

Course Curriculum of Fifth Semester
as per the ICAR-Sixth Deans' Committee Report for
the Academic Programmes in
HORTICULTURE

- ❖ **UG-Certificate in Horticulture**
- ❖ **UG-Diploma in Horticulture**
- ❖ **UG-Degree: B.Sc. (Hons.) Horticulture**



Mahatma Phule
Krishi Vidyapeeth,
Rahuri



Dr. Panjabrao
Deshmukh Krishi
Vidyapeeth, Akola



Vasantao Naik
Marathwada Krishi
Vidyapeeth, Parbhani



Dr. Balasaheb Sawant
Konkan Krishi
Vidyapeeth, Dapoli



Maharashtra Agricultural
Universities Examination
Board, Pune

Compiled & Submitted by

Dr. P.C. Mali

Professor & Head, Dept. of Fruit Science, College of Horticulture, Dr.BSKKV, Dapoli

UG Degree Syllabus State Coordinator

with

UG Degree Syllabus Discipline Coordinators &

DICC - UG Degree Syllabus Core Committee

Submitted to the

Directors of Instruction Coordination Committee

~ w.e.f. AY, 2026-27 ~

**Course Curriculum of Fifth Semester as per the
ICAR-Sixth Deans' Committee Report for Academic Programme in
HORTICULTURE**

Course Layout

B.Sc. (Hons.) Horticulture

Semester: V (New)

w.e.f. Academic Year: 2026-27

Sr. No.	Course No.	Course Title	Credit Hrs.	Remark
1.	GPB-351	Fundamentals of Plant Breeding	3(2+1)	-
2.	HORT-354	Growth and Development of Horticultural Crops	3(2+1)	-
3.	SSAC-352	Soil Fertility and Nutrient Management	3(2+1)	-
4.	PATH-352	General Microbiology	3(2+1)	-
5.	IT-351	Information and Communication Technology in Horticulture	3(1+2)	-
6.	PP-351	Introductory Crop Physiology	2(1+1)	-
7.	STAT-351	Basic Statistics and Experimental Designs	3(2+1)	-
8.	EDT-351	Educational Tour	2(0+2)	NG
9.	OC-1/ OC-2/...	Online Course(s)/ MOOCs [†]	As opted by student	NG
Total Credit Hrs.=			20(12+8) 2(0+2)	G NG
OC: Online Course, G: Gradual, NG: Non-gradual				
[†] Note: It is mandatory for each Student to complete total 10 credits (Non-gradual) of Online Courses from available resources across III to VIII semesters under the guidance of assigned Faculty/ Advisor.				

B.Sc. (Hons.) Horticulture : Fifth Semester

Course-wise Syllabus with Teaching Schedules

Semester	: V	
Course No.	: GPB-351	Credit Hrs. : 3(2+1)
Course Title	: Fundamentals of Plant Breeding	

SYLLABUS

Objectives : To acquaint students with plant breeding techniques, from conventional selection methods to advanced molecular approaches, for developing high-yielding, biotic and abiotic stress-resistant crop varieties to ensure food security.

THEORY

Historical development, Concept, Nature and Role of Plant Breeding. Major achievements and Future prospects. Genetics in relation to Plant Breeding. Modes of reproduction. Male sterility - Genetic consequences and Cultivar options. Domestication, Acclimatization and Introduction. Centres of origin/diversity. Components of Genetic variation, Heritability and Genetic advance. Genetic basis and breeding methods in self-pollinated crops - Mass and Pure line selection, Hybridization techniques and handling of segregating population. Multiline concept. Concepts of Population Genetics and Hardy-Weinberg Law. Genetic basis and methods of breeding cross-pollinated crops. Modes of selection. Population improvement schemes - Ear to Row method, Modified Ear-to-Row, Recurrent selection schemes. Heterosis and Inbreeding depression. Development of Inbred lines and Hybrids, Composite and Synthetic varieties. Breeding methods in Asexually propagated crops - Clonal selection. Wide hybridization and Pre-breeding. Polyploidy in relation to Plant Breeding. Mutation Breeding - Methods and Uses. Breeding for important Biotic and Abiotic stresses. Introduction to Biotechnological tools - DNA markers and Marker Assisted Selection. Participatory Plant Breeding. Plant Breeders' and Farmers' Rights.

PRACTICAL

Plant Breeder's kit. Study of germplasm of various crops. Study of floral structure of self-pollinated and cross-pollinated crops. Emasculation and Hybridization techniques in self- and cross-pollinated crops. Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregation populations. Maintenance of breeding records and data collection. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in Plant Breeding experiments, analysis of Randomized Block Design. Working out the mode of pollination in a given crop and extent of natural out-crossing. Prediction of performance of Double Cross Hybrids.

TEACHING SCHEDULE

THEORY [GPB-351]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1 - 2	Plant Breeding: Concept, Historical Development and Role	Definition, Aims and general Objectives of Plant Breeding; History of Plant Breeding (Early domestication; Mendelian era; Rise of Scientific Breeding), Landmarks of Plant Breeding; Eminent Global and Indian Plant Breeders, Role in food security; Genetics in relation to Plant Breeding	3
3 - 4	Major Achievements and Future Prospects in Plant Breeding	Green Revolution; Hybrid crops; Disease-resistant varieties, Climate-smart Breeding; Genomic selection; Speed Breeding	3
5 - 6	Genetics in relation to Plant Breeding (Basics)	Definitions- Genes, Alleles, Genotype vs. Phenotype; Dominance types, Segregation, Ratios; Punnett squares, Practical examples.	3
7 - 8	Modes of Reproduction; Floral Biology and Pollination	Selfing, Cross-pollination, Mixed mating, Apomixis; Breeding implications Flower structure, Pollination mechanisms & Pollinators, Emasculation and Controlled pollination	5
9 - 10	Male Sterility Systems and Cultivar Options using Male Sterility	Definitions, Types- GMS, CMS, CGMS, Thermosensitive MS, Photosensitive MS, Transgenic MS, Genetic consequences; Maintainer/Restorer concepts; Seed production options- Hybrid systems, Three-line and Two-line systems.	8
11	Domestication, Acclimatization and Introduction	Domestication and Crop Evolution: Definitions, Process of domestication; Genetic bottlenecks; Domestication traits	4
		Acclimatization and Introduction: Definitions, Quarantine, Adaptation testing, Introduction pathways	
12	Centres of Origin / Diversity	Vavilov's Centres, Importance for germplasm conservation (<i>In Situ/ Ex situ</i>) in brief.	3
13	Components of Genetic Variation	Components of Genetic Variation: Additive, Dominance, Epistasis, G x E; Partitioning variance	8
14	Heritability and Genetic Advance	Heritability: Definition, Concept and Types- Narrow and Broad sense heritability; Methods of estimating, Factors affecting heritability; Selection differential; Expected gain	
15	Breeding Methods for Self-pollinated Crop	Mass selection; Pure-line selection; Genetic basis; Principles and Examples	10
16		Pedigree method; Bulk method; Single-Seed Descent; Handling segregating populations	

Continued...

17 - 18	Hybridization Techniques and Multiline Concept	Controlled crosses, Emasculation, Backcrossing, Use of male sterility; Multiline Concept & Varieties; Disease management; Maintenance and Deployment	5
19	Concepts of Population Genetics and Hardy-Weinberg Law	Concept of Population Genetics- Definitions- Hardy-Weinberg Law/Equilibrium: Statement, its validity, Random mating population, Gene/Allele and Genotypic frequencies, Forces of evolution; Factors affecting gene frequency.	5
20	Breeding Methods for Cross-pollinated Crops	Mass selection, Recurrent selection, Family selection concepts	5
21		Population improvement: Ear-to-Row, Modified Ear-to-Row, Half-sib/ Full-sib selection schemes	
22	Recurrent Selection Schemes	Phenotypic and Genotypic Recurrent Selection; Reciprocal Recurrent Selection	5
23	Modes of Selection	Individual, Family, Progeny selection; Selection intensity and Accuracy	
24 - 25	Heterosis and Inbreeding Depression	Genetic basis of Heterosis; Causes and Measurement; Managing inbreeding depression	5
	Development of Inbred Lines and Hybrids	Inbreeding methods, Line development, Hybrid testing and Seed production	
26	Composite and Synthetic Varieties	Concepts, Definitions, Development procedures, Advantages and Limitations	3
27	Breeding Methods in Asexually Propagated Crops	Clonal selection, Virus indexing, Maintenance of clonal fidelity	4
28	Wide Hybridization and Pre-breeding	Introgression from wild relatives, Bridge crosses, Linkage drag management	3
29	Polyploidy in relation to Plant Breeding	Polyploidy: Definitions of Haploid, Monoploid, Diploid, Polyploid, Genome, Heteroploidy, Aneuploidy, Euploidy; Types of Aneuploidy & Polyploidy, their applications in crop improvement	5
30	Mutation Breeding- Methods and Uses	Definitions; Need (Conditions in which it is rewarding) & Usefulness; Mutation induction (Physical & Chemical Mutagens); Procedure for seed and vegetatively propagated crops, applications, its merits, demerits and achievements	5

Continued...

31 - 32	Breeding for Important Biotic & Abiotic Stresses; Biotech Tools; Participatory Plant Breeding; Plant Breeders' and Farmer's Rights	Breeding for Biotic (Disease/Insect) & Abiotic (Drought/Salinity) Resistance: Introduction, Mechanisms & sources of resistance, Types of genetic resistance; Breeding methods/ approaches and Practical achievements; Introduction to Biotechnological Tools (DNA Markers & MAS) in brief; Participatory Plant Breeding (Concept, Objectives; Types) in brief; PBR/ Farmers' Rights (in brief)	8
Total =			100

TEACHING SCHEDULE

PRACTICAL [GPB-351]

Exercise No.	Exercise Title
1	Study and Use of Plant Breeder's Kit.
2	Study of germplasms of various crops (Morphological diversity).
3	Study of floral structures of self-pollinated crops.
4	Study of floral structures of cross-pollinated crops.
5	Emasculation techniques in self-pollinated crops.
6	Hybridization techniques in cross-pollinated crops.
7	Consequences of inbreeding on genetic structure of populations.
8	Study of male sterility systems in crop plants.
9	Handling and maintenance of segregating populations.
10	Maintenance of breeding records and methods of data collection.
11	Calculation of mean, range, variance and standard deviation.
12	Estimation of heritability in Plant Breeding experiments.
13	Study of experimental designs used in Plant Breeding.
14	Analysis of Randomized Block Design (RBD).
15	Determination of mode of pollination and extent of natural out-crossing in a given crop.
16	Estimation of yield potential in Double-cross hybrids.

Suggested Readings [GPB-351]:

1. **Chahal, G.S. and Gosal, S.S.** 2001. Principles and Procedures of Plant Breeding. Narosa Publishing House, New Delhi.
2. **Fehr, W.R.** 1987 Principles of Cultivar Development - Theory and Practice. Macmillan Publishing Company, New York, USA
3. **Poehlman, J.M. and Sleper, D.A.** 1995. Breeding Field Crops. Iowa State University Press, Ames, Iowa, USA.
4. **Singh, B.D.** 2011. A Text Book in Plant Breeding, Kalyani Publishers, Ludhiana.
5. **Singh, B.D.** 2008. Plant Breeding - Principles and Methods. Kalyani Publication, New Delhi.



Semester : V		
Course No. : HORT-354	Credit Hrs. : 3(2+1)	
Course Title : Growth and Development of Horticultural Crops		

SYLLABUS

Objectives:

- (i) To understand the Physiology of canopy management, flowering, fruit setting and seed development in horticultural crops.
- (ii) To impart basic knowledge on the natural phytohormones and their specific functions in controlling the growth and developments.
- (iii) To understand the usage of synthetic growth regulators and their applications for overall manipulation of growth and development in horticultural crops.

THEORY

Growth and Development- Definitions, Components, Photosynthetic productivity, Canopy photosynthesis and Productivity, Leaf Area Index (LAI) - Optimum LAI in horticultural crops, Canopy development; Different stages of growth, Growth curves, Crop development and Dynamics (Case studies of annual/perennial horticultural crops), Growth analysis in horticultural crops. Plant bio-regulators- Auxin, Gibberellin, Cytokinin, Ethylene, Inhibitors and Retardants, Basic functions, Biosynthesis, Role in crop growth and development, Propagation, Flowering, Fruit setting, Fruit thinning, fruit development, Fruit drop and Fruit ripening. Flowering-factors affecting flowering, Physiology of flowering, Photoperiodism - Long day, Short day and Day neutral plants, Vernalization and its application in Horticulture, Pruning and Training, Physiological basis of training and pruning, Source and Sink relationship, Translocation of assimilates. Physiology of seed development and maturation, Seed dormancy and Bud dormancy, Causes and Breaking methods in horticultural crops. Physiology of fruit growth and development, Fruit setting, Factors affecting fruit set and development, Physiology of ripening of fruits-Climatic and Non-climacteric fruits. Physiology of fruits under post-harvest storage.

PRACTICAL

Estimation of photosynthetic potential of horticultural crops, Leaf Area Index, Growth analysis parameters including Harvest index, Bioassay of plant hormones, Identification of synthetic plant hormones and Growth retardants, Preparations of hormonal solution and Induction of rooting in cuttings, Ripening of fruits and Control of flower and fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables, Seed dormancy, Seed germination and Breaking seed dormancy with chemicals and growth regulators.

TEACHING SCHEDULE

THEORY [HORT-354]

Lecture No.	Topics	Sub-topics / Key Points	Weightage (%)
1	Growth and Development	Definition, Components of growth and Phases of growth in horticultural crops	10
2 - 3	Canopy Photosynthesis and Productivity	Canopy photosynthesis and productivity of horticultural crops, C3 and C4 plants and comparison	5
4	LAI	Leaf Area Index (LAI) - Optimum LAI in horticultural crops, Canopy development	5
5 - 6	Different Stages of Growth	Growth curves, Crop development and Dynamics	10
7		Case studies of annual/perennial horticultural crops, Growth analysis in horticultural crops	
8 - 10	Plant Bio-regulators	Definition, Classification of Bio-regulators - Auxin, Gibberellin, Cytokinin, Ethylene inhibitors and Retardants, their basic functions	15
11		Advance Plant Bio-regulators in horticultural crops	
12 - 14	Biosynthesis of Bio-regulators	Biosynthesis of Bio-regulators and their Role in crop growth and development, Propagation, Flowering, Fruit setting, Fruit thinning, Fruit development, Fruit drop and Fruit ripening	5
15 - 16	Flowering	Factors affecting flowering, Physiology of flowering	5
17 - 18	Photoperiodism	Photoperiodism definition, Long day, Short day and Day neutral plants classification and Examples of horticultural crops	10
19 - 20	Vernalization	Vernalization concept and its Application in Horticulture	
21 - 23	Pruning and Training	Pruning and Training Physiological basis	10
24		Physiological basis of training and pruning in Horticultural crops - Fruit, vegetables, Flowers etc.	
25 - 26	Translocation of Assimilates	Translocation of assimilates, Theories of translocation of organic solute, Source and Sink relationship	5
27 - 28	Physiology of Seed Development	Physiology of Seed development and Maturation, Seed dormancy and Bud dormancy, Causes and Breaking methods in horticultural crops	5

Continued...

29 - 30	Physiology of Fruit Growth	Physiology of fruit growth and development, Fruit setting, Factors affecting fruit set and development	5
31		Physiology of ripening of fruits- Climatic and Non-climacteric fruits	5
32		Physiology of fruits under post-harvest storage	5
Total =			100

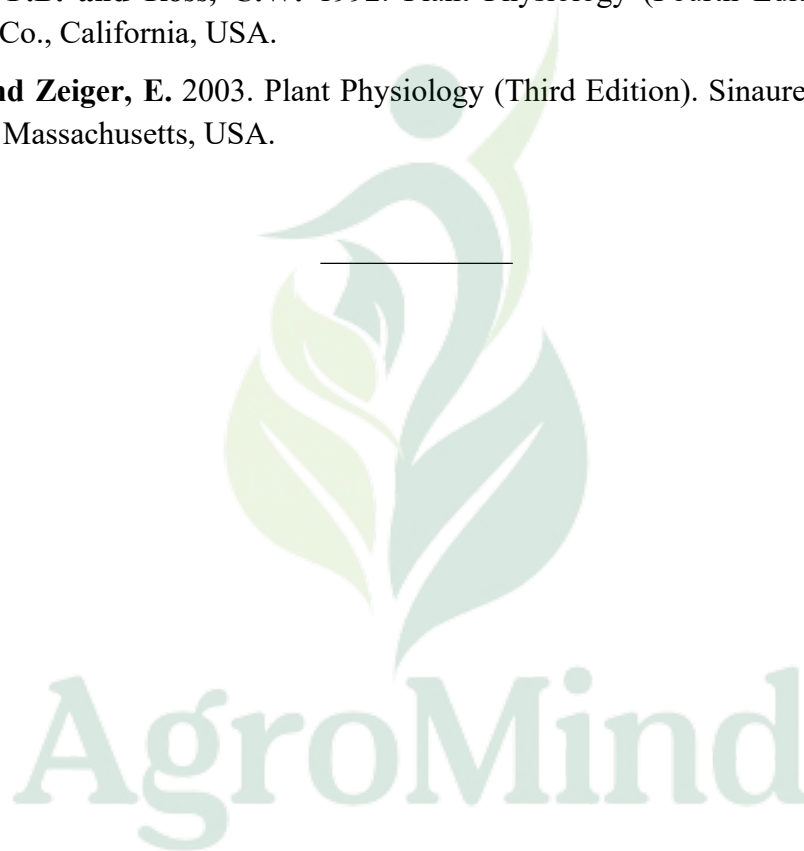
TEACHING SCHEDULE

PRACTICAL [HORT-354]

Exercise No.	Exercise Title
1	Estimation of photosynthetic potential of horticultural crops by IRGA.
2	Estimation of leaf area and leaf area index in horticultural crops.
3	Studies on growth analysis- Measurement of growth by using Arc indicator and Auxanometer.
4	Measurement of growth by different growth analysis equations.
5	Determination of harvest index in different horticultural crops.
6	Studies on preparation of hormonal solutions.
7	Identification and use of synthetic plant hormones and growth retardants; Bioassay of plant hormone.
8	Studies on PGR in induction of rooting in cutting in horticultural crops.
9	Study of role of PGR in fruit ripening.
10	Study of role of PGR in control of flower drops.
11	Studies of important physiological disorders and their remedial measures in fruits and vegetables–I - Macroelements.
12	Studies of important physiological disorders and their remedial measures in fruits and vegetables–II - Microelements.
13	Study of Seed Dormancy - Causes and methods of breaking dormancy with chemicals and growth regulators.
14	Study of Seed Viability testing.
15	Study of Seed Germination - Types of seed germination and factors affecting seed germination.
16	Study of Seed Germination - Methods of seed germination testing.

Suggested Readings [HORT-354]:

1. **Jain, V.K.** 2006. Fundamentals of Plant Physiology (Ninth Edition). S. Chand and Co., New Delhi, India.
2. **Mohr, H. and Schopfer, P.** 1995. Plant Physiology. Springer-Verlag, Berlin, Germany.
3. **Marini, R.P.** 2009. Physiology of Pruning Fruit Trees. Virginia Cooperative Extension, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA. Available at: Virginia Tech Extension Publication (*as online resource*).
4. **Salisbury, F.B. and Ross, C.W.** 1992. Plant Physiology (Fourth Edition). Wadsworth Publishing Co., California, USA.
5. **Taiz, L. and Zeiger, E.** 2003. Plant Physiology (Third Edition). Sinaure Associates, Inc., Publishers, Massachusetts, USA.



Semester	: V	
Course No.	: SSAC-352	Credit Hrs. : 3(2+1)
Course Title	: Soil Fertility and Nutrient Management	

SYLLABUS

Objectives: To acquaint students with the basic knowledge of soil fertility and nutrient management, as to understand the key factors affecting plant growth and development.

THEORY

Plant nutrients - Classification and Sources; Essential and Beneficial elements, Criteria of Essentiality, Forms of nutrients in soil, Mechanisms of nutrient transport to plants, Factors affecting availability of major, secondary and micro-nutrients to plants. Measures to overcome deficiency and toxicities. Soil fertility- Different approaches for soil fertility evaluation; Soil testing for available nutrients; Critical levels of different nutrients in soil. Plant analysis- Total and Rapid tissue tests, Critical levels of nutrients in plants; DRIS method; Deficiency symptoms - Indicator plants. Biological method of soil fertility evaluation. Soil test - based fertilizer recommendations to crops. Site-specific and Plant need-based nutrient management. Factors influencing Nutrient Use Efficiency (NUE) in respect of N, P, K, S, Fe and Zn fertilizers. Source, Method and Scheduling of nutrients for different soils and crops grown under rainfed and irrigated conditions. Integrated plant nutrient supply system and its management. Soil quality in relation to Sustainable Agriculture - acid, salt affected and calcareous soils, Characteristics, Nutrient availabilities, Reclamation- Mechanical, Chemical and Biological methods.

PRACTICAL

Analytical Instruments- Principles, Calibration and Applications; Estimation of available Nitrogen, Available Phosphorus, Available potassium and Available Sulphur in soil; Estimation of exchangeable Calcium and Magnesium in soil, Estimation of available micronutrients in soils; Preparation of plant samples for analysis; Estimation of Nitrogen, Phosphorus and Potassium in plants.

TEACHING SCHEDULE

THEORY [SSAC-352]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1 - 2	Plant Nutrients - Classification and Sources	Definitions of Soil Fertility; History of Soil Fertility and Plant Nutrition; Criteria of Essentiality of Nutrients; Classification of essential nutrients.	8
3 - 5	Essential and Beneficial Elements	Essential and Beneficial Nutrients and their Role; Deficiency and Toxicity symptoms of essential plant nutrients. Measures to overcome deficiency and toxicities; Forms of nutrients in soil; Mobility of nutrients in soil and plant.	10
6 - 7	Mechanism of Nutrient Uptake and Transport to Plants	Mechanism of nutrient uptake and Transport to plants: Factors affecting nutrient (major, secondary & micronutrients) availability to plants	6
8 - 10	Manures and Fertilizers	Introduction and Importance of Manures and Fertilizers; Preparation and Properties of Major Manures: FYM, Compost, Vermicompost, Green manuring, Oil cakes.	6
11 - 12	Soil Fertility Evaluation	Different approaches for soil fertility evaluation: Soil testing for available nutrients; Critical levels of different nutrients in soil.	8
13 - 14	Plant Analysis	Total plant analysis and Rapid plant tissue tests, Critical levels of nutrients in plants; DRIS method; Indicator plants.	8
15 - 16	Soil Fertilizer Recommendations to Crops	Different fertilizer recommendation approaches (in detail); Site-specific and Plant need-based nutrient management.	6
17 - 18	Nutrient Use Efficiency (NUE)	Definition and Factors influencing Nutrient Use Efficiency (NUE) in respect of N, P, K, S, Fe and Zn fertilizers.	6

Continued...

19 - 20	Chemical Fertilizers	Definition and their Classification N, P and K Fertilizers. Secondary and Micronutrient Fertilizers	6
21 - 22	Complex Fertilizers	Definition and Classification; Liquid fertilizers and Nanofertilizers	6
23 - 24	Integrated Plant Nutrient Management	Integrated nutrient management (INM); Concept, Components and Importance	6
25 - 26	Acid Soils	Characteristics, Nutrient availabilities, Reclamation- Mechanical, Chemical and Biological methods	6
27 - 28	Salt Affected Soils (Saline / Sodic)	Characteristics, Nutrient availabilities, Reclamation- Mechanical, Chemical and Biological methods	6
29 - 30	Calcareous Soils	Characteristics, Nutrient availabilities, Reclamation- Mechanical, Chemical and Biological methods	6
31 - 32	Nutrient Applications	Sources, Methods and Scheduling of nutrients applications for different soils and crops grown under Rainfed and Irrigated conditions.	6
Total =			100

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TEACHING SCHEDULE

PRACTICAL [SSAC-352]

Exercise No.	Exercise Title
1	Introduction of analytical instruments and their principles.
2	Calibration and applications of Colorimetry and Flame photometry.
3	Determination of organic Carbon content from soil.
4	Estimation of available Nitrogen in soil by Alkaline permanganate method.
5	Estimation of available Phosphorus in soil.
6	Estimation of available Potassium in soil by Flame photometric method.
7	Estimation of available Sulphur in soil by Turbidimetric method.
8 - 9	Estimation of exchangeable Calcium and Magnesium in soil by Versenate titration method.
10	Estimation of DTPA extractable micronutrients (Fe, Mn, Zn and Cu) from soil.
11	Preparation of plant samples for analysis.
12	Estimation of total Nitrogen in plant by micro-Kjeldhal method.
13	Estimation of total Phosphorus in plant sample by Vanadomolybdate method.
14	Estimation of total Potassium from plant sample by Flame photometric method.
15	Estimation of Sulphur concentration in plant sample.
16	Estimation of total micronutrients (Fe, Mn, Cu and Zn) from plant sample.

Suggested Readings [SSAC-352]:

1. Aggarwal, J.P. Yawalkar, K.S. and Bokde, S. 2011. Manures and Fertilizers. 11th Edn. Agri Horticultural Publishing House, Nagpur.
2. Basak Ranjan Kumar 2016. Fertilizers- A Text Book, Fourth Edition. Kalyani Publishers. Ludhiana.
3. Brady, N.C. 1999. Nature and Properties of Soils, 10th Edition.
4. Das, P.C. 2015. Manures and Fertilizers, Third Edition Kalyani Publishers. Ludhiana.
5. Goswami, N.N. 2009. Fundamentals of Soil Science, 2nd Edition. ISSS, New Delhi.
6. Kanwar, J.S. Soil Fertility - Theory and Practice, ICAR, New Delhi.
7. Soil Science an Introduction, 2015. Indian Society of Soil Science. New Delhi.
8. Tisdale, S.L. Nelson, W.L. and Beaton, J.D. 1985. Soil Fertility and Fertilizers, 4th Edition. MacMillan Publishing Company, New York.

Semester : V		
Course No. : PATH-352	Credit Hrs. : 3(2+1)	
Course Title : General Microbiology		

SYLLABUS

Objectives: To provide knowledge about general concepts of Microbiology.

THEORY

Evolution and Scope of Microbiology. History of Microbiology. Microbial classification, Nomenclature and Identification. Taxonomic groups. General methods of classifying bacteria. Microscopy and Microscopes: Smears and Staining. Morphology and Fine structure of bacteria. Cultivation of bacteria, Nutritional requirements. Nutritional classification of bacteria; Phototrophs, Chemotrophs, Autotrophs and Heterotrophs; Obligate parasites; Bacteriological media, Growth of bacteria; Reproduction of bacteria; Introduction to fungi, algae, protozoa and virus. Microbiology of water and Food nutrient transport phenomenon: Passive diffusion, Facilitated diffusion; Group translocation, Active transport. Metabolism in bacteria - ATP generation, Microbial Genetics; Bacterial recombination; Bacterial conjugation, transduction; Bacterial transformation; Mutations: Types of mutations, Mutagenesis; Mutation rate, Repair of mutations; Phenotypes of bacterial mutants; Designation of bacterial mutants; Destruction of microorganisms: Physical agents and Chemical agents; Chemotherapeutic agents and Chemotherapy; Characteristics of antibiotics; Mode of action of antibiotics; Pure culture: Methods of isolation of pure cultures; Maintenance and preservation of pure cultures; Culture collections.

PRACTICAL

Microscopy; Micrometry; Cleaning and sterilization of glassware and acquainting with equipment used in Microbiology; Preparation of nutrient agar media and techniques of inoculation; Staining methods (Monochrome staining, Gram staining, Negative staining, Capsule-staining, Flagella staining and Endospore staining); Pure culture techniques (Streak plate/ Pour plate/ Spread plate); Identification procedures (Morphology and Cultural characteristics); Growth characteristics of fungi; Determination of microbial numbers, Direct plate count, Generation time; Factors influencing growth: pH, temperature, growth curves for bacteria.

TEACHING SCHEDULE

THEORY [PATH-352]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	Evolution and Scope of Microbiology	Introduction; Definition; Concept, Origin and evolution of Microbiology; Spontaneous generation conflict, Germ theory of diseases. Scope of Microbiology: Pure and applied branches; Role and applications in agriculture & allied areas	5
3 - 4	History of Microbiology	Development of Microbiology in India and Composition of microbial world; Major milestones and Contributions of eminent Scientists.	5
5 - 6	Microbial Classification, Nomenclature and Identification	Major Classification systems; General methods of Classifying Bacteria; Microbial Nomenclature and Taxonomic Hierarchy (Groups); Identification and Characterization of Microorganisms (Morphological, cultural, physiological, biochemical and molecular methods)	5
7 - 8	Microscopy and Microscopes; Smears and Staining	Principles, Types and Components of Microscopy; Specimen preparation: The bright field microscope, Fixation methods, Precautions; Staining Techniques- Dyes and Simple staining and Differential staining.	8
9 - 11	Introduction to Microorganisms	Prokaryotic, Eukaryotic and Mesobiotic microorganisms (Introduction to Fungi, Protozoa, Algae, Bacteria, Actinomycetes, BGA, Mycoplasma, Virus, Bacteriophage, Viroids, etc.) their properties with harmful and beneficial roles	10
12 - 15	Morphology and Fine Structure of Bacteria	General Morphology and Classification based on Shape and Arrangement, Cell grouping, Structure and Functions of Bacterial Cell Components (Internal and External Organelles), Fine Structure and Ultrastructure of Bacterial Cell	10

Continued...

16 - 18	Cultivation of Bacteria and Nutritional Requirements	Nutritional Requirements of Bacteria; Culture Media and Types of Media for Bacterial Cultivation- Bacteriological Media, Growth of Bacteria (Growth Curve and Phases, Physical and Chemical Factors Influencing the Growth); Methods and Conditions for Cultivation of Bacteria.	10
19 - 20	Nutritional Classification of Bacteria	Definitions and suitable Examples: Types of Nutritional Groups- Phototrophs, Chemotrophs, Autotrophs, Lithotrophs, Organotrophs and Heterotrophs- Obligate parasites.	8
21 - 23	Reproduction of Bacteria and Bacterial Metabolism	Modes of Reproduction: Asexual and Sexual reproduction, Group recombination, Microbial Genetics (in brief); Bacterial Conjugation, Transduction, Transformation. Bacterial Metabolism: Definition, Anabolic and Catabolic processes; ATP/Energy generation and metabolic pathways; Aerobic and Anaerobic respiration and significance	10
24	Bacterial Mutations	Definitions; Types of Mutation, Mutagenesis, Mutation rate, Repair of mutations, Phenotypes of Bacterial Mutants, Designation of Bacterial Mutants.	6
25 - 27	Microbiology of Water and Food; Nutrient Transport Phenomenon	Microbiology of Water and Food: Microbial flora associated with water and food; Beneficial and harmful microorganisms; Significance in contamination, spoilage and public health. Structure and functions of microbial cell membrane; Passive diffusion & Facilitated diffusion (Definitions, mechanism, characteristics, differences, factors, examples); Active Transport Mechanism (Definition, transport proteins/carriers, significance) in brief. Group Translocation [Concept, Phosphotransferase system (PTS), significance] in brief.	6
28 - 29	Destruction of Microorganism	Physical and Chemical methods and agents, Chemotherapeutic agents and Chemotherapy	6
30	Antibiotics	Definition; Characteristics of Antibiotics and Modes of Action of Antibiotics	5
31 - 32	Pure Culture	Methods of isolation; Maintenance and Preservation of pure cultures; Culture collections	6
Total =			100

TEACHING SCHEDULE

PRACTICAL [PATH-352]

Exercise No.	Exercise Title
1	Study of Microscopes and Microscopy Techniques.
2	Acquaintance and use of equipments used in Microbiology Laboratory.
3	Methods of sterilization.
4	Preparation of nutrient agar medium and techniques of inoculation.
5	Staining methods: Simple staining and Differential staining.
6	Gram staining.
7	Pure culture techniques (Streak plate/ Pour plate/ Spread plate).
8	Identification procedure (Morphology and Cultural characteristics).
9	Study of growth characteristics of fungi.
10	Isolation of <i>Rhizobium</i> .
11	Isolation of <i>Azospirillum</i> .
12	Isolation of <i>Azotobacter</i> .
13	Isolation of Phosphate solubilizing micro-organisms.
14	Isolation of Potassium solubilizing micro-organisms.
15	Determination of microbial numbers, direct plate count, generation time.
16	Factors influencing growth; pH, Temperature, growth curve for bacteria.

Suggested Readings [PATH-352]:

1. Dubey, R.C. and Maheshwari, D.K. 2013, A Textbook of Microbiology, S. Chand Publishing, New Delhi.
2. Gerard, J.T., Berdell, R.F. and Christine L.C. 2014, Microbiology: An Introduction. 12th Edn., Prentice- Hall, NY, USA.
3. Johanne, M.W., Linda, M.S. and Woolverton, C.J. 2013. Prescott's Microbiology 9th Edn., McGraw-Hill Higher Education, NY., USA.
4. Pelzar, M.J., Chan ECS. and Noel, R.K. 1998, Microbiology 5th Edn. Tata McGraw-Hill Education, New Delhi.
5. Purohit, S.S., 2001, Microbiology - Fundamental and Applications, Agrobios, New Delhi.
6. Sherma, P.D., 1999, Microbiology, Rastogi Publications, Meerut, India.
7. Tauro, P., Kapoor, K.K. and Yadav, K.S. 2002, Introduction to Microbiology, New Age International (P) Ltd. Pub., New Delhi, India.

Semester : V	
Course No. : IT-351	Credit Hrs. : 3(1+2)
Course Title : Information and Communication Technology in Horticulture	

SYLLABUS

Objective: To learn the basics of computing and its practical use in communication.

THEORY

IT and its Importance. IT Tools, IT-Enabled services and their Impact on society; Introduction to Computers, Hardware and Software; Input and Output devices; Word and Character representation; Features of machine language, Assembly language, High-level language and their Advantages and Disadvantages; Operating Systems, Definition and Types, Applications of Word Processing/ Spreadsheet /Presentation/ Databases for document creation and Editing, Data presentation, Interpretation and Graph creation, Statistical analysis, Mathematical expressions, Database concepts and Types, uses of DBMS in Horticulture; Introduction to Local Area Network (LAN), Wide Area Network (WAN), Internet and World Wide Web, HTML and IP and Video conferencing, Introduction to e-Horticulture, Concepts and Applications, Use of ICT in Horticulture.

PRACTICAL

Practice with latest operating system for creating Files, Folders, File management. Use of Word Processing/ Spreadsheet/ Presentation/ Databases with latest software packages; Creating a spreadsheet, Use of statistical tools, Writing expressions, Creating graphs, Analysis of scientific data. Creating database, Preparing queries and Reports, Creation and Operation of E-mail account; Demonstration of Agri-information system using Mobile Apps. Internet applications: Web browsing, Handling of audio-visual equipment. Planning, Preparation, Presentation of posters, charts. Introduction of Geospatial Technology of generating valuable information for Agriculture. Hands on Decision Support System. Preparation of contingent crop planning.

TEACHING SCHEDULE

THEORY [IT-351]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1	IT and its Importance	IT tools; IT-enabled services and their impact on society	8
2	Introduction to Computers	Input and Output devices	7
3	Computer Hardware and Software	Fundamental of Hardware and Software; Types of Software & Hardware	10
4 - 5	Introduction to Machine Language	Word and Character representation	10
6 - 7	Computer Languages	Features of Machine language, Assembly language; High-level language and their advantages and disadvantages	10
8	Operating Systems	Definition and Types (in brief)	4
9 - 10	Word Processing; Spreadsheet; Presentation	Applications and Features of Word processing, Spreadsheet & Presentation	10
11 - 13	Document Creation and Editing	Creation of Word document, Spreadsheet, Presentation and Databases; Data presentation, Interpretation and Graph creation; Statistical analysis, Mathematical expressions	15
14	Database	Concepts and Types of Databases; Uses of DBMS in Horticulture	10
15	Computer Network	Types of Network; Introduction to Local Area Network (LAN), Wide Area Network (WAN), Internet and World Wide Web, HTML and IP, and Video Conferencing	10
16	Introduction to e-Horticulture	Concepts and Applications; Use of ICT in Horticulture.	6
Total =			100

TEACHING SCHEDULE

PRACTICAL [IT-351]

Exercise No.	Exercise Title
1 - 2	Practice with latest operating system for creating Files, Folders, File Management.
3 - 5	Creation of document in Word Processing.
6 - 8	Introduction to Spreadsheet.
9 - 11	Features and preparation of Presentation.
12 - 14	Introduction with Databases with latest software packages.
15 - 17	Creation of spreadsheet with use of statistical tools.
18 - 19	Use of writing expressions, creating graphs, analysis of scientific data in spreadsheet.
20 - 21	Creating Database, preparing queries and reports.
22	Creation and operation of E-mail account.
23 - 24	Demonstration of Agri-information system using Mobile Apps.
25 - 26	Internet applications: Web browsing.
27	Handling of audio-visual equipment.
28 - 29	Planning, preparation, presentation of posters, charts.
30	Introduction of Geospatial Technology of generating valuable information for Agriculture.
31 - 32	Hands-on Decision Support System; Preparation of Contingent crop planning.

Suggested Readings [IT-351]:

1. **Comer Douglas E.** 2018. The Internet Book: Everything You Need to Know About Computer Networking and How the Internet Works. Chapman and Hall/CRC.
2. **Crowther, R., Joe, L., Ash Blue and Wanish, G.** 2014. HTML5 in Action. Manning.
3. **Pradeep, K. Sinha and Priti Sinha,** Computer Fundamentals, III Edition, BPB Publications, B-14, Connaught Place, New Delhi – 110 001.
4. **Rajaraman, V.** 2013. Fundamentals of Computers, Vth Edition. PHI.
5. **Ray, G.L.** Extension communication and Management. Kalyani Publishers.
6. **Mane, M.S.** Introduction to Computer Application. Shri Rajlaxmi Prakashan.

Semester : V		
Course No. : PP-351	Credit Hrs. : 2(1+1)	
Course Title : Introductory Crop Physiology		

SYLLABUS

Objectives:

- i) To study different physiological plant aspects such as water uptake and movement in plants, nutrient absorption, assimilation,
- ii) To study factors affecting photosynthesis and its importance in plants.

THEORY

Water Relations in Plants: Role of water in plant metabolism, Osmosis inhibition, Diffusion, Water potential and its components, Measurement of water potential in plants, Absorption of water, Mechanism of absorption and Ascent of sap. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, Guttation, Stem bleeding; Transpiration methods and Mechanism and factors affecting transpiration. Drought: Different types of stresses; Water, Heat and Cold tolerance; Mechanism of tolerance. Plant Nutrition: Essentiality, Mechanism of absorption and its role in plant metabolism. Biological Nitrogen Fixation. Photosynthesis, Structure and Function of chloroplast, Dark and Light reactions, Cyclic and non-cyclic Electron Transfer, CO₂ fixation – C₃, C₄ and CA metabolism, Advantages of C₄ pathway. Photorespiration and its implications, Factors affecting photosynthesis. Mode of herbicide action, Secondary metabolites and Plant defense.

PRACTICAL

Measurement of water potential, osmosis, root pressure, Structure of the stomata, distribution, opening and closing of the stomata, Measurement, Transpiration and calculation of transpiration pull demonstration. Importance of light and chlorophyll in photosynthesis, Pigment identification in horticultural crops, measurement of Relative Water Content (RWC), Studying plant movements.

TEACHING SCHEDULE

THEORY [PP-351]

Lecture No.	Topic	Sub-topics / Key Points	Weightage (%)
1	Water Relations in Plants	Role of water in plant metabolism, Enzymatic activity, Transport, Growth, Turgor	5
2	Osmosis and Diffusion	Definitions & Principles: Osmosis, Inhibition, Diffusion and Biological significance	5
3	Water Potential	Definition, Concept of Water Potential; Components: Solute, Pressure, Matric potential	5
4	Measurement of Water Potential	Pressure chamber, Psychrometer, Other techniques	5
5	Absorption of Water	Active vs. Passive absorption mechanisms	5
6	Ascent of Sap	Cohesion-tension theory, Capillarity	5
7	Stomata Structure	Structure, Distribution, Classification	5
8	Stomatal Physiology	Mechanism of opening and closing of stomata	5
9	Plant Exudations	Osmotic pressure, Guttation, Stem bleeding	5
10	Transpiration	Definition, Methods, Mechanisms, Factors affecting transpiration	10
11 - 12	Stress Tolerance Mechanisms	Drought- Def ^m .; Classification of Plant Stresses, Stress tolerance mechanism; Osmo-protectants, ABA signaling, Heat-shock proteins	10
13	Plant Nutrition	Essentiality of nutrients, Absorption mechanism, Role in plant metabolism	5
14	Biological Nitrogen Fixation	Symbiotic and Non-symbiotic pathways, Nodulation, Nitrogenase enzyme	5
15	Photosynthesis - I	Chloroplast structure & function, Light and Dark reactions, Cyclic and Non-cyclic electron transfer	10
16	Photosynthesis - II and Applied Physiology	CO ₂ fixation (C ₃ , C ₄ , CAM), Advantages of C ₄ , Photorespiration, Factors affecting photosynthesis, Mode of Herbicide action, Secondary metabolites and Plant defense.	15
Total =			100

TEACHING SCHEDULE

PRACTICAL [PP-351]

Exercise No.	Exercise Title
1	Determination of water potential in plant tissues.
2	Experimental demonstration of osmosis.
3	Measurement of root pressure in plants.
4	Microscopic study of stomatal structure.
5	Comparative study of stomatal distribution on leaf surfaces.
6	Observation of stomatal opening and closing mechanisms.
7	Measurement of stomatal aperture using Micrometry.
8	Demonstration of transpiration in plants.
9	Calculation of transpiration-pull using Photometer.
10	Study of the importance of light in photosynthesis.
11	Demonstration of the role of chlorophyll in photosynthesis.
12	Identification of photosynthetic pigments in horticultural crops.
13	Measurement of Relative Water Content (RWC) in plant tissues.
14	Experimental study of tropic movements in seedlings.
15	Observation of nastic movements in plants.
16	Study of Diurnal leaf movements (Nyctinasty).

Suggested Readings [PP-351]:

1. **Bendre, A.M. and Pande, P.C.**, 2009, Introductory Botany. Rastogi publication, Meerut.
2. **Bhatia, K.N.**, 2015, Plant Physiology. Trueman Book Company, Jalandhar.
3. **Dutta, A.C.**, 2013, A Textbook of Botany. Oxford University Press, Oxford Lecture Schedule.
4. **Gardner, F.P., Pearce, R.B. and Mitchell, R.L.**, 2003, Physiology of Crop Plants. Scientific Publishers, Jodhpur.
5. **Jain, V.K.**, 2019, Fundamentals of Plant Physiology. S. Chand Publishers, New Delhi.

Semester :	V	
Course No. :	STAT-351	Credit Hrs. : 3(2+1)
Course Title :	Basic Statistics and Experimental Designs	

SYLLABUS

Objectives:

- i) To understand the analytical techniques for data analysis and interpretation,
- ii) To help students to compete for various competitive examinations.

THEORY

Definition of Statistics, its Use and Limitations. Variable statistics, Types and Sources of data, Classification and Tabulation of data. Construction of frequency distribution tables – Graphic presentation of data, Simple, Multiple component and Percentage, Bar diagram, Pie diagram, Histogram, Frequency polygon and Frequency curve, Cumulative frequency curve. Measures of Central tendency: Mean, Median, Mode, Geometric mean, Harmonic mean, Percentiles and Quartiles for raw and grouped data, Measures of dispersion: Range, Quartile deviation, Mean deviation, Standard deviation for raw and grouped data, Coefficient of variation. Skewness and Kurtosis. Probability- Definition, Additive and Multiplicative law for two events, Normal distribution and its Properties. Introduction of sampling. Basic concepts, sampling vs. Complete enumeration parameter and Statistic. Sampling techniques (Simple random sampling: Lottery method and Random number table method). Tests of significance, Null hypothesis, Alternate hypothesis, Type I and II Error, One and Two tail tests, Level of significance and Confidence interval. Large sample tests for mean (Single sample and Two samples), Student's t-test for Single sample, Two samples and Paired t-test, F-test, Chi-square test for application of attributes (Contingency table) and Test for goodness to fit of Mendelian ratios, Yates' correction for continuity. Correlation - Scatter diagram and Karl Pearson coefficient of correlation for ungrouped data and its testing. Linear regression and its Properties. Inter-relation between 'r' and the Regression coefficient, Introduction to design of experiment- Basic principles of experimental design-Replication, Randomization and Local control, Analysis of Variance (ANOVA) and its Assumptions, Analysis of Completely Randomized Design (CRD), Randomized Block Design (RBD) and Latin Square Design (LSD), Comparisons based on means-critical difference.

PRACTICAL

Construction of frequency distribution tables and frequency curves, Measures of Central tendency: Mean, Median, Mode, Geometric mean, Harmonic mean, Percentiles and Quartiles. Measures of dispersion: Range, Quartile deviation, Mean deviation, Standard deviation for raw and grouped data, Coefficient of variation. Skewness and Kurtosis. Probability. Large sample tests for mean, Student's t-test, F-test and Chi-square test, Correlation coefficient 'r' and its testing, Fitting of regression equations, Analysis of CRD, RBD and LSD.

Suggested Readings [STAT-351] :

1. **Bansal M.L., Singh Sukhminder, Singh Tejinderpal and Jindal Rakesh Kumar.** 2014. Statistical Methods for Research Workers. Kalyani Publishers, 4th Edn.
2. **Chandal S.R.S.** 2014. A Handbook of Agricultural Statistics. Achal Prakashan Mandir.
3. **Gupta S.P.** 2021. Statistical Methods. Sultan Chand and Sons.
4. **William G. Cochran and George W. Snedecor.** 2014. Statistical Methods. Wiley India Pvt. Ltd. 8th Edn.

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TEACHING SCHEDULE

THEORY [STAT-351]

Lecture No.	Topic	Sub-topics/ Key Points	Weightage (%)
1 - 2	Statistics and Data	Definition, Use and Limitations. Variable Statistics, Types and Sources of Data, Classification and Tabulation of data, Construction of frequency distribution tables.	5
3 - 4	Representation of Data	Graphic presentation of data, Simple, Multiple component and Percentage, Bar diagram, Pie diagram, Histogram, Frequency polygon and Frequency curve, Cumulative frequency curve.	5
5 - 7	Measures of Central Tendency	Mean, Median, Mode, Geometric mean, Harmonic mean, Percentiles and Quartiles for raw and grouped data	5
8 - 10	Measures of Dispersion	Range, Quartile deviation, Mean deviation, Standard deviation for raw and grouped data, Coefficient of variation. Skewness and Kurtosis	5
11 - 12	Probability	Definition, Additive and Multiplicative Law for two events	5
13	Normal Distribution	Concept and its Properties	5
14 - 15	Sampling	Basic Concepts; Sampling vs. Complete enumeration; Sampling techniques (Simple random sampling: Lottery method and Random number table method)	5
16 - 18	Tests of Significance	Null hypothesis, Alternate hypothesis, Type I and II errors, One and Two tail tests, Level of significance and Confidence interval. Large sample tests for mean (Single sample and Two samples)	10
19 - 21	Student's t-Test	Single sample, Two samples and Paired t-test, F-test	10
22	Chi-square Test	Chi-square (χ^2) test for application of attributes (Contingency table) and Test for Goodness to fit of Mendelian ratios	10
23 - 24	Correlation	Yates' correction for continuity, Correlation-scatter diagram and Karl Pearson coefficient of correlation for ungrouped data and its testing	5
25	Linear Regression	Introduction and its properties. Inter-relation between 'r' and the Regression coefficient	5
26 - 28	Design of Experiment	Basic Principles of Experimental design - Replication, Randomization and Local control, Analysis of Variance (ANOVA) and its Assumptions	10
29 - 30	CRD and RBD	Analysis of Completely Randomized Design (CRD), Randomized Block Design (RBD)	10
31 - 32	LSD	Analysis of Latin Square Design (LSD), Comparisons based on means - Critical difference.	5
Total =			100

PRACTICAL [STAT-351]

Exercise No.	Exercise Title
1	Construction of frequency distribution tables and frequency curves.
2	Computation of Measures of Mean, Median and Mode.
3	Calculation of geometric mean, harmonic mean, percentiles and quartiles.
4	Measurement of range, quartile deviation, mean deviation.
5 - 6	Calculation of standard deviation for raw and grouped data and coefficient of variation.
7	Concept of Skewness and Kurtosis.
8	Introduction to Probability concepts.
9 - 10	Large sample tests for mean, Student's t-test and F-test.
11	Introduction to Chi-square test.
12	Computation of Correlation coefficient 'r' and its testing.
13	Introduction to Fitting of regression equations.
14	Problems on analysis of Completely Randomized Design (CRD).
15	Problems on analysis of Randomized Block Design (RBD).
16	Problems on analysis of Latin Square Design (LSD).

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