

# POST GRADUATE SYLLABUS

(Prepared from ICAR PG Syllabus of Horticulture)

*Degree to be awarded*

## **M. Sc. (Hort.) in Pomology and Post Harvest Technology**

**Department of Pomology and Post Harvest Technology**

FACULTY OF HORTICULTURE

UTTAR BANGA KRISHI VISWAVIDYALAYA

PUNDIBARI, COOCH BEHAR

## Departmental PG Courses and Syllabus

### a) M.Sc. courses

<i>Sl</i>	<i>Course</i>	<i>Course Title</i>	<i>Credit</i>
1	PPT501*	Tropical & SubtropicalFruitProduction- I	2+1
2	PPT502*	Tropical & SubtropicalFruitProduction- II	2+1
3	PPT 503*	TemperateFruitProduction Technology	2+1
4	PPT504*	BreedingofFruitCrops	2+1
5	PPT 505*	Post Harvest Physiology & Handling of Horticultural Crops	2+1
6	PPT 506*	Principal of Preservation of Horticultural Crops	2+1
7	PPT507*	Propagation, NurseryManagement &Biotechnology ofFruitCrops	2+1
8	PPT508	Storage Systems and Operations	2+0
9	PPT509	Organic Fruit Production and Gap For Fruit Crops	2+0
10	PPT510	Orchard Management Including CanopyManagementinFruitCrops	1+0
11	PPT511	Protected Cultivation and Climate Management for Fruit Crops	2+1
12	PPT512	Growth and Development of Horticultural Crops	2+1
13	PPT 513	Biodiversity and Conservation of Fruit Crops	1+0
14	PPT 591	Master'sSeminar	1+0
15	PPT599	Master'sResearch	20

### b) Ph.D. courses

<i>Sl</i>	<i>Course</i>	<i>CourseTitle</i>	<i>Credit</i>
1	PPT601**	AdvancesinBreedingofFruitCrops	2+1
2	PPT602**	AdvancesinProductionofFruitCrops- I	2+1
3	PPT603**	AdvancesinProductionofFruitCrops- Ii	2+1
4	PPT 604	Advances in Growth Regulation of Fruit Crops	2+1
5	PPT605	GenomicsandBioinformaticsinHorticulture	2+1
6	PPT606	BioticandAbioticStressManagementin HorticulturalCrops	2+1
7	PPT 607**	Commercial Fruit Nursery	1+1
8	PPT 608**	Advances in Post Harvest Physiology	2+0
9	PPT 609	Advances in Food Preservation	2+0
10	PPT691	DoctoralSeminarI	1+0
11	PPT692	DoctoralSeminarII	1+0
12	PPT699	DoctoralResearch	45

\*CompulsoryforMaster'sprogramme;\*\*CompulsoryforDoctoralprogramme, # for B.Sc. (Ag.)

## M.SC. SYALLBUS

### **1. PPT501: Tropical & Subtropical Fruit Production- I                      3 (2+1)**

#### **Theory**

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, nutrient management, water management, role of bio-regulators, training and pruning, flowering, pollination, fruit set and development, physiological disorders-causes and remedies, maturity indices, harvesting, grading, packing, storage and ripening; export potential, Agri. Export Zones (AEZ) of following crops: Mango, Banana, Citrus, Papaya, Guava, Pineapple, Litchi and Grape

#### **Practical**

Nutrition, weed management and propagation techniques of above mentioned crops. Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and sub-tropical orchards, Project preparation for establishing commercial orchards.

### **2. PPT502: Tropical & Subtropical Fruit Production- II                      2+1**

#### **Theory**

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, nutrient management, water management, role of bio-regulators, training and pruning, flowering, pollination, fruit set and development, physiological disorders-causes and remedies, maturity indices, harvesting, grading, packing, storage and ripening; export potential, Agri. Export Zones (AEZ) of following crops:

Sapota, Jackfruit, rambutan, Avocado, aonla, Pomegranate, Ber, Loquat, Persimmon, mango steen, Carambola, bael, fig, jamun,

#### **Practical**

Nutrition, weed management and propagation techniques of above mentioned crops. Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, orchards, Project preparation for establishing commercial orchards.

### **3. PPT 503: Temperate Fruit Production Technology                      3 (2+1)**

#### **Theory**

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, nutrient management, water management, role of bio-regulators, training and pruning, flowering, pollination, fruit set and development, physiological disorders-causes and remedies, maturity indices, harvesting, grading, packing, storage and ripening; export potential, of following crops: Apple, pear, Plums, peach, apricot, kiwifruit, strawberry, cherries, walnut, almond, pistachio, pecan, hazelnut

#### **Practical**

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to temperate orchards, Project preparation for establishing commercial orchards.

### **4. PPT 504: Breeding of Fruit Crops                      3(2+1)**

#### **Theory**

Origin and distribution, taxonomical status- species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement- introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievement and future thrust in the following selected fruit crops:

Mango, banana, pineapple, Citrus, grapes, guava, sapota, papaya, custardapple, litchi, apple, pear, and strawberry

### **Practical**

Characterization of germplasm, blossom biology, determination of sex ratio, study of floral and leaf characteristics, study of anthesis, practices in hybridization, evaluation of biometrical traits and quality traits, visit to research stations working on tropical, subtropical and temperate fruit improvement

## **5. PPT 505: Post Harvest Physiology & Handling of Horticultural Crops 3(2+1)**

### **Theory**

Pre harvest factors affecting post harvest quality and physiology of fruits and vegetables. Structure and composition of fruits and vegetables, physiological implications and structure on water movement, its loss and uptake and exchange of gasses. Maturity & Harvesting Indices, Harvesting injuries, Methods of harvesting. Postharvest changes, Ripening & Senescence, Respiration & Respiratory climacteric Ethylene biosynthesis and its action on ripening. Manipulation and regulation of postharvest physiology, ripening, senescence to extend storage life of fruits and vegetables, Bulk handling methods, Pack house operations – cleaning, trimming, grading, sorting, curing, de-greening, pre-cooling, washing and waxing. Storage: Goals, storage considerations, methods of storage- low cost storage, refrigerated storage, CA and MA storage, Storage disorders.

### **Practical**

Judging harvest maturity, Quality evaluation of different harvested fruits and vegetables – determination of firmness, TSS, moisture, acidity, sugars, ascorbic acid, chlorophylls, carotenoids, phenol, tannin, starch, proteins, Grading and sizing, Methods of waxing and its evaluation. Visit to cold storage and CA storage units.

## **6. PPT 506: Principal of Preservation of Horticultural Crops 3(2+1)**

### **Theory**

History of food preservation, general principles of preservation; asepsis. Thermal processing, heat resistance of micro-organism & enzymes in food, heat penetration in cans, determination of process time. Low temperature preservation: freezing, methods of freezing, changes during freezing, changes during storage of freezing products. Theory of gel formation, pectin chemistry, sources, problems in jelly making. Drying & Dehydration: blanching, sun drying, mechanical drying, and different types of driers. Food fermentation - alcoholic, acetic, and lactic fermentation, pickling. Preservatives - Class-I & II preservatives, their mode of action, use of antibiotics in food preservation, Preservation by ionizing radiation - principles, sources and types of radiations, their mode of action. Food colour, Food flavour, Food additives.

### **Practical**

Studies of food additives, colour, flavour, preservatives and antioxidants. Extraction and quantification of pectin. Determination of water activity, Determination of syrup, and brine strength. Drying and dehydration of fruits and vegetables. Demonstration of canning and freezing operation. List & cost of equipments, utensils and other additives required for small scale industry. visit to fruit and vegetable processing units.

## **7. PPT 507: Propagation, Nursery Management & Biotechnology of Fruit Crops 3(2+1)**

### **Theory**

Introduction, sexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination, dormancy. Asexual propagation – different types of cutting. Physiological, anatomical and biochemical aspects of root induction in cuttings. Layering. Budding and grafting – selection of elite mother plants. Establishment of budwood bank, stock, scion and interstock

relationship, Incompatibility. Rejuvenation through top working, Progeny orchard and scion bank. Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Micro-propagation – principles and concepts, commercial exploitation in fruit crops. Techniques – *in vitro* clonal propagation, organogenesis, embryogenesis, micrografting, meristem culture. Hardening, packing and transport of micro-propagules. Harnessing bio-technology in fruit crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture. Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis. Physiology of hardening – hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion. Omata hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, cryopreservation, rapid clonal propagation, genetic engineering in fruit crops, use of molecular markers.

### **Practical**

Different propagation methods for fruit crops. Study of construction of propagation structures, study of media and PGR. Visit to nurseries. Hardening – case studies, micropropagation, explant preparation, media preparation. An exposure visit to low cost, commercial and homestead tissue culture laboratories, Media preparation, Project preparation for establishment of commercial tissue culture laboratory.

## **8. PPT 508 : Storage systems and operations 3(2+1)**

### **Theory:**

Introduction. Principles of storage, Objectives of storage, storage considerations- temperature, relative humidity and atmospheric composition. Concept of cool chain. Storage systems- low cost storage techniques; zero energy cool chamber, high cost storage techniques: ambient temperature storage. Refrigerated storage: design and operation, hypobaric storage, MAP and CAP, storage with irradiation, concept of multipurpose cold storage. Chilling injuries and other physiological disorder in storage.

**Practical:** equipments and design of different storage system, Effectiveness of ZECC in extending storage life, post harvest loss assessment. Demonstration of chilling injury and physiological disorder in storage. Calculation related to mass and energy balance. Visit to cold storage.

## **9. PPT 509: Organic Fruit Production And Gap For Fruit Crops 2(1+1)**

### **Theory**

Organic horticulture – definition, principles, methods, merits and demerits. Organic farming systems, components of organic horticultural systems, different organic inputs, their role in organic horticulture, role of biofertilizers, biodynamics and their recent developments. Sustainable soil fertility management, weed management practices in organic farming, biological/natural control of pests and diseases, organic horticulture in quality improvement. Genesis of GAP –

definition/description, components listed by FAO, framework. Management of site history and soil, crop and fodder production, IPM, INM, IWM, irrigation water, crop production and protection. Identification of ways of improving the productivity, profitability, and resource efficiency. Harvest and post-harvest handling.

Animal production, product certification, animal waste management, animal health and welfare, harvest. On farm processing, storage, energy and waste management, human health,

welfare, safety, wildlife benefits. Institutions involved in GAP certification. Indian agencies, EUREPGAP (European Retail Producers Group-Good Agricultural Practices), EUREP etc.

### **Practical**

Bio-composting, biofertilizers and their application, methods of preparation of compost, vermicompost, application of neem products, visit to fields cultivated under organic practices

## **10. PPT510 Orchard Management Including Canopy Management in Fruit Crops 2(1+1)**

### **Theory**

Principles, planning for orchard establishment, Selection of site for orchard, Layout and system of planting in orchard. High density orcharding, Cropping systems followed in orchard: Intercropping, multitier cropping, mulching, sod culture, cover cropping, green manuring. Weed management. Canopy management- importance and advantages; factors affecting canopy development. Canopy types and structures with special emphasis on geometry of planting, canopy manipulation for optimum utilization of light. Light interception and distribution in different types of tree canopies. Spacing and utilization of land area - Canopy classification; Canopy management through rootstock and scion. Canopy management through plant growth inhibitors, training and pruning and management practices. Canopy development and management in relation to growth, flowering, fruiting and fruit quality in tropical, subtropical and temperate fruit crops.

### **Practical**

Lay out of orchard, study of different system of planting. green manuring, cover cropping, intercropping, use of fillers, soil solarization, Study of different types of canopies, training of plants, canopy development through pruning, use of plant growth inhibitors, geometry of planting; study on effect of different canopy types on production and quality of fruits.

## **11. PPT 511: Protected Cultivation and Climate Management for Fruit Crops 3(2+1)**

### **Theory**

Greenhouse – World scenario, Indian situation: present and future, Different agro-climatic zones in India, Environmental factors and their effect on plant growth. Basics of greenhouse design, different types of structures – glasshouse, shade net, poly tunnels - Design and development of low cost greenhouse structures. Interaction of light, temperature, humidity, CO<sub>2</sub>, water on crop regulation. Greenhouse heating, cooling, ventilation and shading. Types of ventilation - Forced cooling techniques - Glazing materials - Micro irrigation and Fertigation. Automated greenhouses, microcontrollers, waste water recycling, Management of pest and diseases - IPM. Introduction to climate change. Factors directly connected to climate change, average temperature, change in rainfall amount and patterns, rising atmospheric concentrations of CO<sub>2</sub>, pollution levels such as tropospheric ozone, change in climatic variability and extreme events like receding of glaciers in Himalayas. Sensors for climate registration and crop monitoring, phytomonitoring and biosensors, plants response to the climate changes, premature bloom, marginally overwintering or inadequate winter chilling hours, insect pests, longer growing seasons and shifts in plant hardiness for perennial fruit crops. Impact of climate changes on invasive insect, disease, weed, pests, horticulture yield, quality and sustainability, climate management in field production - mulching - use of plastic - wind break - spectral changes - frost protection. Climate management in greenhouse - heating - vents - CO<sub>2</sub> injection - screens - artificial light.

### **Practical**

Designs of greenhouse, low cost poly tunnels, net house - Regulation of light, temperature, humidity in greenhouses, media, greenhouse cooling systems, ventilation systems, fertigation systems, special management practices, project preparation for greenhouses, visit to greenhouses.

## **12. PPT512: Growth and Development of Horticultural Crops 3(2+1)**

### **Theory**

Growth and development - definition, parameters of growth and development, growth dynamics, morphogenesis. Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism vernalisation, effect of temperature, heat units, thermoperiodism. Assimilate partitioning during growth and development, influence of water



## Ph.D. SYLLABUS

### 1. PPT601                      **Advances in Breeding of Fruit Crops**                      3(2+1)

#### **Theory**

Evolutionary mechanisms, adaptation and domestication, Genetic resources, cytogenetics, cytomorphology, chemotaxonomy, genetics of important traits and their inheritance pattern, variations and natural selection, spontaneous mutations, incompatibility systems in fruits, recent advances in crop improvement efforts-introduction and selection, chimeras, apomixis, clonal selections, intergeneric, interspecific and intervarietal hybridization, mutation and polyploid breeding, resistance breeding to biotic and abiotic stresses, breeding for improving quality, molecular and transgenic approaches in improvement of following fruit crops. Mango, banana, Papaya, grapes, citrus, Guava, sapota, Pineapple, Apple, pear, and strawberry

#### **Practical**

Description and cataloguing of germplasm, pollen viability tests, pollen germination survey and clonal selection, observations on pest, disease and stress reactions in inbreds and hybrids, use of mutagenesis and colchicine for inducing mutation and ploidy changes, practices in different methods of breeding fruit crops and in-vitro breeding techniques.

### 2. PPT602                      **Advances in Production of Fruit Crops-I**                      3(2+1)

#### **Theory**

National and International scenario in fruit production, Recent advances in propagation- rootstock influence, planting systems, High density planting, crop modeling, Precision farming, decision support systems- aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, Total quality management (TQM) of following crops: Mango, banana, Papaya, grapes, citrus, Guava, sapota and onion

#### **Practical**

Survey of existing fruit cropping systems and development of a model cropping system, Estimating nutrient deficiency- estimation of water use efficiency, soil test-crop response correlations, practices in plant growth regulation, studying physiological and biochemical responses, quality analysis.

### 3. PPT603                      **Advances in Production of Fruit Crops-II**                      3(2+1)

#### **Theory**

National and International scenario in fruit production, Recent advances in propagation- rootstock influence, planting systems, High density planting, crop modeling, Precision farming, decision support systems- aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient management, Total quality management (TQM) of following crops: Pineapple, avocado, jack, Apple, pear, plums, strawberry, peach, apricot, cherries

#### **Practical**

Survey of existing fruit cropping systems and development of a model cropping system, Estimating nutrient deficiency- estimation of water use efficiency, soil test-crop response correlations, practices in plant growth regulation, studying physiological and biochemical responses, quality analysis.

### 4. PPT604                      **Advances in Growth Regulation of Fruit Crops**                      3(2+1)

#### **Theory**

Ecophysiological influences on growth and development of fruit crops- flowering, fruit set- Root and canopy regulation, study of plant growth regulators in fruit culture- biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants.



Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, Growth regulation aspects of propagation, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production. Flower drop and thinning, fruit set and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation

#### **Practical**

Root-shoot studies, quantifying the physiological and biochemical effects of physical and chemical growth regulation, bioassay and isolation through chromatographic analysis for auxins, gibberellins, experiments on growth regulation during propagation, dormancy, flowering, fruit set and fruit development stages.

### **5. PPT605**

#### **Genomics and Bioinformatics in Horticulture**

**3 (2+1)**

#### **Theory**

Primer on bioinformatics and computational genomics, database fundamentals – biological databases, horticultural genome and protein databases, functional genomics. Dynamic Programming Sequence Alignment, BLAST search engine, FASTA search engine, Microarrays, Microarray Clustering and Classification, Terminologies and Ontologies- EcoCYC knowledge base of E. Coli metabolism- Description of UMLS Semantic Network. Multiple Sequence Alignment, MSA algorithm descriptions, Clustal W, 1D Motifs, Algorithms and Databases, methods for sequence weighting, BLOCKS database, Making BLOCK motifs, PROSITE database, 3D structure alignment, SCOP, DALI, LOCK, MUSTA algorithm for geometric hashing and multiple alignment. Hidden Markov models, Molecular energetics and dynamics, Protein structure prediction, Genetic networks- Modeling and Simulation of Genetic Regulatory Systems- KEGG database of genes and gene pathways/networks- EcoCYC database of metabolic pathways in E. Coli- EGF-signal pathway modeling, Gene finding algorithms- Genome Annotation Assessment Project for Arabidopsis, Comparative genomics algorithms, Genome Alignment. 3D structure computations, NMR, X-ray crystallography, NMR Structure Determination, X-ray Crystallography Structure Determination, Distance Geometry Description, RNA secondary structure, Molecular Modeling and Drug discovery programs. Phylogenetic algorithms - Tree based database of phylogenetic information for plants mostly, Tree of Life Page, Samples from the Tree of Life, Ribosomal Database Project, Natural Language Processing, Proteomics, 3D Motifs, Applications and Integration with Horticulture, Final Thoughts.

#### **Practical**

Computers, Operating systems and Programming languages, Internet Resources, Horticultural Genome and Protein Databases, BLAST/RNA Structure, Sequence Alignment, Microarray Data Analysis, Ontology, MSA, HMMs, Identification of Functional Sites in Structures, Protein Structure Prediction- Phylogenetics- Gene Finding- Molecular Modeling and Drug Discovery Software – Assignments.

### **6. PPT606: Biotic and Abiotic Stress Management in Horticultural Crops**

**3(2+1)**

#### **Theory**

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.). Pollution- increased level of CO<sub>2</sub>, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations. Crop modeling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stress and their impact on crop growth and productivity. Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti-transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers. Rainwater harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate

different stress situations, cropping systems, stability and sustainability indices.

### **Practical**

Seed treatment/hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors, RWC, chlorophyll fluorescence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusivity resistance, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and water shed locations.

### **7. PPT 607: COMMERCIAL FRUIT NURSERY 2(1+1)**

**Theory:** Selection of soil, locality, site for fruit nursery, progeny tree, structures for a nursery. Propagation of different fruit plants, care of young nursery plants, maintenance, lifting and packing operations, preparation of a calendar for nursery operations, Economics for development of a fruit nursery. Nursery registration act.

**Practical:** Planning and lay out of a fruit nursery. Preparation of a nursery bed and planting techniques for different fruit crops. Layout of different propagation structure. Methods of lifting and packing of fruit plants.

### **8. PPT 608: Advances in Post Harvest Physiology 2(2+0)**

**Theory:** The general biology of plant senescence, control of RNA and enzyme synthesis during fruit ripening, Respiration and energy metabolism in senescence plant tissue, Enzyme activities and post-Harvest changes, plant membrane lipids, changes and alteration during ageing and senescence, hormonal regulation of senescence, ageing and ripening. Formation of enzymatic products in the fruits during growth and storage. Stress metabolites in postharvest fruits and vegetables- role of ethylene. Post harvest pathology- etiology of postharvest disease, important postharvest disease, host pathogen interaction in postharvest disease, control of postharvest disease, hormonal and chemical postharvest treatments, which influence the postharvest quality, maturity and storability of fruits.

### **9. PPT 609: Advances in Food Preservation 2(2+0)**

#### **Theory:**

Principles of Hurdle Technology- thermal and non-thermal methods as hurdles, microbial stability and quality aspect. Minimally Processed foods, Intermediate moisture foods, role of water activity in food preservation, Chemicals and Biochemicals Used in Food Preservation- Natural food preservatives, bacteriocins; Pulsed electric field- microbial inactivation, application, present status and future scope; Fundamentals and Applications of High Pressure Processing to Foods, Advances in Use of High Pressure to Processing and Preservation of Plant Foods, Commercial High-Pressure Equipment; Food Irradiation—An Emerging Technology; Ultraviolet Light and Food Preservation; Microbial Inactivation by Ultrasound; Use of oscillating Magnetic Fields as a Nonthermal Technology; Nonthermal Technologies in Combination with Other Preservation Factors. Preservation by ohmic heating-Advances in Ohmic Heating and Moderate Electric Field (MEF) Processing; Radio-Frequency Heating in Food Processing; Current State of Microwave Applications to Food Processing; Supercritical Fluid Extraction: An Alternative to Isolating bioactive compounds.

### **10. PPT: 591 Doctoral Seminar –I 1(1+0)**

### **11. PPT: 592 Doctoral Seminar –II 1(1+0)**