



Department of Agricultural Botany
Mahatma Phule Krishi Vidyapeeth, Rahuri
Tal. Rahuri 413 722, Dist. Ahmednagar (MS)



Doctoral Programme
in
Plant Physiology

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	15
2.	Minor	08
3.	Supporting	05
4.	Seminar	02
5.	Research	45
	Total Credits	75
	Compulsory Non Credit Courses	06

Sr. No.	Course Number	Course Title	Credits
A) Major subjects (Min. 15 credits)			
1.	PP-604**	Techniques in Plant Physiology	1+2=3
2.	PP-609**	Advances in Crop Physiology	2+0=2
3.	PP-610**	Nitrogen Metabolism	2+1=3
4.	PP-605	Climate Change and Crop Growth	2+0=2
5.	PP-606	Post Harvest Physiology	1+1=2
6.	PP-607	Weed Physiology and Herbicide Action	1+1=2
7.	PP-608	Seed Physiology	2+1=3
B) Minor Subjects (Min. 8 credits)			
1.	BIOCHEM-607	Advance Techniques in Biochemistry	0+2=2
2.	BIOCHEM-603	Biochemistry of Biotic and Abiotic Stresses	3+0=3
3.	SST-607	Seed Germination	2+1=3
C) Supporting Subjects (Min. 05 credits)			
	SST-606	Seed Development and metabolism	2+0=2
	SST-604	DUS Testing for Plant Variety Protection	2+1=3

D) Seminar (2 credits)			
1.	PP-691	Doctoral Seminar-I	0+1=1
2.	PP-692	Doctoral Seminar-II	0+1=1
E) Doctoral Research (45 credits)			
1.		Doctoral Research	0+45=45
F) Non Credit Compulsory Courses			
1.	PGS-501	Library and Information Services	0+1=1
2.	PGS-504	Basic concepts in Laboratory techniques	0+1=1
3.	PGS-502	Technical Writing and Communication Skill	0+1=1
4.	PGS-503	Intellectual Property and Its Management in Agriculture	1+0=1
5.	PGS-505	Agriculture Research Ethics and Rural Development Programmes	1+0=1
6.	PGS-506	Disaster Management	1+0=1

**** Compulsory course**

Note: Ph. D. students may be exempted from NCCC, if already completed during Master's degree ..

Course Content

A) Major Subjects:

Course No. : PP 604- TECHNIQUES IN PLANT PHYSIOLOGY. Credits :1+2 =3

Theory

Lecture No	Topic
1-2	Recent experimental techniques to study various physiological processes, Photosynthetic gas exchange measurements, light and CO ₂ response curves-determination of relative limitations to photosynthesis; chlorophyll fluorescence measurements.
3-4	Estimation of water use efficiency at whole plant and single leaf level. Use of stable isotopes to understand physiological processes.
5	Radio isotopes in plant biology.
6-7	Tools and techniques (molecular and biochemical) to study physiological processes and to screen & assess stress responses in plants, such as (a) DNA & RNA isolation, cDNA synthesis & library construction, semi-quantitative & quantitative RT-PCR, northern blot, immunoassays; (b) techniques for defined physiological processes.
8	Methods to phenotype germplasm for specific physiological traits.
9-10	Quantification of mineral nutrients using advanced instruments like AAS, & ICP.
11-12	Techniques in plant transformation & analysis of transgenic plants
13-14	Molecular markers- genetic distance and mapping population concept of linkage maps and identification of QTLs.
15-16	Instrumentation: Acquaintance of the operation of specific instruments important in physiological research like Mass spec., phosphor-imager, DNA sequencer, spectro-fluorometer, oxygen electrode, etc.

Practical :

Practical No.	Topic
1	Photosynthetic gas exchange measurements.
2	Light and CO ₂ response curves-determination of relative limitations to photosynthesis
3	Chlorophyll fluorescence measurements
4	Estimation of water use efficiency at whole plant and single leaf level.
5	Use of stable and radioactive isotopes to understand physiological processes.
6	DNA & RNA isolation, cDNA synthesis & library construction,
7	Semiquantitative & quantitative RT-PCR, northern blot, immunoassays; techniques for defined physiological processes,
8	Quantification of mineral nutrients using advanced instruments like AAS.

Suggested Readings

Dhopte MA & Manuael Livera M. 1986. Useful Techniques for Plant Scientists. Forum for Plant Physiologists, R. D. G., Aloka.

Course No.: PP 609 -ADVANCES IN CROP PHYSIOLOGY . Credits : 2+0 =2**Theory**

Lecture No	Topic
1-6	Physiological aspects in relation to crop growth and productivity in cash crops like sugarcane, cotton, groundnut, safflower, sesamum etc.
7.-12	Physiological aspects in relation to crop growth and productivity in important fruits crops like Mango, Grape, Pomegranate, Guava, Citrus, Banana, Papaya etc.
13-18	Physiological aspects in relation to crop growth and productivity in important vegetable crops
19-24	Crop growth factors related to biomass - concept of crop growth rates, canopy photosynthesis, Light interception net assimilation rates environmental factors determining crop growth in relation to important cash crops, indices for improving crop productivity
25-28	Crop growth factors related to biomass - concept of crop growth rates, canopy photosynthesis, Light interception net assimilation rates environmental factors determining crop growth in relation to important fruit crops, indices for improving crop productivity
29-32	Crop growth factors related to biomass - concept of crop growth rates, canopy photosynthesis, Light interception net assimilation rates environmental factors determining crop growth in relation to important vegetable crops, indices for improving crop productivity

Suggested Readings :

Selected articles from various journals

- 1) F.P. Gardner, R.B.Pearse and R.L. Mitchell (1985) The Physiology of Crop Plants, Scientific Publisher, Jodhpur.
- 2) U.S. Gupta (1988) Progress in Crop PHysiology, Oxford IBH, Publi. Co., New Delhi.

- 3) M.Pessarakh (Ed.) Handbook of Plant and Crop Physiology, Marcel dekker Inc. U.S.A.
- 4) U.S. Gupta (ED.) (1996) Crop Improvement : Physiology Attributes, Vol.1, Oxford, IBH Publi. Co.Pvt. Ltd., New Delhi.
- 5) P.S. Nobel (1999) Physicochemical and Environmental Plant Physiology, Academic Press, London.
- 6) Amar Singh (1997) Fruit Physiology and Production, Kalyani Publishers, Ludhiana.
- 7) Scheffer B. and P.C. Anderson (1994) Mango : In handbook of Environmental Physiology of fruit crops, Vol. II, Subtropical and Tropical, cRS Inc. U.S.A.

Course No. : PP 610 - NITROGEN METABOLISM. Credits : 2+1 = 3

Theory

Lecture No	Topic
1-4	Nitrogen : Absorption, translocation and reduction
5-8	Symbiotic nitrogen fixation,
9-12	Amino acids, synthesis, amination, transamination
13-16	Nucleic acids : chemistry, structure, biosynthesis, degradation
17-20	Formation of nucleotide and nucleotides.
21-25	Proteins, peptide bond, mechanism of synthesis, types of protein, structure of protein
26-28	Break down of proteins, role and energy relation of protein
29-30	Relation of nitrogen metabolism with other plant metabolism
31-32	Relation of nitrogen with absorption and utilization of other elements.

Practical

Lecture No	Topic
1	Separation of amino acids and nucleic acids
2	Estimation of amino acids by chromatography and Amino acid analyzer
3	Estimation of enzyme activities
4	Estimation and identification of protein by gel electrophoresis
5	Estimation of nucleic acid
6	Determination of symbiotic N fixation

Suggested Readings :

Selected articles from various journals

- 1) S.L. Mehta, M.L. Lodha and P.V. Sane (1993). Recent Advances in Plant Biochemistry, ICAR, Publi., New Delhi.
- 2) D.E. Fosket (1994), Plant growth and development - A Molecular approach Academic Press, New York.

Course No.: PP 605 -CLIMATE CHANGE AND CROP GROWTH . Credits: 2+0 =2

Theory

Lecture No	Topic
1-4	History and evidences of climate change and its implications. Effect of climate change on monsoons, hydrological cycle and water availability.
5-10	Natural and anthropogenic activities and agricultural practices on GHG production, Monitoring of greenhouse gases and their influence on global warming and climate change, Ozone depletion leading to increased ionizing radiations and its implications on crop growth.
11-15	Long-term and short-term projections of climate change effects on natural vegetations and ecosystems, crop-pest interaction, area shift, food production and supply.
16-19	Approaches to mitigate climate change through studies on plant responses.
20-24	Direct and indirect effects of climate change on plant processes – phenology, net carbon assimilation, water relations, grain development and quality, nutrient acquisition and yield.
25-28	Conventional and biotechnological approaches to improve the crop adaptation to climate change. Relevance of “Genome wide mutants” to identify genes/processes for improved adaptation to changing environments
29-32	International conventions and global initiatives on Carbon sequestration, carbon trading .

Suggested Readings

- 1) Abrol YP & Gadgil S. (Eds.). 1999. Rice in a Changing Climate .
- 2) Reddy KR & Hodges HF. 2000. Climate Change and Global Crop Productivity. CABI.
- 3) Watson RT, Zinyowera MC & Moss RH. 1998. The Regional Impacts of Climate Change - an Assessment of Vulnerability. Cambridge Univ.Press.

Course No.: PP 606 -POST HARVEST PHYSIOLOGY . Credits: 1+1 =2

Theory

Lecture No	Topic
1-4	Environmental factors influencing senescence, ripening and post harvest life of flowers, vegetables and seeds.
5-8	Molecular mechanism of senescence and ageing. Physiological, biochemical and molecular aspects of senescence and fruit ripening.
9-11	Senescence associated genes and gene products.
12-15	Functional and ultra structural changes in chloroplast membranes, mitochondria and cell wall during senescence and ripening.
16-19	Regulatory role of ethylene in senescence and ripening, ethylene biosynthesis, perception and molecular mechanism of action.
20-23	Post harvest changes in seed and tubers biochemical constituent's quality parameters. Effect of environmental factors on post harvest changes in seed and tubers.
24-26	Biotechnological approaches to manipulate ethylene biosynthesis and action.

27-29	Alternate post harvest methodology and quality attributes. Scope for genetic modification of post harvest life of flowers and fruits.
30-32	Uses of GM crops and ecological risk assessment.

Practical

Practical No.	Topic
1	Physiological and biochemical changes during senescence and ripening
2	Estimation of ethylene during senescence and ripening
3	Determination of Reactive Oxygen Species and scavenging enzymes
4	Measurement of dark and alternate respiration rates during senescence and ripening.
5	Estimation of ripening related enzyme activity, Cellulases pectin methyl esterases, polygalacturonase etc.

Suggested Readings :

Jeffrey K Brecht & Weichmann J. 2003 . Post Harvest Physiology and Pathology of Vegetables. CRC Press.

Course No.: PP 607 - WEED PHYSIOLOGY AND HERBICIDE ACTION

Credits: 1+1 =2

Theory

Lecture No	Topic
1-2	Weed biology, ecology and physiology. Weed and crop competition, allelochemicals, their nature and impact. Weed-seed physiology.
3-5	Classification of herbicides and selectivity. Recent concepts on entry, uptake, translocation and metabolism of soil and foliar applied herbicides. Environmental and plant factors influencing entry, uptake and translocation of herbicides.
6-8	Classification and chemistry of common herbicides. Physiological, biochemical and molecular mechanism of action of different groups of herbicides; ACC synthase inhibitors, ALS inhibitors, Mitotic inhibitors, Cellulose biosynthesis inhibitors, Inhibitors of fatty acid biosynthesis, inhibitors of Photosynthesis, Auxinic Herbicides, New herbicides,
9-10	Metabolic pathway of herbicide degradation in plants and soil. Herbicide adjuvants and their classification.
11-12	Molecular mechanism of action of herbicide synergists and antagonists
13-14	Physiological and molecular mechanism of herbicide selectivity.
15-16	Herbicide resistant crops; transgenic & tissue culture approaches to develop herbicide tolerant varieties

Practical :

Practical No.	Topic
1	Adjuvants and their effect on spray droplets, chemical entry and transport.
2	Determination of physiological and biochemical processes like photosynthesis
3	Determination respiration, cell division, Protein & fatty acid synthesis, membrane permeability as affected by herbicides.
4	Quantification of pigment levels in leaves, specific enzyme activities affected by herbicides.
5	Demonstration of translocating type of herbicides by radio labeling studies.

Suggested Readings

- 1) Devine MD, Duke SO & Fedtake C. 1993. Physiology of Herbicide Action . Prentice Hall.
- 2) Monaco TJ, Weller SC & Ashton FM. 2002. Weed Science - Principles and Practices . Wiley.com Publ.

Course No.:PP 608 -SEED PHYSIOLOGY Credits: 2+1 = 3

Theory :

Lecture No	Topic
1-4	Seed and fruit development, seed and fruit abortion, proximate mechanism of seed and fruit abortion. Hereditary and environmental effect on seed development. Gene imprints and seed development.
5-9	Importance of seeds, seed structure and function, physiological and biochemical changes, environmental influences, physiology of seed and fruit development; seed and fruit abortion and means to overcome it; proximate mechanisms of seed and fruit abortion.
10-13	Structure of seeds and their storage resources, seed developmental patterns and source of assimilates for seed development.
14-18	Pathway of movement of assimilates in developing grains of monocots and dicots, Chemical composition of seeds, Storage of carbohydrates, proteins and fats in seeds and their biosynthesis.
19-23	Seed respiration, mitochondrial activity, Seed ageing, Mobilization of stored resource in seeds, Chemistry of oxidation of starch, proteins and fats, Utilization of breakdown products by embryonic axis.
24-27	Control processes in mobilization of stored resources, Role of embryonic axes, Gibberllin and a-amylase and other hydrolytic activity. Seed maturation phase and desiccation damage, Role of LEA proteins.
28-32	Seed viability, Physiology of and means to prolong seed viability, Seed vigour: concept, importance, measurement; invigoration: methods and physiological basis of it, Seed dormancy, types and regulation, Means to overcome seed dormancy.

Practical :

Practical No.	Topic
1	Determination of seed storage proteins
2	Sink drawing ability of ovules, empty ovule technique
3	Alpha-amylase activity in germinating seeds
4	Role of GA in inducing amylase activity
5	Role of embryo in GA induced α - amylase activity
6	Protease and lipase activity in germinating seeds
7	Seed viability test and accelerated ageing test.
8	Seed hardening/osmotic priming of seeds
9	Seed respiration rates
10	Seed viability losses through membrane leakage studies

Suggested Readings :

1. Bewley J D & Black M. 1985. Seed Physiology of Development and Germination . Plenum Publ.
2. Copeland LO & McDonald MB . Principles of Seed Sciences and Technology . Burgers Publ. Co.
3. Srivastav L M. Plant Growth and Development - Hormones and Environment, Academic Press.

B) Minor Subjects

Course No. : BIOCHEM 607 -ADVANCED TECHNIQUES IN BIOCHEMISTRY

Credits : 0+2=2

THEORY :**UNIT I**

Isolation and purification of protein from microbial/plant/animal source. Electrophoretic separation of protein. Determination of molecular weight of protein using PAGE/ gel filtration method.

UNIT II

Experiments on DNA: Isolation, agarose gel electrophoresis and restriction analysis of DNA.

UNIT III

Isolation of chloroplast and mitochondria by differential centrifugation and their purification by density gradient centrifugation.

UNIT IV

Isolation and purification of enzymes, isozymic analysis and enzyme immobilization

Suggested Readings:

- Kolowick NP & Kaplan NP. Methods in Enzymology. Academic Press (Series).
Plummer DT. 1998. An Introduction to Practical Biochemistry. 3rd Ed. Tata McGraw Hill.
Rickwood D. (Ed.). 1984. Practical Approaches in Biochemistry. 2nd Ed. IRL Press, Washington DC.
Wilson K & Goulding KH. 1992. A Biologist's Guide to Principles and Techniques of Practical Biochemistry. 3rd Ed. Cambridge Univ. Press.
Wilson K & Walker J. 2000. Principles and Techniques of Practical Biochemistry. 5th Ed. Cambridge Univ. Press.

TEACHING SCHEDULE:

No of Practicals	Name of the topics
2	Isolation and purification of protein (d-endo toxin) from <i>Bacillus thuringensis</i>
2	Isolation and purification of Bt. Toxin from Bt-transgenic
2	Isolation and purification of protein from animal source
2	Electrophoresis : Technique for separation of proteins
1	Electrophoretic separation of soluble proteins extracted from germinating seeds.
1	Determination of molecular weight of protein using SDS- PAGE
2	Determination of molecular wt. of protein by using gl filtration chromatography
2	Isolation and purification of genomic DNA From plant tissue
2	Isolation and purification of genomic DNA From plasmid DNA from bacterial culture.
2	Amplification of DNA using PCR
2	Agrose gel electrophoreses of amplified DNA
2	Restriction analysis of DNA
1	Isolation of chloroplasts by differential centrifugation
2	Isolation of mitochondria by differential centrifugation
2	Isolation of organelle DNA from mitochondria/chloroplasts
2	Isolation and Purification of peroxidase from wheat seedlings.
2	Isolation and purification of nitrate reductase from spinach leaves
1	Isozyme analysis using native PAGE
32	

Course No : BIOCHEM 603 - BIOCHEMISTRY OF BIOTIC AND ABIOTIC STRESSES

Credits 3+0=3

THEORY**UNIT I**

Plant-pathogen interaction and disease development; molecular mechanisms of fungal and bacterial infection in plants; changes in metabolism, cell wall composition and vascular transport in diseased plants.

UNIT II

Plant defence response, antimicrobial molecules; genes for resistance, hypersensitive response and cell death; systemic and acquired resistance.

UNIT III

Plant viruses, host-virus interactions, disease induction, virus movement, and host range determination; viroids, pathogen-derived resistance.

UNIT IV

Biochemical basis of abiotic stresses namely osmotic (drought, salinity), temperature, heavy metals, air and water pollutants, synthesis and functions of proline and glycine betaine in stress tolerance interaction between biotic and abiotic stresses; stress adaptation.

UNIT V

Reactive oxygen species and biotic and abiotic stress, antioxidants, enzymes defense system. Role of calcium, nitric oxide and salicylic acid in plant development. Molecular strategies for imparting tolerance against biotic and abiotic stress.

Suggested Readings:

Basra AS. 1997. Stress Induced Gene Expression in Plants. Harwood Academic Publ.
Chessin M, DeBorde D & Zipf A. 1995. Antiviral Proteins in Higher Plants. CRC Press.
Crute IR, Burdon JJ & Holub EB. (Eds.). 1997. Gene-for-Gene Relationship in Host-Parasite Interactions. CABI. 40

THEORY :

TEACHING SCHEDULE

No of Lectures	Name of the topics
2	Plant-pathogen interaction and disease development
6	Molecular, mechanisms of fungal and bacterial infection in plants changes in metabolism, cell wall composition and vascular transport in diseased plants
3	Plant defense response, antimicrobial molecules
2	Genes for resistance
2	Hypersensitive response and cell death
2	Systemic and acquired resistance
4	Plant viruses, host-virus interactions, disease induction, virus movement, and host range determination; viroids, pathogen-derived resistance
4	Biochemical basis of abiotic stresses namely drought and salinity
2	Biochemical basis of abiotic stresses namely temperature
2	Biochemical basis of abiotic stresses namely heavy metals
2	Biochemical basis of abiotic stresses namely air and water pollutants
5	Synthesis and functions of proline and glycine betaine in stress tolerance interaction between biotic and abiotic stresses; stress adaptation.
3	Reactive oxygen species and biotic and abiotic stress
4	Antioxidants in enzymes defense system

3	Role of calcium, nitric oxide and salicylic acid in plant development
2	Molecular strategies for imparting tolerance against biotic and abiotic stress
48	

Course No. : SST 607 - Seed Germination Credit : 2+1 = 3

THEORY

Lecture No	Topic
1-5	Seed germination : environmental control, essential requirements, role of structural features, effect of temperature and radiation regimes and their interactions
6-8	Effect of age, size, position on mother plant on germination and vigour
9-10	Seed treatment : Chemical and physical
11-18	Germination metabolism : enzymatic changes, hormonal changes, metabolic changes, metabolic pathways; breakdown of reserve food.
19-23	Germination in field and laboratory injuries caused by heat cold, salt etc.
24-26	Role of phytochrome photomorphogenesis
27-29	Energy relations : requirement of energy, energy supply, energetic compounds, quantitative and kinetic aspects
30-33	Hormones : Quality and activity of natural promoters and quality inhibitors, changes during germination, activation of micromolecules and cell organelles.

Practical

Practical No.	Topic
1	Study of different methods of germination
2	Role of growth promoters and inhibitors in germination
3	Role of environmental factors in germination
4	Determination of enzymatic changes during germination
5	Estimation of metabolic changes during germination
6	Effect of chemicals on germination and vigour

C) Supporting Subjects

Course No. :SST 606 - Seed Development & Metabolism .Credit : 2+0 = 2

THEORY

Lecture No	Topic
1-3	Metabolic changes during pre and post maturation of seed
4-7	Hormonal level and biochemical changes during pre and post maturation
8-10	Indices for harvest ability of different kinds of seed
11-14	Effect of environment during pre and post-harvest period and storage on maturity and

	development, biochemical contents and hormonal levels.
15-18	Enzymatic and hormonal levels and their significance in synthesis
19-24	Degradation of proteins, fats and starches during pre and post maturation and its relation with cell organelles
24-28	Inheritance of metabolic drifts gene action and metabolic modulation
29-32	Basic metabolism : respiration and mitochondria

Suggested Readings

1. Physiology and Biochemistry of Seed by A.A. Black & Bewelly
2. Seed Technology by L.O. Copeland
3. Seed Science & Technology by A.K.Joshi & B.D.Joshi

Course No. : SST 604- DUS TESTING FOR PLANT VARIETY PROTECTION

Credit : 2+1 = 3

THEORY

Lect. No.	Name of topic
1-2	Genesis of plant variety protection and farmers right (PVP & FR) act 2001
3-4	International Union for Protection of New Varieties of Plants (UPOV) and its functions
5	General agreements on Tariff and Trades (GATT) agreement in relation to protection of plant varieties;
6-7	Protection of Plant Varieties and Farmers' Rights (PPV &FR) Act, 2001; PPV&FR rules, 2003.
8	Criteria for protection of new varieties of plants.
9-10	Principles and procedures of Distinctness, Uniformity and Stability (DUS) testing;
11-13	Test guidelines, planting material, duration, testing options, varieties of common knowledge, reference collection, grouping of varieties, types and categories of characters; technical questionnaire.
14-16	Assessment of DUS characters based on morphological, biochemical and molecular markers
17-19	statistical procedures; computer software for use in DUS testing;
20	impact of PVP on growth of seed industry
21-23	Procedure of DUS testing –seed material required conduct of test, methods and observation , grouping of varieties etc.
24-26	Procedure of DUS testing in Rice
27	Procedure of DUS testing in Sorghum
28	Procedure of DUS testing in pearl millet
29	Procedure of DUS testing in Rose
30	Procedure of DUS testing in Cauliflower

Practical

Practical No.	Name of topic
1	Study of morphological description of plant parts and plant
2-4	Study of character expression and states, recording observation
5-6	Study of interpretation of data

Suggested Readings

1. Chakrabarty SK, Prakash S, Sharma SP & Dadlani M. 2007. *Testing Of Distinctiveness, Uniformity And Stability For Plant Variety Protection* . IARI, New Delhi.
2. Joshi AK & Singh BD. 2004. *Seed Science And Technology* . Kalyani.
3. The Protection of Plant Varieties And Farmers' Rights Act 2001.
Bare Act With Short Notes 2006. Universal Law Publ.

D) Seminar**F) Doctoral Research****F) Compulsory Non Credit Courses**

Course No. : PGS 501 -LIBRARY AND INFORMATION SERVICES
Credits : 0+1=1

PRACTICAL :

Exercise No.	Title of the exercise
1-2	Introduction to library and its services; types of library.
3	Role of libraries in education, research and technology transfer;
4	Classification systems and organization of library;
5-6	Sources of information- Primary sources, secondary sources and tertiary sources;
7-9	Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABs reference sources;
10	Literature survey;
11	Citation techniques/Preparation of bibliography;
12	Use of CD-ROM Databases,
13	Online Public Access Catalogue and other computerized library services;
14-15	Use of Internet including search engines and its resources;
16	e-resources access methods.

Course No. : PGS 502 - TECHNICAL WRITING AND COMMUNICATIONS
SKILLS Credits : 0+1=1

PRACTICAL :

Exercise No.	Title of the exercise
1	Various forms of scientific writings- theses, technical papers, reviews, manuals, etc;
2	Various parts of thesis and research communications (title page, authorship, contents page, preface, introduction, review of literature, material and methods, experimental results and discussion);
3	Writing of abstracts, summaries, précis, citations etc.;
4	Commonly used abbreviations in the theses and research communications;
5	Illustrations, photographs and drawings with suitable captions;
6	Pagination, numbering of tables and illustrations;
7	Writing of numbers and dates in scientific write-ups;
8	Editing and proof-reading;
9	Writing of a review article.
10-11	Grammar (Tenses, parts of speech, clauses, punctuation marks);
12	Error analysis (Common errors);
13	Concord; Collocation; Phonetic symbols and transcription; Accentual pattern;
14	Weak forms in connected speech;
15	Participation in group discussion: Facing an interview;
16	Presentation of scientific papers.

Suggested Readings :

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

**Course No. : PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT
IN AGRICULTURE Credits : 1+0=1**

Theory Teaching schedule

Lecture No.	Topics to be covered
1-2	Historical perspectives and need for the introduction of Intellectual Property Right regime
3-4	TRIPs and various provisions in TRIPS Agreement
5	Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs
6	Indian Legislations for the protection of various types of Intellectual Properties
7-9	Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and bio-diversity protection
10-11	Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection
12	National biodiversity protection initiatives
13	Convention on biological diversity
14-15	International Treaty on Plant Genetic Resources for Food and Agriculture
16	Licensing of technologies, Material transfer agreements, Research Collaboration Agreement, License Agreement

Suggested Readings :

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

**Course No. : PGS 504 -BASIC CONCEPTS IN LABORATORY TECHNIQUES
Credits : 0+1=1**

PRACTICAL :

Exerc. No.	Title of the exercise
1	Safety measures while in Lab;
2	Handling of chemical substances;
3	Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers,

	micropipettes and vascupets;
4	washing, drying and sterilization of glassware;
5	Drying of solvents/chemicals.
6	Weighing and preparation of solutions of different strengths and their dilution;
7	Handling techniques of solutions;
8	Preparation of different agro-chemical doses in field and pot applications;
9	Preparation of solutions of acids;
10	Neutralization of acid and bases;
11	Preparation of buffers of different strengths and pH values.
12	Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath;
13	Electric wiring and earthlings.
14	Preparation of media and methods of sterilization;
15	Seed viability testing, testing of pollen viability;
16	Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

Suggested Readings :

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

Course No. : PGS 505 -AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES

Credits : 1+0=1

Theory Teaching schedule

Lecture No.	Topics to be covered
1	History of agriculture in brief;
2	Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment;
3	National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions;
4	Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS,
5	role as a partner in the global agricultural research system, strengthening capacities at national and regional levels;
6	International fellowships for scientific mobility.
7	Research ethics: research integrity, research safety in laboratories,
8	Welfare of animals used in research,
9	Computer ethics,
10	Standards and problems in research ethics.
11	Concept and connotations of rural development,
12-13	rural development policies and strategies.
14	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.
15	Critical evaluation of rural development policies and programmes.
16	Constraints in implementation of rural policies and programmes.

Suggested Readings :

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

Course No. : PGS 506- DISASTER MANAGEMENT. Credits : 1+0=1

Theory Teaching schedule

Lecture No.	Topics to be covered
1-3	To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards and risks vulnerability; and capacity building.
4-5	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold waves
6-7	Climatic Change: Global warming, Sea level rise, Ozone depletion
8-10	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
11-12	Disaster Management- Efforts to mitigate natural disasters at national and global levels.
13-14	International Strategy for Disaster reduction.
15-16	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.

Suggested Readings :

1. Gupta HK. 2003. Disaster Management. Indian National Science Academy. Orient Blackswan.
2. Hodgkinson PE & Stewart M. 1991. Coping with Catastrophe: A Handbook of Disaster Management. Routledge.
3. Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.