations. Climate change and reforestation incentive policies**.**

Marketintelligenceforagroforestryproducts.Agroforestryvaluechainmodels:consortiaconcepts. Successfulcasestudies.

Course Outcomes (CO)

- SAF-602- CO-1: Remembering different Agroforestry system.

- SAF-602- CO-2: Understanding Agroforestrylandusesystems
- SAF-602-CO-3: Applying Biomassproductionandallocationpatterns-changesthoroughagroforestryinterventions
- SAF-602- CO-4:Analyzing, marketintelligenceforagroforestryproducts.
- SAF-602-CO-5:Evaluation of Carbon and nutrient dynamics in agroforestry- carbon sequestration- carbon credits- mitigatory and adaptive roles of agroforestry

SAF-602- CO-6 Creating simulationmodelingofagroforestrysystems.

Suggested readings:

- Chin K Ong, Colin Black and Julia Wilson. 2015. Tree-Crop Interactions, 2nd Edition: Agroforestry in a Changing Climate. CAB International.
- Kumar BM and Nair PKR. 2011. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges. Springer.
- Nair PKR, Rai MR and Buck LE. 2004. New Vistas in Agroforestry. Kluwer
- Ong CK and HuXley PK. 1996. Tree Crop Interactions – A Physiological Approach.
- ICRAF. Snelder DJ and Lasco RD. 2008. Smallholder Tree Growing for Rural Development and Environmental Services. Springer Science, Amsterdam.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	1	2	1	2	2	1	2	1	1	1	1
CO-2	1	1	2	2	1	1	1	1	1	1	1
CO-3	1	2	1	2	3	1	3	1	1	1	2
CO-4	1	1	1	2	2	1	2	1	1	1	1
CO-5	1	2	2	2	2	1	2	1	1	1	2
CO-6	1	1	1	2	2	1	2	1	1	1	1
Average	1.0	1.5	1.3	2.0	2.0	1.0	2.0	1.0	1.0	1.0	1.3

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practica
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
SAF-602	AgroforestryResearchandManagement	2	0	0	40	10	0	50	100	2(2+0)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	SAF603	Credit	1(1+0)
Year/Sem	Year 1; Semester I/II	L-T-P	1-0-0
Course name	ForestStandDynamics (Elective Course)		

Course Objectives:

1. To remember tree architecture and growth- general growth pattern.
2. Tounderstandandanticipate how forests grow and respond to intentional manipulations and naturaldisturbances.
3. To apply Disturbances and stand development – impact of disturbances.
4. To study temporal and spatial patterns of treeinvasion.
5. To evaluatequantification of stand development.
6. To Creater e s i l i e n c e todisturbances.

UNITS I (Total Topics- 6 and Hrs- 8)

Introduction-plantinteractionsandlimitationsofgrowth–mutualismandcompetition–theniche–limitationsofgrowth–conceptofgrowingspace. Tree architecture and growth- general growth patterns – shoot development patterns,crownshapes,heightgrowth,rootgrowth,andtreedevelopment

UNIT II (Total Topics -8 and Hrs-8)

Disturbances and stand development – impact of disturbances – major and minor-classificationofdisturbances–characteristicsofdisturbanceagents.Standstructureandfirebehaviour.Buildingresiliencetodisturbances

UNIT- III (Total Topics -8 and Hrs-6)

Overview of stand development patterns – temporal and spatial patterns of treeinvasion – stand initiation stage – stem exclusion stage – understorey reinitiationstage – old growth stage – multicohort stands – behavior of component cohorts-development of multicohort stands – quantification of stand development – forestpatternsoverlongtimesandlargeareas.Gapdynamics.

Course Outcomes (CO)

SAF -603- CO-1 Remembering plant interactions and limitations of growth.
SAF -603- CO-2 Understanding conceptofgrowingspace.
SAF -603- CO-3 Applying disturbance in Forest stand.
SAF -603- CO-4 Analyzing, impact of disturabance.
SAF -603- CO-5 Evaluation behaviour of component.
SAF -603- CO-6 Creating various regenration practices.

Suggested readings:

- Chin K Ong, Colin Black and Julia Wilson. 2015. Tree-Crop Interactions, 2nd Edition: Agroforestry in a Changing Climate. CAB International.
- Kumar BM and Nair PKR. 2011. Carbon Sequestration Potential of Agroforestry Systems: Oportunities and Challenges. Springer.
- Nair PKR, Rai MR and Buck LE. 2004. New Vistas in Agroforestry. Kluwer
- Ong CK and HuXley PK. 1996. Tree Crop Interactions – A Physiological Approach. ICRAF. Snelder DJ and Lasco RD. 2008. Smallholder Tree Growing for Rural Development and Environmental Services. Springer Science, Amsterdam.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	1	2	1	2	2	1	1	1	1	1	1	1
CO-2	1	1	2	2	1	1	1	1	1	1	1	1
CO-3	1	2	1	2	3	1	1	1	1	2	2	2
CO-4	1	1	1	2	2	1	1	1	1	1	1	1
CO-5	1	2	2	2	2	1	1	1	1	2	2	2
CO-6	1	1	1	2	2	1	1	1	1	1	1	1
Average	1.0	1.5	1.3	2.0	2.0	1.0	1.0	1.0	1.0	1.3	1.3	1.3

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
SAF-603	ForestStandDynamics	1	0	0	40	10	-	50	100	1(1+0)

Programme Name	Ph.D. (Forestry) Silviculture and	Programme	23-

	Agroforestry	Code	
Course Code	SAF 604	Credit	3(2+1)
Year/Sem	Year 1; Semester I/II	L-T-P	2-0-2
Course name	ProductivityandEvaluationofAgroforestrySystems (Elective Course)		

Course Objectives:

- Toacquaintthestudentswithconceptsinagroforestrysystemsproductivity,managingthefactor sofproductionandsustainedyieldlevels.
- To understand Systemcomplementarity,supplementarity,competitiveness,sustainabilityandmanagement techniques.
- To apply biological yield and harvest index.
- To evaluatecombinedproductivity andprofitabilityofdifferentagroforestrysystems
- To create Growth and yield functions and role of various financing agencies in agroforestry

UNITS I (Total Topics- 6 and Hrs- 8)
Conceptofcropproductivity.Productivitypotentialinrelationtolight,waterandnutrients.

UNIT II (Total Topics -8 and Hrs-8)
Systemcomplementarity,supplementarity,competitiveness,sustainabilityandmanagement techniques. Tree root architecture, re-allocation of resources withintheplantsystem.

UNIT- III (Total Topics -8 and Hrs-6)
Biological yield and harvest index. Growth and yield functions. Land equivalentratio.Wateruseefficiency,photosyntheticefficiency,radiationbalance,canopytransmissivity,canopymanagement,plantgeometryandcropyield.
Allelopathiceffects.Strategiestoimprovetheefficiencyandproductivityofdifferentlandusesystems.

UnitIV
Role of various financing agencies in agroforestry and critical evaluation of differentcreditsystemswithemphasisonagroforestry.Methodologiesforevaluatingagroforestryhedonicpricing,PES,LERandLEV. Financial, economic and social accounting of agroforestry projects. Advances inmarketingmanagementofagroforestryproducts.Evaluatingcombinedproductivity andprofitabilityofdifferentagroforestrysystems*vis-a-vis*otherscompetitiveagro-basedsystems.Treeinsuranceschemes.

Practical
Techniquesforleafareaindex;Photosyntheticallyactiveradiation;Soilmoistureandleafwaterpotential;Canopydensitymeasurements;Exercisesondevelopingalternativeoptimalagroforestryplansunderperfectandimperfectknowledgesituations;Socio-economicandfinancialevaluationofagroforestryprojects.

Course Outcomes (CO)

- SAF-604- CO-1Remembering productivitypotentialinrelationtolight,waterandnutrients.
- SAF-604- CO-2 Understanding concept of re-allocation of resources withintheplantsystem.
- SAF-604- CO-3 Applying plantgeometryandcropyield.
- SAF-604- CO-4 Analyzing, Strategies to improve the efficiency and productivity of different land use systems.

- SAF-604- CO-5 Evaluation of various competitive agro- based systems.
- SAF-604- CO-6Creatingsustainabilityandmanagement techniques for different agroforestry system

Suggested readings:

- AlavalapatiJRRandDEvanMercer.2004.ValuingAgroforestrySystems:Methodsandapplications,KluwerAcademicPublishers.
- KantShashiandJanakiAlavalapati.2014.HandbookofForestResourceEconomics,Publisher:Routledge.
- NairPKR,RaiMRandBuckLE.2004.NewVistasinAgroforestry.Kluwer.NairPKR.1993.AnIntroductionto Agroforestry.Kluwer.
- OngCKandHuxleyPK.1996.TreeCropInteractions–APhysiologicalApproach. ICRAF.Sullivan,GregoryM,SusanMHokeandJeffersonMFox (editors).1992.FinancialandEconomic
- AnalysesofAgroforestrySystems.ProceedingsofaworkshopheldinHonolulu.Hawaii.USA.July1991.Paia,Ill:NitrogenFixingTreeAssociation.
- TejwaniKG1994.AgroforestryinIndiaOxfordandIBHpublishingCo.Pvt.Ltd.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	1	2	1	2	2	1	1	1	1	1	1
CO-2	1	1	2	2	1	1	1	1	1	1	1
CO-3	1	2	1	2	3	1	1	1	1	2	1
CO-4	1	1	1	2	2	1	1	1	1	1	1
CO-5	1	2	2	2	2	1	1	1	1	2	1
CO-6	1	1	1	2	2	1	1	1	1	1	1
Average	1.0	1.5	1.3	2.0	2.0	1.0	1.0	1.0	1.0	1.3	1.0

urse de	Course Title	Periods per week			Evaluation Scheme					C (T Pra
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
F-04	ProductivityandEvaluationofAgroforestrySystems	2	0	2	30	5	15	50	100	3

Pogramme Name	Ph.D.(Forestry) Silviculture and Agroforestry	Programme Code
Course Code	SAF 605	Credit
Year/Sem	Year 1; Semester I/II	L-T-P
Course name	ForestStandManagementTechniques (Elective Course)	
Course Objectives:		

1. To develop understanding of students about advances in silviculture.
2. To Understand and silvicultural practice, effect of silvicultural practices on forest stand management.
3. To apply new Technique for stand development.
4. To analyse, advances in coppice silviculture.
5. To Evaluate status of silviculture in India and abroad.
6. To create problem solving procedure for silviculture.

UNITS I (Total Topics- 6 and Hrs- 8)

Philosophy of silviculture – advance reproduction methods and their role in silviculture – Judging succe of active and passive site preparation – Silviculture with an ecosystem approach. Advances in silvicult sub-tropical forest and temperate forest.

UNIT II (Total Topics -8 and Hrs-8)

Analysis of different techniques of silviculture in forest stand management, Technique for early sta thinning methods and its impact on wood yield and quality; Stand protection and health management. S fire. Mechanization and role in silviculture.

UNIT- III (Total Topics -8 and Hrs-6)

Advance silviculture techniques for plantation forestry; Case studies of advance silviculture in India a forestry, Precision silviculture, silviculture of intensively managed plantations, silviculture for climat silviculture. Silviculture management for watershed and catchment areas. Silviculture for wildlife habitat

UnitIV

Adjusting silviculture to meet industrial demands – silviculture in perspective – Problem solving silviculture in retrospect

Practical

Study of components of silvicultural system for sustained yield;Management strategies for ev stands;Choiceofsitepreparationmethods,Plantationmap,Qualityplantingstock,Planningfortreeplanting,Rele of thinning methods, Intensity of thinning;Analysis of site quality and biomass production for timbe species;Problems in silviculture in tropical, subtropical plantation and their solutions.

Course Outcomes (CO)

- SAF -605-CO-1 Remembering reproduction methods and their role in silviculture.SAF-605-CO-2 Understandin of resources withintheplantsystem.
- SAF-605- CO-3 Applying plantgeometryandcropyield.
- SAF-605-CO-4 Analyzing, Analysis of active and passive sitepreparation–Silviculturewithanecosystemapproach
- SAF-605-CO-5 Evaluation of various competitive agro-based systems.
- SAF-605-CO-6 Creating sustainabilityandmanagement techniques for different agro -forestry system.

Suggested readings:

- Brang P, Spathelf P, Larsen JB, Bauhus J, Bonèina A and Chauvin C. 2014. Suitability of Close-To-Nature Silv European Forests to Climate Change. Forestry.
- Colak AH, Rotherham ID and Calikoglu M. 2003. Combining 'Naturalness Concepts' with Close- to-Nature Silvi 421–431.
- Cole DN and Yung L. (eds) 2010. Beyond Naturalness: Rethinking Park and Wilderness Stewardship in an Era of Ra
- Daniel TW, Helms JA and Baker FS. 1979. Principles of Silviculture, 2nd edition, McGraw-Hill,2nd ed.
- Fettig CJ, Reid ML, Bentz BJ, Sevanto S, Spittlehouse DL and Wang T. 2013. Changing climates, changing fo perspective.
- Franklin JF. 1989. Towards a New Forestry. Am. For.
- Holm-Nielsen LB, Nielsen IC and Balsev H. (eds.) 1989. Tropical Forests, Academic Press, London.
- Pukkala T and Gadow KV. 2012. Continuous Cover Forestry. 2nd Edition Springer.
- Sairll PS, Evans J, Auclair D and Flack J. 1997. Plantation Silviculture in Europe. Oxford University Press.
- Smith DM, Larson BC, Ketty MJ and Ashton PMS. 1997. The Practices of Silviculture: Applied Forest Ecology. Joh

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	3	3	2	1	1	1	1	-	1	1	1
CO-2	3	2	1	1	1	1	1	-	-	1	1
CO-3	3	2	1	1	2	1	1	-	1	1	1
CO-4	3	2	2	1	1	2	1	1	-	1	2
CO-5	3	2	2	1	1	-	1	-	1	1	1
CO-6	3	2	2	1	1	1	1	1	-	1	1
Average	3.0	2.2	1.7	1.0	1.2	1.2	1	1.0	1.0	1.0	1.2

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
SAF-605	Forest Stand Management Techniques	1	0	2	30	5	15	50	100	2(1+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-

Course Code	SAF 606	Credit	2(2+0)
Year/Sem	Year 1; Semester I/II	L-T-P	2-0-0
Course name	Agroforestry for Ecosystem Services andEnvironmental Benefits(Elective Course)		

Course Objectives:

- To develop understanding of students about ecosystem services.
- To understand environmental benefits and quantification of ecosystem services.
- To apply soil enrichment – mechanisms – litter and fine root dynamics.
- To analyze Agroforestry for biodiversity conservation.
- To evaluate carbon sequestration potential – measurement – prospects and problems of Agroforestry.
- To create Landscape connectivity for wildlife, supporting the pollinators of plant species.

UNITS I (Total Topics- 6 and Hrs- 8)
Multifunctionality of agroforestry. Major ecosystem services and environmental benefits and international conventions and charters on climate change (UNFCCC, UNCCD, agroforestry and climate change negotiations: CoP) and biodiversity conservation (CBD) – an overview.

UNIT II (Total Topics -8 and Hrs-8)
Agroforestry for carbon conservation, sequestration, substitution – role and potentials of various agroforestry systems. Estimates of carbon sequestration potential – measurement – prospects and problems. Factors affecting above and belowground carbon sequestration potential

UNIT- III (Total Topics -8 and Hrs-6)
Agroforestry for soil enrichment – mechanisms – litter and fine root dynamics, rhizo-deposition and other rhizosphere effects, symbiotic and free-living N_2 fixation, mycorrhizal associations. Soil and water conservation benefits.
Agroforestry for biodiversity conservation. Synergy with climate change mitigation. Landscape connectivity for wildlife, supporting the pollinators of plant species. Agroforestry for improved air and water quality. Non-point source pollution in Indian agro-ecosystems. Riparian buffers for alleviating agricultural non-point source pollution.

UnitIV
Private profitability vs. social profitability – exclusion or inclusion of social benefits and costs and non-market values, or externalities. Theory of externalities, effect of environmental costs and benefits on the profitability of agroforestry practices. Valuing environmental services. Profitability of timber-based agroforestry systems. Costs and benefits in agroforestry- valuation of inputs and outputs- environmental outputs.

Course Outcomes (CO)

- SAF-606- CO-1: Remembering Multifunctionalityofagroforestry.
- SAF-606-CO-2: Understanding concept of Agroforestry for carbon conservation, sequestration, substitution – role and potentialsofvariousagroforestrysystems
- SAF-606-CO-3: Applying mechanismsof soil enrichment-litterandfinerootdynamics,rhizo-deposition and other rhizosphere
- SAF-606-CO-4: Analyzing, Non-pointsourcepollutioninIndian agro-ecosystems
- SAF-606-CO-5: Evaluation of various Riparian buffers for alleviating agricultural non-point sourcepollution.
- SAF -606-CO-6: Valuing environmental services. Profitability of timber-based agroforestry systems.

Suggested readings:

- Alavalapati JRR, Shrestha RK, Stainback GA and Matta JR. 2004. Agroforestry development: An environmental Economic Perspective. Agroforestry Systems. 61: 299–310.
- IPCC. 2007. ‘‘Climate Change 2007’’. Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
- Jain SK and Singh P. 2000. Economic Analysis of Industrial Agroforestry: Poplar (Populus deltoides) In Uttar Pradesh (India). Agroforestry Systems. 49: 255–273.
- 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. 76: 1-10.
- Lyngbaek AE, Muschler RG and Sinclair FL. 2001. Productivity and Profitability of Multistrata Organic Versus Conventional Coffee Farms in Costa Rica. Agroforest. Syst. 53: 205–213.
- 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, Wallingofrd, UK.Edition Springer.
- Sairll PS, Evans J, Auclair D and Flack J. 1997. Plantation Silviculture in Europe. Oxford University Press.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	3	3	2	1	1	1	-	1	1	1	-
CO-2	3	2	1	1	1	1	-	-	1	1	1
CO-3	3	2	1	1	2	1	-	1	1	1	-
CO-4	3	2	2	1	1	1	1	-	1	2	2
CO-5	3	2	2	1	1	1	-	1	1	1	-
CO-6	3	2	2	1	1	1	1	-	1	1	1
Average	3.0	2.2	1.7	1.0	1.2	1	1.0	1.0	1.0	1.2	1.3

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
SAF-606	Agroforestry forEcosystem Services and Environmental Benefits	2	0	0	40	10	-	50	100	2(2+0)

Programme Name	Ph.D.(Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	SAF 607	Credit	2(1+1)
Year/Sem	Year 1; Semester I/II	L-T-P	1-0-2
Course name	PlantationForestProductivity (Elective Course)		

Course Objectives:

- To develop understanding of students about plantation forest productivity.
- To understand dynamics of plantation growth.
- To apply the various tending operation, thinning and fertilization of plantation.
- To analyse the effect of silvicultural interventions.
- To evaluate productivity decline in plantation forests second rotation, decline harvest related.
- To create clonal forests, their management and productivity comparisons.

UNITS I (Total Topics- 6 and Hrs- 8)

Plantation forests – scope and perspectives, international and national scenario.Dynamics of plantation growth – site quality, stand density, dynamics of nutrient cycling, thinning, spacing and crown efficiency, nutrient pools and dynamics, biological factors in nutrient supply.

UNIT II (Total Topics -8 and Hrs-8)

Advances in site preparation techniques. Recent trends in fertilization and irrigation of plantations. Tending and cultural operations and plantation productivity – prospects of mechanization in tropical plantations. Reduced impact logging. Clonal forests, their management and productivity comparisons.

UNIT- III (Total Topics -8 and Hrs-6)

Productivity decline in plantation forests – second rotation decline – harvest related resource export – Modern silvicultural interventions.Project formulation, designing and appraisal of different kinds of plantations to meet specific objectives.

Practical

Plantation productivity analysis – growing stock and MAI assessment – stand density estimation;Fertilizers and fertilizer application in plantation;Response of plantation to irrigation;Productivity of clonal forestry;Modern tools in site preparation;Weed management methods;Management strategies for enhancing plantation productivity.

Course Outcomes (CO)

- SAF-607- CO-1 Remembering dynamics of plantation growth, thinning and fertilization of plantation.
- SAF-607- CO-2 Understanding conceptsitequality,standdensity,dynamicsofnutrientcycling,thinning,spacingandcrownefficiency ,
- SAF-607- CO-3 Applying Recenttrendsinfertilizationandirrigationofplantations.
- SAF-607- CO-4 Analyzing, impact logging. Clonal forests, their management and productivity comparisons.
- SAF-607- CO-5 Evaluation of harvest related resource export and modern silvicultural interventions.
- SAF-607- CO-Project formulation, designing and appraisal of different kinds of plantations to

meet specific objectives.

Suggested readings:

- Evans J. 1982. Plantation Forestry in the Tropics. Clarendon Press. Ford ED. 1984. Nutrition of Plantation Forests. Academic Press.
- Krishnapillay B. 2000. Silviculture and Management of teak plantations. Unasy. 201. 51:14-21p.
- Nambiar EKS, Cossalter C and Tiarks A. 1998. Site Management and Productivity in Tropical Plantation Forests. Workshop Proceedings, South Africa.
- Sairll PS, Evans J, Auclair D and Flack J. 1997. Plantation Silviculture in Europe. Oxford University Press.
- Smith DM. 1980. The Practice of Silviculture. 8th ed., John Wiley & Sons.
- Suzuki K, Ishii K, Sakurai S and Sasaki S. 2006. Plantation Forestry in the Tropics. Springer Tokyo.
- Zobel BJ, Wyk G and Stahlper P. 1987. Growing Exotic Forests. John Wiley & Sons.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	3	2	2	-	2	1	1	-	1	3	2
CO-2	3	2	2	-	1	1	1	-	1	2	2
CO-3	3	1	2	1	1	-	-	-	-	1	1
CO-4	2	1	2	2	2	1	-	1	-	1	1
CO-5	1	1	-	-	-	1	1	-	-	-	1
CO-6	1	-	-	-	1	-	1	1	1	-	-
Average	2.2	1.4	2.0	1.5	1.4	1.0	1.0	1.0	1.0	1.8	1.4

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
SAF-607	PlantationForestProductivity	2	0	0	30	5	-	50	100	2(1+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	SAF 608	Credit	1(1+0)
Year/Sem	Year 1; Semester I/II	L-T-P	1-0-0
Course name	Restoration Forestry(Elective Course)		

Course Objectives:

- To develop understanding of students about advances in restoration forestry and forest landscape restoration
- To understand Forest restoration techniques, tools for prioritization
- To apply the various methods of natural regeneration,
- To Analyse adaptive management for forested landscapes in transformation
- To evaluate resilient and genetically diverse forests..
- To create mangrove restoration .

UNITS I (Total Topics- 6 and Hrs- 8)

Introduction to restoration forestry, scope and opportunities for forest restoration, Natural regeneration, forest and land degradation in the Asia-Pacific region. Forest restoration techniques, tools for prioritization, decision-making and monitoring to enhance restoration success, The Bonn Challenge, The Bonn Challenge in Asia, Africa and Latin America.

UNIT II (Total Topics -8 and Hrs-8)

Forest landscape restoration, environment for natural regeneration in forest and landscape restoration, economic and social aspects for successful integration of natural regeneration in forest landscape restoration, adaptive management for forested landscapes in transformation, measures to improve resilient and genetically diverse forests.

UNIT- III (Total Topics -8 and Hrs-6)

Mangrove restoration. Case studies on successful forest landscape restoration.

Course Outcomes (CO)

- SAF-608-CO-1 Remembering restoration forestry, scope and opportunities for forest restoration
- SAF-608-CO-2 Understanding forest and land degradation in the Asia-Pacific region ,
- SAF-608-CO-3 Applying Forest restoration techniques, tools for prioritization
- SAF-608-CO-4 Analyzing economic and social aspects for successful integration of natural regeneration in forest landscape restoration
- SAF-608-CO-5 Evaluation of improve resilient and genetically diverse forests.
- SAF-608-CO-6Case studies on successful forest landscape restoration objectives.

Suggested readings:

- Beatty CR, Cox NA and Kuzee ME. 2018. Biodiversity Guidelines for Forest Landscape Restoration Opportunities Assessments. First edition. Gland, Switzerland: IUCN.
- Blakesley D and Buckley P. 2016. Grassland Management and Restoration. Conservation handbooks. Pelagic Publishing. Food and Agriculture Organization of the United Nations. Chokkalingam U, Shono K, Sarigumba MP, Durst PB and Leslie R. (eds). 2018. Advancing the Role of Natural Regeneration in Large-Scale Forest and Landscape Restoration in the

- Asia-Pacific Region. FAO and APFNet. Bangkok.
- FAO. 2010. Forests Beneath the Grass. Proceedings of the Regional Workshop on Advancing The Application of Assisted Natural Regeneration for Effective Low-Cost Forest Restoration. Bangkok, FAO.
- FAO/ RECOFTC. 2016. Forest Landscape Restoration in Asia-Pacific Forests. by Appanah, S. (ed.). Bangkok, Thailand.198p
- Prober SM, Byrne M, McLean EH, Steane DA, Potts BM, Vaillancourt RE and Stock WD. 2015. Climate-Adjusted Provenancing: A Strategy for Climate-Resilient Ecological Restoration. Frontiers in Ecology and Evolution, 23 June.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	3	2	2	1	2	1	1	2	1	1	2
CO-2	2	1	2	1	1	2	2	2	1	1	3
CO-3	2	2	3	1	2	2	3	1	2	2	1
CO-4	2	3	3	2	1	1	1	1	2	1	1
CO-5	2	1	1	1	2	1	2	1	3	2	1
CO-6	1	1	2	1	1	-	1	2	1	1	2
Average	2.0	1.6	2.1	1.1	1.3	1.3	1.6	1.4	1.6	1.3	1.6

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
SAF-608	RestorationForestry	1	0	0	40	10	-	50	100	1(1+0)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	SAF 609	Credit	3(2+1)
Year/Sem	Year 1; Semester I/II	L-T-P	2-0-2
Course name	Regeneration Silviculture(Elective Course)		

Course Objectives:

- To develop understanding of students understanding of students about advances in regeneration silviculture
- To understand forest continuum
- To apply advancement in artificial regeneration.
- To AnalysePlant quality assessment tools. Nursery production system of important timber and Non-Timber Forest Products,
- To evaluate regeneration problems of important conifers and broad leaved species-case studies.
- To create quality planting stock.

UNITS I (Total Topics- 6 and Hrs- 8)

Planning for regeneration, setting the objectives for regeneration, principles and methodologies of forest regeneration, ecological basis of natural regeneration techniques
Basic Concepts in forest regeneration, importance of different combinations of light, moisture, soil in determining success or failure of regeneration. Factors affecting natural and artificial regeneration- kinds, extent and quality of sites.

UNIT II (Total Topics -8 and Hrs-8)

Techniques of canopy manipulation and forest continuum in regular and irregular forests canopy, light pattern and regeneration establishment. Regeneration survey and methodology. Major silvicultural systems of tropical and temperate parts of the world. Continuous cover forestry. Advances in coppice silviculture. Silviculture in a changing

UNIT- III (Total Topics -8 and Hrs-6)

Advances in artificial regeneration techniques, advances in vegetative propagation techniques like mini and micro-cutting techniques, production technology for quality planting stock, carbon enrichment techniques for production of quality planting stock. Integrated nutrient management in nursery production. Plant quality assessment tools. Nursery production system of important timber and Non-Timber Forest Products, NTFP's yielding species in the region.

UNIT- IV (Total Topics -8 and Hrs-6)

Sustainable site establishment practices, Novel tree establishment techniques. Regeneration problems of important conifers and broad leaved species-case studies.

Practical

Factors affecting natural and artificial regeneration;Advances in vegetative propagation techniques like mini and micro-cutting techniques;Production technology for quality planting stock;Carbon enrichment techniques for production of quality planting stock;Integrated nutrient management in nursery production;Novel tree establishment techniques. Modern approaches in containerized seedling production.

Course Outcomes (CO)

- SAF-609- CO-1 Remembering principles and methodologies of forest regeneration.

- SA-609- CO-2 Understanding methodologiesofforestregeneration.
- SAF-609- CO-3 Applying the Techniques of canopy manipulation and forest continuum in regular and irregularforests canopy.
- SAF-609- CO-4 AnalyzingMajorsilviculturalsystemsoftropicalandtemperatepartsofthe world.
- SAF-609- CO-5 Evaluation of NTFP'syieldingspeciesintheregion.
- SAF-609- CO- Creating Sustainable site establishment practices.

Suggested readings:

- Colak AH, Rotherham ID and Calikoglu M. 2003. *Combining 'naturalness concepts' with close- to-nature silviculture*. Forstwiss. Centralbl. 122, 421–431.
- Sairll PS, Evans J, Auclair D and Flack J. 1997. *Plantation Silviculture in Europe*. Oxford University Press.
- Smith DM, Larson BC, Ketty MJ and Ashton PMS. 1997. *The Practices of Silviculture*: Applied Forest Ecology. John Wiley & Sons.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	3	1	2	1	1	1	1	1	1	1	1
CO-2	2	2	1	2	1	1	-	1	1	-	
CO-3	2	2	2	1	-	-	1	1	1	1	1
CO-4	1	2	1	1	2	1	-	1	1	1	-
CO-5	-	1	-	-	2	-	-	1	1	3	1
CO-6	1	1	1	1	1	1	1	1	1	1	1
Average	1.8	1.5	1.4	1.2	1.4	1.0	1.0	1.0	1.0	1.4	1.0

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
SAF-609	RegenerationSilviculture	2	0	2	30	5	-	50	100	3(2+1)

Programme Name	Ph.D. Forestry(Silviculture and Agroforestry)	Programme Code	23-
Course Code	SAF 610	Credit	2(1+1)
Year/Sem	Year 1; Semester I/II	L-T-P	1-0-2
Course name	ForestSoilManagement (Elective Course)		

Course Objectives:

1. To develop understanding of students about advances in forest soil management.
2. To understand forest soils and vegetation management.
3. To apply techniques for management of long-term soil productivity.
4. To Analyse Soil organic matter.
5. To evaluate Nitrogen fixation in tropical forest plantations: N_2 fixation process, species, rates of N_2 fixation.
6. To create managementstrategies for future management.

UNITS I (Total Topics- 6 and Hrs- 8)

Forest soils and vegetation development. Physical properties of forest soils. Forest soil classification. Soils of the major forest biomes – soils under different forest types – tropical rainforest soils – moist deciduous forests – dry deciduous. Soils and plant roots.

UNIT II (Total Topics -8 and Hrs-8)

Soil chemistry and nutrient uptake. Soil organic matter – maintenance and buildup. Biology of forest soils – role of microorganisms in ameliorating soils; N and C cycles. Forest biogeochemistry. Mycorrhizae. Role of forests in conserving soils.

UNIT- III (Total Topics -8 and Hrs-6)

Nutrient transformation in soils. Nitrogen fixation in tropical forest plantations: N_2 fixation process, species, rates of N_2 fixation, factors influencing N_2 fixation; nutrient cycling – comparison of plantation productivity – case studies. Nutrition management: nutrient limitations, fertilization. Soil carbon sequestration – processes and mechanisms.

UNIT- IV (Total Topics -8 and Hrs-6)

Soil management for reforestation of salt affected soils, acid soils, coastal soils. Effects of fire on soils and their properties.Management of long term soil productivity – soil compaction and erosion – harvest removal and nutrient budgeting – harvest effect on water quality – strategies for future management.

Practical

Nutrient budgeting for different plantation systems;Quantification of physical and chemical soil constraints in plantation and agroforestry systems;Evolving new strategies for soil and site development.

Course Outcomes (CO)

- SAF-610- CO-1 Remembering physical properties of forest soils. Forestsoil classification. Soils of the major forest biomes.
- SAF-610- CO-2 Understanding the roleofforestsinconservingsoils.
- SAF-610- CO-3 Applying theTechniques of soil management.
- SAF-610- CO-4 Analyzingnutrient status in forest soil of different biomes.
- SAF-610- CO-5 Evaluation of N_2 fixation, factors influencing N_2 fixation.
- SAF-610- CO-6Reforestation of salt affected soils, acid soils, coastal soils.

Suggested readings:

- Binkley D and R. Fisher. 2012. Ecology and Management of Forest Soils (4th Edition), John
- Wiley & Sons Singapore Pte. Ltd., Singapore.
- Fisher RF, Binkley D and Pritchett WL. 2000. Ecology and Management of Forest Soils. 3rd Ed.John Wiley & Sons Inc., New York.
- Havlin et al. 2014. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (8th
- Edition), PHI Learning Pvt. Ltd., Delhi.
- Khan TO. 2013 Forest Soils: Properties and Management, Springer International Publishing, Switzerland.
- Pritchett and Fisher RF 1987. Properties and Management of Forest Soils. John Wiley, New York.
- Reddy MV. 2001. Management of Tropical Plantation Forests and Their Soil Litter System-Litter, Biota and Soil Nutrient Dynamics. Science Publishers, U.S.
- Sadanandan Nambiar EK and Grown AG. (Eds.). 1997. Management of Soil, Nutrients and Water in Tropical Plantation Forests. ACIAR, CSIR and CIFOR, Australia.
- Schulte A and Ruhiyat D. 1998. Soils of Tropical Forest Ecosystems: Characteristics, Ecology, and Management. Springer Verlag,Berlin, New York.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	3	2	-	-	2	1	-	-	1	1	1
CO-2	3	2	2	2	1	1	2	2	2	2	1
CO-3	1	1	1	1	2	-	-	-		1	
CO-4	2	2	1	1	2	1	-	-	-	1	-
CO-5	1	1	-	-	1	1	-	-	1	1	-
CO-6	3	2	2	-	1	1	2	2	2	2	1
Average	2.2	1.7	1.5	1.3	1.5	1.0	2.0	2.0	1.5	1.3	1.0

Course Code	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit (Theory + Practical)**
					Internal Exam			**External Theory Exam**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Exam**	**Assignment**	**Practical**			
SAF-610	ForestSoilManagement	1	0	2	30	5	-	50	100	2(1+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	SAF 611	Credit	1(2+1)
Year/Sem	Year 1; Semester I/II	L-T-P	2-0-2
Course name	Agroforestry For Sustainable Agriculture (Elective Course)		

Course Objectives:

1. To develop understandingof sustainable agriculture.
2. To understand land use changes- through agroforestry.
3. To apply Strategies on integration of trees suitable for different cropping systems for important agro-ecological regions.
4. To analyse tree management for productivity optimization.
5. To evaluate Agroforestry for different land holdings.
6. To create opportunities for value addition and marketing of agroforestry products.

UNITS I (Total Topics- 6 and Hrs- 8)

Current Agricultural scenario in India. Sustainable agriculture: issues and challenges. Land use changes- agroforestry: an opportunity for sustainability and rainfed agriculture.

UNIT II (Total Topics -8 and Hrs-8)

Agroforestry options for sustainable agriculture: integration of perennial components in agriculture. Role of trees in enhancing the productivity of traditional agriculture. Strategies on integration of trees suitable for different cropping systems for important agro-ecological regions. Tree management for productivity optimization.

UNIT- III (Total Topics -8 and Hrs-6)

Agroforestry for different land holdings. Integrated farming systems. Agroforestry strategies for short term and long term returns.

UNIT- IV (Total Topics -8 and Hrs-6)

Processing, value addition and marketing of agroforestry products.

Suggested readings:

- Chin K Ong, Colin Black and Julia Wilson. 2015. Tree-Crop Interactions, 2nd Edition: Agroforestry in a Changing Climate. CAB International ICRAF.
- Nair PKR, Rai MR and Buck LE. 2004. New Vistas in Agroforestry. Kluwer. Nair PKR. 1993. An Introduction to Agroforestry. Kluwer, Netherlands.
- Ong CK and Huxley PK. 1996. Tree Crop Interactions – A Physiological Approach.
- Schroth G and Sinclair F. 2003. Tree Crops and Soil Fertility: Concepts and Research Methods.
- CABI, Wallingford, UK.
- Snelder DJ and Lasco RD. 2008. Smallholder Tree Growing for Rural Development and Environmental Services. Springer Science, Amsterdam.

Course Outcomes (CO)

- SAF-611- CO-1 Remembering the Agroforestry strategies for short term and long term returns.
- SAF-611- CO-2 Understanding role of agroforestry in sustainableagriculture,
- SAF-611- CO-3 Integrating the trees in Agroforestry
- SAF-611- CO-4 Analyzingcomponents in agriculture.

- SAF-611- CO-5 Strategies for short term and long term returns.
- SAF-611- CO-6 Treemanagementforproductivityoptimization.

Suggested Readings:

- Alavalapati JRR, Shrestha RK, Stainback GA and Matta JR. 2004. Agroforestry development: An environmental Economic Perspective. Agroforestry Systems. **61**: 299–310.
- IPCC. 2007. ‘‘Climate Change 2007’’. Mitigation of Climate Change. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
- Jain SK and Singh P. 2000. Economic Analysis of Industrial Agroforestry: Poplar (Populus deltoides) In Uttar Pradesh (India). Agroforestry Systems. **49**: 255–273.
- 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. **76**: 1-10.
- Lyngbaek AE, Muschler RG and Sinclair FL. 2001. Productivity and Profitability of Multistrata Organic Versus Conventional Coffee Farms in Costa Rica. Agroforest. Syst. **53**: 205–213.
- 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, Wallingofrd, UK. Edition Springer.
- Sairll PS, Evans J, Auclair D and Flack J. 1997. Plantation Silviculture in Europe. Oxford University Press.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	3	1.3	-	-	1	-	-	-	-	1	1
CO-2	3	2	-	-	1	-	-	-	-	1	1
CO-3	3	1.3	2	1	1	-	-	-	-	1	1
CO-4	3	1.3	2	1	1	-	-	-	-	1	1
CO-5	3	1.3	-	3	-	-	-	-	-	1	-
CO-6	3	1.3	2	1	1	1	-	-	1	1	1
Average	3.0	1.4	2.0	1.5	1.0	1.0	-	-	1.0	1.0	1.0

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
SAF-610	AgroforestryForSustainableAgriculture	1	0	0	40	10	-	50	100	1(1+0)

Minor Courses (Gradial courses)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	FPU 606	Credit	3(2+1)
Year/Sem	Year 1; Semester I/II	L-T-P	2-0-2
Course name	Processing Technology of Forest Products (Elective Course)		

Course Objectives:

1. To identification of harvesting period based on active content of drugs.
2. To develop understanding Harvesting method of underground parts, leaves, stem, bark
3. To apply Storage and value addition.
4. To analyze Deterioration degradation of active principles during storage and their control
5. To evaluate technological advances in collection of Forest products
6. To create Latest methods of extraction of volatile and fixed oil.

UNITS I (Total Topics- 6 and Hrs- 8)
Identification of harvesting period based on active content of drugs. Harvesting method of underground parts, leaves, stem, bark, wood, fruits, flowers, etc.

UNIT II (Total Topics -8 and Hrs-8)
Processing of harvested crops of various forest products (*e.g.* Gums, Resin, Katha, Cutch, Tans, Dyes and fixed oil). Storage and value addition. Deterioration degradation of active principles during storage and their control.

UNIT- III (Total Topics -8 and Hrs-6)
Isolation of major bioactive compounds. Preparation of active content enriched extracts.

UNIT- IV (Total Topics -8 and Hrs-6)
Latest methods of extraction of volatile and fixed oil.

Practical
Harvesting, drying, grading, and packaging of various forest products; Assessment of deterioration of active principles during storage and their control; Preparation of active content enriched extracts of important forest products.

Course Outcomes (CO)

- FPU-606- CO-1 Remembering harvesting period based on active content of drugs
- FPU-606- CO-2 Understanding Harvesting method of underground parts,
- FPU-606- CO-3 Applying Isolation of major bioactive compounds
- FPU-606- CO-4 AnalyzingMajorsilviculturalsystemsoftropicalandtemperatepartsofthe world.
- FPU- 606- CO-5 Evaluation of degradation of active principles during storage and their control.
- FPU-606- CO-6 Creating latest methods of extraction of volatile and fixed oil.

Suggested readings:

- Bedi S, Singh T and Vyas SP. 2012. A Handbook of Aromatic and Essential Oil Plants: Cultivation, Chemistry, Processing and Uses. Agrobios (India).
- Dawn CPA, Annamalai M and Naik R. 2016. Leafy Medicinal Herbs: Botany, Chemistry, Postharvest Technology and Uses. CABI.
- Serdar O and Milan M. 2014. Medicinal and Aromatic Crops: Harvesting, Drying and Processing. CRC Press.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5	PSO-6
CO-1	3	1.3	-	-	1	1	1	-	3	1	-
CO-2	3	2	-	-	1	1	1	-	3	1	-
CO-3	3	1.3	2	1	1	1	1	-	3	1	-
CO-4	3	1.3	2	1	1	1	1	-	3	1	-
CO-5	3	1.3	-	3	-	1	-	-	3	-	-
CO-6	3	1.3	2	1	1	1	1	1	3	1	1
Average	3.0	1.4	2.0	1.5	1.0	1.0	1.0	1.0	3.0	1.0	1.0

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
FPU 606	**Processing Technology of Forest Products**	1	0	0	30	5	15	50	100	3(2+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	FPU 607	Credit	3(2+1)
Year/Sem	Year 1; Semester I/II	L-T-P	2-0-2
Course name	Value Addition and Marketing of Forest Products (Elective Course)		

Course Objectives:

1. To develop understanding of students for marketing under disorganized and organized sector
2. To understand extraction methods of forest products.
3. To apply Concept of e-market and quality standards.
4. To analyse pharmaceutical concern for understanding value addition processes ,
5. To evaluate high value forest products
6. To create local market and data collection of sale and sale procedure

UNITS I (Total Topics- 6 and Hrs- 8)

Value addition – concepts and procedures. Drying and grading of various forestproducts. Preparation of powders, aqueous and alcoholic extracts essences, etc.Preparation of tablets, mixtures, balms, ointments, etc. Bulk storage and packaging.

UNIT II (Total Topics -8 and Hrs-8)

Basic and advanced concepts of trade and marketing, marketing under disorganized and organized sector. Village and regional markets, state, national and international market of forest products. Internet marketing practices for latest market value and other pattern of fluctuations for high value forest products. Concept of e-market and quality standards.

Practical

Visit to nearby pharmaceutical concern for understanding value addition processes;Visit to local market and data collection of sale and sale procedure – organized and unorganized; Internet surfing for latest market value of high value forest products.

Course Outcomes (CO)

- FPU 607:CO-1 Remembering Value addition – concepts and procedures
- FPU 607-CO-2 Understanding Drying and grading of various forest
- products.
- FPU 607-CO-3 Applying theTechniques Preparation of powders, aqueous and alcoholic extracts essences, etc.
- FPU 607-CO-4 Analyzing Basic and advanced concepts of trade and marketing, marketing under disorganized and organized sector.
- FPU 607-CO-5 Evaluation Preparation of tablets, mixtures, balms, ointments, etc. Bulk storage and packaging.
- FPU 607-CO-6Creating Internet marketing practices for latest market value and other pattern of fluctuations for high value forest products.

Suggested readings:

- Govil JN, Arunachalam C and Singh VK. 2006. *Recent Progress in Medicinal Plants.* Volume11: drug development from molecules. Studium Press LLC.
- Sharma AK and Singh VK, Govil JN and Goyal NK. 2006. *Recent Progress in Medicinal Plants.*
- Volume 12: Globalization Of Herbal Health. Studium Press LLC.
- Singh MP and Somadey. 2015. *Indian Medicinal Plants*. Satish Serial Publishing House. Singh VK, Govil JN and Singh G. 2002. *Ethnomedicine and Pharmacognosy*. Science Technology,
- Publishing LLC.
- Syamal MM. 2008. *Production Technology of Medicinal and Aromatic Plants*. IBDC Publishers.

Articulated Attainment

Cos	PO-1	PO-2	PO-3	PO-4	PO-5	PO-8	PO-9	PSO-1	PSO-2	PSO-3	PSO-4	PO-6	PO-7
CO-1	3	3	2	1	1	-	1	1	1	-	2	1	1
CO-2	3	2	1	1	1	-	-	1	1	1	1	1	1
CO-3	3	2	1	1	2	-	1	1	1	-	1	1	1
CO-4	3	2	2	1	1	1	-	1	2	2	2	2	1
CO-5	3	2	2	1	1	-	1	1	1	-	1	-	1
CO-6	3	2	2	1	1	1	-	1	1	1	1	1	1
Average	3.0	2.2	1.7	1.0	1.2	1.0	1.0	1.0	1.2	1.3	1.3	1.2	1

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
FPU607	Value Addition and Marketing of Forest Products	2	0	2	30	5	15	50	100	3(2+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	FPU 608	Credit	3(2+1)
Year/Sem	Year 1; Semester I/II	L-T-P	2-0-2
Course name	Modern Trends in Wood Modification (Elective Course)		

Course Objectives:

1. To remember Woodpolymerhybridcomposites.
2. To understand Engineeredwoodproducts.
3. To apply testingofbiologicalperformanceofmodifiedwoodproducts.
4. To Analyse Degradation of cellular structure of wood during use.
5. To evaluate Environmentalissues.
6. To create Substation of woodmodification.

UNITS I (Total Topics- 6 and Hrs- 8)
Engineeredwoodproducts.Woodpolymerhybridcomposites.Stabilizationofwoodpreservatives.

UNIT II (Total Topics -8 and Hrs-8)
Testingofbiologicalperformanceofmodifiedwoodproducts.Degradationofcellularstructureofwooddur inguse.

UNIT III (Total Topics -8 and Hrs-8)
Environmentalissuesrelatedtowoodmodification

Practical
Differentpreservativetreatmentsofwood;Chemicalmodificationofwood;Testingofbiologicalperfor manceofmodifiedwood;Treatedwoodfinishing.

Course Outcomes (CO)
FPU 608 CO-1 Remembering wood chemistry and its utilization
FPU 608- CO-2 Understanding Advances in wood working
FPU 608- CO-3 Applying various wood modification in different types of timber
FPU 608- CO-4 Analyzing performanceofmodifiedwood
FPU 608- CO-5 Evaluation of Treatedwoodfinishing.
FPU 608- CO- 6. Creating Sustainable site establishment practices

Suggested readings:

- Ansell MP. 2015. Wood Composites. Elsevier-Science-Technology.
- FAO. 2007. Wood Preservation Manual. International Book Distributor, Dehradun.
- Hill CAS. 2006. Wood Modification: Chemical, Thermal and Other Processes. John Wiley and Sons Ltd.
- Pizzi A and Mittal KL. 2011. Wood Adhesives. CRC Press.
- Rowell RM. 2013. Handbook of Wood Chemistry and Wood Composites. 2nd Ed. CRC Press. USDA. 1999. Wood Handbook – Wood as an Engineered Material. US Department of Agriculture,
- Forest Service. Forest Products Laboratory, Madison.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	-	-	2	-	1	-	3	-	2	-
CO-2	1	1	1	1	1	1	3	-	3	-	3
CO-3	-	1	3	2	3	3	2	2	-	3	2
CO-4	-	-	2	-	3	2	2	-	2	-	2
CO-5	2	2	1	2	2	2	1	2	1	2	1
CO-6	2	2	1	3	1	3	1	1	1	1	1
Average	1.0	1.0	1.3	1.3	1.3	2.0	1.3	1.3	1.1	1.3	1.3

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
FPU 608	Modern Trends in Wood Modification	2	0	2	30	5	15	50	100	3(2+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	FPU 609	Credit	2(2+0)
Year/Sem	Year 1; Semester I/II	L-T-P	2-0-0
Course name	Development in Pulp and Paper Technology (Elective Course)		

Course Objectives:

1. To understand the development of the pulp and paper industry
2. To understand Chemistry of fibrous raw material – raw material preparation.
3. To apply advances in pulping processes for softwood, hardwoods and other fibrous material
4. To analysethe Bio-pulping,
5. To evaluate chlorine free bleaching, organo solve pulping.
6. To create quality paper

UNITS I (Total Topics- 6 and Hrs- 8)

Historical development of the pulp and paper industry. Chemistry of fibrous raw material – raw material preparation.

UNIT II (Total Topics -8 and Hrs-8)

Advances in pulping processes for softwood, hardwoods, and other fibrous material. Recent trends in Bio-pulping, Chorine free bleaching, organo solve pulping.

UNIT III (Total Topics -8 and Hrs-8)

Nanotechnology in pulp and paper making. Substation of wood with recycled fibers.

UNIT IV (Total Topics -8 and Hrs-8)

Reduction in water utilization and effluent discharge.

Course Outcomes (CO)

- FPU 609-CO-1 Remembering Historical development of the pulp and paper industry
- FPU 609-CO-2 Understanding Advances in pulping processes for softwood
- FPU 609-CO-3 Applying theTechniques Chemistry of fibrous raw material – raw material preparation.
- FPU 609-CO-4 AnalyzingMajorsilviculturalsystemsoftropicalandtemperatepartsofthe world.
- FPU 609-CO-5 Evaluation Chemistry of fibrous raw material – raw material preparation.
- FPU 609-CO-6 Make quality paper by using Nanotechnology.

Suggested readings:

Rowell RM. 2013. *Handbook of Wood Chemistry and Wood Composites*. 2nd Ed. CRC Press.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	POS-6	PSO-7
CO-1	3	3	2	1	1	1	1	-	2	1	1
CO-2	3	2	1	1	1	1	1	1	1	1	1
CO-3	3	2	1	1	2	1	1	-	1	1	1
CO-4	3	2	2	1	1	1	2	2	2	2	1
CO-5	3	2	2	1	1	1	1	-	1	-	1
CO-6	3	2	2	1	1	1	1	1	1	1	1
Average	3.0	2.2	1.7	1.0	1.2	1.0	1.2	1.3	1.3	1.2	1

Course Code	Course Title	Periods per week			Evaluation Scheme					Credit (Theory + Practical)
					Internal Exam			External Theory Exam	Subject Total	
		L	T	P	Midterm Theory Exam	Assignment	Practical			
FPU 609	**Development in Pulp and Paper Technology**	2	0	0	40	10	-	50	100	2(2+0)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	FPU 610	Credit	2(2+0)
Year/Sem	Year 1; Semester I/II	L-T-P	2-0-0
Course name	Application of Traditional Knowledge (Elective Course)		

Course Objectives:

1. To develop understanding traditional remedies for treating specific diseases
2. To understand difference between traditional therapies *vis-a-vis* modern therapies.
3. To apply scientific validation of traditional systems of medicines.
4. To analyseintegration of herbal remedies with allopathic system of medicine,
5. To evaluate allopathic drugs based on medicines herbs.
6. To develop ITK for different agroforestry systems.

UNIT I (Total Topics- 6 and Hrs- 8)

Traditional remedies for treating specific diseases like cardiovascular disease, mental disorders, rheumatic arthritis, diabetes, cough and asthma, fatigue, liver diseases, kidney and bladder stones, wounds stomach disorders, etc. Traditional therapies *vis-a-vis* modern therapies.

UNIT II (Total Topics -8 and Hrs-8)

Scientific validation of traditional systems of medicines/ remedies – case studies. Important herbs used in traditional medicines. Integration of herbal remedies with allopathic system of medicine. Allopathic drugs based on medicines herbs.

UNIT III (Total Topics -8 and Hrs-8)

National and international research and other institutions involved in scientific validation of traditional knowledge e.g., CDRI, CIMAP, RRL's, CCRAS, WHO, etc., their role and major achievements.

UNIT IV (Total Topics -8 and Hrs-8)

Composition of major herbal formulations e.g. Chavanprash, Vasavaleha, Arjunarishta, Pachakchurna, etc. Major herbal pharmaceutical companies and their products like Dabur, Zandhu, Baidyanath, Himalayan Drug Company, Charak Pharmaceuticals, etc. Role of local health traditions in primary health care.

Course Outcomes (CO)

- FPU 610- CO-1. Developing understanding Traditional remedies for treating specific diseases
- FPU 610- CO-2 Understanding difference between traditional therapies *vis-a-vis* modern therapies.
- FPU 610- CO-3 Apply scientific validation of traditional systems of medicines.
- FPU 610- CO-4 Analyzing ITK for different agroforestry systemofthe world.
- FPU 610- CO-5 Evaluation of different Advance and Traditional therapies
- FPU 610- CO-6 creation of Pharmaceuticals, etc. for well being of human and plants

Suggested readings:

- Alikhan I and Khanum A. 2008. Role of Biotechnology in Medicinal and Aromatic Plants. UKAZ Publishers.
- Chadha KL and Gupta R. 2006. Advances in Horticulture. Vol. XI. Medicinal and aromatic plants. Malhotra Publ. House.
- Gupta AK and Sharma M. 2008. Reviews on Indian Medicinal Plants. ICMR.
- Johnson CB and Franz C. 2005. Breeding Research on Aromatic and Medicinal Plants.
- International Book Distr.
- Sharma R. 2004. Agrotechniques of Medicinal Plants. Daya Publ.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5
CO-1	1	-	-	2	-	1	-	3	-	2	2
CO-2	1	1	1	1	1	1	3	-	3	-	-
CO-3	-	1	3	2	3	3	2	2	-	3	3
CO-4	-	-	2	-	3	2	2	-	2	-	-
CO-5	2	2	1	2	2	2	1	2	1	2	2
CO-6	2	2	1	3	1	3	1	1	1	1	1
Average	1.0	1.0	1.3	1.3	1.3	2.0	1.3	1.3	1.1	1.3	1.3

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
FPU 610	Application of traditional Knowledge	2	0	0	40	10	-	50	100	2(2+0)

Supporting courses (Compulsory for all students) (Gradial courses)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	RM-101	Credit	4(4+0)
Year/Sem	Year 1; Semester - II	L-T-P	4-0-0
Course Name	Research Methodology in Forestry		

Course Objectives:

1. To Equip the Students with the Concept and Methodology of Research.
2. To provide knowledge about type of research, preparation of reports and thesis, designing of Research using Scientific Methods.
3. To develop the ability to apply principles and procedure for data analysis and interpretation of results.
4. To analyze various sampling methods and probability of research analysis.
5. To evaluate interpretations and significance of report writing.
6. To develop the ability to create appropriate hypothesis, select experimental design and presentation of results after analysis of data.

UNIT I (Total Topics- 7 and Hrs-12)

Introduction to Research: Definition, Nature and significance, Role and Objectives; Types of Research: exploratory, descriptive, experimental and diagnostic research, social and legal research and traditional, analytical, empirical & fundamental research, Doctrinal and non-doctrinal research methods; Various Research Designs; Scientific Research Process: Overview, Problem identification and formulation of research statement.

UNIT II(Total Topics- 7 and Hrs- 12)

Data Collection: sources, primary and secondary methods, significance of Primary and Secondary Data, questionnaire Vs. schedules; Data Processing: Editing, Coding Organization and Presentation; Attitude Measurement and scaling: Measurement Scales, Sources of Errors in Measurement, Techniques of Developing Measurement Tools, Classification and Testing (Reliability, Verification and Validity) Scales, Designing Questionnaires and Interviews.

UNIT- III (Total Topics- 5 and Hrs- 10)

Sampling, Sampling Methods, Sampling Plans, Sampling Error, Sampling Distributions: Theory and Design of Sample Survey, Census Vs Sample Enumerations, Objectives and Principles of Sampling, Types of Sampling, Sampling and Non-Sampling Errors, Concept of Permutation, Combination & Probability for research analysis.

UNIT-IV(Total Topics- 5 and Hrs- 10)

Interpretations and Report Writing: Meaning of Interpretation, Techniques of Interpretation, Precautions in Interpretation, Significance of Report Writing, Steps in Report Writing, Layout of Report and Precautions in Writing Research Reports. Limitations of RM: Ethics in Research, Philosophical Issues in Research.

Practical)- NA

Course Outcomes (COs):

- RM-101 CO1. Acquire in-depth knowledge of various fundamentals, theories and principles relatto the research and apply the acquired knowledge in carrying out research studies in the

area of interest.

- RM-101 CO2. Identify, formulate and critically investigate research problems by applying research-oriented knowledge and analyze relevant data to reach certain conclusions in the form of alternative solutions to these problems.
- RM-101 CO3. Apply the acquired knowledge and skills to develop minds to think out of the box while carrying out research operations to conclude something.
- RM-101 CO4. Apply parametric and non-parametric statistical tests to verify the developed hypothesis to suggest innovative solutions to the problem being investigated.
- RM-101 CO5. Evaluation interpretations and significance of report writing.
- RM-101 CO6. Creation of appropriate hypothesis, select experimental design and presentation of results after analysis of data.

Suggested readings:

1. William G. Zikmund, "Business Research Methods", Orlando: Dryden Press.
2. C. William Emory and Cooper R. Donald, "Business Research Methods", Boston, Irwin.
3. Fred N Kerlinger, "Foundations of Behavioural Research", New Delhi: Surjeet Publications.
4. Naresh Malhotra, Marketing Research: An Applied Orientation, Pearson publication David Nachmias and Chava Nachmias, "Research Methods in the Social Sciences", New York: St.Marlia's Press.
5. Bhattacharya, D. K. (2004) Research Methodology, New Delhi, Excel Books

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
RM-101	Research Methodology in Horticulture	4	0	0	40	10	-	50	100	4(4+0)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	RM-102	Credit	2(2+0)
Year/Sem	Year 1; Semester - II	L-T-P	2-0-0
Course Name	Computer & Stats Application in Research		

Course Objectives:

1. To appraise computational skills for research application.
2. To assess statistical method for research analysis.
3. To create skills in methods of collection of any type of data, classification of data, presentation of data, analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
4. To analyze statistical calculations and their validation.
5. To justify the decision in the reference of data analysis, formation and Analysis of data.
6. To create ANOVA through different methods and their interpretation.

UNIT I (Total Topics- 7 and Hrs-12)

Characteristics of Computers, Evolution of computers, computer memory, computer generations, Basic computer organization; System software, Application software, introduction to operating system, single user, multi-user, multitasking single tasking, application of computer for business and research, MS-windows, Linux .Application of Internet in research: INFLIBNET, Use of Internet, sights (DOAJ), Use of E Journals, Use of E library, use of EBSCO HOST online database of Academic Libraries. Subject/field specific tools on www.freeware.com

UNIT II(Total Topics- 7 and Hrs- 12)

Computer Application in Research,. Basic concept of Computer, Use of Internet for Research Purpose: E-mail, WWW, Web browsing, technical skills, drawing inferences from data, Research publishing tools-MS Word, Adobe acrobat, Graphics tool-MS Excel, Presentation tool-MS Power, Data Analysis Software and Analysis Techniques point. Creating presentation and adding effects, Introduction to Data analysis software-SPSS: Definition, objectives and features, data analysis using SPSS.

UNIT- III (Total Topics- 5 and Hrs- 10)

Statistical methods for research application in analysis of data, Measurement in Research , data interpretation, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness), std deviation, Measures of Relationship, Simple Regression Analysis, Correlation and Regression, Partial Correlation.

UNIT-IV(Total Topics- 5 and Hrs- 10)

Statistical Tools-Hypothesis and Hypothesis Testing: Parametric & Non-Parametric Tests, Important Parametric Tests ,Hypothesis Testing of Correlation Coefficients ,U Test, Chi Square Test, ,T-Test. Analysis of Variance (ANOVA) , The Basic Principle of ANOVA ,ANOVA Technique, Setting up Analysis of Variance Table, Short-cut Method for One-way ANOVA, Coding Method, Two-way ANOVA .

Practical- NA

Course Outcomes (COs):

- RM-102.CO.1: Remembering basics terms used in collection, classification, presentation and analysis of data, descriptive statistics, parametric and non-parametric tests, etc.

- RM-102.CO.2: Understanding of use of various formulas, principles and methods of statistical calculations used in agriculture.
- RM-102.CO.3: Applying skills in methods of collection of any type of data, classification of data, presentation of data, analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
- RM-102.CO.4: Analysis of statistical calculations and their validation.
- RM-102.CO.5: Evaluation the various data through statistical tests.
- RM-102CO.6: Creation of ANOVA table through different methods and its interpretation..

Suggested readings:

1. C. R. Kothari, "Research Methodology: Methods and techniques", New Delhi: Vishwa Prakashan.
2. Brymann, Alan and Carmer, D. (1995) Qualitative data analysis for social scientist, New York, Routledge Publication.
3. Jain, Satish: "Introduction to Computer Science and basic Programming." BPB Publications, New Delhi, 1990. • Rajaraman, V., "Fundamental of Computers", Prentice Hall of India, New Delhi, 1996.
1. Hogg, R.V.& Craig, T.T. 1978. Introduction to Mathematical Statistics. Macmillan.
2. (PDF) Statistical Methods and their Applications (researchgate.net)
3. Welcome to Web Agri Stat Package (icar.gov.in)
4. (PDF) BASIC STATISTICAL TECHNIQUES IN RESEARCH (researchgate.net)
5. Statistical Methods & Applications | Home (springer.com)
6. Statistical Methodology - Journal - Elsevier

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
RM-102	Computer & Stats Application in Research	4	0	0	40	10	-	50	100	4(4+0)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	RPE-103	Credit	2(2+0)
Year/Sem	Year 1; Semester - II	L-T-P	2-0-0
Course Name	Research& Publication Ethics		

Course Objectives:

1. To acquaint with knowledge about basics of Agricultural Research and research ethics
2. To understand research ethics including research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards, and problems in research ethics.
3. To apply research ethics in collection and interpretation of data.
4. To analyze the major publication ethics to be followed during research.
5. To evaluate violation of publication ethics, authorship, and contributor ship
6. To develop ability to identify different predatory publishers and journals.

UNIT I (Total Topics- 2 and Hrs-8)

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgments and reactions

UNIT II (Total Topics- 5 and Hrs- 5)

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

UNIT- III (Total Topics-7 and Hrs-7)

1. Publication ethics: definition, introduction, and importance
2. Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest.
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributor ship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

UNIT- IV (Total Topics-4and Hrs-4)

Practice

Open Access Publishing

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder/ Journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal Suggester, etc.

Course Outcomes (COs):

- RPE-103.CO1. Recognize the basics of philosophy of science & ethics, research integrity, publication ethics and theories of research ethics.
- RPE-103.CO2. Familiarize with important issues in research ethics, research integrity, scientific

misconduct and misinterpretation of data.

- RPE-103.CO3. Analyze the best practices for publications, publication ethics and identify the predatory publishers & journals.
- RPE-103.CO4. Demonstrate &use plagiarism software tools, open-source software tools, citation databases and research metrics.
- RPE-103.CO5.Evaluation credible & scholarly publications in reputed peer-reviewed journals.
- RPE-103.CO6.Creation of ethical publications for high impact peer reviewed journals.

Suggested readings:

Research and Publication Ethics, Dr Sumanta Dutta, Bharti Publications,2021
Research and Publication Ethics, Dr Santosh kumar Yadav, Anne Publications,2020

- Kumar, R. 2014. Research Methodology: A Step-by-Step Guide for Beginners. 4th Edition. SAGE Publications Ltd.
- Parikh, M.N, Gogtay, N. 2009. ABC of Research Methodology and Applied Biostatistics. Jaypee Publishers, New Delhi.
- Library & Information Science Research | Journal | ScienceDirect.com by Elsevier
- (PDF) Library and Information Science Research (researchgate.net)
- Research Journal of Library Sciences Introduction :ISCA
- Research Ethics: Definition, Principles and Advantages - Public Health Notes
- What Is Ethics in Research & Why Is It Important? - by David B. Resnik, J.D., Ph.D. (nih.gov)
- The Journal of Ethics | Home (springer.com)

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
RPE-103	Research& Publication Ethics	2	0	0	40	10	-	50	100	2(2+0)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	SAF-691	Credit	1(0+1)
Year/Sem	Year -1; Semester-I	L-T-P	0-0-1
Course Name	Doctoral Seminar (Compulsory Course)		

Course Objectives:

1. To remember scientific terms, concepts, and content preparation, etc.
2. To understand procedures of power point presentation.
3. To apply usage of photographs and sketches in power point to give valuable information.
4. To analyze data incorporation in seminar and its effectiveness.
5. To evaluate utilization of different sources of data.
6. To develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

UNIT I (Total Topics- and Hrs-) NA

UNIT II (Total Topics - and Hrs-) NA

UNIT- III (Total Topics - and Hrs-) NA

UNIT-IV (Total Topics - and Hrs-) NA

Practical (Hrs- 20)

A power point presentation on any topic chosen from the courses studied to be prepared and delivered to the group of faculty members/staff and students of department.

Essential components of Presentation are:

Organization of topic, Presentation of data. Oral presentation, Delivery, language, explanation of figures, Ability to grasp and understand the subject, Depth of understanding the topic.

Course Outcomes (COs):

- SAF-691.CO.1: Acquaint with scientific terms, concepts, and content preparation, etc.
- SAF-691.CO.2: Understand ability to make power point and presentation.
- SAF-691.CO.3: Apply utilization of photographs and sketches in power point to give valuable information.
- SAF-691.CO.4: Analyze data incorporation in seminar and its effectiveness.
- SAF-691.CO.5 Evaluate utilization of different sources of data.
- SAF-691.CO.6 Develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

Suggested readings:

Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
VSC-691	Doctoral Seminar	0	0	2	-	-	100	-	100	1(0+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	SAF-691	Credit	1(0+1)
Year/Sem	Year 1; Semester - II	L-T-P	0-0-1
Course Name	Doctoral Seminar (Compulsory Course)		

Course Objectives:

1. To remember scientific terms, concepts, and content preparation, etc.
2. To understand procedures of power point presentation.
3. To apply usage of photographs and sketches in power point to give valuable information.
4. To analyze data incorporation in seminar and its effectiveness.
5. To evaluate utilization of different sources of data.
6. To develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

UNIT I (Total Topics- and Hrs-) NA

UNIT II (Total Topics - and Hrs-) NA

UNIT- III (Total Topics - and Hrs-) NA

UNIT-IV (Total Topics - and Hrs-) NA

Practical (Hrs- 20)

A power point presentation on any topic chosen from the courses studied to be prepared and delivered to the group of faculty members/staff and students of department.

Essential components of Presentation are:

Organization of topic, Presentation of data. Oral presentation, Delivery, language, explanation of figures, Ability to grasp and understand the subject, Depth of understanding the topic.

Course Outcomes (COs):

- SAF-691.CO.1: Acquaint with scientific terms, concepts, and content preparation, etc.
- SAF-691.CO.2: Understand ability to make power point and presentation.
- SAF-691.CO.3: Apply utilization of photographs and sketches in power point to give valuable information.
- SAF-691.CO.4: Analyze data incorporation in seminar and its effectiveness.
- SAF-691.CO.5 Evaluate utilization of different sources of data.
- SAF-691.CO.6 Develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

Suggested readings:

Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
VSC-691	Doctoral Seminar	0	0	2	-	-	100	-	100	1(0+1)

Doctoral Research Work

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	SAF-699	Credit	75(0+75)
Year/Sem	Not Applicable	L-T-P	Not Applicable
Course Name	Doctoral Research (Compulsory Course)		

Course Objectives:

1. To acquaint with the scientific terms of research designing, citation and bibliography, intellectual property right (IPR) and its uses in academic life, theoretical arguments, content preparation, etc.
2. To develop ability to make the ethical dimensions of research work and knowledge to obtain appropriate approval.
3. To improve understandings of the systematic discovery, scientific measurements, statistical calculations and analysis of data, critical review, novelty of work, etc.
4. To develop skills in the research works, formulation of hypotheses, collection, classification, presentation and analysis primary/secondary data, assessment of resources, time management, fund utilization, critical analysis, preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs.
5. To develop ability to create the links between theory and practical during lab and field experiments.
6. To develop a sense of responsibility for the making conclusions and recommendations by scientific pursuits and influence the new opportunities for entrepreneurship and employability.

UNIT I (Total Topics- and Hrs-) NA

UNIT II (Total Topics - and Hrs-) NA

UNIT- III (Total Topics - and Hrs-) NA

UNIT-IV (Total Topics - and Hrs-) NA

Practical (Hrs-)

Synopsis, Research Work & Thesis writing provides the students an excellent opportunity to develop analytical research and entrepreneurial skills, and knowledge through meaningful hands on experience, confidence in their ability to design and investigate the things.

Course Outcomes (COs):

- SAF-699.CO.1: Acquaint with scientific terms, concepts, and content preparation, etc.
- SAF-699.CO.2: Understand ability to make power point and presentation.
- SAF -699.CO.3: Apply utilization of photographs and sketches in power point to give valuable information.
- SAF-699.CO.4: Analyze data incorporation in seminar and its effectiveness.
- SAF-699.CO.5 Evaluate utilization of different sources of data.
- SAF-699.CO.6 Develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

Suggested readings:

Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	3	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3	3
CO-6	3	3	3	3	3	3	3	3	3	3	3
Average	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
SAF-699	Doctoral Seminar	NA	NA	NA	NA	NA	NA	NA	NA	75(0+75)

Non Gradial Compulsory Courses

(To be opted if not in course curriculum of M.Sc. degree Programme of a student)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	NCLIB -501	Credit	1(0+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	0-0-2
Course Name	Library and Information Services		

Course Objectives:

1. To educate about the basics of library and its services.
2. To understand the system and organization of library.
3. To use the different sources information of library.
4. To analyses the Intricacies of abstracting and indexing services.
5. To select appropriate information and database available online and offline and categorize them.
6. To author an abstract, scientific manuscript, report, review, etc. with appropriate citation and bibliography.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - and Hrs -) NA

UNIT-IV (Total Topics - and Hrs -) NA

Practical (Topic- 11, Hrs- 20)

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 (Scopus index, 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.

Course Outcomes (COs):

- NCLIB-501.CO.1. To educate about the basics of library and its services.
- NCLIB-501.CO.2. To understand the system and organization of library.
- NCLIB-501.CO.3. To use the different sources information of library.
- NCLIB-501.CO.4. To analyses the Intricacies of abstracting and indexing services.
- NCLIB-501.CO.5. To select appropriate information and database available online and offline and categorize them.
- NCLIB-501.CO.6. To author an abstract, scientific manuscript, report, review, etc. with appropriate citation and bibliography.

Suggested readings:

- Sharma, B.K. and Thakur, U.M., 2013. Library, Information Science & Information Technology: Descriptive Study (2 Vols). YK Publishers, India.
- Omesh, A. 2010. Management of Digital Library. Oxford Book Company.
- Kumbhar, R. 2014. Library and Information Science Research Methods and Techniques.

Universal Prakashan, Pune, India.
- Sukula, S. 2014. Introduction to Library & Information Science. EssEss Publications.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	-	-	2	-	1	-	3	-	2	2
CO-2	1	1	1	1	1	1	3	-	3	-	-
CO-3	-	1	3	2	3	3	2	2	-	3	3
CO-4	-	-	2	-	3	2	2	-	2	-	-
CO-5	2	2	1	2	2	2	1	2	1	2	2
CO-6	2	2	1	3	1	3	1	1	1	1	1
Average	1.0	1.0	1.3	1.3	1.3	2.0	1.3	1.3	1.1	1.3	1.3

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCLIB-501	Library and Information Services	1	0	0	-	20	80	-	100	1(0+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	NCHU-501	Credit	1(0+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	0-0-2
Course Name	Technical Writing and Communication Skills		

Course Objectives:

To educate about the various forms of writings frequently required in a preparation of documents, reports, manuscripts, manual, research paper, dissertation.

To develop the understanding of principles and method of effective and professional communication and speech.

To develop the ability to differentiate among and to use facts, inferences and judgments and editing and proof-reading and organizing information for research communication, report, thesis and other publication.

To develop the analytical skills in composing the abstracts, content, notation, citation, captions, pagination, bibliography, review of literature, scientific manuscript, research article, review article, etc.

To able to evaluate the principles and need of technical communication and scientific writing style.

To able to design the scientific article writing and other professional encrypts.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - andHrs -) NA

UNIT-IV (Total Topics - andHrs -) NA

Practical (Topics- 13 Hrs- 26)

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.; Type and style of bibliographycommonly 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.

Course Outcomes (COs):

- NCHU-501 CO1 Educate about the various forms of writings frequently required in a preparation of documents, reports, manuscripts, manual, research paper, dissertation etc.
- NCHU-501 CO2 Develop the understanding of principles and method of effective and professional communication and speech.
- NCHU-501 CO3 Develop the ability to differentiate among and to use facts, inferences and judgments and editing and proof-reading and organizing information for research communication, report, thesis and other publication.
- NCHU-501. CO4 Develop the analytical skills in composing the abstracts, content, notation,

citation, captions, pagination, bibliography, review of literature, scientific manuscript, research article, review article, etc.

- NCHU-501 CO5. Able to evaluate the principles and need of technical communication and scientific writing style.
- NCHU-501 CO6 Able to design the scientific article writing and other professional encrypts.

Suggested readings:

- Gordon, H.M.& Walter, J.A. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Hornby, A.S. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6thEd. Oxford University Press.
- Joseph, G. 2000. MLA Handbook for writers of Research Papers. 5th Ed. Affiliated EastWest Press.
- Mohan, K. 2005. Speaking English Effectively. MacMillan India.
- Richard, W.S. 1969. Technical Writing. Barnes & Noble.
- Abhishek Sethi, J.& Dhamija, P.V. 2004. Course in Phonetics and Spoken English. 2ndEd. Prentice Hall of India.
- Wren, P.C.& Martin, H. 2006. High School English Grammar and Composition. S. Chand & Co.
- Mohan, K. 2015. Speaking English Effectively. MacMillan India.
- Link:https://agrimoon.com/comprehension-developing-communication-skills-in-english-pdf-book/

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	2	2	-	2	1	3	2	1	3	3
CO-2	3	2	2	-	1	1	2	2	1	2	2
CO-3	3	1	2	1	1	-	1	1	-	2	2
CO-4	2	1	2	2	2	-	1	1	1	-	-
CO-5	1	1	-	-	-	-	-	1	-	-	-
CO-6	1	-	-	-	1	1	-	-	-	-	-
Average	2.2	1.4	2.0	1.5	1.4	1.0	1.8	1.4	1.0	2.3	2.3

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCHU-501	Technical Writing and Communication Skills	0	0	2	-	20	80	-	100	1(0+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	NCPH-501	Credit	1(1+0)
Year/Sem	Year 1; Semester – I/II	L-T-P	1-0-0
Course Name	Disaster Management		

Course Objectives:

1. To educate about the natural and manmade disasters/hazards and their causes.
2. To develop the understanding of standard methods for mitigation process of disaster.
3. To develop ability for social support in national disaster management framework governed by government and non-government organizations.
4. To motivate for the efforts for conservation of environment.
5. To evaluate disaster response.
6. To create the disaster management framework.

UNIT I (Total Topics- 13 and Hrs- 5)

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Cloudburst and its causes; Case studies of cloudburst in Uttarakhand, Earthquakes, Landslides, Case study of landslide in Uttarakhand, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.

UNIT II (Total Topics - 17 and Hrs- 5)

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT- III (Total Topics - 5 and Hrs- 5)

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

UNIT-IV (Total Topics - andHrs-) – NA

Practical – NA

Course Outcomes (COs):

- NCPH-501. CO.1. Educate for identifying the natural and manmade disasters/hazards and their causes.
- NCPH-501. CO.2. Develop the understanding of standard methods for mitigation process of disaster.
- NCPH-501. CO.3. Develop ability for social support in national disaster management framework governed by government and non government organizations.
- NCPH-501. CO.4. Motivate for the efforts for conservation of environment.
  NCPH-501. CO.5. Evaluate disaster response.
- NCPH-501. CO.6. Create the disaster management framework.

Suggested readings:

- Bharucha, E. 2004. Textbook for Environmental Studies For Undergraduate Courses of Higher Education. UGC, New Delhi and Bharati Vidyapeeth Institute of Environment

Education and Research, Pune.
- Gupta, H.K. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
- Hodgkinson, P.E. & Stewart, M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
- Sharma, V.K. 2001. Disaster Management. National Centre for Disaster Management, India.
- Sharma P.D. Ecology and Environment. 2017. Thirteenth Edition. Rastogi Publications.
- Rao, M N. & Datta, A.K. 1987. WasteWater treatment. Oxford & IBH Publ. Co. Pvt. Ltd.
- Brunner, R.C., 1989. Hazardous Waste Incineration, McGraw Hill Inc.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5
CO-1	1	1	1	1	1	1	1	1	1	1	1
CO-2	1	1	1	-	1	1	1	1	1	1	1
CO-3	1	1	2	-	1	-	1	1	1	1	1
CO-4	1	1	2	-	1	-	1	1	3	1	1
CO-5	1	1	1	1	1	-	1	1	1	1	1
CO-6	1	1	1	1	1	-	1	1	1	1	1
Average	1.0	1.0	1.8	1.0	1.0	1.0	1.0	1.0	1.8	1.0	1.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCPH-501	Disaster Management	1	0	0	80	20	-	-	100	1(1+0)

Programme Name	Ph.D Forestry (Silviculture and Agroforestry)	Programme Code	23-
Course Code	NCIT-501	Credit	1(1+0)
Year/Sem	Year 1; Semester – I/II	L-T-P	1-0-0
Course Name	Intellectual Property Rights and Their Management in Agriculture		

Course Objectives:

1. To acquaint the meaning of intellectual property and differentiate it from tangible property.
2. To develop understanding of the process of IPR, their eligibility and various treaties and conventions.
3. To develop ability to apply Licensing technologies, Material transfer agreements and Research collaboration Agreement.
4. To develop the ability to analyze TRIPs and various provisions in TRIPS Agreement, GI, ITK, protection of plant varieties, researcher's right and farmers' right.
5. To develop ability to evaluate the ethical and professional issues that arise in the intellectual property law.
6. To develop the skill to create patents, copyrights, geographical indications, designs and layout.

UNIT I (Total Topics- 3 and Hrs - 3)

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.

UNIT II (Total Topics - 5 and Hrs- 3)

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

UNIT- III (Total Topics - 6 and Hrs- 4)

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

UNIT-IV (Total Topics - 4 and Hrs- 3)

Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Practical (Hrs-) – NA

Course Outcomes (COs):

- NCIT-501.CO.1 Acquaint the meaning of intellectual property and differentiate it from tangible property.
- NCIT-501.CO.2. To understand the process of IPR, their eligibility and various treaties and conventions.
- NCIT-501.CO.3. Develop ability to apply Licensing technologies, Material transfer agreements and Research collaboration Agreement.
- NCIT-501.CO.4. Develop the ability to analyze TRIPs and various provisions in TRIPS Agreement, GI, ITK, protection of plant varieties, researcher's right and farmers' right.
- NCIT-501. CO.5. Develop ability to evaluate the ethical and professional issues that arise in the intellectual property law.

- NCIT-501.CO.6. Develop the skill to create patents, copyrights, geographical indications, designs and layout.

Suggested readings:

- Bilek Debroy, 2004. Intellectual Property Rights, BR World of books, New Delhi.
- Ganguli, P., 2001. Intellectual Property Rights - Unleashing the Knowledge Economy. Tata McGraw Hill, New Delhi.
- Narayanan, R., 2006. Patent Law, Eastern Law House, New Delhi.
- Ramappa, T., 2000. Intellectual Property Rights under WTO - Tasks before India, Wheeler Publishing, New Delhi.
- Link: https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZzUApmBk4i7kYctp+aiP1w==

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5	PSO -6
CO-1	1	1	1	1	1	1	1	1	1	1	1	1
CO-2	1	1	1	-	1	1	1	1	1	1	1	1
CO-3	1	1	2	-	1	-	1	1	1	1	1	1
CO-4	1	1	2	-	1	-	1	1	3	1	1	1
CO-5	1	1	1	1	1	-	1	1	1	1	1	1
CO-6	1	1	1	1	1	-	1	1	1	1	1	1
Average	1.0	1.0	1.8	1.0	1.0	1.0	1.0	1.0	1.8	1.0	1.0	1.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCIT-501	Intellectual Property and Its Management in Agriculture	0	0	2	80	20	-	-	100	1(1+0)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	NCBT-501	Credit	1(0+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	0-0-2
Course Name	Basic Concepts in Laboratory Techniques		

Course Objectives:

1. To educate about basic rules and regulations of laboratory, use.
2. To develop the understanding of principles and methods of handling chemicals and equipments, preparation of solution, testing samples, etc. in the laboratory.
3. To develop the skills to operate laboratory equipments efficiently and safely.
4. To develop the skill to analyse handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing.
5. To evaluate the preparation of buffers of different strengths and pH values.
6. To develop the ability to design appropriate procedure of scientific works in the laboratory in such a way that accuracy of results remains higher.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - and Hrs -) NA

UNIT-IV (Total Topics - and Hrs -) NA

Practical (Experiments- 17 Hrs- 20)

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; Neutralization 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, sandbath, waterbath, oilbath; 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.

Course Outcomes (COs):

- NCBT-501.CO.1. Educate about basic rules and regulations of laboratory, use.
- NCBT-501.CO.2. To develop the understanding of principles and methods of handling chemicals and equipments, preparation of solution, testing samples, etc. in the laboratory.
- NCBT-501.CO.3. To develop the skills to operate laboratory equipments efficiently and safely.
- NCBT-501.CO.4. To develops the skill to analyse handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, water bath, oilbath; Electric wiring and earthing.
- NCBT-501.CO.5. Evaluate the preparation of buffers of different strengths and pH values.
- NCBT-501.CO.6. Develops the ability to design appropriate procedure of scientific works in the laboratory in such a way that accuracy of results remains higher.

Suggested readings:

- Furr, A.K. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

- Gabb, M.H. &Latchem, W.E. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
- Prescott, L.M., Harley, P. and Klein, A. 2003. Microbiology , 5thEdition, MC. GrawHill, USA.
- Gupta,P.K.1997. Elements of Biotechnology. Rastogi Publications. Meerut.
- Singh, B.D. 2005.Bio technology, Expanding Horizons. Kalyani Publications, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5	PSO -6
CO-1	-	-	-	-	-	-	1	-	-	-	-	-
CO-2	-	-	-	-	-	-	-	1	1	2	2	2
CO-3	-	-	-	-	-	-	1	1	1	-	-	-
CO-4	-	-	-	2	-	-	1	-	-	-	-	-
CO-5	-	-	-	-	-	-	1	1	-	-	-	-
CO-6	-	-	-	-	-	-	1	1	-	-	-	-
Average	-	-	-	1.0	-	-	1.0	1.0	1.0	1.0	1.0	1.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCBT-501	Basic Concepts in Laboratory Techniques	0	0	2	-	20	80	-	100	1(0+1)

Programme Name	Ph.D. (Forestry) Silviculture and Agroforestry	Programme Code	23-
Course Code	NCRM-501	Credit	1(1+0)
Year/Sem	Year 1; Semester – I/II	L-T-P	1-0-0
Course Name	Agricultural Research, Research Ethics and Rural Development Programme		

Course Objectives:

1. To acquaint with knowledge about basics of Agricultural Research, Research Ethics and Rural Development Programmes in India.
2. To understand research ethics including research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.
3. To apply research ethics in collection and interpretation of data.
4. To analyze the major constraints in implementation of rural policies and programmes.
5. To evaluate different rural developmental programs, policies and strategies at different levels.
6. To formulate analyzed data according to different designs.

UNIT I (Total Topics - 6 and Hrs-6)

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 (Total Topics - 5 and Hrs- 3)

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

UNIT- III (Total Topics - 9 and Hrs- 4)

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, and Voluntary Agencies/Non R Governmental Organizations. Critical evaluation of rural development policies and programmes.

UNIT-IV (Total Topics - 1 and Hrs- 2)

Constraints in implementation of rural policies and programmes.

Practical (Total Topics - and Hrs -) NA

Course Outcomes (COs):

- NCRM-501. CO.1: Acquaint about basics of Agricultural Research and Research Ethics
- NCRM-501. CO.2: Understand of research ethics including research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and
- NCRM-501. CO.3: Apply research ethics in collection and interpretation of data.
- NCRM-501. CO.4: Analyze the major constraints in implementation of rural policies and Programmes.

- NCRM-501. CO.5: Evaluate different rural developmental programs, policies and strategies at different levels.
- NCRM-501. CO.6: Formulate analyzed data according to different designs.

Suggested readings:

- Kumar, R. 2014. Research Methodology: A Step-by-Step Guide for Beginners. 4th Edition. SAGE Publications Ltd.
- Parikh, M.N, Gogtay, N. 2009. ABC of Research Methodology and Applied Biostatistics. Jaypee Publishers, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	2	2	2	1	1	2	1	2	1	2	2
CO-2	1	1	2	1	-	-	1	1	-	1	1
CO-3	2	2	2	1	1	2	-	2	2	1	1
CO-4	2	2	1	1	-	1	1	1	1	-	-
CO-5	2	2	2	1	1	-	1	1	1	-	-
CO-6	1	2	2	1	1	1	-	1	-	1	1
Average	1.7	1.8	1.8	1.0	1.0	1.5	1.0	1.3	1.2	1.2	1.2

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCRM-501	Agriculture Research, Research Ethics and Rural Development Programme	1	0	0	80	20	-	-	100	1(1+0)

Detailed Syllabus of Ph.D. (Hort.) Vegetable Science

Major courses (Gradial courses)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	VSC-601	Credit	3(3+0)
Year/Sem	Year 1; Semester – I	L-T-P	3-0-0
Course Name	Recent Trends in Vegetable Production		

Course Objectives:

1. To Familiarize with the production technology of vegetables and spices with recent trends and technologies.
2. To acquaint with the new system of planting and application of fertilizers adopted in production technology of vegetables and spices.
3. To develop skills to production seeds from existing vegetables crops.
4. To identify the various types of problems related to biotic and abiotic stress occurred during the cultivation of vegetables and spices crops.
5. To classify and cultivate the crop based on their basic requirement for cultivation.
6. To judge the harvesting time and techniques of various vegetable and spices crops, storage conditions.

UNITS I (Total Topics- 5 and Hrs- 6)
Recent trends in vegetable production Solanaceouscrops:Tomato,brinjal,chilli,sweetpepperandpotato.

UNIT II (Total Topics -5 and Hrs-7)
Recent trends in vegetable production. Colecrops:Cabbage,cauliflowerandknol-khol,sproutingbroccoli.

UNIT- III (Total Topics -6 and Hrs-8)
Recent trends in vegetable production. Okra,onion,peasandbeans,amaranthanddrumstick.

UNIT-IV (Total Topics -15 and Hrs- 10)
Recent trends in vegetable production. RootcropsCarrot,beetroot,turnipandradishandcucurbits.

UNIT- V (Total Topics -5 and Hrs- 7)
Recent trends in vegetable production. Tubercrops:Sweetpotato,Cassava,elephantfootyam,Dioscoreaandtaro.

Course Outcomes (CO)

- VSC-601 CO-1: Familiarized with the production technology of vegetables and spices with recent trends and technologies.
- VSC-601 CO-2 Acquaint with the new system of planting and application of fertilizers adopted in production technology of vegetables and spices.
- VSC-601 CO-3 Develop skills to production seeds from existing vegetables crops.
- VSC-601 CO-4 Identify the various types of problems related to biotic and abiotic stress occurred during the cultivation of vegetables and spices crops.
- VSC-601 CO-5 Classify and cultivate the crop on the basis of their basic requirement for cultivation.
- VSC-601 CO-6 Judge harvesting time and techniques of various vegetable and spices crops with

proper storage system.

Suggested readings:

- BoseTKandSomNG.1986.*VegetablecropsofIndia*.Nayaprokash.
- BoseTK,KabirJ,MaityTK,ParthasarathyVAandSomMG.2003.*Vegetablecrops*.Vols.I-III.NayaUdyog.
- BrewsterJL.1994. *Onionsandothervegetablealliums*.CABI.
- ChadhaKLandKallooG(Eds.).1993-94.*AdvancesinHorticulture*Vols.V-X.MalhotraPubl. House.
- ChadhaKL(Ed.).2002.*Handbookofhorticulture*.ICAR.
- ChauhanDVS(Ed.).1986.*VegetableproductioninIndia*.RamprasadandSons.
- FageriaMS,ChoudharyBRandDhakaRS.2000.*Vegetablecrops:productiontechnology*.Vol. II.Kalyani.
- FFTC.*ImprovedvegetableproductioninAsia*.BookSeriesNo.36.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5
CO-1	2	2	2	1	1	2	1	2	1	2	2
CO-2	1	1	2	1	-	-	1	1	-	1	1
CO-3	2	2	2	1	1	2	-	2	2	1	1
CO-4	2	2	1	1	-	1	1	1	1	-	-
CO-5	2	2	2	1	1	-	1	1	1	-	-
CO-6	1	2	2	1	1	1	-	1	-	1	1
Average	1.7	1.8	1.8	1.0	1.0	1.5	1.0	1.3	1.2	1.2	1.2

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
VSC-601	Recent Trends in Vegetable Production	3	0	0	40	10	-	50	100	3(3+0)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	VSC-602	Credit	3(3+0)
Year/Sem	Year 1; Semester – I	L-T-P	3-0-0
Course Name	Advances in Breeding of Vegetable Crops		

Course Objectives:

1. To remember about germplasm conservation, utilization, and center of origin of various vegetable crops
2. To understand genetics of qualitative and quantitative characters and their inheritance
3. To apply advance breeding objectives and procedures including conventional as well as innovative approaches used for development of improved varieties
4. To analyze Seed production technology in different vegetable crops.
5. To evaluate efficient breeding methods for different tuber crops.
6. To formulate high yielding seed production methods for different vegetable crops.

UNITS I (Total Topics- 6 and Hrs- 8)
AdvancesinBreedingofvegetable *Solanaceouscrops*—Tomato,Brinjal,HotPeeper,SweetPepper,OkraandPotato.

UNIT II (Total Topics -15 and Hrs-20)
AdvancesinBreedingofvegetable Cucurbits andColecrops.

UNIT- III (Total Topics -12 and Hrs-14)
AdvancesinBreedingofvegetable Legumesandleafyvegetables—PeasandBeans,Amaranth,Palak,ChenopodsandLettuce.

UNIT-IV (Total Topics -6 and Hrs-8)
AdvancesinBreedingofvegetable Rootcropsandonion—Carrot,Beetroot,Radish,Turnip,Onion.

UNIT-IV (Total Topics -5 and Hrs-7)
AdvancesinBreedingofvegetable Tubercrops—Sweetpotato,Tapioca,Elephantfootyam,Colocasia,Dioscorea

Practical (Experiments- and Hrs -)
NA

Course Outcomes (COs):

- VSC-602 CO-1: Remembering the evolutionary history of important field crops along with their centre of origin, its wild species and wild relatives that can be utilized in breeding.
- VSC-602 CO-2: Develop the understanding of germplasm conservation, utilization, and centre of origin of various crops, genetics of qualitative and quantitative characters, and their inheritance.
- VSC-602 CO-3: Applying breeding procedures, and objectives in different crop important for the development of improved varieties.
- VSC-602 CO-4: Analyzing seed production technology in different classes of crop.
- VSC-602 CO-5: Evaluating effective breeding methods in vegetable crops.
- VSC-602 CO-6: Formulation of best seed production technique for high yield and quality in different crops.

Suggested readings:

- Allard RW. 1999. *Principle of plant breeding*. John Willey and Sons,

USA.BassetMJ.(Ed.).1986.Breedingvegetablecrops.AVIPubl.
- DhillonBS,TyagiRK,SaxenaSandRandhawaGJ.2005.*Plantgeneticresources:horticulturalcrops*.NarosaPubl.House.
- FageriaMS,AryaPSandChoudharyAK.2000.*Vegetablecrops:Breedingandseedproduction*.
- Vol.I.Kalyani.
- GardnerEJ.1975.*Principlesofgenetics*.JohnWileyandSons.
- HayesHK,Immer FRand SmithDC. 1955.*Methods ofplantbreeding*. McGraw-Hill.
- HaywardMD,BosemarkNOandRomagosaI.(Eds.).1993.*PlantBreeding-principlesandprospects*.ChapmanandHall.
- HazraPandSomMG.2015.*Vegetablescience*(Secondrevisededition),Kalyanipublishers,Ludhiana,598p
- HazraPandSomMG.2016.*Vegetableseedproductionandhybridtechnology*(Secondrevisededition),KalyaniPublishers,Ludhiana,459p
- KallooG.1988.*Vegetablebreeding*(Vol.I,II,III).CRCPress,Fl,USA.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	2	3	1	1	2	1	1	1	1	1	1
CO-2	1	1	2	2	1	2	2	3	1	2	2
CO-3	1	1	1	2	2	2	1	1	3	3	3
CO-4	1	2	1	1	1	2	1	2	1	1	1
CO-5	2	1	2	1	2	1	2	2	1	2	2
CO-6	1	2	1	2	2	1	1	1	2	1	1
Average	1.3	1.6	1.3	1.4	1.6	1.5	1.3	1.3	1.5	1.6	1.6

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
VSC-602	Advances in Breeding of Vegetable Crops	3	0	0	40	10	-	50	100	3(3+0)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	VSC-604	Credit	3(2+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	2-0-1
Course Name	Seed Certification, Processing and storage of Vegetable Crops		

Course Objectives:

1. To remember importance of seed technology in agriculture.
2. To understand seed production techniques in various field crops.
3. To apply methods of seed processing, seed quality, seed storage and marketing.
4. To analyze various seed control act, order and tests for confirming status of seed.
5. To evaluate seed acts and certification processes.
6. To formulate best germination methods for higher germination of crops.

UNITS I (Total Topics- 8 and Hrs- 11)

Seedcertification,history,conceptsandobjectives,seedcertificationagency,phasesof seed certification, Indian Minimum seed Certification standards, Planning andmanagementofseedcertificationprogrammes.

UNIT II(Total Topics -5 and Hrs-7)

Principles and procedures of field inspection, seed sampling, testing and grantingcertification,OECDcertificationSchemes.

UNIT- III (Total Topics -9 and Hrs-12)

Principles of seed processing, Methods of seed drying and cleaning, seed processingplant-Layoutanddesign,seedtreatment,seedqualityenhancement,packagingandmarketing.

UNIT-IV (Total Topics -10 and Hrs- 13)

PrinciplesofSeedStorage,orthodox/recalcitrantseeds,typesofstorage(open,bulk,controlled,germplasm, cryopreservation),factorsaffectingseedlongevityinstorage(Preandpostharvestfactors).

UNIT- V (Total Topics -8 and Hrs- 10)

Seedaginganddeterioration,maintenanceofseedviabilityandvigorduringstorage,storagemethods,storagestructures,transportationandmarketingofseeds.

Course Outcomes (COs):

- VSC-604.CO-1 : Remembering importance of seed technology in agriculture
- VSC-604.CO-2 : Understanding of various seed production techniques for different field crops, the importance of maintenance of purity of crop varieties, and factors causing deterioration of variety.
- VSC-604.CO-3: Applying the factors related to genetic and physical purity of seed and its health status of seeds of a variety during seed processing.
- VSC-604.CO-4: Analyzing different methods of seed certification, field inspection, and seed purity testing
- VSC-604.CO-5: Evaluation of seed acts and certification methods.
- VSC-604.CO-6: Formulation of best germination and seed production techniques of different crops.

Practical (Experiment-8; Hrs-16)

Generalproceduresofseedcertification; Fieldinspectionandstandards; Isolationandrouging; Inspectionandsamplingatharvesting,threshingandprocessing;

Testingphysicalpurity,germinationandmoisture,grow-outtest;
Visittoregulatoryseedtestingandplantquarantinelaboratories;
Seedprocessingplantsandcommercialseedstores.

Suggested readings:

- AgarwaalPKandAnuradhaV.2018.*Fundamentalsofseedscienceandtechnology*.Brilliantpublications,NewDelhi.
- BasraAS.2000.*Hybridseedproductioninvegetables*.CRCpress,Florida,USA.
- BenchALRandSanchezRA.2004.*Handbookofseedphysiology*.Foodproductspress,NY/London.
- ChakrabortySK,PrakashS,SharmaSPandDadlaniM.2002.*Testingofdistinctiveness,uniformityandstabilityforplantvarietyprotection*.IARI,NewDelhi
- CoplandLOandMcDonaldMB.2004.*Seedscienceandtechnology*,Kluweracademicpress.FageriaMS,AryaPSandChoudhryAK.2000.*Vegetablecrops:breedingandseedproduction*
- Vol1.Kalyanipublishers,NewDelhi.
- GeorgeRAT.1999.*Vegetableseedproduction*(2nd Edition).CABInternational.
- HazraPandSomMG.2016.*Vegetableseedproductionandhybridtechnology*(Secondrevisededition),Kalyanipublishers,Ludhiana,459p

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	2	1	1	2	1	2	1	2	2	3	3
CO-2	2	3	1	2	1	1	1	3	1	2	2
CO-3	1	1	2	1	2	1	3	1	3	1	1
CO-4	1	2	1	1	2	1	1	2	3	2	2
CO-5	2	1	2	1	1	1	2	1	1	1	1
CO-6	1	2	2	1	2	2	2	1	2	1	1
Average	1.6	1.6	1.5	1.3	1.5	1.3	1.6	1.6	2	1.6	1.6

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
VSC-604	Seed Certification, Processing and storage of Vegetable Crops	2	0	1	40	10	50	50	100	3(2+1)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	VSC-606	Credit	2(2+0)

Year/Sem	Year 1; Semester – I/II	L-T-P	2-0-0
Course Name	Biodiversity and Conservation of Vegetable Crops		

Course Objectives:

1. To remember about germplasm conservation, utilization, and centre of origin of various vegetable crops.
2. To understand in situ and ex situ conservation and importance in Biodiversity.
3. To apply major intellectual property rights regulatoryhorticulture
4. To analyze Breeder's rights, Farmer's rights, PPV and FRAct. GIS and documentation of local biodiversity.
5. To evaluate GIS application in horticultural mapping and spatial analyses of field data
6. 6. To formulate high yielding GI tagged fruit varieties in India.

UNITS I (Total Topics- 8 and Hrs- 11)

Generalaspects:issues,goalsandcurrentstatus:Biodiversityandconservation;issuesandgoals-needsandchallenges;presentstatusofgenecentres;world'smajor centres of fruit crop domestication; current status of germplasm availability/databaseoffruitcropsinIndia

UNIT II (Total Topics -13 and Hrs-16)

Germplasm conservation: collection, maintenance and characterization: Explorationand collection of germplasm; sampling frequencies; size and forms of fruit and nutgermplasmcollections;activeandbasecollections.Germplasmconservation-insituandexsitustrategies,onfarmconservation;problemofrecalcitrance-coldstorageofscions,tissueculture,cryopreservation,pollenandseedstorage.

UNIT- III (Total Topics -20 and Hrs-25)

Regulatory horticulture:Germplasm exchange, quarantine and intellectual propertyrights germplasm exchange, quarantine and intellectual property rights regulatoryhorticulture, inventory and exchange of fruit and nut germplasm, plant quarantine,phytosanitarycertification,detectionofgeneticconstitutionofgermplasmandmaintenance of core collection. IPRs, Breeder's rights, Farmer's rights, PPV and FRAct. GIS and documentation of local biodiversity, Geographical indications, GISapplicationinhorticulturalmappingandspatialanalysesoffielddata;benefitsofGIprotection;GItaggedfruitvarietiesinIndia.

Practical (Experiment-8; Hrs-16)

Documentationofgermplasm-maintenanceofpassportdataandotherrecordsofaccessions;Field exploration trips andsampling procedures;Exerciseon*exsitu*conservation–coldstorage,pollen/seedstorage;
Cryopreservation;VisitstonationalgenebankandothercentersofPGRactivities;Detectionofgeneticconstitutionofgermplasm;Germplasmcharacterizationusingastandardised DUStestprotocol;Specialtestswithbiochemicalandmolecularmarkers.

Course Outcomes (COs):

- VSC-606.CO 1. Remember about germplasm conservation, utilization and centre of origin of various vegetable crops.
- VSC-606.CO 2. Understand in situ and ex situ conservation and importance in Biodiversity.
- VSC-606.CO 3. Apply major intellectual property rights regulatoryhorticulture
- VSC-606.CO 4. To analyze Breeder's rights, Farmer's rights, PPV and FRAct. GIS and documentation of local biodiversity.

- VSC-606.CO 5. To evaluate GIS application in horticultural mapping and spatial analyses of field data
- VSC-606.CO 6. To formulate high yielding GI tagged fruit varieties in India.

Suggested readings:

- DhillonBS,TyagiRK,LalAandSaxenaS.2004.Plantgeneticresourcemanagement.–horticulturalcrops.Narosapublishinghouse,NewDelhi.
- EnglesJM,RamanathRV,BrownAHDandJacksonMT.2002.Managingplantgeneticresources,CABI,Wallingford,UK.
- HancockJ.2012.Plantevolutionandtheoriginofcropsspecies.CABInternational.
- JacksonM,Ford-LloydBandParryM.2014,Plantgeneticresourcesandclimatechange.CABI,Wallingford,UK
- MooreJNandBallingtonJR.1991.GeneticresourcesoftemperateFruitandnutcrops.ISHS,Belgium.
- PeterKV.2008.Biodiversityofhorticulturalcrops.Vol.II.DayaPubl.House,Delhi.PeterKV.2011.Biodiversityinhorticulturalcrops.Vol.III.DayaPubl.House,Delhi.
- RajasekharanPE,RaoVandRamanathaV.2019.Conservationandutilizationofhorticulturalgeneticresources.Springer.
- RanaJCandVermaVD.2011.Geneticresourcesoftemperateminorfruits(indigenousandexotic).
- NBPGR,NewDelhi.
- Sthapitetal.2016.Tropicalfruittreediversity(goodpracticesforinsituandexsituconservation).

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
VSC-606	Biodiversity and Conservation of Vegetable Crops	2	0	0	80	20	0	0	100	2(2+0)

Minor Course (Gradial Course)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	FSC-601	Credit	3(3+0)
Year/Sem	Year 1; Semester – I	L-T-P	3-0-0
Course Name	Innovative Approaches in Fruit Breeding		

Course Objectives:

1. To remember various contribution of plant breeding methods in fruit crops.
2. To understand genetics of qualitative and quantitative characters, population genetics.
3. To apply breeding techniques and biotechnological tools for development of fruit cultivars.
4. To analyze various inheritance pattern and incompatibility systems in fruit crops.
5. To evaluate various fast track breeding methods such as molecular breeding and transgenic breeding.
6. To assemble appropriate variety of fruit crops suitable for cultivation.

UNITS I (Total Topics- 6 and Hrs- 8)

Introduction, CurrentTrendsand Status: Modern trends in fruit breeding – withmajoremphasisonprecocity,lowtreevolume, suitability formechanization,healthbenefits,etc.

UNIT II (Total Topics -7 and Hrs-10)

GeneticMechanisms: Inheritance Patterns and Breeding Systems: Genetics of important traitsandtheirinheritancepattern,variationsandnaturalselection,spontaneousmutations,incompatibilitysystemsinfruits.

UNIT- III (Total Topics -10 and Hrs-10)

BreedingforSpecificTraits: Plant Architecture, Stress Tolerance and Fruit Quality: Recent advancesincropimprovementefforts-wideradaptation,plantarchitecture,amenabilitytomechanization,fruitqualityattributes,stresstolerance cropspecifictraits;useof apomixis, gene introgression and wide hybridization(aliengenes).

UNIT- III (Total Topics -15 and Hrs-18)

Fast-TrackBreeding: Transgenics,MarkersandGenomics:Molecular and transgenicapproaches in improvement of selected fruit crops; fast track breeding –marker assisted selection and breeding (MAS and MAB), use of genomicsandgeneeditingtechnologies. Crops: Mango,banana,guava,papaya,Citrus,grapes,pomegranate,litchi,apple,pear, strawberry,kiwifruit,plums,peaches,apricot,cherries,nectarines,nutcrops.

Practical: NA

Course Outcomes (COs):

- FSC-601 CO-1: Remembering various contribution of plant breeding methods in fruit crops.
- FSC-601 CO-2: Understand of genetics of qualitative and quantitative characters, population genetics.
- FSC-601 CO-3: Apply breeding techniques and biotechnological tools for development of crop

varieties.

- FSC-601 CO-4: Analyzing various inheritance pattern and incompatibility systems in fruit crops.
- FSC-601 CO-5: Evaluation of various fast track breeding methods such as molecular breeding and transgenic breeding.
- FSC-601 CO-6: Assemblage of appropriate variety of fruit crops suitable for cultivation.

Suggested readings:

- Al-KhayariJ,JainSNandJohnsonDV.2018.*AdvancesinPlantBreedingStrategies.Vol.3:Fruits.*Springer.
- BadenesSandByrneDH.2012.*FruitBreeding*.Springer.
- HancockJF.2008.*TemperateFruitCropBreeding:GermplasmtoGenomics*.Springer.KoleCandAbbottAG.2012.*Genetics,GenomicsandBreedingofStonefruits.*CRC.
- Kole,C.2011.*WildCropsRelatives:GenomicsandBreedingResources:TropicalandSubtropicalFruits.*Springer-Verlag.
- KoleC.2011.*WildCropsRelatives:GenomicsandBreedingResource:TemperateFruits.*Springer
- -Verlag.
- JainSNandPriyadarshanPM.2009.*BreedingPlantationandTreeCrops:TropicalSpecies;TemperateSpecies*.Springer-Verlag.
- JanickJandMooreJN,1996.*FruitBreeding*.Vols.I-III.JohnWiley&Sons,USA.OrtonT.2019.*MethodsinFruitBreeding*.Elsevier.
- SinghSK,PatelVB,GoswamiAK,PrakashJandKumarC.2019.*BreedingofPerennialHorticulturalCrops*.BiotechBooks.Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	3	-	1	1	1	2	1	-	3	3
CO-2	1	2	1	-	1	1	2	2	1	1	1
CO-3	-	1	-	1	-	-	2	1	1	1	1
CO-4	1	2	2	1	1	1	-	-	-	-	-
CO-5	1	1	1	1	-	1	1	1	1	1	1
CO-6	1	1	1	-	1	1	1	-	1	1	1
Average	1.0	1.7	1.2	1.0	1.0	1.0	1.6	1.2	1.0	1.4	1.4

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
FSC-601	Innovative Approaches in Fruit Breeding	3	0	0	40	10	-	50	100	3(3+0)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	FSC-607	Credit	3(2+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	2-0-1
Course Name	Biodiversity and Conservation of Fruit Crops.		

Course Objectives:

7. To remember about germplasm conservation, utilization and centre of origin of various vegetable crops.
8. To understand in situ and ex situ conservation and importance in Biodiversity.
9. To apply major intellectual property rights regulatoryhorticulture

To analyze Breeder's rights, Farmer's rights, PPV and FRAct. GIS and documentation of local biodiversity.

To evaluate GIS application in horticultural mapping and spatial analyses of field data

6. To formulate high yielding GI tagged fruit varieties in India.

UNITS I (Total Topics- 10 and Hrs- 15)

GeneralAspects: Issues,GoalsandCurrentStatus:Biodiversityandconservation;issuesand goals- needs and challenges; present status of gene centres; world'smajorcentresoffruitcropdomestication;currentstatusofgermplasmavailability/databaseoffruitcr opsinIndia.

UNIT II (Total Topics -13 and Hrs-16)

GermplasmConservation: Collection, Maintenance and Characterization: Exploration and collectionofgermplasm;samplingfrequencies;sizeandformsoffruitandnutgermplasm collections;activeandbasecollections. Germplasmconservation- *in situ* and *ex situ* strategies, on farm conservation; problemofrecalcitrancy-coldstorageofscions,tissueculture,cryopreservation,pollenandseedstorage.

UNIT- III (Total Topics -20 and Hrs-25)

RegulatoryHorticulture: Germplasm Exchange, Quarantine and Intellectual Property Rights:Regulatory horticulture,inventory and exchange of fruitandnut germplasm, plant quarantine, phyto-sanitary certification, detection ofgenetic constitution of germplasm and maintenance of core collection.IPRs,Breeder'srights,Farmer'srights,PPVandFRAct. GIS and documentation of local biodiversity, Geographical indications,GIS application in horticultural mapping and spatial analyses of fielddata;benefitsofGIprotection;GItaggedfruitvarietiesinIndia.

Practical (Experiment-8; Hrs-16)

Documentationofgermplasm-maintenanceofpassportdataandotherrecords; accessions;Fieldexplorationtripsandsamplingprocedures; Exerciseon*exsitu*conservation–coldstorage,pollen/seedstorage;
Cryopreservation;VisitstoNationalGeneBankandothercentersofPGRactivities;Detectionofgeneticco nstitutionofgermplasm;Germplasmcharacterizationusingastandardised DUStestprotocol;Specialtest swithbiochemicalandmolecularmarkers(2).

Course Outcomes (COs):

- FSC-607.CO 1. Remember about germplasm conservation, utilization and centre of origin of various vegetable crops.
- FSC-607.CO 2. Understand in situ and ex situ conservation and importance in Biodiversity.
- FSC-607.CO 3. Apply major intellectual property rights regulatoryhorticulture

- FSC-607.CO 4. To analyze Breeder's rights, Farmer's rights, GIS and documentation of local biodiversity.
- FSC-607.CO 5. To evaluate GIS application in horticultural mapping and spatial analyses of field data
- FSC-607.CO 6. To formulate high yielding GI tagged fruit varieties in India.

Suggested readings:

- EnglesJM,RamanathRV,BrownAHDandJacksonMT.2002.*ManagingPlantGeneticResources*, CABI,Wallingford,UK.
- FrankelOHandHawkesJG.1975.*CropGeneticResourcesforTodayandTomorrow*. CambridgeUniversityPress,USA.
- HancockJ.2012.*PlantEvolutionandtheOriginofCropsSpecies*.CABInternational.Jackson M,Ford-LloydBandParryM.2014.*PlantGeneticResourcesandClimateChange*.CABI,Wallingford, UK.
- MooreJNandBallingtonJr,JR.1991.*GeneticResourcesofTemperateFruitandNutCrops.* ISHS,Belgium.
- PeterKV.2008.*BiodiversityofHorticulturalCrops*.Vol.II.DayaPubl.House,Delhi.PeterKV.2011.*BiodiversityinHorticulturalCrops*.Vol.III.DayaPubl.House,Delhi.
- Rana JC and Verma VD. 2011. *GeneticResourcesofTemperateMinorFruits(IndigenousandExotic).*NBPGR,NewDelhi.
- RajasekharanPE,RaoVandRamanathaV.2019.*ConservationandUtilizationofHorticulturalGeneticResources*.Springer.
- SthapitB,*etal*.2016.*TropicalFruitTreeDiversity(GoodPracticesforinsituandexsituconservation*).BioversityInternational.Routledge,TaylorandFrancisGroup.
- VirchowD.2012.*ConservationofGeneticResources*,SpringerVerlag,Berlin.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			

FSC-607	Biodiversity and Conservation of Fruit Crops.	2	0	1	20	10	20	50	100	3(2+1)

Supporting courses (Compulsory for all students) (Gradial courses)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	RM-101	Credit	4(4+0)
Year/Sem	Year 1; Semester – I	L-T-P	4-0-0
Course Name	Research Methodology in Horticulture		

Course Objectives:

1. To Equip the Students with the Concept and Methodology of Research.
2. To provide knowledge about type of research, preparation of reports and thesis, designing of Research using Scientific Methods.
3. To develop the ability to apply principles and procedure for data analysis and interpretation of results.
4. To analyze various sampling methods and probability of research analysis.
5. To evaluate interpretations and significance of report writing.
6. To develop the ability to create appropriate hypothesis, select experimental design and presentation of results after analysis of data.

UNIT I (Total Topics- 7 and Hrs-12)

Introduction to Research: Definition, Nature and significance, Role and Objectives; Types of Research: exploratory, descriptive, experimental and diagnostic research, social and legal research and traditional, analytical, empirical & fundamental research, Doctrinal and non-doctrinal research methods; Various Research Designs; Scientific Research Process: Overview, Problem identification and formulation of research statement.

UNIT II(Total Topics- 7 and Hrs- 12)

Data Collection: sources, primary and secondary methods, significance of Primary and Secondary Data, questionnaire Vs. schedules; Data Processing: Editing, Coding Organization and Presentation; Attitude Measurement and scaling: Measurement Scales, Sources of Errors in Measurement, Techniques of Developing Measurement Tools, Classification and Testing (Reliability, Verification and Validity) Scales, Designing Questionnaires and Interviews.

UNIT- III (Total Topics- 5 and Hrs- 10)

Sampling, Sampling Methods, Sampling Plans, Sampling Error, Sampling Distributions: Theory and Design of Sample Survey, Census Vs Sample Enumerations, Objectives and Principles of Sampling, Types of Sampling, Sampling and Non-Sampling Errors, Concept of Permutation, Combination & Probability for research analysis.

UNIT-IV(Total Topics- 5 and Hrs- 10)

Interpretations and Report Writing: Meaning of Interpretation, Techniques of Interpretation, Precautions in Interpretation, Significance of Report Writing, Steps in Report Writing, Layout of Report and Precautions in Writing Research Reports. Limitations of RM: Ethics in Research,

Philosophical Issues in Research.

Practical)- NA

Course Outcomes (COs):

- RM-101 CO1. Acquire in-depth knowledge of various fundamentals, theories and principles relatto the research and apply the acquired knowledge in carrying out research studies in the area of interest.
- RM-101 CO2. Identify, formulate and critically investigate research problems by applying research-oriented knowledge and analyze relevant data to reach certain conclusions in the form of alternative solutions to these problems.
- RM-101 CO3. Apply the acquired knowledge and skills to develop minds to think out of the box while carrying out research operations to conclude something.
- RM-101 CO4. Apply parametric and non-parametric statistical tests to verify the developed hypothesis to suggest innovative solutions to the problem being investigated.
- RM-101 CO5. Evaluation interpretations and significance of report writing.
- RM-101 CO6. Creation of appropriate hypothesis, select experimental design and presentation of results after analysis of data.

Suggested readings:

1. William G. Zikmund, "Business Research Methods", Orlando: Dryden Press.
2. C. William Emory and Cooper R. Donald, "Business Research Methods", Boston, Irwin.
3. Fred N Kerlinger, "Foundations of Behavioural Research", New Delhi: Surjeet Publications.
4. Naresh Malhotra, Marketing Research: An Applied Orientation, Pearson publication David Nachmias and Chava Nachmias, "Research Methods in the Social Sciences", New York: St.Marlia's Press.
5. Bhattacharya, D. K. (2004) Research Methodology, New Delhi, Excel Books

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			

RM-101	Research Methodology in Horticulture	4	0	0	40	10	-	50	100	4(4+0)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	RM-102	Credit	2(2+0)
Year/Sem	Year 1; Semester – I	L-T-P	2-0-0
Course Name	Computer & Stats Application in Research		

Course Objectives:

7. To appraise computational skills for research application.
8. To assess statistical method for research analysis.
9. To create skills in methods of collection of any type of data, classification of data, presentation of data, analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
10. To analyze statistical calculations and their validation.
11. To justify the decision in the reference of data analysis, formation and Analysis of data.
12. To create ANOVA through different methods and their interpretation.

UNIT I (Total Topics- 7 and Hrs-12)

Characteristics of Computers, Evolution of computers, computer memory, computer generations, Basic computer organization; System software, Application software, introduction to operating system, single user, multi-user, multitasking single tasking, application of computer for business and research, MS-windows, Linux .Application of Internet in research: INFLIBNET, Use of Internet, sights (DOAJ), Use of E Journals, Use of E library, use of EBSCO HOST online database of Academic Libraries. Subject/field specific tools on www.freeware.com

UNIT II(Total Topics- 7 and Hrs- 12)

Computer Application in Research,. Basic concept of Computer, Use of Internet for Research Purpose: E-mail, WWW, Web browsing, technical skills, drawing inferences from data, Research publishing tools-MS Word, Adobe acrobat, Graphics tool-MS Excel, Presentation tool-MS Power, Data Analysis Software and Analysis Techniques point. Creating presentation and adding effects, Introduction to Data analysis software-SPSS: Definition, objectives and features, data analysis using SPSS.

UNIT- III (Total Topics- 5 and Hrs- 10)

Statistical methods for research application in analysis of data, Measurement in Research , data interpretation, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness), std deviation, Measures of Relationship, Simple Regression Analysis, Correlation and Regression, Partial Correlation.

UNIT-IV(Total Topics- 5 and Hrs- 10)

Statistical Tools-Hypothesis and Hypothesis Testing: Parametric & Non-Parametric Tests, Important Parametric Tests ,Hypothesis Testing of Correlation Coefficients ,U Test, Chi Square Test, ,T-Test. Analysis of Variance (ANOVA) , The Basic Principle of ANOVA ,ANOVA Technique, Setting up Analysis of Variance Table, Short-cut Method for One-way ANOVA, Coding Method, Two-way ANOVA .

Practical- NA

Course Outcomes (COs):

- RM-102.CO.1: Remembering basics terms used in collection, classification, presentation and analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
- RM-102.CO.2: Understanding of use of various formulas, principles and methods of statistical calculations used in agriculture.
- RM-102.CO.3: Applying skills in methods of collection of any type of data, classification of data, presentation of data, analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
- RM-102.CO.4: Analysis of statistical calculations and their validation.
- RM-102.CO.5: Evaluation the various data through statistical tests.
- RM-102CO.6: Creation of ANOVA table through different methods and its interpretation..

Suggested readings:

1. C. R. Kothari, "Research Methodology: Methods and techniques", New Delhi: Vishwa Prakashan.
2. Brymann, Alan and Carmer, D. (1995) Qualitative data analysis for social scientist, New York, Routledge Publication.
3. Jain, Satish: "Introduction to Computer Science and basic Programming." BPB Publications, New Delhi, 1990. • Rajaraman, V., "Fundamental of Computers", Prentice Hall of India, New Delhi, 1996.
7. Hogg, R.V.& Craig, T.T. 1978. Introduction to Mathematical Statistics. Macmillan.
8. (PDF) Statistical Methods and their Applications (researchgate.net)
9. Welcome to Web Agri Stat Package (icar.gov.in)
10. (PDF) BASIC STATISTICAL TECHNIQUES IN RESEARCH (researchgate.net)
11. Statistical Methods & Applications | Home (springer.com)
12. Statistical Methodology - Journal - Elsevier

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week	Evaluation Scheme			Credit Hours (Theory +
			Internal Examination	External	Subject	

		L	T	P	Midterm Theory Examination	Assignment	Practical Examination	Theory Examination	Total	Practical)
RM-102	Computer & Stats Application in Research	4	0	0	40	10	-	50	100	4(4+0)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	RPE-103	Credit	2(2+0)
Year/Sem	Year 1; Semester – I	L-T-P	2-0-0
Course Name	Research& Publication Ethics		

Course Objectives:

7. To acquaint with knowledge about basics of Agricultural Research and research ethics
8. To understand research ethics including research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards, and problems in research ethics.
9. To apply research ethics in collection and interpretation of data.
10. To analyze the major publication ethics to be followed during research.
11. To evaluate violation of publication ethics, authorship and contributor ship
12. To develop ability to identify different predatory publishers and journals.

UNIT I (Total Topics- 2 and Hrs-8)

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgments and reactions

UNIT II (Total Topics- 5 and Hrs- 5)

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

UNIT- III (Total Topics-7 and Hrs-7)

1. Publication ethics: definition, introduction and importance
2. Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest.
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributor ship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

UNIT- IV (Total Topics-4and Hrs-4)

Practice

Open Access Publishing

1. Open access publications and initiatives

2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder/ Journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal Suggester, etc.

Course Outcomes (COs):

- RPE-103.CO1. Recognize the basics of philosophy of science & ethics, research integrity, publication ethics and theories of research ethics.
- RPE-103.CO2. Familiarize with important issues in research ethics, research integrity, scientific misconduct and misinterpretation of data.
- RPE-103.CO3. Analyze the best practices for publications, publication ethics and identify the predatory publishers & journals.
- RPE-103.CO4. Demonstrate &use plagiarism software tools, open-source software tools, citation databases and research metrics.
- RPE-103.CO5.Evaluation credible & scholarly publications in reputed peer-reviewed journals.
- RPE-103.CO6.Creation of ethical publications for high impact peer reviewed journals.

Suggested readings:

Research and Publication Ethics, Dr Sumanta Dutta, Bharti Publications,2021
Research and Publication Ethics, Dr Santosh kumar Yadav, Anne Publications,2020

- Kumar, R. 2014. Research Methodology: A Step-by-Step Guide for Beginners. 4th Edition. SAGE Publications Ltd.
- Parikh, M.N, Gogtay, N. 2009. ABC of Research Methodology and Applied Biostatistics. Jaypee Publishers, New Delhi.
- Library & Information Science Research | Journal | ScienceDirect.com by Elsevier
- (PDF) Library and Information Science Research (researchgate.net)
- Research Journal of Library Sciences Introduction :ISCA
- Research Ethics: Definition, Principles and Advantages - Public Health Notes
- What Is Ethics in Research & Why Is It Important? - by David B. Resnik, J.D., Ph.D. (nih.gov)
- The Journal of Ethics | Home (springer.com)

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods	Evaluation Scheme	Credit

		per week			Internal Examination			External Theory Examination	Subject Total	Hours (Theory + Practical)
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
RPE-103	Research& Publication Ethics	2	0	0	40	10	-	50	100	2(2+0)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	VSC-691	Credit	1(0+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	0-0-2
Course Name	Doctoral Seminar (Compulsory Course)		

Course Objectives:

1. To remember scientific terms, concepts, and content preparation, etc.
2. To understand procedures of power point presentation.
3. To apply usage of photographs and sketches in power point to give valuable information.
4. To analyze data incorporation in seminar and its effectiveness.
5. To evaluate utilization of different sources of data.
6. To develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

UNIT I (Total Topics- and Hrs-) NA

UNIT II (Total Topics - and Hrs-) NA

UNIT- III (Total Topics - and Hrs-) NA

UNIT-IV (Total Topics - and Hrs-) NA

Practical (Hrs- 20)

A power point presentation on any topic chosen from the courses studied to be prepared and delivered to the group of faculty members/staff and students of department.

Essential components of Presentation are:

Organization of topic, Presentation of data. Oral presentation, Delivery, language, explanation of figures, Ability to grasp and understand the subject, Depth of understanding the topic.

Course Outcomes (COs):

- VSC-691.CO.1: Acquaint with scientific terms, concepts, and content preparation, etc.
- VSC-691.CO.2: Understand ability to make power point and presentation.
- VSC-691.CO.3: Apply utilization of photographs and sketches in power point to give valuable information.
- VSC-691.CO.4: Analyze data incorporation in seminar and its effectiveness.
- VSC-691.CO.5 Evaluate utilization of different sources of data.
- VSC-691.CO.6 Develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

Suggested readings:

Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
VSC-691	Doctoral Seminar	0	0	2	-	-	100	-	100	1(0+1)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	VSC-691	Credit	1(0+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	0-0-2
Course Name	Doctoral Seminar (Compulsory Course)		

Course Objectives:

1. To remember scientific terms, concepts, and content preparation, etc.
2. To understand procedures of power point presentation.
3. To apply usage of photographs and sketches in power point to give valuable information.
4. To analyze data incorporation in seminar and its effectiveness.
5. To evaluate utilization of different sources of data.
6. To develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

UNIT I (Total Topics- and Hrs-) NA

UNIT II (Total Topics - and Hrs-) NA

UNIT- III (Total Topics - and Hrs-) NA

UNIT-IV (Total Topics - and Hrs-) NA

Practical (Hrs- 20)

A power point presentation on any topic chosen from the courses studied to be prepared and delivered to the group of faculty members/staff and students of department.

Essential components of Presentation are:

Organization of topic, Presentation of data. Oral presentation, Delivery, language, explanation of figures, Ability to grasp and understand the subject, Depth of understanding the topic.

Course Outcomes (COs):

- VSC-691.CO.1: Acquaint with scientific terms, concepts, and content preparation, etc.
- VSC-691.CO.2: Understand ability to make power point and presentation.
- VSC-691.CO.3: Apply utilization of photographs and sketches in power point to give valuable information.
- VSC-691.CO.4: Analyze data incorporation in seminar and its effectiveness.
- VSC-691.CO.5 Evaluate utilization of different sources of data.
- VSC-691.CO.6 Develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

Suggested readings:

Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
VSC-691	Doctoral Seminar	0	0	2	-	-	100	-	100	1(0+1)

Doctoral Research Work

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	VSC-699	Credit	75(0+75)
Year/Sem	Not Applicable	L-T-P	Not Applicable
Course Name	Doctoral Research (Compulsory Course)		

Course Objectives:

1. To acquaint with the scientific terms of research designing, citation and bibliography, intellectual property right (IPR) and its uses in academic life, theoretical arguments, content preparation, etc.
2. To develop ability to make the ethical dimensions of research work and knowledge to obtain appropriate approval.
3. To improve understandings of the systematic discovery, scientific measurements, statistical calculations and analysis of data, critical review, novelty of work, etc.
4. To develop skills in the research works, formulation of hypotheses, collection, classification, presentation and analysis primary/secondary data, assessment of resources, time management, fund utilization, critical analysis, preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs.
5. To develop ability to create the links between theory and practical during lab and field experiments.
6. To develop a sense of responsibility for the making conclusions and recommendations by scientific pursuits and influence the new opportunities for entrepreneurship and employability.

UNIT I (Total Topics- and Hrs-) NA

UNIT II (Total Topics - and Hrs-) NA

UNIT- III (Total Topics - and Hrs-) NA

UNIT-IV (Total Topics - and Hrs-) NA

Practical (Hrs-)

Synopsis, Research Work & Thesis writing provides the students an excellent opportunity to develop analytical research and entrepreneurial skills, and knowledge through meaningful hands on experience, confidence in their ability to design and investigate the things.

Course Outcomes (COs):

- VAC-699.CO.1: Acquaint with scientific terms, concepts, and content preparation, etc.
- VAC-699.CO.2: Understand ability to make power point and presentation.
- VAC-699.CO.3: Apply utilization of photographs and sketches in power point to give valuable information.
- VAC-699.CO.4: Analyze data incorporation in seminar and its effectiveness.
- VAC-699.CO.5 Evaluate utilization of different sources of data.
- VAC-699.CO.6 Develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

Suggested readings:

Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	3	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3	3
CO-6	3	3	3	3	3	3	3	3	3	3	3
Average	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
VAC-699	Doctoral Seminar	NA	NA	NA	NA	NA	NA	NA	NA	75(0+75)

Non Gradial Compulsory Courses

(To be opted if not incourse curriculum of M.Sc. degree Programme of a student)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	NCLIB -501	Credit	1(0+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	0-0-2
Course Name	Library and Information Services		

Course Objectives:

1. To educate about the basics of library and its services.
2. To understand the system and organization of library.
3. To use the different sources information of library.
4. To analyses the Intricacies of abstracting and indexing services.
5. To select appropriate information and database available online and offline and categorize them.
6. To author an abstract, scientific manuscript, report, review, etc. with appropriate citation and bibliography.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - and Hrs -) NA

UNIT-IV (Total Topics - and Hrs -) NA

Practical (Topic- 11, Hrs- 20)

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 (Scopus index, 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.

Course Outcomes (COs):

- NCLIB-501.CO.1. To educate about the basics of library and its services.
- NCLIB-501.CO.2. To understand the system and organization of library.
- NCLIB-501.CO.3. To use the different sources information of library.
- NCLIB-501.CO.4. To analyses the Intricacies of abstracting and indexing services.
- NCLIB-501.CO.5. To select appropriate information and database available online and offline and categorize them.
- NCLIB-501.CO.6. To author an abstract, scientific manuscript, report, review, etc. with appropriate citation and bibliography.

Suggested readings:

- Sharma, B.K. and Thakur, U.M., 2013. Library, Information Science & Information Technology: Descriptive Study (2 Vols). YK Publishers, India.
- Omesh, A. 2010. Management of Digital Library. Oxford Book Company.
- Kumbhar, R. 2014. Library and Information Science Research Methods and Techniques.

Universal Prakashan, Pune, India.
- Sukula, S. 2014. Introduction to Library & Information Science. EssEss Publications.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	-	-	2	-	1	-	3	-	2	2
CO-2	1	1	1	1	1	1	3	-	3	-	-
CO-3	-	1	3	2	3	3	2	2	-	3	3
CO-4	-	-	2	-	3	2	2	-	2	-	-
CO-5	2	2	1	2	2	2	1	2	1	2	2
CO-6	2	2	1	3	1	3	1	1	1	1	1
Average	1.0	1.0	1.3	1.3	1.3	2.0	1.3	1.3	1.1	1.3	1.3

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCLIB-501	Library and Information Services	1	0	0	-	20	80	-	100	1(0+1)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	NCHU-501	Credit	1(0+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	0-0-2
Course Name	Technical Writing and Communication Skills		

Course Objectives:

1. To educate about the various forms of writings frequently required in a preparation of documents, reports, manuscripts, manual, research paper, dissertation.
2. To develop the understanding of principles and method of effective and professional communication and speech.
3. To develop the ability to differentiate among and to use facts, inferences and judgments and editing and proof-reading and organizing information for research communication, report, thesis and other publication.
4. To develop the analytical skills in composing the abstracts, content, notation, citation, captions, pagination, bibliography, review of literature, scientific manuscript, research article, review article, etc.
5. To able to evaluate the principles and need of technical communication and scientific writing style.
6. To able to design the scientific article writing and other professional encrypts.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - andHrs -) NA

UNIT-IV (Total Topics - andHrs -) NA

Practical (Topics- 13 Hrs- 26)

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.; Type and style of bibliographycommonly 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.

Course Outcomes (COs):

- NCHU-501 CO1 Educate about the various forms of writings frequently required in a preparation of documents, reports, manuscripts, manual, research paper, dissertation etc.
- NCHU-501 CO2 Develop the understanding of principles and method of effective and professional communication and speech.
- NCHU-501 CO3 Develop the ability to differentiate among and to use facts, inferences and judgments and editing and proof-reading and organizing information for research communication, report, thesis and other publication.
- NCHU-501. CO4 Develop the analytical skills in composing the abstracts, content, notation, citation, captions, pagination, bibliography, review of literature, scientific manuscript,

research article, review article, etc.

- NCHU-501 CO5. Able to evaluate the principles and need of technical communication and scientific writing style.
- NCHU-501 CO6 Able to design the scientific article writing and other professional encrypts.

Suggested readings:

- Gordon, H.M.& Walter, J.A. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Hornby, A.S. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6thEd. Oxford University Press.
- Joseph, G. 2000. MLA Handbook for writers of Research Papers. 5th Ed. Affiliated EastWest Press.
- Mohan, K. 2005. Speaking English Effectively. MacMillan India.
- Richard, W.S. 1969. Technical Writing. Barnes & Noble.
- Abhishek Sethi, J.& Dhamija, P.V. 2004. Course in Phonetics and Spoken English. 2ndEd. Prentice Hall of India.
- Wren, P.C.& Martin, H. 2006. High School English Grammar and Composition. S. Chand & Co.
- Mohan, K. 2015. Speaking English Effectively. MacMillan India.
- Link:https://agrimoon.com/comprehension-developing-communication-skills-in-english-pdf-book/

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	2	2	-	2	1	3	2	1	3	3
CO-2	3	2	2	-	1	1	2	2	1	2	2
CO-3	3	1	2	1	1	-	1	1	-	2	2
CO-4	2	1	2	2	2	-	1	1	1	-	-
CO-5	1	1	-	-	-	-	-	1	-	-	-
CO-6	1	-	-	-	1	1	-	-	-	-	-
Average	2.2	1.4	2.0	1.5	1.4	1.0	1.8	1.4	1.0	2.3	2.3

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCHU-501	Technical Writing and Communication Skills	0	0	2	-	20	80	-	100	1(0+1)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	NCPH-501	Credit	1(1+0)
Year/Sem	Year 1; Semester – I/II	L-T-P	1-0-0
Course Name	Disaster Management		

Course Objectives:

1. To educate about the natural and manmade disasters/hazards and their causes.
2. To develop the understanding of standard methods for mitigation process of disaster.
3. To develop ability for social support in national disaster management framework governed by government and non-government organizations.
4. To motivate for the efforts for conservation of environment.
5. To evaluate disaster response.
6. To create the disaster management framework.

UNIT I (Total Topics- 13 and Hrs- 5)

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Cloudburst and its causes; Case studies of cloudburst in Uttarakhand, Earthquakes, Landslides, Case study of landslide in Uttarakhand, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.

UNIT II (Total Topics - 17 and Hrs- 5)

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT- III (Total Topics - 5 and Hrs- 5)

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

UNIT-IV (Total Topics - andHrs-) – NA

Practical – NA

Course Outcomes (COs):

- NCPH-501. CO.1. Educate for identifying the natural and manmade disasters/hazards and their causes.
- NCPH-501. CO.2. Develop the understanding of standard methods for mitigation process of disaster.
- NCPH-501. CO.3. Develop ability for social support in national disaster management framework governed by government and non government organizations.
- NCPH-501. CO.4. Motivate for the efforts for conservation of environment.
  NCPH-501. CO.5. Evaluate disaster response.
- NCPH-501. CO.6. Create the disaster management framework.

Suggested readings:

- Bharucha, E. 2004. Textbook for Environmental Studies For Undergraduate Courses of Higher Education. UGC, New Delhi and Bharati Vidyapeeth Institute of Environment Education and Research, Pune.

- Gupta, H.K. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
- Hodgkinson, P.E. & Stewart, M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
- Sharma, V.K. 2001. Disaster Management. National Centre for Disaster Management, India.
- Sharma P.D. Ecology and Environment. 2017. Thirteenth Edition. Rastogi Publications.
- Rao, M N. & Datta, A.K. 1987. WasteWater treatment. Oxford & IBH Publ. Co. Pvt. Ltd.
- Brunner, R.C., 1989. Hazardous Waste Incineration, McGraw Hill Inc.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5
CO-1	1	1	1	1	1	1	1	1	1	1	1
CO-2	1	1	1	-	1	1	1	1	1	1	1
CO-3	1	1	2	-	1	-	1	1	1	1	1
CO-4	1	1	2	-	1	-	1	1	3	1	1
CO-5	1	1	1	1	1	-	1	1	1	1	1
CO-6	1	1	1	1	1	-	1	1	1	1	1
Average	1.0	1.0	1.8	1.0	1.0	1.0	1.0	1.0	1.8	1.0	1.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCPH-501	Disaster Management	1	0	0	80	20	-	-	100	1(1+0)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	NCIT-501	Credit	1(1+0)
Year/Sem	Year 1; Semester – I/II	L-T-P	1-0-0
Course Name	Intellectual Property Rights and Their Management in Agriculture		

Course Objectives:

1. To acquaint the meaning of intellectual property and differentiate it from tangible property.
2. To develop understanding of the process of IPR, their eligibility and various treaties and conventions.
3. To develop ability to apply Licensing technologies, Material transfer agreements and Research collaboration Agreement.
4. To develop the ability to analyze TRIPs and various provisions in TRIPS Agreement, GI, ITK, protection of plant varieties, researcher's right and farmers' right.
5. To develop ability to evaluate the ethical and professional issues that arise in the intellectual property law.
6. To develop the skill to create patents, copyrights, geographical indications, designs and layout.

UNIT I (Total Topics- 3 and Hrs - 3)

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.

UNIT II (Total Topics - 5 and Hrs- 3)

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

UNIT- III (Total Topics - 6 and Hrs- 4)

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

UNIT-IV (Total Topics - 4 and Hrs- 3)

Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Practical (Hrs-) – NA

Course Outcomes (COs):

- NCIT-501.CO.1 Acquaint the meaning of intellectual property and differentiate it from tangible property.
- NCIT-501.CO.2. To understand the process of IPR, their eligibility and various treaties and conventions.
- NCIT-501.CO.3. Develop ability to apply Licensing technologies, Material transfer agreements and Research collaboration Agreement.
- NCIT-501.CO.4. Develop the ability to analyze TRIPs and various provisions in TRIPS Agreement, GI, ITK, protection of plant varieties, researcher's right and farmers' right.
- NCIT-501. CO.5. Develop ability to evaluate the ethical and professional issues that arise in

the intellectual property law.

- NCIT-501.CO.6. Develop the skill to create patents, copyrights, geographical indications, designs and layout.

Suggested readings:

- Bilek Debroy, 2004. Intellectual Property Rights, BR World of books, New Delhi.
- Ganguli, P., 2001. Intellectual Property Rights - Unleashing the Knowledge Economy. Tata McGraw Hill, New Delhi.
- Narayanan, R., 2006. Patent Law, Eastern Law House, New Delhi.
- Ramappa, T., 2000. Intellectual Property Rights under WTO - Tasks before India, Wheeler Publishing, New Delhi.
- Link: https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZzUApmBk4i7kYctp+aiP1w==

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5	PSO -6
CO-1	1	1	1	1	1	1	1	1	1	1	1	1
CO-2	1	1	1	-	1	1	1	1	1	1	1	1
CO-3	1	1	2	-	1	-	1	1	1	1	1	1
CO-4	1	1	2	-	1	-	1	1	3	1	1	1
CO-5	1	1	1	1	1	-	1	1	1	1	1	1
CO-6	1	1	1	1	1	-	1	1	1	1	1	1
Average	1.0	1.0	1.8	1.0	1.0	1.0	1.0	1.0	1.8	1.0	1.0	1.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCIT-501	Intellectual Property and Its Management in Agriculture	0	0	2	80	20	-	-	100	1(1+0)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	NCBT-501	Credit	1(0+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	0-0-2
Course Name	Basic Concepts in Laboratory Techniques		

Course Objectives:

1. To educate about basic rules and regulations of laboratory, use.
2. To develop the understanding of principles and methods of handling chemicals and equipments, preparation of solution, testing samples, etc. in the laboratory.
3. To develop the skills to operate laboratory equipments efficiently and safely.
4. To develop the skill to analyze handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing.
5. To evaluate the preparation of buffers of different strengths and pH values.
6. To develop the ability to design appropriate procedure of scientific works in the laboratory in such a way that accuracy of results remains higher.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - and Hrs -) NA

UNIT-IV (Total Topics - and Hrs -) NA

Practical (Experiments- 17 Hrs- 20)

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; Neutralization 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, sandbath, waterbath, oilbath; 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.

Course Outcomes (COs):

- NCBT-501.CO.1. Educate about basic rules and regulations of laboratory, use.
- NCBT-501.CO.2. To develop the understanding of principles and methods of handling chemicals and equipments, preparation of solution, testing samples, etc. in the laboratory.
- NCBT-501.CO.3. To develop the skills to operate laboratory equipments efficiently and safely.
- NCBT-501.CO.4. To develops the skill to analyse handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, water bath, oilbath; Electric wiring and earthing.
- NCBT-501.CO.5. Evaluate the preparation of buffers of different strengths and pH values.
- NCBT-501.CO.6. Develops the ability to design appropriate procedure of scientific works in the laboratory in such a way that accuracy of results remains higher.

Suggested readings:

- Furr, A.K. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

- Gabb, M.H. &Latchem, W.E. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
- Prescott, L.M., Harley, P. and Klein, A. 2003. Microbiology , 5thEdition, MC. GrawHill, USA.
- Gupta,P.K.1997. Elements of Biotechnology. Rastogi Publications. Meerut.
- Singh, B.D. 2005.Bio technology, Expanding Horizons. Kalyani Publications, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5	PSO -6
CO-1	-	-	-	-	-	-	1	-	-	-	-	-
CO-2	-	-	-	-	-	-	-	1	1	2	2	2
CO-3	-	-	-	-	-	-	1	1	1	-	-	-
CO-4	-	-	-	2	-	-	1	-	-	-	-	-
CO-5	-	-	-	-	-	-	1	1	-	-	-	-
CO-6	-	-	-	-	-	-	1	1	-	-	-	-
Average	-	-	-	1.0	-	-	1.0	1.0	1.0	1.0	1.0	1.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCBT-501	Basic Concepts in Laboratory Techniques	0	0	2	-	20	80	-	100	1(0+1)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	NCRM-501	Credit	1(1+0)
Year/Sem	Year 1; Semester – I/II	L-T-P	1-0-0
Course Name	Agricultural Research, Research Ethics and Rural Development Programme		

Course Objectives:

1. To acquaint with knowledge about basics of Agricultural Research, Research Ethics and Rural Development Programmes in India.
2. To understand research ethics including research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.
3. To apply research ethics in collection and interpretation of data.
4. To analyze the major constraints in implementation of rural policies and programmes.
5. To evaluate different rural developmental programs, policies and strategies at different levels.
6. To formulate analyzed data according to different designs.

UNIT I (Total Topics - 6 and Hrs-6)

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 (Total Topics - 5 and Hrs- 3)

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

UNIT- III (Total Topics - 9 and Hrs- 4)

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, and Voluntary Agencies/Non R Governmental Organizations. Critical evaluation of rural development policies and programmes.

UNIT-IV (Total Topics - 1 and Hrs- 2)

Constraints in implementation of rural policies and programmes.

Practical (Total Topics - and Hrs -) NA

Course Outcomes (COs):

- NCRM-501. CO.1: Acquaint about basics of Agricultural Research and Research Ethics
- NCRM-501. CO.2: Understand of research ethics including research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and
- NCRM-501. CO.3: Apply research ethics in collection and interpretation of data.
- NCRM-501. CO.4: Analyze the major constraints in implementation of rural policies and Programmes.

- NCRM-501. CO.5: Evaluate different rural developmental programs, policies and strategies at different levels.
- NCRM-501. CO.6: Formulate analyzed data according to different designs.

Suggested readings:

- Kumar, R. 2014. Research Methodology: A Step-by-Step Guide for Beginners. 4th Edition. SAGE Publications Ltd.
- Parikh, M.N, Gogtay, N. 2009. ABC of Research Methodology and Applied Biostatistics. Jaypee Publishers, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	2	2	2	1	1	2	1	2	1	2	2
CO-2	1	1	2	1	-	-	1	1	-	1	1
CO-3	2	2	2	1	1	2	-	2	2	1	1
CO-4	2	2	1	1	-	1	1	1	1	-	-
CO-5	2	2	2	1	1	-	1	1	1	-	-
CO-6	1	2	2	1	1	1	-	1	-	1	1
Average	1.7	1.8	1.8	1.0	1.0	1.5	1.0	1.3	1.2	1.2	1.2

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCRM-501	Agriculture Research, Research Ethics and Rural Development Programme	1	0	0	80	20	-	-	100	1(1+0)

Programme Name	Ph.D. (Hort.) Vegetable Science	Programme Code	23-
Course Code	NCHU-501	Credit	1(0+1)
Year/Sem	Year 1; Semester – I/II	L-T-P	0-0-2
Course Name	Technical Writing and Communication Skills		

Course Objectives:

1. To educate about the various forms of writings frequently required in a preparation of documents, reports, manuscripts, manual, research paper, dissertation.
2. To develop the understanding of principles and method of effective and professional communication and speech.
3. To develop the ability to differentiate among and to use facts, inferences and judgments and editing and proof-reading and organizing information for research communication, report, thesis and other publication.
4. To develop the analytical skills in composing the abstracts, content, notation, citation, captions, pagination, bibliography, review of literature, scientific manuscript, research article, review article, etc.
5. To able to evaluate the principles and need of technical communication and scientific writing style.
6. To able to design the scientific article writing and other professional encrypts.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - andHrs -) NA

UNIT-IV (Total Topics - andHrs -) NA

Practical (Topics- 13 Hrs- 26)

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.; Type and style of bibliography 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.

Course Outcomes (COs):

- NCHU-501 CO1 Educate about the various forms of writings frequently required in a preparation of documents, reports, manuscripts, manual, research paper, dissertation etc.
- NCHU-501 CO2 Develop the understanding of principles and method of effective and professional communication and speech.
- NCHU-501 CO3 Develop the ability to differentiate among and to use facts, inferences and judgments and editing and proof-reading and organizing information for research communication, report, thesis and other publication.

- NCHU-501 CO4 Develop the analytical skills in composing the abstracts, content, notation, citation, captions, pagination, bibliography, review of literature, scientific manuscript, research article, review article, etc.
- NCHU-501 CO5 Able to evaluate the principles and need of technical communication and scientific writing style.
- NCHU-501 CO6 Able to design the scientific article writing and other professional encrypts.

Suggested readings:

- Gordon, H.M.& Walter, J.A. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Hornby, A.S. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6thEd. Oxford University Press.
- Joseph, G. 2000. MLA Handbook for writers of Research Papers. 5th Ed. Affiliated EastWest Press.
- Mohan, K. 2005. Speaking English Effectively. MacMillan India.
- Richard, W.S. 1969. Technical Writing. Barnes & Noble.
- AbhishekSethi, J.&Dhamija, P.V. 2004. Course in Phonetics and Spoken English. 2ndEd. Prentice Hall of India.
- Wren, P.C.& Martin, H. 2006. High School English Grammar and Composition. S. Chand & Co
- .Mohan, K. 2015. Speaking English Effectively. MacMillan India.
- Journal: Effective Communication Skills
- (http://ijrar.com/upload_issue/ijrar_issue_140.pdf).

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	1	1	1	1	1	1	1	1	1	1
CO-2	1	1	1	-	1	1	1	1	1	1	1
CO-3	1	1	2	-	1	-	1	1	1	1	1
CO-4	1	1	2	-	1	-	1	1	3	1	1
CO-5	1	1	1	1	1	-	1	1	1	1	1
CO-6	1	1	1	1	1	-	1	1	1	1	1
Average	1.0	1.0	1.3	1.0	1.0	1.0	1.0	1.0	1.3	1.0	1.0

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
NCHU-501	Technical Writing and Communication Skills	0	0	2	-	20	80	-	100	2(0+2)

Detailed Syllabus of Ph.D. Plant Protection-Entomology

Major courses (Gradial courses)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	ENT-601	Credit	3(1+2)
Year/Sem	Year 1; Semester – I	L-T-P	2-0-2
Course Name	Insect Phylogeny and Systematics		

Course Objectives:

1. To impart the knowledge about different terms of phylogeny & systematics, phenograms, cladograms, Phylocode etc.
2. To understand the concepts of taxonomic hierarchy, studytaxonomiccharacters,variations,intra-specificphenotypicplasticity.
3. To apply multivariate analysis techniques for clustering specimens into different taxa, and development of phenograms.
4. To develop ability to differentiate various insect species based ontheir morphological and molecular characters.
5. To evaluation of diversity of insects over geological times on the basis of fossil evidences.
6. To preparetaxonomickeys, phylogenetic tree forspecificgroupsandwritepapersandreviews.

UNIT I (Total Topics- 5 and Hrs- 8)

Detailed study of three schools of classification- numerical, evolutionary and cladistics. Methodologies employed. Development of phenograms, cladograms, molecular approaches for the classification of organisms. Methods in identification of homology. Species concepts, speciation processes and evidences. Zoogeography.

UNIT II (Total Topics - 3 and Hrs- 6)

Study of different views on the evolution of insects- alternative phylogenies of insects: Kukalova Peck and Kristensen. Fossil insects and evolution of insect diversity over geological times.

UNIT- III (Total Topics - 6 and Hrs- 10)

Detailed study of International Code of Zoological Nomenclature, including appendices to ICZN; scientific ethics. Nomenclature and documentation protocols and procedures; report preparation on new species; deposition of holotypes, paratypes, and insect specimens as a whole in national and international repositories – requirements and procedures.

UNIT-IV (Total Topics - 4 and Hrs- 6)

Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications – small publications of species descriptions, works on revision of taxa, monographs, and check lists, faunal volumes etc. Websites related to insect taxonomy and databases. Molecular taxonomy, barcoding species and the progress made in molecular sytematics.

Practical (Experiments- 6 and Hrs - 14)

Collection, curation and study of one taxon of insects- literature search, compilation of a checklist, study of characters, development of character table, and construction of taxonomic keys for the selected group;Development of descriptions, photographing, writing diagrams, and preparation of

specimens for "type like" preservation, Submission of the collections made of the group;Multivariate analysis techniques for clustering specimens into different taxa, and development of phenograms;Rooting and character polarization for developing cladograms and use of computer programmes to develop cladograms.

Course Outcomes (CO):

- ENT-601-CO1: Impart the knowledge about different terms of phylogeny & systematics, phenograms, cladograms, Phylocode etc.
- ENT-601-CO2: Understand the concepts of taxonomic hierarchy, studytaxonomiccharacters,variations,intra-specificphenotypicplasticity.
- ENT-601-CO3: Apply multivariate analysis techniques for clustering specimens into different taxa, and development of phenograms.
- ENT-601-CO4: Develop ability to differentiate various insect species on the basis of morphological and molecular characters.
- ENT-601-CO5: Evaluation of diversity of insects over geological times on the basis of fossil evidences.
- ENT-601-CO6: Preparetaxonomickeys, phylogenetic tree forspecificgroupsandwritepapersandreviews.

References:

- CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers.* 2nd Ed. Vols.I and II, CSIRO. Cornell Univ. Press, Ithaca.
- Dakeshott J and Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer-Verlag, Berlin.
- Freeman S and Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall, New Delhi. Hennig W. 1960. *Phylogenetic Systematics*. Urbana Univ. Illinois Press, USA.
- Hoy MA. 2003. *Insect Molecular Genetics: An Introduction to Principles and Applications*. 2nd Ed. Academic Press, New York.
- Mayr E and Ashlock PD. 1991. *Principles of Systematic Zoology.* 2nd Ed. McGraw Hill, New York.
- Mayr E.1969. *Principles of Systematic Zoology.* McGraw-Hill, New York.
- Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy.* Blackie Academic and Professional, London.
- Ross HH. 1974. *Biological Systematics.* Addison Wesley Publ. Co., London.
- Wiley EO. 1981. *Phylogenetics: The Theory and Practices of Phylogenetic Systematics for Biologists*. Columbia Univ. Press, USA.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	2	1	-	-	-	2	3	1	-	-	-
CO-2	1	-	-	-	1	2	-	-	-	1	1
CO-3	2	2	2	2	1	3	2	1	1	1	1
CO-4	1	-	-	2	1	2	2	3	1	2	2
CO-5	1	-	-	2	1	2	2	3	1	2	2
CO-6	1	-	-	2	1	2	2	3	1	2	2
Average	1.5	1.5	2.0	2.0	1.0	2.3	2.3	1.7	1.0	1.3	1.3

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
ENT-661	Insect Phylogeny and Systematics	2	0	2	20	10	20	50	100	3(2+1)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	ENT-604	Credit	2(1+1)
Year/Sem	Year 1; Semester – I	L-T-P	1-0-1
Course Name	Insect behavior		

Course Objectives:

1. To impart the knowledge about ethology and communication pattern in insects.
2. To understand the concepts of super-normal stimuli and behavioral manipulation as potential tool in pest management.
3. To use physical cues in host selection in a phytophagous insect, chemical and odor cues in host selection in phytophagous insect.
4. To develop ability to differentiate olfactory and auditory signals in inter- and intra-specific communication
5. To develop ability to evaluate different types of traps against fruit flies with respect to signals
6. To develop semio-chemicals to analyze different behavioral mechanism in insects.

UNIT I (Total Topics- 5 and Hrs- 8)

Defining Behaviour- Concept of umwelt, instinct, fixed action patterns, imprinting, complex behavior, inducted behavior, learnt behavior and motivation. History of Ethology- development of behaviorism and ethology, contribution of Darwin, Frisch, Tinbergen and Lorenz; Studying behavior- Proximate and Ultimate approaches, behavioral traits under natural selection, genetic control of behavior and behavioural polymorphism.

UNIT II (Total Topics - 3 and Hrs- 6)

Orientation- Forms of primary and secondary orientation including taxes and kinesis; Communication- primary and secondary orientation, responses to environmental stimuli, role of visual, olfactory and auditory signals in inter- and intra-specific communication, use of signals in defense, mimicry, polyphenism; evolution of signals.

UNIT- III (Total Topics - 6 and Hrs- 10)

Reproductive behavior- mate finding, courtship, territoriality, parental care, parental investment, sexual selection and evolution of sex ratios; Social behavior- kin selection, parental manipulation and mutualism; Self organization and insect behavior.

UNIT-IV (Total Topics - 4 and Hrs- 6)

Foraging- Role of different signals in host searching (plant and insects) and host acceptance, ovipositional behavior, pollination behavior, co-evolution of plants and insect pollinators. Behaviour in IPM- Concept of super-normal stimuli and behavioural manipulation as potential tool in pest management, use of semio- chemicals, auditory stimuli and visual signals in pest management.

Practical (Experiments- 6 and Hrs - 14)

Quantitative methods in sampling behavior; Training bees to artificial feeders; Sensory adaptation and habituation in a fly or butterfly model, physical cues used in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect (DBM or gram pod borer), colour discrimination in honey bee or butterfly model, learning and memory in bees, role of self-organization in resource tracking by honeybees; Evaluation of different types of traps against fruit flies with respect to signals; Use of honey bees/ *Helicoverpa armigera* to understand behavioural polymorphism with respect to learning and response to pheromone mixtures, respectively.

Course Outcomes (CO):

- ENT-604-CO1: To impart the knowledge about ethology and communication pattern in insects.
- ENT-604-CO2: To understand the concepts of super-normal stimuli and behavioural manipulation as potential tool in pest management.
- ENT-604-CO3: To use physical cues in host selection in a phytophagous insect, chemical and odour cues in host selection in phytophagous insect.
- ENT-604-CO4: To develop ability to differentiate olfactory and auditory signals in inter- and intra-specific communication
- ENT-604-CO5: To develop ability to evaluate different types of traps against fruit flies with respect to signals
- ENT-604-CO6: To develop semio-chemicals to analyse different behavioural mechanism in insects.

References:

- Ananthkrishnan TN. (Ed.). 1994. Functional Dynamics of Phytophagous Insects. Oxford and
- IBH, New Delhi.
- Awasthi VB. 2001. Principles of Insect Behaviour. Scientific Publ., Jodhpur.
- Bernays EA and Chapman RF. 1994. Host-Plant Selection by Phytophagous Insects. Chapman and Hall, London.
- Brown LB. 1999. The Experimental Analysis of Insect Behaviour. Springer, Berlin.
- Krebs JR and Davies NB. 1993. An Introduction to Behavioural Ecology. 3rd Ed. Chapman and
- Hall, London.
- Manning A and Dawkins MS. 1992. An Introduction to Animal Behaviour. Cambridge University Press, USA.
- Mathews RW and Mathews JR. 1978. Insect Behaviour. A Wiley-InterScience Publ. John Wiley and Sons, New York.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	2	1	-	-	-	2	3	1	-	-	-
CO-2	1	-	-	-	1	2	-	-	-	1	1
CO-3	2	2	2	2	1	3	2	1	1	1	1
CO-4	1	-	-	2	1	2	2	3	1	2	2
CO-5	2	2	2	2	1	3	2	1	1	1	1
CO-6	1	-	-	2	1	2	2	3	1	2	2
Average	1.5	1.7	2.0	2.0	1.0	2.3	2.2	1.8	1.0	1.4	1.4

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Mid term Theory Examination**	**Assignment**	**Practical Examination**			
ENT-604	Insect behaviour	2	0	2	20	10	20	50	100	2(1+1)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	ENT-604	Credit	2(1+1)
Year/Sem	Year 1; Semester – I	L-T-P	1-0-1
Course Name	Molecular Entomology		

Course Objectives:

1. To acquaint with basic knowledge about molecular biology and its techniques.
2. To develop understanding of DNA-based diagnostics, genetic improvement of inebriate tolerance of natural enemies.
3. To develop skills in isolation of DNA/ RNA; Purity determinations, purification of total DNA from animal tissues; Base pair estimation.
4. To develop ability to DNA-based diagnostics, insect immune systems in comparison to vertebrates.
5. To develop ability to select the marker genes for sex identification.
6. To develop resistance management strategies in transgenic crops by using recombinant technology.

UNIT I (Total Topics - 2 and Hrs - 2)

Introduction to molecular biology; 1-0 techniques used in molecular biology.

UNIT II (Total Topics - 10 and Hrs- 12)

DNA and RNA analysis in insects-transcription and translocation mechanisms. DNA recombinant technology, identification of genes/ nucleotide sequences for characters of interest. Genetic improvement of natural enemies. Cell lines, genetic engineering in baculoviruses, Bt and entomopathogenic fungi.

UNIT- III (Total Topics - 10 and Hrs- 5)

Genes of interest in entomological research- marker genes for sex identification, neuropeptides, JH esterase, St toxins and venoms, chitinase, CPTI; lectins and proteases. Transgenic plants for pest resistance and diseases.

UNIT-IV (Total Topics - 4 and Hrs-2)

Insect gene transformation; biotechnology in relation to silkworms and honey bees; introduction of lectin genes for pest suppression; DNA finger printing for taxonomy and phylogeny. Genetic improvement of inebriate tolerance of natural enemies.

UNIT-V (Total Topics - 4 and Hrs-2)

DNA-based diagnostics; insect immune systems in comparison to vertebrates; molecular basis of metamorphosis; Sf transgenic technology and implications; molecular biology of baculoviruses; insecticide resistance. Resistance management strategies in transgenic crops.

Practical (Experiments- 8 and Hrs -16)

Isolation of DNA/ RNA; Purity determinations, purification of total DNA from animal tissues; Base pair estimation. Agarose gel electrophoresis; Quantitative enzyme profile of alimentary canal;restriction mapping of DNA;demonstration of PCR, RFLP and RAPD techniques.

Course Outcomes (CO):

- ENT-609.CO.1: To acquaint with basic knowledge about molecular biology and its techniques.
- ENT-609.CO.2: Understand the DNA-based diagnostics, genetic improvement of inebriate tolerance of natural enemies.
- ENT-609.CO.3: Develop skills in isolation of DNA/ RNA; Purity determinations, purification

of total DNA from animal tissues; Base pair estimation.

- ENT-609.CO.4: Develop ability to demonstration of PCR, RFLP and RAPD techniques.
- ENT-609.CO.5: Make able to select the marker genes for sex identification.
- ENT-609.CO.6: Develop resistance management strategies in transgenic crops by using recombinant technology.

Suggested readings:

- Bhattacharya TK, Kumar P and Sharma A. 2007. Animal Biotechnology. 1st Ed., Kalyani
- Publication, New Delhi.
- Hagedon HH, Hilderbrand JG, Kidwell MG and Law JH. 1990. Molecular Insect Science. Plenum
- Press, New York.
- Hoy MA. 2003. Insect Molecular Genetics: An Introduction to Principles and Applications. 2nd
- Ed. Academic Press, New York.
- Oakeshott J and Whitten MA. 1994. Molecular Approaches to Fundamental and Applied
- Entomology. Springer Verlag.
- Rechcigl JE and Rechcigl NA. 1998. Biological and Biotechnological Control of Insect Pests.
- Lewis Publ., North Carolina.
- Roy U and Saxena V. 2007. A Hand Book of Genetic Engineering. 1st Ed., Kalyani Publishers, New Delhi.
- Singh BD. 2008. Biotechnology (Expanding Horizons). Kalyani Publishers, New Delhi. Singh P. 2007. Introductory to Biotechnology. 2nd Ed. Kalyani Publishers, New Delhi.

Articulated attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	2	2	1	2	-	3	1	1	-	2	2
CO-2	-	-	-	-	-	3	-	-	-	1	1
CO-3	-	-	-	-	-	2	-	-	-	-	-
CO-4	1	1	1	-	-	2	2	1	3	2	2
CO-5	2	2	1	2	-	3	1	1	-	2	2
CO-6	1	1	1	-	-	2	2	1	3	2	2
Average	1.5	1.5	1.0	2.0	-	2.5	1.5	1.0	3.0	1.8	1.8

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Mid-term Theory Examination	Assignment	Practical Examination			
ENT 609	Molecular Entomology	1	0	1	20	10	20	50	100	2(1+1)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	ENT- 606	Credit	3(2+1)
Year/Sem	Year 1; Semester – II	L-T-P	2-0-2
Course Name	Insect Toxicology and Residues		

Objectives of the Course:

1. To acquaint with scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.
2. To classify the insecticides based on mode of entry, mode of action and chemical nature.
3. To implement biological techniques for detection of insecticide resistance in insects.
4. To analyze factors affecting toxicity of insecticides and their mode of action of newer insecticide.
5. To calculate maximum residue limits (MRLs) of insecticides and their significance and environmental implications.
6. To develop skills to safe use of insecticides; diagnosis and treatment of insecticide poisoning.

UNIT I (Total Topics- 8 and Hrs- 9)

Penetration and distribution of insecticides in insect systems; insecticide selectivity; factors affecting toxicity of insecticides. Modes of action of newer insecticide molecules; developments in bio-rational approaches; SPLAT; RNAi technology for pest management.

UNIT II (Total Topics - 7 and Hrs- 7)

Biochemical and physiological target sites of insecticides in insects; developments in bio-rationals, bio-pesticides and newer molecules; their modes of action and structural – activity relationships; advances in metabolism of insecticides.

UNIT- III (Total Topics - 3 and Hrs- 2)

Joint action of insecticides; activation, synergism and potentiation.

UNIT-IV (Total Topics - 8 and Hrs- 5)

Problems associated with pesticide use in agriculture: pesticide resistance; resistance mechanisms and resistant management strategies; pest resurgence and outbreaks; persistence and pollution; health hazards and other side effects.

Unit V (Total Topics - 9 and Hrs- 7)

Estimation of insecticidal residues- sampling, extraction, clean-up and estimation by various methods; maximum residue limits (MRLs) and their fixation; bound and conjugated residues, effect on soil fertility; insecticide laws and standards, and good agricultural practices.

Practical (Total Topics - 10 and Hrs- 20) Residue sampling, extraction, clean-up and estimation of insecticide residues by various methods; Calculations and interpretation of data; Biochemical and biological techniques for detection of insecticide resistance in insects; Preparation of EC formulation using neem oil.

Course Outcomes (CO):

- ENT-606.CO.1: Acquaint with scope of insecticide toxicology; history of chemical control; pesticide use and pesticide industry in India.
- ENT-606.CO.2: Classify the insecticides based on mode of entry, mode of action and chemical nature.
- ENT-606.CO.3: Implement various techniques for detection of insecticide resistance in insects.

- ENT-606.CO.4: Analyze factors affecting toxicity of insecticides and their mode of action of newer insecticide.
- ENT-606.CO.5: Calculate maximum residue limits (MRLs) of insecticides and their significance and environmental implications.
- ENT-606.CO.6: Develop skills to safe use of insecticides; diagnosis and treatment of insecticide poisoning.

Suggested readings:

- Busvine JR. 1971. *A Critical Review on the Techniques for Testing Insecticides.* CABI, London. Dhaliwal GS and Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publishers, New Delhi.
- Hayes WJ and Laws ER. 1991. *Handbook of Pesticide Toxicology.* Academic Press, New York.
- Ishaaya I and Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ.
- House, New Delhi.
- Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.
- O' Brien RD. 1974. *Insecticides Action and Metabolism.* Academic Press, New York.
- Perry AS, Yamamoto I, Ishaaya I and Perry R. 1998. *Insecticides in Agriculture and Environment.*
- Narosa Publ. House, New Delhi.
- Prakash A and Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

Articulated attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	-	-	-	3	-	-	-	-	-	-
CO-2	1	-	-	-	3	-	-	-	-	-	-
CO-3	1	-	-	-	3	-	-	-	-	-	-
CO-4	1	-	-	-	3	-	-	-	-	-	-
CO-5	1	-	-	-	3	-	-	-	-	-	-
CO-6	1	-	-	-	3	-	-	-	-	-	-
Average	1.0	-	-	-	3.0	-	-	-	-	-	-

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
ENT-606	Insect Toxicology and Residues	2	0	2	20	10	20	50	100	3(2+1)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	ENT-610	Credit	2(2+0)
Year/Sem	Year-1; Semester-II	L-T-P	2-0-2
Course Name	Integrated Pest Management		

Course Objectives:

1. To educate about the concepts, tools and principles of Integrated Pest and Disease Management.
2. To develop understanding of the role of IPM in sustainable agriculture as the future of modern plant protection in pest and disease control strategy.
3. To develop skills in methods of detection and diagnosis of insect pest and diseases and application of different pest and disease control techniques.
4. To develop skills for analyzing the agricultural ecosystem, level of pest damage, Pest risk and timing of different pest control tactics to manage the pest population effectively.
5. To evaluate economic injury level and economic threshold level for timely application of control measures for pest management.
6. To design crop model for implementing IPM system.

UNIT I (Total Topics - 6 and Hrs- 5)

Principles of sampling and surveillance, database management and computer programming; simulation techniques, system analysis and modeling.

UNIT II (Total Topics - 2 and Hrs- 5)

Study of case histories of national and international programmes, their implementation, adoption and criticism; global trade and risk of invasive pests; updating knowledge on insect outbreaks and their management.

UNIT- III (Total Topics - 7 and Hrs- 14)

Genetic engineering and new technologies- their progress and limitations in IPM programmes, deployment of benevolent alien genes for pest management- case studies; scope and limitations of bio-intensive and ecological based IPM programmes; application of IPM to farmers' real time situation.

UNIT-IV (Total Topics - 8 and Hrs- 6)

Challenges, needs and future outlook; dynamism of IPM under changing cropping systems and climate; insect pest management under protected cultivation; strategies for pesticide resistance management.

Practical (Experiments – 00 and Hrs - 00)

NA

Course Outcomes (CO):

ENT 610.CO.1: To educate about the concepts, tools and principles of Integrated Pest and Disease Management.
ENT 610.CO.2: To develop understanding of the role of IPM in sustainable agriculture as the future of modern plant protection in pest and disease control strategy.
ENT 610.CO.3: To develop skills in methods of detection and diagnosis of insect pest and diseases and application of different pest and disease control techniques.
ENT 610.CO.4: To develop skills for analyzing the agricultural ecosystem, level of pest damage, Pest risk and timing of different pest control tactics to manage the pest population effectively.
ENT 610.CO.5: To evaluate economic injury level and economic threshold level for timely application of control measures for pest management.
ENT 610.CO.6: To design crop model for implementing IPM system.

Suggested readings:

- Dhaliwal GS and Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.*
- Kalyani Publishers, New Delhi.
- Dhaliwal GS, Singh R and Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publishers, New Delhi.
- Flint MC and Bosch RV. 1981. *Introduction to Integrated Pest Management.* Springer, Berlin. Koul O and Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI, London. Koul O, Dhaliwal GS and Curperus GW. 2004. *Integrated Pest Management –Potential,*
- *Constraints and Challenges.* CABI, London.
- Maredia KM, Dakouo D and Mota-Sanchez D. 2003. *Integrated Pest Management in the Global Arena.* CABI, London.
- Metcalf RL and Luckman WH. 1982. *Introduction to Insect Pest Management.* John Wiley and Sons, New York.
- Norris RF, Caswell-Chen EP and Kogan M. 2002. *Concepts in Integrated Pest Management.*
- Prentice Hall, New Delhi.
- Pedigo RL. 1996. *Entomology and Pest Management.* Prentice Hall, New Delhi. Subramanyam B and Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.*
- Marcel Dekker, New York.

Articulated attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	1	1	1	-	3	1	3	2	3	3
CO-2	1	-	-	-	-	2	2	1	-	2	2
CO-3	1	1	-	-	-	2	1	2	3	2	2
CO-4	1	1	-	-	-	2	1	2	3	2	2
CO-5	1	1	1	1	-	3	1	3	2	3	3
CO-6	1	-	-	-	-	2	2	1	-	2	2
Average	1.0	1.0	1.0	1.0	-	2.3	1.3	2.0	2.7	2.3	2.3

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
ENT-610	Integrated Pest Management	2	0	2	40	10	-	50	100	2(2+0)

Minor Courses (Gradial Course)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	PL PATH 601	Credit	3(2+1)
Year/Sem	Year-1; Semester-I	L-T-P	2-0-2
Course Name	AdvancesinMycology		

Course Objectives:

1. To educate fundamentals, concepts, relationship and classification of fungi are studied.
2. To develop the understanding about morphological and biology of fungi in the laboratory.
3. To apply the different techniques for identification and preservation of fungi.
4. To examine the morphological and reproductive structure of fungi.
5. To evaluate the chemicals for preserve and manage of fungal pathogen.
6. To demonstrate the morphological structures and disease samples in lab

UNIT I (Total Topics - 6 and Hrs- 5)

General introduction, historical development and advances in mycology. Recent taxonomic criteria, morphological criteria for classification. Serological, chemical (chemotaxonomy), molecular and numerical (computer based assessment) taxonomy. Interaction between groups: Phylogeny, Micro conidiation, conidiogenesis and sporulating structures of fungi imperfecti.

UNIT II (Total Topics - 2 and Hrs- 5)

Population biology, pathogenic variability/ vegetative compatibility. Heterokaryosis and parasexual cycle. Sex hormones in fungi. Pleomorphism and speciation in fungi. Mechanism of nuclear inheritance. Mechanism of extra-nuclear inheritance. Biodegradation.

UNIT- III (Total Topics - 7 and Hrs- 14)

Ultra structures and chemical constituents of fungal cells, functions of cell organelles. Mitosis, meiosis, gene action and regulation. Effects of fungal interaction with host plants and other microorganisms; parasitism, symbiosis and commensalism.

UNIT-IV (Total Topics - 8 and Hrs- 6)

Genetic Improvement of Fungal strains. Fungal biotechnology. Fungi mediated synthesis of nano particles – characterization process and application. Mycotoxins problems and its management

Practical (Experiments – 6 and Hrs - 12)

Isolation,purificationandidentificationofcultures,sporesandmatingtypedetermination; Studyofconidiogenesis-Phialides,porospores,arthospores; StudyoffruitingbodiesinAscomycotina; Identificationoffungiuptospecieslevel; Studyofhyphalanastomosis; Morphologyofrepresentativeplantpathogenicgeneraformdifferentgroupsoffungi; Molecularcharacterizationoffungi.

Course Outcomes (CO):

- PL PATH 601.CO.1: Students gain knowledge about fundamentals, concepts, relationship and classification of fungi.
- PL PATH 601.CO.2: Students develop the understanding about morphological and biology of fungi in the laboratory.
- PL PATH 601.CO.3: Students apply the different techniques for identification and preservation of fungi.
- PL PATH 601.CO.4: In this subject students easily examine the morphological and reproductive structure of fungi.

- PL PATH 601.CO.5: Students evaluate the chemicals for preserve and manage of fungal pathogen.
- PL PATH 601.CO.6: Students easily demonstrate the morphological structures and disease samples in lab.

Suggested readings:

- Alexopoulos CJ, Mims CW and Blackwell M. 1996. *Introductory Mycology*. John Wiley & Sons, New York.
- Dube HC. 2005. *An Introduction to Fungi.* 3rd Ed. Vikas Publ. House, New Delhi.
- Kirk PM, Cannon PF, David JC and Stalpers JA. (Eds.). 2001. *Ainsworth and Bisby's Dictionary of Fungi*. 9th Ed., CABI, Wallington.
- Maheshwari R. 2016. *Fungi: Experimental Methods in Biology* 2nd edn. CRC Press, US.
- Ulloa M and Hanlin RT. 2000. *Illustrated Dictionary of Mycology*. APS, St. Paul, Minnesota. Webster J and Weber R. 2007. *Introduction to Fungi.* Cambridge University Press, Cambridge.

Articulated attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5
CO-1	1	1	1	1	-	3	1	3	2	3	3
CO-2	1	-	-	-	-	2	2	1	-	2	2
CO-3	1	1	-	-	-	2	1	2	3	2	2
CO-4	1	1	-	-	-	2	1	2	3	2	2
CO-5	1	1	1	1	-	3	1	3	2	3	3
CO-6	1	1	-	-	-	2	1	2	3	2	2
Average	1.0	1.0	1.0	1.0	-	2.3	1.2	2.2	2.6	2.3	2.3

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
PL PATH 601	Advances in Mycology	2	0	2	20	10	20	50	100	3(2+1)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	PL PATH 605	Credit	1(1+0)
Year/Sem	Year 1; Semester – II	L-T-P	1-0-0
Course Name	Principles and Procedures of Certification		

Course Objectives:

1. To acquaint with certification procedures of seed and planting material.
2. To understand the International scenario of certification and role of ISTA, EPPO, OECD, etc. in certification and quality control.
3. To develop skills to apply ecological based IPM to farmers' real time situation.
4. To examine genetic identity, physical purity, germination percentage, seed health etc.
5. To evaluate quality of various seed/ planting material before certification.
6. To prepare highly equipped laboratory for seed/plant material testing.

UNIT I (Total Topics - 6 and Hrs- 5)

Introduction to certification. International scenario of certification and role of ISTA, EPPO, OECD, etc. in certification and quality control. Case studies of certification systems of USA and Europe. National Regulatory mechanism and certification system including seed certification, minimum seed certification standards. National status of seed health in seed certification. Methods for testing genetic identity, physical purity, germination percentage, seed health, etc. Fixing tolerance limits for diseases and insect pests in certification and quality control programmes

UNIT II (Total Topics - 2 and Hrs- 5)

Methods used in certification of seeds, vegetative propagules and in-vitro cultures. Accreditation of seed testing laboratories. Role of seed/ planting material health certification in national and international trade.

Practical (Experiments – NA and Hrs - NA)

NA

Course Outcomes (CO):

- PL PATH-605-CO.1: Acquaint with certification procedures of seed and planting material.
- PL PATH-605-CO.2: Understand the International scenario of certification and role of ISTA, EPPO, OECD, etc. in certification and quality control.
- PL PATH-605-CO.3: Develop skills to apply ecological based IPM to farmers' real time situation.
- PL PATH-605-CO.4: Examine genetic identity, physical purity, germination percentage, seed health etc.
- PL PATH-605-CO.5: Evaluate quality of various seed/ planting material before certification.
- PL PATH-605-CO.6: Develop highly equipped laboratory for seed/plant material testing.

Suggested readings:

- Association of Official Seed Certifying Agencies. Hutchins D and Reeves JE. (Eds.). 1997. Seed Health Testing: Progress Towards the 21st Century. CABI, UK. ISHI-veg Manual of Seed
- Health Testing Methods.
- ISHI-F Manual of Seed Health Testing Methods. ISTA Seed Health Testing Methods.
- Tunwar NS and Singh SV. 1988. Indian Minimum Seed Certification Standards. Central Seed

Certification Board, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India, New Delhi. US National Seed Health System.

- e-Resources
  http://www.aosca.org/index.htm.
  http://www.worldseed.org/enus/international_seed/ishi_vegetable.html
  http://www.worldseed.org/en-us/international _seed/ ishi_f.html
  http://www.seedtest.org/en/content—1—1132—241.html http://www.seedhealth.org

Articulated attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	1	1	1	-	3	1	3	2	3	3
CO-2	1	-	-	-	-	2	2	1	-	2	2
CO-3	1	1	-	-	-	2	1	2	3	2	2
CO-4	1	1	-	-	-	2	1	2	3	2	2
CO-5	1	-	-	-	-	2	2	1	-	2	2
CO-6	1	1	-	-	-	2	1	2	3	2	2
Average	1.0	1.0	1.0	1.0	-	2.3	1.3	2.0	2.7	2.3	2.3

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
PL PATH-605	Principles and procedures of Certification	2	0	2	40	10	00	50	100	1(1+0)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	PL PATH 606	Credit	2(2+0)
Year/Sem	Year 1; Semester – II	L-T-P	2-0-0
Course Name	Plant Biosecurity and Biosafety		

Course Objectives:

1. To define the terms quarantine, Invasive Alien Species, biowarfare, Emerging/ resurgence of pests.
2. To understand the concept of biosecurity and its importance.
3. To develop skills to use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity.
4. To analyze pest risk and its assessment by using GIS & GPS systems.
5. To examine invasive species, emerging/ resurgence of pests and diseases quality of various seed/ planting material before certification.
6. To develop strategies for combating risks and costs associated with agro-terrorism event, mitigation planning, integrated approach for biosecurity.

UNIT I (Total Topics - 8 and Hrs- 8)

History of biosecurity, Concept of biosecurity, Components of biosecurity, Quarantine, Invasive Alien Species, Biowarfare, Emerging/ resurgence of pests and diseases. Introduction and History of biosecurity and its importance.

UNIT II (Total Topics - 15 and Hrs- 12)

National Regulatory Mechanism and International Agreements/ Conventions, viz., Agreement on Application of Sanitary and Phytosanitary (SPS) Measures. World Trade Organization (WTO), Convention on Biological Diversity (CBD), International Standards for Phytosanitary Measures, pest risk analysis, risk assessment models, pest information system, early warning and forecasting system, use of Global Positioning System (GPS) and Geographic Information System (GIS) for plant biosecurity, pest/ disease and epidemic management, strategies for combating risks and costs associated with agroterrorism event, mitigation planning, integrated approach for biosecurity.

UNIT III (Total Topics - 15 and Hrs- 12)

Biosafety, policies and regulatory mechanism, Cartagena Protocol on Biosafety and its implications, Issues related to release of genetically modified crops. Emerging/ resurgence of pests and diseases in the changing scenario of climatic conditions. Issues related to release of genetically modified crops.

Practical (Experiments – 00 and Hrs - 00)NA

Course Outcomes (CO):

- PLPATH-606-CO.1: To define the terms quarantine, Invasive Alien Species, biowarfare, Emerging/ resurgence of pests.
- PL PATH-606-CO.2: To understand the concept of biosecurity and its importance.
- PL PATH-606-CO.3: To develop skills to use of Global Positioning System (GPS) and Geographic Information system (GIS) for plant biosecurity.
- PL PATH-606-CO.4: To analyze pest risk and its assessment by using GIS & GPS systems.
- PL PATH-606-CO.5: To examine invasive species, emerging/ resurgence of pests and diseases quality of various seed/ planting material before certification.
- PL PATH-606-CO.6: To develop strategies for combating risks and costs associated with agro-terrorism event, mitigation planning, integrated approach for biosecurity.

Suggested readings:

- Biosecurity: A Comprehensive Action Plan. Biosecurity Australia.
- Biosecurity for Agriculture and Food Production. FAO Biosecurity Toolkit 2008.
- Grotto Andrew J and Jonathan B Tucker. 2006. Biosecurity Guidance.
- Khetarpal RK and Kavita Gupta 2006. Plant Biosecurity in India – Status and Strategy. Asian
- Biotechnology and Development Review 9(2): 3963.
- Randhawa GJ, Khetarpal RK, Tyagi RK and Dhillon BS (Eds.). 2001. Transgenic Crops and
- Biosafety Concerns. NBPGR, New Delhi. e-Resources
  http://www.inspection.gc.ca/english/anima/heasan/fad/biosecure.sht ml
- www.fao.org/docrep/010/a1140e/a1140e00.htm Laboratory
- http://www.who.int/csr/resources/publications/biosafety/WHO_CD S_EPR_2006.pdf
  http://www.americanprogress.org/kf/biosecurity_ a_comprehensive_ action_plan.pdf
  www.biosecurity.govt.nz DEFRA. www.defra.gov.uk/animalh/diseases/control/biosecurity/
- index.htm
- www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia Biosecurity New Zealand.
  http://www.fao.org/biosecurity/ CFIA.

Articulated attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	1	1	1	-	3	1	3	2	3	3
CO-2	1	-	-	-	-	2	2	1	-	2	2
CO-3	1	1	-	-	-	2	1	2	3	2	2
CO-4	1	1	-	-	-	2	1	2	3	2	2
CO-5	1	1	-	-	-	2	1	2	3	2	2
CO-6	1	1	-	-	-	2	1	2	3	2	2
Average	1.0	1.0	1.0	1.0	-	2.3	1.3	2.0	2.7	2.3	2.3

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
PL PATH-606	Plant biosecurity and biosafety of Certification	2	0	2	40	10	00	50	100	2(2+0)

Supporting courses (Compulsory for all students) (Gradial courses)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	RM-101	Credit	4(4+0)
Year/Sem	Year -1; Semester-I	L-T-P	4-0-0
Course Name	Research Methodology in Entomology		

Course Objectives:

1. To Equip the Students with the Concept and Methodology of Research.
2. To provide knowledge about type of research, preparation of reports and thesis, designing of Research using Scientific Methods.
3. To develop the ability to apply principles and procedure for data analysis and interpretation of results.
4. To analyze various sampling methods and probability of research analysis.
5. To evaluate interpretations and significance of report writing.
6. To develop the ability to create appropriate hypothesis, select experimental design and presentation of results after analysis of data.

UNIT I (Total Topics- 7 and Hrs-12)

Introduction to Research: Definition, Nature and significance, Role and Objectives; Types of Research: exploratory, descriptive, experimental and diagnostic research, social and legal research and traditional, analytical, empirical & fundamental research, Doctrinal and non-doctrinal research methods; Various Research Designs; Scientific Research Process: Overview, Problem identification and formulation of research statement.

UNIT II(Total Topics- 7 and Hrs- 12)

Data Collection: sources, primary and secondary methods, significance of Primary and Secondary Data, questionnaire Vs. schedules; Data Processing: Editing, Coding Organization and Presentation; Attitude Measurement and scaling: Measurement Scales, Sources of Errors in Measurement, Techniques of Developing Measurement Tools, Classification and Testing (Reliability, Verification and Validity) Scales, Designing Questionnaires and Interviews.

UNIT- III (Total Topics- 5 and Hrs- 10)

Sampling, Sampling Methods, Sampling Plans, Sampling Error, Sampling Distributions: Theory and Design of Sample Survey, Census Vs Sample Enumerations, Objectives and Principles of Sampling, Types of Sampling, Sampling and Non-Sampling Errors, Concept of Permutation, Combination & Probability for research analysis.

UNIT-IV(Total Topics- 5 and Hrs- 10)

Interpretations and Report Writing: Meaning of Interpretation, Techniques of Interpretation, Precautions in Interpretation, Significance of Report Writing, Steps in Report Writing, Layout of Report and Precautions in Writing Research Reports. Limitations of RM: Ethics in Research, Philosophical Issues in Research.

Practical)- NA

Course Outcomes (COs):

- RM-101 CO1. Acquire in-depth knowledge of various fundamentals, theories and principles relatto the research and apply the acquired knowledge in carrying out research studies in the

area of interest.

- RM-101 CO2. Identify, formulate and critically investigate research problems by applying research-oriented knowledge and analyze relevant data to reach certain conclusions in the form of alternative solutions to these problems.
- RM-101 CO3. Apply the acquired knowledge and skills to develop minds to think out of the box while carrying out research operations to conclude something.
- RM-101 CO4. Apply parametric and non-parametric statistical tests to verify the developed hypothesis to suggest innovative solutions to the problem being investigated.
- RM-101 CO5. Evaluation interpretations and significance of report writing.
- RM-101 CO6. Creation of appropriate hypothesis, select experimental design and presentation of results after analysis of data.

Suggested readings:

1. William G. Zikmund, "Business Research Methods", Orlando: Dryden Press.
2. C. William Emory and Cooper R. Donald, "Business Research Methods", Boston, Irwin.
3. Fred N Kerlinger, "Foundations of Behavioural Research", New Delhi: Surjeet Publications.
4. Naresh Malhotra, Marketing Research: An Applied Orientation, Pearson publication David Nachmias and Chava Nachmias, "Research Methods in the Social Sciences", New York: St.Marlia's Press.
5. Bhattacharya, D. K. (2004) Research Methodology, New Delhi, Excel Books

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
RM-101	Research Methodology in Horticulture	4	0	0	40	10	-	50	100	4(4+0)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	RM-102	Credit	2(2+0)
Year/Sem	Year -1; Semester-I	L-T-P	2-0-0
Course Name	Computer & Stats Application in Research		

Course Objectives:

13. To appraise computational skills for research application.
14. To assess statistical method for research analysis.
15. To create skills in methods of collection of any type of data, classification of data, presentation of data, analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
16. To analyse statistical calculations and their validation.
17. To justify the decision in the reference of data analysis, formation and Analysis of data.
18. To create ANOVA through different methods and their interpretation.

UNIT I (Total Topics- 7 and Hrs-12)

Characteristics of Computers, Evolution of computers, computer memory, computer generations, Basic computer organization; System software, Application software, introduction to operating system, single user, multi-user, multitasking single tasking, application of computer for business and research, MS-windows, Linux .Application of Internet in research: INFLIBNET, Use of Internet, sights (DOAJ), Use of E Journals, Use of E library, use of EBSCO HOST online database of Academic Libraries. Subject/field specific tools on www.freeware.com

UNIT II(Total Topics- 7 and Hrs- 12)

Computer Application in Research,. Basic concept of Computer, Use of Internet for Research Purpose: E-mail, WWW, Web browsing, technical skills, drawing inferences from data, Research publishing tools-MS Word, Adobe acrobat, Graphics tool-MS Excel, Presentation tool-MS Power, Data Analysis Software and Analysis Techniques point. Creating presentation and adding effects, Introduction to Data analysis software-SPSS: Definition, objectives and features, data analysis using SPSS.

UNIT- III (Total Topics- 5 and Hrs- 10)

Statistical methods for research application in analysis of data, Measurement in Research , data interpretation, Measures of Central Tendency, Measures of Dispersion, Measures of Asymmetry (Skewness), std deviation, Measures of Relationship, Simple Regression Analysis, Correlation and Regression, Partial Correlation.

UNIT-IV(Total Topics- 5 and Hrs- 10)

Statistical Tools-Hypothesis and Hypothesis Testing: Parametric & Non-Parametric Tests, Important Parametric Tests ,Hypothesis Testing of Correlation Coefficients ,U Test, Chi Square Test, ,T-Test. Analysis of Variance (ANOVA) , The Basic Principle of ANOVA ,ANOVA Technique, Setting up Analysis of Variance Table, Short-cut Method for One-way ANOVA, Coding Method, Two-way ANOVA .

Practical- NA

Course Outcomes (COs):

- RM-102.CO.1: Remembering basics terms used in collection, classification, presentation and analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
- RM-102.CO.2: Understanding of use of various formulas, principles and methods of statistical

calculations used in agriculture.

- RM-102.CO.3: Applying skills in methods of collection of any type of data, classification of data, presentation of data, analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
- RM-102.CO.4: Analysis of statistical calculations and their validation.
- RM-102.CO.5: Evaluation the various data through statistical tests.
- RM-102CO.6: Creation of ANOVA table through different methods and its interpretation..

Suggested readings:

1. C. R. Kothari, "Research Methodology: Methods and techniques", New Delhi: Vishwa Prakashan.
2. Brymann, Alan and Carmer, D. (1995) Qualitative data analysis for social scientist, New York, Routledge Publication.
3. Jain, Satish: "Introduction to Computer Science and basic Programming." BPB Publications, New Delhi, 1990. • Rajaraman, V., "Fundamental of Computers", Prentice Hall of India, New Delhi, 1996.
13. Hogg, R.V.& Craig, T.T. 1978. Introduction to Mathematical Statistics. Macmillan.
14. (PDF) Statistical Methods and their Applications (researchgate.net)
15. Welcome to Web Agri Stat Package (icar.gov.in)
16. (PDF) BASIC STATISTICAL TECHNIQUES IN RESEARCH (researchgate.net)
17. Statistical Methods & Applications | Home (springer.com)
18. Statistical Methodology - Journal - Elsevier

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
RM-102	Computer & Stats Application in Research	4	0	0	40	10	-	50	100	4(4+0)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	RPE-103	Credit	2(2+0)
Year/Sem	Year -1; Semester-I	L-T-P	2-0-0
Course Name	Research& Publication Ethics		

Course Objectives:

1. To acquaint with knowledge about basics of Agricultural Research and research ethics
2. To understand research ethics including research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards, and problems in research ethics.
3. To apply research ethics in collection and interpretation of data.
4. To analyze the major publication ethics to be followed during research.
5. To evaluate violation of publication ethics, authorship and contributor ship
6. To develop ability to identify different predatory publishers and journals.

UNIT I (Total Topics- 2 and Hrs-8)

1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgments and reactions

UNIT II (Total Topics- 5 and Hrs- 5)

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

UNIT- III (Total Topics-7 and Hrs-7)

1. Publication ethics: definition, introduction and importance
2. Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest.
4. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types
5. Violation of publication ethics, authorship and contributor ship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

UNIT- IV (Total Topics-4and Hrs-4)

Practice

Open Access Publishing

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder/ Journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal Suggester, etc.

Course Outcomes (COs):

- RPE-103.CO1. Recognize the basics of philosophy of science & ethics, research integrity, publication ethics and theories of research ethics.
- RPE-103.CO2. Familiarize with important issues in research ethics, research integrity, scientific

misconduct and misinterpretation of data.

- RPE-103.CO3. Analyze the best practices for publications, publication ethics and identify the predatory publishers & journals.
- RPE-103.CO4. Demonstrate &use plagiarism software tools, open-source software tools, citation databases and research metrics.
- RPE-103.CO5.Evaluation credible & scholarly publications in reputed peer-reviewed journals.
- RPE-103.CO6.Creation of ethical publications for high impact peer reviewed journals.

Suggested readings:

Research and Publication Ethics, Dr Sumanta Dutta, Bharti Publications,2021
Research and Publication Ethics, Dr Santosh kumar Yadav, Anne Publications,2020

- Kumar, R. 2014. Research Methodology: A Step-by-Step Guide for Beginners. 4th Edition. SAGE Publications Ltd.
- Parikh, M.N, Gogtay, N. 2009. ABC of Research Methodology and Applied Biostatistics. Jaypee Publishers, New Delhi.
- Library & Information Science Research | Journal | ScienceDirect.com by Elsevier
- (PDF) Library and Information Science Research (researchgate.net)
- Research Journal of Library Sciences Introduction :ISCA
- Research Ethics: Definition, Principles and Advantages - Public Health Notes
- What Is Ethics in Research & Why Is It Important? - by David B. Resnik, J.D., Ph.D. (nih.gov)
- The Journal of Ethics | Home (springer.com)

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
RPE-103	Research& Publication Ethics	2	0	0	40	10	-	50	100	2(2+0)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	ENT-691	Credit	1(0+1)
Year/Sem	Year 1; Semester – I	L-T-P	0-0-2
Course Name	Doctoral Seminar (Compulsory Course)		

Course Objectives:

1. To remember scientific terms, concepts, and content preparation, etc.
2. To understand procedures of power point presentation.
3. To apply usage of photographs and sketches in power point to give valuable information.
4. To analyze data incorporation in seminar and its effectiveness.
5. To evaluate utilization of different sources of data.
6. To develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

UNIT I (Total Topics- and Hrs-) NA

UNIT II (Total Topics - and Hrs-) NA

UNIT- III (Total Topics - and Hrs-) NA

UNIT-IV (Total Topics - and Hrs-) NA

Practical (Hrs- 20)

A power point presentation on any topic chosen from the courses studied to be prepared and delivered to the group of faculty members/staff and students of department.

Essential components of Presentation are:

Organization of topic, Presentation of data. Oral presentation, Delivery, language, explanation of figures, Ability to grasp and understand the subject, Depth of understanding the topic.

Course Outcomes (COs):

- ENT-691.CO.1: Acquaint with scientific terms, concepts, and content preparation, etc.
- ENT-691.CO.2: Understand ability to make power point and presentation.
- ENT-691.CO.3: Apply utilization of photographs and sketches in power point to give valuable information.
- ENT-691.CO.4: Analyze data incorporation in seminar and its effectiveness.
- ENT-691.CO.5 Evaluate utilization of different sources of data.
- ENT-691.CO.6 Develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

Suggested readings:

Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
ENT-691	Doctoral Seminar	0	0	2	-	-	100	-	100	1(0+1)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	ENT-691	Credit	1(0+1)
Year/Sem	Year 1; Semester – II	L-T-P	0-0-2
Course Name	Doctoral Seminar (Compulsory Course)		

Course Objectives:

1. To remember scientific terms, concepts, and content preparation, etc.
2. To understand procedures of power point presentation.
3. To apply usage of photographs and sketches in power point to give valuable information.
4. To analyze data incorporation in seminar and its effectiveness.
5. To evaluate utilization of different sources of data.
6. To develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

UNIT I (Total Topics- and Hrs-) NA

UNIT II (Total Topics - and Hrs-) NA

UNIT- III (Total Topics - and Hrs-) NA

UNIT-IV (Total Topics - and Hrs-) NA

Practical (Hrs- 20)

A power point presentation on any topic chosen from the courses studied to be prepared and delivered to the group of faculty members/staff and students of department.

Essential components of Presentation are:

Organization of topic, Presentation of data. Oral presentation, Delivery, language, explanation of figures, Ability to grasp and understand the subject, Depth of understanding the topic.

Course Outcomes (COs):

- ENT-691.CO.1: Acquaint with scientific terms, concepts, and content preparation, etc.
- ENT-691.CO.2: Understand ability to make power point and presentation.
- ENT-691.CO.3: Apply utilization of photographs and sketches in power point to give valuable information.
- ENT-691.CO.4: Analyze data incorporation in seminar and its effectiveness.
- ENT-691.CO.5 Evaluate utilization of different sources of data.
- ENT-691.CO.6 Develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

Suggested readings:

Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	1	1	3	2	2	2	1	2	2
CO-2	1	3	1	2	3	2	2	2	1	1	1
CO-3	2	1	2	3	1	1	1	3	2	1	1
CO-4	3	3	1	1	2	1	1	2	1	1	1
CO-5	1	2	2	1	1	2	2	2	1	2	2
CO-6	1	1	1	2	2	2	1	1	1	2	2
Average	1.8	2.1	1.1	1.6	2.0	1.6	1.5	2.0	1.1	1.5	1.5

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
ENT-691	Doctoral Seminar	0	0	2	-	-	100	-	100	1(0+1)

Doctoral Research Work

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	ENT-699	Credit	75(0+75)
Year/Sem	Not Applicable	L-T-P	Not Applicable
Course Name	Doctoral Research (Compulsory Course)		

Course Objectives:

1. To acquaint with the scientific terms of research designing, citation and bibliography, intellectual property right (IPR) and its uses in academic life, theoretical arguments, content preparation, etc.
2. To develop ability to make the ethical dimensions of research work and knowledge to obtain appropriate approval.
3. To improve understandings of the systematic discovery, scientific measurements, statistical calculations and analysis of data, critical review, novelty of work, etc.
4. To develop skills in the research works, formulation of hypotheses, collection, classification, presentation and analysis primary/secondary data, assessment of resources, time management, fund utilization, critical analysis, preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs.
5. To develop ability to create the links between theory and practical during lab and field experiments.
6. To develop a sense of responsibility for the making conclusions and recommendations by scientific pursuits and influence the new opportunities for entrepreneurship and employability.

UNIT I (Total Topics- and Hrs-) NA

UNIT II (Total Topics - and Hrs-) NA

UNIT- III (Total Topics - and Hrs-) NA

UNIT-IV (Total Topics - and Hrs-) NA

Practical (Hrs-)

Synopsis, Research Work & Thesis writing provides the students an excellent opportunity to develop analytical research and entrepreneurial skills, and knowledge through meaningful hands on experience, confidence in their ability to design and investigate the things.

Course Outcomes (COs):

- ENT-699.CO.1: Acquaint with scientific terms, concepts, and content preparation, etc.
- ENT-699.CO.2: Understand ability to make power point and presentation.
- ENT-699.CO.3: Apply utilization of photographs and sketches in power point to give valuable information.
- ENT-699.CO.4: Analyze data incorporation in seminar and its effectiveness.
- ENT-699.CO.5 Evaluate utilization of different sources of data.
- ENT-699.CO.6 Develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

Suggested readings:

Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	3	3	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	3	3	3	3
CO-4	3	3	3	3	3	3	3	3	3	3	3
CO-5	3	3	3	3	3	3	3	3	3	3	3
CO-6	3	3	3	3	3	3	3	3	3	3	3
Average	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
ENT-699	Doctoral Seminar	NA	NA	NA	NA	NA	NA	NA	NA	75(0+75)

Non Gradial Compulsory Courses

(To be opted if not in course curriculum of M.Sc. degree Programme of a student)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	NCLIB -501	Credit	1(0+1)
Year/Sem	Year 1; Semester I/II	L-T-P	0-0-2
Course Name	Library and Information Services		

Course Objectives:

1. To educate about the basics of library and its services.
2. To understand the system and organization of library.
3. To use the different sources information of library.
4. To analyses the Intricacies of abstracting and indexing services.
5. To select appropriate information and database available online and offline and categorize them.
6. To author an abstract, scientific manuscript, report, review, etc. with appropriate citation and bibliography.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - and Hrs -) NA

UNIT-IV (Total Topics - and Hrs -) NA

Practical (Topic- 11, Hrs- 20)

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 (Scopus index, 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.

Course Outcomes (COs):

- NCLIB-501.CO.1. To educate about the basics of library and its services.
- NCLIB-501.CO.2. To understand the system and organization of library.
- NCLIB-501.CO.3. To use the different sources information of library.
- NCLIB-501.CO.4. To analyses the Intricacies of abstracting and indexing services.
- NCLIB-501.CO.5. To select appropriate information and database available online and offline and categorize them.
- NCLIB-501.CO.6. To author an abstract, scientific manuscript, report, review, etc. with appropriate citation and bibliography.

Suggested readings:

- Sharma, B.K. and Thakur, U.M., 2013. Library, Information Science & Information Technology: Descriptive Study (2 Vols). YK Publishers, India.
- Omesh, A. 2010. Management of Digital Library. Oxford Book Company.
- Kumbhar, R. 2014. Library and Information Science Research Methods and Techniques.

Universal Prakashan, Pune, India.
- Sukula, S. 2014. Introduction to Library & Information Science. EssEss Publications.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	-	-	2	-	1	-	3	-	2	2
CO-2	1	1	1	1	1	1	3	-	3	-	-
CO-3	-	1	3	2	3	3	2	2	-	3	3
CO-4	-	-	2	-	3	2	2	-	2	-	-
CO-5	2	2	1	2	2	2	1	2	1	2	2
CO-6	2	2	1	3	1	3	1	1	1	1	1
Average	1.0	1.0	1.3	1.3	1.3	2.0	1.3	1.3	1.1	1.3	1.3

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCLIB-501	Library and Information Services	1	0	0	-	20	80	-	100	1(0+1)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	NCHU-501	Credit	1(0+1)
Year/Sem	Year 1; Semester I/II	L-T-P	0-0-2
Course Name	Technical Writing and Communication Skills		

Course Objectives:

1. To educate about the various forms of writings frequently required in a preparation of documents, reports, manuscripts, manual, research paper, dissertation.
2. To develop the understanding of principles and method of effective and professional communication and speech.
3. To develop the ability to differentiate among and to use facts, inferences and judgments and editing and proof-reading and organizing information for research communication, report, thesis and other publication.
4. To develop the analytical skills in composing the abstracts, content, notation, citation, captions, pagination, bibliography, review of literature, scientific manuscript, research article, review article, etc.
5. To able to evaluate the principles and need of technical communication and scientific writing style.
6. To able to design the scientific article writing and other professional encrypts.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - andHrs -) NA

UNIT-IV (Total Topics - andHrs -) NA

Practical (Topics- 13 Hrs- 26)

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.; Type and style of bibliographycommonly 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.

Course Outcomes (COs):

- NCHU-501 CO1 Educate about the various forms of writings frequently required in a preparation of documents, reports, manuscripts, manual, research paper, dissertation etc.
- NCHU-501 CO2 Develop the understanding of principles and method of effective and professional communication and speech.
- NCHU-501 CO3 Develop the ability to differentiate among and to use facts, inferences and judgments and editing and proof-reading and organizing information for research communication, report, thesis and other publication.
- NCHU-501. CO4 Develop the analytical skills in composing the abstracts, content, notation,

citation, captions, pagination, bibliography, review of literature, scientific manuscript, research article, review article, etc.

- NCHU-501 CO5. Able to evaluate the principles and need of technical communication and scientific writing style.
- NCHU-501 CO6 Able to design the scientific article writing and other professional encrypts.

Suggested readings:

- Gordon, H.M.& Walter, J.A. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Hornby, A.S. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6thEd. Oxford University Press.
- Joseph, G. 2000. MLA Handbook for writers of Research Papers. 5th Ed. Affiliated EastWest Press.
- Mohan, K. 2005. Speaking English Effectively. MacMillan India.
- Richard, W.S. 1969. Technical Writing. Barnes & Noble.
- Abhishek Sethi, J.& Dhamija, P.V. 2004. Course in Phonetics and Spoken English. 2ndEd. Prentice Hall of India.
- Wren, P.C.& Martin, H. 2006. High School English Grammar and Composition. S. Chand & Co.
- Mohan, K. 2015. Speaking English Effectively. MacMillan India.
- Link:https://agrimoon.com/comprehension-developing-communication-skills-in-english-pdf-book/

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	3	2	2	-	2	1	3	2	1	3	3
CO-2	3	2	2	-	1	1	2	2	1	2	2
CO-3	3	1	2	1	1	-	1	1	-	2	2
CO-4	2	1	2	2	2	-	1	1	1	-	-
CO-5	1	1	-	-	-	-	-	1	-	-	-
CO-6	1	-	-	-	1	1	-	-	-	-	-
Average	2.2	1.4	2.0	1.5	1.4	1.0	1.8	1.4	1.0	2.3	2.3

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCHU-501	Technical Writing and Communication Skills	0	0	2	-	20	80	-	100	1(0+1)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	NCPH-501	Credit	1(1+0)
Year/Sem	Year 1; Semester I/II	L-T-P	1-0-0
Course Name	Disaster Management		

Course Objectives:

1. To educate about the natural and manmade disasters/hazards and their causes.
2. To develop the understanding of standard methods for mitigation process of disaster.
3. To develop ability for social support in national disaster management framework governed by government and non-government organizations.
4. To motivate for the efforts for conservation of environment.
5. To evaluate disaster response.
6. To create the disaster management framework.

UNIT I (Total Topics- 13 and Hrs- 5)

Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Cloudburst and its causes; Case studies of cloudburst in Uttarakhand, Earthquakes, Landslides, Case study of landslide in Uttarakhand, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.

UNIT II (Total Topics - 17 and Hrs- 5)

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT- III (Total Topics - 5 and Hrs- 5)

Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

UNIT-IV (Total Topics - andHrs-) – NA

Practical – NA

Course Outcomes (COs):

- NCPH-501. CO.1. Educate for identifying the natural and manmade disasters/hazards and their causes.
- NCPH-501. CO.2. Develop the understanding of standard methods for mitigation process of disaster.
- NCPH-501. CO.3. Develop ability for social support in national disaster management framework governed by government and non government organizations.
- NCPH-501. CO.4. Motivate for the efforts for conservation of environment.
  NCPH-501. CO.5. Evaluate disaster response.
- NCPH-501. CO.6. Create the disaster management framework.

Suggested readings:

- Bharucha, E. 2004. Textbook for Environmental Studies For Undergraduate Courses of

Higher Education. UGC, New Delhi and Bharati Vidyapeeth Institute of Environment Education and Research, Pune.

- Gupta, H.K. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
- Hodgkinson, P.E. & Stewart, M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
- Sharma, V.K. 2001. Disaster Management. National Centre for Disaster Management, India.
- Sharma P.D. Ecology and Environment. 2017. Thirteenth Edition. Rastogi Publications.
- Rao, M N. & Datta, A.K. 1987. WasteWater treatment. Oxford & IBH Publ. Co. Pvt. Ltd.
- Brunner, R.C., 1989. Hazardous Waste Incineration, McGraw Hill Inc.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5
CO-1	1	1	1	1	1	1	1	1	1	1	1
CO-2	1	1	1	-	1	1	1	1	1	1	1
CO-3	1	1	2	-	1	-	1	1	1	1	1
CO-4	1	1	2	-	1	-	1	1	3	1	1
CO-5	1	1	1	1	1	-	1	1	1	1	1
CO-6	1	1	1	1	1	-	1	1	1	1	1
Average	1.0	1.0	1.8	1.0	1.0	1.0	1.0	1.0	1.8	1.0	1.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCPH-501	Disaster Management	1	0	0	80	20	-	-	100	1(1+0)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	NCIT-501	Credit	1(1+0)
Year/Sem	Year 1; Semester I/II	L-T-P	1-0-0
Course Name	Intellectual Property Rights and Their Management in Agriculture		

Course Objectives:

1. To acquaint the meaning of intellectual property and differentiate it from tangible property.
2. To develop understanding of the process of IPR, their eligibility and various treaties and conventions.
3. To develop ability to apply Licensing technologies, Material transfer agreements and Research collaboration Agreement.
4. To develop the ability to analyze TRIPs and various provisions in TRIPS Agreement, GI, ITK, protection of plant varieties, researcher's right and farmers' right.
5. To develop ability to evaluate the ethical and professional issues that arise in the intellectual property law.
6. To develop the skill to create patents, copyrights, geographical indications, designs and layout.

UNIT I (Total Topics- 3 and Hrs - 3)

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.

UNIT II (Total Topics - 5 and Hrs- 3)

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

UNIT- III (Total Topics - 6 and Hrs- 4)

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

UNIT-IV (Total Topics - 4 and Hrs- 3)

Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Practical (Hrs-) – NA

Course Outcomes (COs):

- NCIT-501.CO.1 Acquaint the meaning of intellectual property and differentiate it from tangible property.
- NCIT-501.CO.2. To understand the process of IPR, their eligibility and various treaties and conventions.
- NCIT-501.CO.3. Develop ability to apply Licensing technologies, Material transfer agreements and Research collaboration Agreement.
- NCIT-501.CO.4. Develop the ability to analyze TRIPs and various provisions in TRIPS Agreement, GI, ITK, protection of plant varieties, researcher's right and farmers' right.
- NCIT-501. CO.5. Develop ability to evaluate the ethical and professional issues that arise in

the intellectual property law.

- NCIT-501.CO.6. Develop the skill to create patents, copyrights, geographical indications, designs and layout.

Suggested readings:

- Bilek Debroy, 2004. Intellectual Property Rights, BR World of books, New Delhi.
- Ganguli, P., 2001. Intellectual Property Rights - Unleashing the Knowledge Economy. Tata McGraw Hill, New Delhi.
- Narayanan, R., 2006. Patent Law, Eastern Law House, New Delhi.
- Ramappa, T., 2000. Intellectual Property Rights under WTO - Tasks before India, Wheeler Publishing, New Delhi.
- Link: https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=ZzUApmBk4i7kYctp+aiP1w==

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5	PSO -6
CO-1	1	1	1	1	1	1	1	1	1	1	1	1
CO-2	1	1	1	-	1	1	1	1	1	1	1	1
CO-3	1	1	2	-	1	-	1	1	1	1	1	1
CO-4	1	1	2	-	1	-	1	1	3	1	1	1
CO-5	1	1	1	1	1	-	1	1	1	1	1	1
CO-6	1	1	1	1	1	-	1	1	1	1	1	1
Average	1.0	1.0	1.8	1.0	1.0	1.0	1.0	1.0	1.8	1.0	1.0	1.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCIT-501	Intellectual Property and Its Management in Agriculture	0	0	2	80	20	-	-	100	1(1+0)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	NCBT-501	Credit	1(0+1)
Year/Sem	Year 1; Semester I/II	L-T-P	0-0-2
Course Name	Basic Concepts in Laboratory Techniques		

Course Objectives:

1. To educate about basic rules and regulations of laboratory, use.
2. To develop the understanding of principles and methods of handling chemicals and equipments, preparation of solution, testing samples, etc. in the laboratory.
3. To develop the skills to operate laboratory equipments efficiently and safely.
4. To develop the skill to analyse handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing.
5. To evaluate the preparation of buffers of different strengths and pH values.
6. To develop the ability to design appropriate procedure of scientific works in the laboratory in such a way that accuracy of results remains higher.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - and Hrs -) NA

UNIT-IV (Total Topics - and Hrs -) NA

Practical (Experiments- 17 Hrs- 20)

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; Neutralization 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, sandbath, waterbath, oilbath; 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.

Course Outcomes (COs):

- NCBT-501.CO.1. Educate about basic rules and regulations of laboratory, use.
- NCBT-501.CO.2. To develop the understanding of principles and methods of handling chemicals and equipments, preparation of solution, testing samples, etc. in the laboratory.
- NCBT-501.CO.3. To develop the skills to operate laboratory equipments efficiently and safely.
- NCBT-501.CO.4. To develops the skill to analyse handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, water bath, oilbath; Electric wiring and earthing.
- NCBT-501.CO.5. Evaluate the preparation of buffers of different strengths and pH values.
- NCBT-501.CO.6. Develops the ability to design appropriate procedure of scientific works in the laboratory in such a way that accuracy of results remains higher.

Suggested readings:

- Furr, A.K. 2000. CRC Hand Book of Laboratory Safety. CRC Press.

- Gabb, M.H. &Latchem, W.E. 1968. A Handbook of Laboratory Solutions. Chemical Publ. Co.
- Prescott, L.M., Harley, P. and Klein, A. 2003. Microbiology , 5thEdition, MC. GrawHill, USA.
- Gupta,P.K.1997. Elements of Biotechnology. Rastogi Publications. Meerut.
- Singh, B.D. 2005.Bio technology, Expanding Horizons. Kalyani Publications, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -5	PSO -6
CO-1	-	-	-	-	-	-	1	-	-	-	-	-
CO-2	-	-	-	-	-	-	-	1	1	2	2	2
CO-3	-	-	-	-	-	-	1	1	1	-	-	-
CO-4	-	-	-	2	-	-	1	-	-	-	-	-
CO-5	-	-	-	-	-	-	1	1	-	-	-	-
CO-6	-	-	-	-	-	-	1	1	-	-	-	-
Average	-	-	-	1.0	-	-	1.0	1.0	1.0	1.0	1.0	1.0

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCBT-501	Basic Concepts in Laboratory Techniques	0	0	2	-	20	80	-	100	1(0+1)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	NCRM-501	Credit	1(1+0)
Year/Sem	Year 1; Semester I/II	L-T-P	1-0-0
Course Name	Agricultural Research, Research Ethics and Rural Development Programme		

Course Objectives:

1. To acquaint with knowledge about basics of Agricultural Research, Research Ethics and Rural Development Programmes in India.
2. To understand research ethics including research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.
3. To apply research ethics in collection and interpretation of data.
4. To analyze the major constraints in implementation of rural policies and programmes.
5. To evaluate different rural developmental programs, policies and strategies at different levels.
6. To formulate analyzed data according to different designs.

UNIT I (Total Topics - 6 and Hrs-6)

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 (Total Topics - 5 and Hrs- 3)

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

UNIT- III (Total Topics - 9 and Hrs- 4)

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, and Voluntary Agencies/Non R Governmental Organizations. Critical evaluation of rural development policies and programmes.

UNIT-IV (Total Topics - 1 and Hrs- 2)

Constraints in implementation of rural policies and programmes.

Practical (Total Topics - and Hrs -) NA

Course Outcomes (COs):

- NCRM-501. CO.1: Acquaint about basics of Agricultural Research and Research Ethics
- NCRM-501. CO.2: Understand of research ethics including research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and
- NCRM-501. CO.3: Apply research ethics in collection and interpretation of data.
- NCRM-501. CO.4: Analyze the major constraints in implementation of rural policies and

Programmes.

- NCRM-501. CO.5: Evaluate different rural developmental programs, policies and strategies at different levels.
- NCRM-501. CO.6: Formulate analyzed data according to different designs.

Suggested readings:

- Kumar, R. 2014. Research Methodology: A Step-by-Step Guide for Beginners. 4th Edition. SAGE Publications Ltd.
- Parikh, M.N, Gogtay, N. 2009. ABC of Research Methodology and Applied Biostatistics. Jaypee Publishers, New Delhi.

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	2	2	2	1	1	2	1	2	1	2	2
CO-2	1	1	2	1	-	-	1	1	-	1	1
CO-3	2	2	2	1	1	2	-	2	2	1	1
CO-4	2	2	1	1	-	1	1	1	1	-	-
CO-5	2	2	2	1	1	-	1	1	1	-	-
CO-6	1	2	2	1	1	1	-	1	-	1	1
Average	1.7	1.8	1.8	1.0	1.0	1.5	1.0	1.3	1.2	1.2	1.2

CODE	**Course Title**	**Periods per week**			**Evaluation Scheme**					**Credit Hours (Theory + Practical)**
					Internal Examination			**External Theory Examination**	**Subject Total**	
		L	**T**	**P**	**Midterm Theory Examination**	**Assignment**	**Practical Examination**			
NCRM-501	Agriculture Research, Research Ethics and Rural Development Programme	1	0	0	80	20	-	-	100	1(1+0)

Programme Name	Ph.D. Plant Protection-Entomology	Programme Code	23-
Course Code	NCHU-501	Credit	1(0+1)
Year/Sem	Year 1; Semester I/II	L-T-P	0-0-2
Course Name	Technical Writing and Communication Skills		

Course Objectives:

1. To educate about the various forms of writings frequently required in a preparation of documents, reports, manuscripts, manual, research paper, dissertation.
2. To develop the understanding of principles and method of effective and professional communication and speech.
3. To develop the ability to differentiate among and to use facts, inferences and judgments and editing and proof-reading and organizing information for research communication, report, thesis and other publication.
4. To develop the analytical skills in composing the abstracts, content, notation, citation, captions, pagination, bibliography, review of literature, scientific manuscript, research article, review article, etc.
5. To able to evaluate the principles and need of technical communication and scientific writing style.
6. To able to design the scientific article writing and other professional encrypts.

UNIT- I (Total Topics - and Hrs -) NA

UNIT-II (Total Topics - and Hrs -) NA

UNIT- III (Total Topics - andHrs -) NA

UNIT-IV (Total Topics - andHrs -) NA

Practical (Topics- 13 Hrs- 26)

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.; Type and style of bibliography 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.

Course Outcomes (COs):

- NCHU-501 CO1 Educate about the various forms of writings frequently required in a preparation of documents, reports, manuscripts, manual, research paper, dissertation etc.
- NCHU-501 CO2 Develop the understanding of principles and method of effective and professional communication and speech.
- NCHU-501 CO3 Develop the ability to differentiate among and to use facts, inferences and judgments and editing and proof-reading and organizing information for research communication, report, thesis and other publication.
- NCHU-501 CO4 Develop the analytical skills in composing the abstracts, content, notation,

citation, captions, pagination, bibliography, review of literature, scientific manuscript, research article, review article, etc.

- NCHU-501 CO5 Able to evaluate the principles and need of technical communication and scientific writing style.
- NCHU-501 CO6 Able to design the scientific article writing and other professional encrypts.

Suggested readings:

- Gordon, H.M.& Walter, J.A. 1970. Technical Writing. 3rd Ed. Holt, Rinehart & Winston.
- Hornby, A.S. 2000. Comp. Oxford Advanced Learner's Dictionary of Current English. 6thEd. Oxford University Press.
- Joseph, G. 2000. MLA Handbook for writers of Research Papers. 5th Ed. Affiliated EastWest Press.
- Mohan, K. 2005. Speaking English Effectively. MacMillan India.
- Richard, W.S. 1969. Technical Writing. Barnes & Noble.
- AbhishekSethi, J.&Dhamija, P.V. 2004. Course in Phonetics and Spoken English. 2ndEd. Prentice Hall of India.
- Wren, P.C.& Martin, H. 2006. High School English Grammar and Composition. S. Chand & Co
- .Mohan, K. 2015. Speaking English Effectively. MacMillan India.
- Journal: Effective Communication Skills
- (http://ijrar.com/upload_issue/ijrar_issue_140.pdf).

Articulated Attainment

COs	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO -2	PSO -3	PSO -4	PSO -5	PSO -6
CO-1	1	1	1	1	1	1	1	1	1	1	1
CO-2	1	1	1	-	1	1	1	1	1	1	1
CO-3	1	1	2	-	1	-	1	1	1	1	1
CO-4	1	1	2	-	1	-	1	1	3	1	1
CO-5	1	1	1	1	1	-	1	1	1	1	1
CO-6	1	1	1	1	1	-	1	1	1	1	1
Average	1.0	1.0	1.3	1.0	1.0	1.0	1.0	1.0	1.3	1.0	1.0

CODE	Course Title	Periods per week			Evaluation Scheme					Credit Hours (Theory + Practical)
					Internal Examination			External Theory Examination	Subject Total	
		L	T	P	Midterm Theory Examination	Assignment	Practical Examination			
NCHU-501	Technical Writing and Communication Skills	0	0	2	-	20	80	-	100	2(0+2)