POST GRADUATE DEPARTMENT OF AGRICULTURE

SYLLABUS FOR THE BATCH FROM THE YEAR 2024 TO YEAR 2026

Programme Code : MHFS

Programme Name : M.Sc. Ag. Horticulture (Fruit Science)
(Semester I-IV)

Examinations: 2024-26

Khalsa College Amritsar

Programme Objectives:-

1. To train and develop scholars and promote research by providing students with contemporary concepts in various fields of crop Horticulture.
2. To generate knowledge through cognitive, affective and psychomotor which are necessary for productive scholarly research in the specific field of fruit science.
3. To acquire in depth knowledge in areas of specialization.
4. The program will contribute to the development of agriculture sector and thereby ensure food security and self sufficiency.

M.Sc. Ag.(Horticulture- Fruit Science)
Programme Specific Outcomes(PSOs) and Course Outcomes(Cos)

PROGRAMME SPECIFIC OUTCOMES

PSO-1	To evolve into postgraduates with knowledge and understanding of concepts across diverse areas in Horticulture..
PSO-2	To serve as skilled human resource tailored to formulate, analyse, and resolve complex problems in horticultural crops..
PSO-3	To apply the knowledge and skills acquired to cater the needs of the industry, academia, research and the society for contributing to nation-building
PSO-4	To provide and promote consultancy services in the fields of Horticultural research, training and dissemination of information and technology
PSO-5	To utilize the opportunities present in the market for the upliftment of society.
PSO-6.	To cater the needs of line departments and horticulture based industries through the acquired knowledge in horticulture
PSO-7	To develop into an entrepreneur by harnessing the acquired knowledge and skills of horticulture
PSO-8	To emerge as an ambassador of horticulture through the service rendered to the farming community.

M.Sc. Ag. Horticulture (Fruit Science)

SEMESTER-I

Course Code	Course Title	Credit Hours	Marks	Total Marks	Page Number
			Theory+Practical+ I. Assessment		
FSC-511	Tropical Fruit Production	3(2+1)	50+25+25	100	6-7
FSC-512	Canopy Management in	3(2+1)	50+25+25	100	8

	Fruit Crops				
PHM-511 (Minor)	Post harvest Management of Horticultural Produce	3(2+1)	50+25+25	100	9-10
STAT-511 (Supporting)	Statistical Methods for Applied Sciences/Social Sciences	4(3+1)	57+18+25	100	11-12
*PGS-511	Technical Writing and Communication Skills	1(0+1)	100 (Pr)	100	13
*PGS-512	Library and Information Services	1(0+1)	100(Pr)	100	14
*FSC-599	Masters' Research	5(0+5)	-	S/US	15
	Total	20 (13+7*)			

* Non - credit course

Total Internal Assessment = 25 marks (House Test –10 marks ; Attendance – 10 marks; Conduct &Academic, Extra Curricular Activities – 5 marks).

M.Sc. Ag. Horticulture (Fruit Science)

SEMESTER-II

Course Code	**Course Title**	**Credit Hours**	**Marks**	**Total Marks**	**Page Number**
			Theory+Practical+ I.Assessment		
FSC-521	Sub Tropical and Temperate Fruit Production	3(2+1)	50+25+25	100	16-17
FSC-522	Breeding of Fruit Crops	3(2+1)	50+25+25	100	18-19

PHM-521 (Minor)	Post harvest physiology and Biochemistry of Perishables	3(2+1)	50+25+25	100	20-21
STAT-521	Experimental Designs	3(2+1)	50+25+25	100	22-23
*PGS-521	Agricultural Research, Research Ethics and Rural Development Programmes	1(1+0)	100(Th)	100	24
*FSC-599	Master's Research	5(0+5)	--	S/US	25
	Total	**18 (12+6*)**			

* Non - credit course

Total Internal Assessment = 25 marks (House Test –10 marks ; Attendance – 10 marks; Conduct &Academic, Extra Curricular Activities – 5 marks).

M.Sc. Ag. Horticulture (Fruit Science)

SEMESTER-III

Course Code	**Subject**	**Credit hours**	**Marks**	**Total Marks**	**Page Number**
			Theory+Practical + I.Assessment		
FSC-531	Systematics of Fruit Crops	3(2+1)	50+25+25	100	26-27

FSC-532	Organic Fruit Culture	3(2+1)	50+25+25	100	28-29
FSC-533 (Minor)	Growth and Development of Fruit Crops	3(2+1)	50+25+25	100	30-31
FSC-591	Credit seminar	1(1+10)	100	100	32
*PGS-531	Intellectual Property and its management in Agriculture	1(1+0)	100(Th)	100	33
*FSC-599	Master's Research	10(0+10)	--	S/US	34
Total		**21(10+11*)**			

* Non - credit course

Total Internal Assessment = 25 marks (House Test –10 marks ; Attendance – 10 marks; Conduct &Academic, Extra Curricular Activities – 5 marks).

M.Sc. Ag. Horticulture (Fruit Science)

SEMESTER-IV

Course Code	**Subject**	**Credit hours**	**Marks**	**Total Marks**	**Page Number**
			Theory+Practical + I.Assessment		
FSC-541	Propagation and Nursery Management in Fruit Crops	3(2+1)	50+25+25	100	35-36
*PGS-541	Basic concepts in Laboratory Techniques	1(0+1)	100 (Pr)	100	37
*FSC-599	Master' s Research	10(0+10)	-	S/US	38

	Total	**13(3+11*)**			

* Non - credit course

Total Internal Assessment = 25 marks (House Test –10 marks ; Attendance – 10 marks; Conduct &Academic, Extra Curricular Activities – 5 marks).

SEMESTER-I

FSC-511: Tropical Fruit Production

Maximum marks: 100
Theory: 50
Practical: 25
Internal assessment: 25
Time: 3 Hours **Credit hours: 3(2+1)**

Instructions for the paper setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All questions will carry equal marks (10).

Course Objective

- To impart comprehensive knowledge to the students on cultural and management practices for growing tropical fruits.

Theory

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements. Propagation, Planting and Orchard Floor Management: Asexual and sexual methods of propagation, planting systems and planting densities, training and pruning methods, rejuvenation, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production. Flowering, Fruit-Set and Harvesting: Physiology of flowering, pollination management, fruit set and development, physiological disorders–causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management. Fruit Crops-

Section-A: Citrus, Mango, Papaya, Pineapple, Banana,
Section-B: Avocado, Sapota, Guava, Ber, Pomegranate,
Section-C: Aonla, Jack Fruit, Annonas
Section-D: Minor Fruits of Tropics

Practical

Distinguished features of tropical fruit species, cultivars and rootstocks. Demonstration of planting systems, training and pruning. Hands on practices on pollination and crop regulation. Leaf sampling and nutrient analysis. Physiological disorders-malady diagnosis. Physico-chemical analysis of fruit quality attributes. Field/ Exposure visits to tropical orchards. Project preparation for establishing commercial orchards.

Suggested Reading

- Bartholomew DP, Paull RE and Rohrbach KG. 2002. *The Pineapple: Botany, Production, and Uses.* CAB International.
- Bose TK, Mitra SK and Sanyal D. 2002. *Fruits of India – Tropical and Sub-Tropical.*3rd Edn. Naya Udyog, Kolkata.
- Dhillon WS. 2013. *Fruit Production in India.* Narendra Publ. House, New Delhi.
- Iyer CPA and Kurian RM. 2006. *High Density Planting in Tropical Fruits:* Principlesand Practices. IBDC Publishers, New Delhi.
- Litz RE. 2009. *The Mango: Botany, Production and Uses.* CAB International. Madhawa Rao VN. 2013. Banana. ICAR, New Delhi.
- Midmore D. 2015. *Principles of Tropical Horticulture.* CAB International.
- Mitra SK and Sanyal D. 2013. *Guava,* ICAR, New Delhi.
- Morton JF. 2013. *Fruits of Warm Climates.* Echo Point Book Media, USA.
- Nakasome HY and Paull RE. 1998. *Tropical Fruits.* CAB International.
- Paull RE and Duarte O. 2011. *Tropical Fruits (Vol. 1).* CAB International.
- Rani S, Sharma A and Wali VK. 2018. *Guava (Psidium guajava L.).* Astral, New Delhi.
- Robinson JC and Saúco VG. 2010. *Bananas and Plantains*. CAB International.

- Sandhu S and Gill BS. 2013. *Physiological Disorders of Fruit Crops.* NIPA, New Delhi.
- Schaffer B, Wolstenholme BN and Whiley AW. 2013. *The Avocado: Botany, Production and Uses.* CAB International.
- Sharma KK and Singh NP. 2011. *Soil and Orchard Management*. Daya Publishing House, New Delhi.
- Valavi SG, Peter KV and Thottappilly G. 2011. *The Jackfruit.* Stadium Press, USA

Course Title : Tropical Fruit Production and Dry Land Horticulture Course Code : FSC-511

Sr.no.	On completing the course, the students will be able to
CO1	Equip themselves with know-how on agro-techniques for establishment and management of an orchard leading to optimum and quality fruit production of tropical fruits

SEMESTER-I

FSC-512 Canopy Management of Fruit Crops

Time: 3 Hours **Maximum Marks: 100**
Theory: 50
Practical: 25
Internal assessment: 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course Objective

• To impart knowledge on principles and practices in management of canopy architecture for quality fruit production

Theory

Section-A: Introduction, Types and Classification: Canopy management – importance and factors affecting canopy development

Section-B: Canopy types and structures, canopy manipulation for optimum utilization of light and its interception. Spacing and utilization of land area – Canopy classification.

Section-C: Physical Manipulation and Growth Regulation: Canopy management through rootstock and scion. Canopy management through plant growth regulators, training and pruning and management practices.

Section-D: Canopy development and management in relation to growth, flowering, fruiting and fruit quality.

Practical:

Study of different types of canopies. Training of plants for different canopy types. Canopy development through pruning . Understanding bearing behaviour and canopy management in different fruits. Use of plant growth regulators . Geometry of planting . Development of effective canopy with support system . Study on effect of different canopy types on production and quality of fruits.

Suggested Reading

- Bakshi JC, Uppal DK and Khajuria HN. 1988. *The Pruning of Fruit Trees and Vines.* Kalyani Publishers, New Delhi.
- Chadha KL and Shikhamany SD. 1999. *The Grape, Improvement, Production and Post Harvest Management.* Malhotra Publishing House, Delhi.
- Iyer CPA and Kurian RM. 2006. *High Density Planting in Tropical Fruits: Principles and Practices.* IBDC Publishers, New Delhi.
- Pradeepkumar T. 2008. *Management of Horticultural Crops.* NIPA, New Delhi.

- Singh G. 2010. *Practical Manual on Canopy Management in Fruit Crops*. Dept. of Agriculture and Co-operation, Ministry of Agriculture (GoI), New Delhi.
- Srivastava KK. 2012. *Canopy Management in Fruits*. ICAR, New Delhi.

Course Title : Canopy Management of Fruit Crops **Course Code : FSC-512**

Sr.no.	**On completing the course, the students will be able to**
CO1	The basic principles of canopy management to modify plant architecture
CO2	The skills on training and pruning of fruit crops, and growth regulation

SEMESTER-I

PHM-511 **Post harvest Management of Horticultural Produce**
Time: 3 Hours

Maximum Marks: 100

Theory: 50
Practical: 25
Internal assessment: 25
Credit hours: 3(2+1)

Instructions for the Paper Setters:

1.Question paper should be set strictly according to the syllabus.
2.The language of questions should be straight & simple.
3.In all nine questions should be asked, of which first question of 10 marks (Comprising of short answer type questions covering the whole syllabus) will be compulsory.
4.Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course Objective

- To impart comprehensive knowledge on management of horticultural produce thus extending the post-harvest life of the produce by various treatments.

Theory

Section-A: History, Importance and scope of Postharvest technology of horticultural produce. Nature and structure of horticultural produce. Pre and Postharvest losses and their causes. Climacteric and non-climacteric fruits. Regulation of ripening by use of chemicals and growth regulators. Control of sprouting, rooting and discoloration in vegetables.

Section-B: Maturity indices for harvest. Harvesting and harvesting tools. Curing in roots and tubers. Prepackage Operation: Preecooling, washing, sorting, grading of horticultural perishables for local markets and export. Postharvest handling of spices, plantation crops, medicinal and aromatic plants. Equipments for washing, sizing, grading

Section-C: Pre and Postharvest treatments for extending storage life/ vase life. VHT, irradiation treatment, skin coating, degreening, etc. Prepackaging, Packaging techniques for local market and export. Standards and specifications for fresh produce.

Section-D: Postharvest handling system for horticulture crops of regional importance. Principles of transport, modes of transportation, types of vehicles and transit requirements for different horticultural produce. Marketing: Factors influencing marketing of perishable crops, marketing systems and organizations.

Practical:

Study of maturity indices for harvest of fruits, vegetables, spices and plantation crops. Protective skin coating with wax emulsion and pre and Postharvest treatment with fungicides, chemicals and growth regulators to extend the shelf life of fruits and vegetables. Prepackaging of perishables. Extension of vaselife of cut flowers by use of chemicals and growth regulators. Control of sprouting of potato and onion by using growth regulators. Study of modern harvesting, sorting and grading equipments. Study of effect of pre-cooling on shelf-life and

quality of fresh fruits, vegetables and flowers. Visit to packaging centers. Visit to local markets, cooperative organizations, super markets dealing with marketing of Perishables.

Suggested Reading

- Bhattacharjee SK and Dee LC. 2005. *Postharvest technology of flowers and ornamental plants*. Pointer publishers, Jaipur.
- Chattopadhyay SK. 2007. *Handling, transportation and storage of fruit and vegetables*. GeneTech books, New Delhi.
- FAO. 2007. *Handing and Preservation of Fruits and Vegetables by Combined methods for Rural Areas*-Technical Manual.
- Kader AA. 1992. *Postharvest technology of horticultural crops*. 2nd ed university of California.
- Paliyath G, Murr DP, Handa AK and Lurie S. 2008. *Postharvest Biology and Technology of Fruits, Vegetables and Flowers*, Wiley-Blackwell, ISBN: 9780813804088.
- Pruthi JS. 2001 (Reprint). *Major spices of India crop management and Postharvest technology*. ICAR, NewDelhi
- Stawley J Kays. 1998. *Postharvest physiology of perishable plant products*. CBS publishers.
- Sudheer KP, Indira V. 2007. *Postharvest Technology of Horticultural Crops*, Peter K.V. (Ed.), New India Publishing Agency, ISBN 9788189422431.
- Sunil Pareek (Ed.) 2016. *Postharvest Ripening Physiology of Crops,* CRC Press, ISBN 9781498703802.
- Thompson AK. (Ed.) 2014. *Fruit and Vegetables: Harvesting, Handling and Storage* (Vol. 1 & 2) Blackwell Publishing Ltd, Oxford, UK. ISBN: 9781118654040.
- Verma LR and Joshi VK. 2000. *Postharvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management*. Indus Publishing Company, New Delhi, India. ISBN 8173871086.
- Wills RBH and Golding J. 2016. *Postharvest: an introduction to the physiology and handling of fruit and vegetables*, CABI Publishing, ISBN 9781786391483.
- Wills RBH and Golding J. 2017. *Advances in Postharvest Fruit and Vegetable Technology, CRC Press*, ISBN 9781138894051.

Websites:

- Horticulture-Post harvest management CSIR-NISTADS http://www.nistads.res.in/indiasnt2008/ t6rural/t6rur13.htm
- Post harvest technology- MANAGE http://www.manage.gov.in/ftf-itt/prgReports/iihr.pdf
- Role of post-harvest management http://www.fao.org/3/y5431e/y5431e02.htm

Course Title : Post harvest Management of Horticultural Produce Course Code : PHM-511

Sr.no.	On completing the course, the students will be able to
CO1	Regulation of ripening by use of chemicals and growth regulators
CO2	Pre and Postharvest treatments for extending storage life/ vase life
CO3	Standards and specifications for fresh produce

SEMESTER-I

STAT-511 Statistical Methods for Applied/ Social Sciences

Time: 3 Hours

Maximum marks: 100
Theory: 57
Practical: 18
Internal assessment: 25

Credit hours: 4(3+1)

Instructions for the Paper Setters:
Question paper should be set strictly according to the syllabus.
The language of questions should be straight & simple.
In all nine questions should be asked, of which first question of 9 marks (Comprising of 9 short answer type questions covering the whole syllabus) will be compulsory.
Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All questions will carry equal marks (12).

Course Objectives

- The aim of this course is to understand the basics of statistical methods and their applications in agriculture.
- It helps the students in understanding, analyzing and interpreting the agricultural data.
- It also helps in making appropriate decisions in agricultural research findings.

Theory

Section-A: Box-plot, Descriptive statistics:- measures of central tendency, dispersion, Theory of probability:- types and introduction, Introduction to Random variable and Mathematical expectation and their properties

Section-B: Discrete and continuous probability distributions:- Binomial, Poisson, Normal distribution and their applications. Concept of sampling distribution: chi-square, t and F distributions. Tests of significance based on Normal, chi-square, t and F distributions.

Section-C: Simple and multiple correlation coefficient, partial correlation, rank correlation, Simple and multiple linear regression model, test of significance of correlation coefficient and regression coefficients, Coefficient of determination.

Section-D: Non-parametric tests:- sign, Mann-Whitney U-test, Run test for the randomness of a sequence, Median test:- introduction and their applications. Introduction to ANOVA: One way and Two Way, Introduction to Sampling Techniques:- SRS, cluster, stratified, systematic sampling:- introduction and their applications, Transformation of Data.

Practical:
Fitting of distributions ~ Binomial, Poisson, Normal. Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi-square, t and F. Correlation and regression analysis. Non-parametric tests. ANOVA: One way, Two Way.

Suggested Reading:

- Goon A.M, Gupta M.K and Dasgupta B. 1977. An Outline of Statistical Theory. Vol. I. TheWorld Press.

- Goon A.M, Gupta M.K. and Dasgupta B. 1983. Fundamentals of Statistics. Vol. I. The WorldPress.
- Hoel P.G. 1971. Introduction to Mathematical Statistics. John Wiley.
- Hogg R.V and Craig T.T. 1978. Introduction to Mathematical Statistics. Macmillan.
- Morrison D.F. 1976. Multivariate Statistical Methods. McGraw Hill.
- Hogg RV, McKean JW, Craig AT. 2012. Introduction to Mathematical Statistics 7th Edition.
- Siegel S, Johan N & Casellan Jr. 1956. Non-parametric Tests for Behavior Sciences. JohnWiley.
- Anderson TW. 2009. An Introduction to Multivariate Statistical Analysis, 3rd Ed. John Wiley
- http://freestatistics.altervista.org/en/learning.php.
- http://www.statsoft.com/textbook/stathome.html.

Course Title Statistical Methods for Applied/Social science Course Code: STAT-511

Sr. No.	On completing the course, the students will be able to:
CO1	Understand the concept of probability, sampling techniques, standard error etc.
CO2	Apply correction and regression techniques.
CO3	Know the use of T-Test, chi-square and large sample tests

SEMESTER-I

***PGS 511 Technical Writing & Communication Skills**

Time:-3 hours

Maximum Marks: 100
Practical: 100
Credit hours:1 (0+1)

Instructions for the paper setters:

1. The question paper will consist of ten skill-oriented questions.
2. The first 5 questions carry 8 marks each. There will be internal choice wherever possible. The answer should be in 50-80 words. (5x8=40 marks).
3. There will be four essay type questions from the entire syllabus. There will be internal choice wherever possible. The answer should be in 250words.(4x15=60 marks).

Course Objectives

- To equip the students with skills and techniques to write dissertations, research papers, review paper, book chapter and articles etc.
- To equip the students with skills to communicate and articulate in English and scientific language (verbal as well as writing).

Practical:

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc. Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion). Writing of abstracts, summaries, précis, citations, etc. Commonly used abbreviations in the theses and research communications. Illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations. Writing of numbers and dates in scientific write-ups. Editing and proof-reading. Writing of a review article. Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks). Error analysis (Common errors), Concord, Collocation, Phonetic symbols and transcription. Accentual pattern: Weak forms in connected speech. Participation in group discussion. Facing an interview. Presentation of scientific papers.

Suggested Readings

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

Course Title: Technical writing & communication skills , library & information services
Course Code: *PGS-511

Sr. No.	On completing the course, the students will be able to:
CO1	Understand the basic components like definitions, descriptions, process explanations and other common forms of technical writing
CO2	Understand how to follow the stages of the writing process and apply them to technical and workplace writing tasks
CO3	Synthesize material collected from primary and secondary sources with their own ideas while writing research papers

SEMESTER-I

***PGS 512** **Library & Information Services**

Time:-3 hours

Maximum marks: 100
Practical : 100
Credit hours:1 (0+1)

Course objectives

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

Practical:

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

SEMESTER-I

***FSC-599 Masters' Research**

S/US
Credit hours: 5(0+5)

SEMESTER-II

FSC-521: Sub-Tropical and Temperate Fruit Production

Time: 3 Hours **Maximum Marks: 100**
Theory: 50
Practical: 25
Internal assessment: 25

Credit hours: 3(2+1)

Instructions for the paper setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All questions will carry equal marks (10).

Course Objective

- To impart comprehensive knowledge to the students on cultural and management practices for growing subtropical and temperate fruits

Theory

Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements. Propagation, planting systems and densities, training and pruning, rejuvenation and replanting, intercropping, nutrient management, water management, fertigation, use of bio-fertilizers, role of bio-regulators, abiotic factors limiting fruit production. Physiology of flowering, pollination management, fruit set and development, physiological disorders- causes and remedies, crop regulation, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; insect and disease management. Fruit crops-

Section-A: Citrus, Grapes, Litchi, Loquat, Pomegranate, Apple, Pear, Peach

Section-B: Plum, Quince, Apricot, Cherries, Bael, Fig, Jamun, Wood apple.

Section-C: Berries, Persimmon, Kiwifruit, strawberry, Mangosteen, Carambola

Section-D: Nuts- Walnut, Almond, Pecan, Hazelnut, Pistachio

Practical:

Distinguished features of fruit species, cultivars and rootstocks. Demonstration of planting systems, training and pruning. Hands on practices on pollination and crop regulation. Leaf sampling and nutrient analysis. Physiological disorders-malady diagnosis. Physico-chemical analysis of fruit quality attributes . Field/ Exposure visits to subtropical and temperate orchards. Project preparation for establishing commercial orchards.

Suggested Reading

- Chadha KL and Awasthi RP. 2005. The Apple. Malhotra Publishing House, New Delhi. Chadha TR. 2011. *A Text Book of Temperate Fruits*. ICAR, New Delhi.
- Childers NF, Morris JR and Sibbett GS. 1995. *Modern Fruit Science: Orchard and Small Fruit Culture.* Horticultural Publications, USA.
- Creasy G and Creasy L. 2018. *Grape*s. CAB International.

- Davies FS and Albrigo LG. 1994. *Citrus*. CAB International.
- Dhillon WS. 2013. *Fruit Production in India*. Narendra Publishing House, New Delhi.
- Jackson D, Thiele G, Looney NE and Morley-Bunker M. 2011. *Temperate and Subtropical Fruit Production*. CAB International.
- Ladanyia M. 2010. *Citrus Fruit: Biology, Technology and Evaluation*. Academic Press.
- Layne DR and Bassi D. 2008. *The Peach: Botany, Production and Uses*. CABI.
- Menzel CM and Waite GK. 2005. *Litchi and Longan: Botany, Production and Uses.* CAB International.
- Pandey RM and Randey SN. 1996. *The Grape in India*. ICAR, New Delhi.
- Rajput CBS, and Haribabu RS. 2006. *Citriculture*, Kalyani Publishers, New Delhi.
- Sandhu S and Gill BS. 2013. *Physiological Disorders of Fruit Crops*. NIPA, New Delhi.
- Sharma RM, Pandey SN and Pandey V. 2015. The *Pear – Production, Post-harvest Management and Protection.* IBDC Publisher, New Delhi.
- Sharma RR and Krishna H. 2018. *Textbook of Temperate Fruits*. CBS Publishers and Distributors Pvt. Ltd., New Delhi.
- Singh S, Shivshankar VJ, Srivastava AK and Singh IP. 2004. *Advances in Citriculture*. NIPA, New Delhi.
- Tromp J, Webster AS and Wertheim SJ. 2005. *Fundamentals of Temperate Zone Tree Fruit Production.B*ackhuys Publishers, Lieden, The Netherlands.
- Webster A and Looney N. *Cherries:* Crop Physiology, Production and Uses. CABI. Westwood MN. 2009. Temperate Zone Pomology:Physiology and Culture. Timber Press, USA

Course Title : Sub-Tropical and Temperate Fruit Production Course Code : FSC-521

Sr.no.	On completing the course, the students will be able to
CO1	Equip themselves with principles and practices of producing subtropical (citrus, grapes, litchi, pomegranate, etc.) and temperate fruits (apple, pear, peach, plum, apricot, cherries, berries, kiwifruit, etc.) and nuts (almond, walnut, pecan, etc.)

SEMESTER-II

FSC-522: Breeding of Fruit Crops

Time: 3 Hours **Maximum Marks: 100**
Theory: 50

Practical: 25
Internal assessment: 25
Credit hours: 3(2+1)

Instructions for the paper setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course Objective

• To impart comprehensive knowledge on principles and practices of fruit breeding

Theory

Introduction and importance, origin and distribution, taxonomical status – species and cultivars, cytogenetics, genetic resources. Blossom biology, breeding systems – spontaneous mutations, polyploidy, incompatibility, sterility, parthenocarpy, apomixis, breeding objectives, ideotypes. Approaches for crop improvement – direct introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrusts.

Crops:

Section-A: Mango, Banana, Pineapple, Citrus, Grapes
Section-B: Litchi, Guava, Pomegranate, Papaya, Apple.
Section-C: , Pear, Plum, Peach, Apricot, Cherries
Section-D: Strawberry, Kiwifruit, Nuts

Practical:

Exercises on bearing habit, floral biology. Pollen viability and fertility studies. Hands on practices in hybridization. Raising and handling of hybrid progenies. Induction of mutations and polyploidy . Evaluation of biometrical traits and quality traits. Screening for resistance against abiotic stresses. Developing breeding programme for specific traits. Visit to research stations working on fruit breeding.

Suggested Reading

- Abraham Z. 2017. *Fruit Breeding*. Agri-Horti Press, New Delhi.
- Badenes ML and Byrne DH. 2012. *Fruit Breeding*. Springer Science, New York.
- Dinesh MR. 2015. *Fruit Breeding,* New India Publishing Agency, New Delhi.
- Ghosh SN, Verma MK and Thakur A. 2018. *Temperate Fruit Crop Breeding-Domestication to Cultivar Development.* NIPA, New Delhi.

- Hancock JF. 2008. *Temperate Fruit Crop Breeding: Germplasm to Genomics*. Springer Science, New York.
- ain SN and Priyadarshan PM. 2009. *Breeding Plantation and Tree Crops: Tropical Species.* Springer Science, New York.
- Jain S and Priyadarshan PM. 2009. *Breeding Plantation and Tree Crops: Temperate Species.* Springer Science, New York.
- Janick J and Moore JN. 1996. *Fruit Breeding. Vols. I–III*. John Wiley & Sons, USA.
- Kumar N. 2014. *Breeding of Horticultural Crops:Principles and Practices*. NIPA, N. Delhi.
- Moore JN and Janick J. 1983. *Methods in Fruit Breeding*. Purdue University Press, USA.
- Ray PK. 2002. *Breeding Tropical and Subtropical Fruits*. Narosa Publ. House, New Delhi

Course Title : Breeding of Fruit Crops **Course Code : FSC-522**

Sr.no.	**On completing the course, the students will be able to**
CO1	Have an understanding on importance and peculiarities of fruit breeding
CO2	Have an updated knowledge on reproductive biology, genetics and inherent breeding systems.
CO3	Have detailed knowledge of various methods/ approaches of breeding fruit crops

SEMESTER-II

PHM-521 Post Harvest Physiology and Biochemistry of Perishables (Minor)

Time: 3 Hours **Maximum Marks: 100**
Theory: 50
Practical: 25
Internal assessment: 25
Credit hours : 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course Objectives

- To impart comprehensive knowledge on physiology of horticultural produce after harvest
- To understand different physiological processes like respiration ripening

Theory:

Section-A: Introduction, biochemical structure and composition of fruits, vegetables and ornamentals. Biochemical changes during development and ripening. Structural Deterioration of the Produce-cell wall degradation, change in membrane lipid.: Biosynthesis of ethylene and its regulation. Ethylene action and ripening processes, its perception-action and regulation.

Section-B: Determining maturity and maturity indices. Ripening processes: events of ripening and factors affecting them.

Section-C: Physiology of preharvest and postharvest; factors affecting shelf-life and quality of fruits, vegetables and ornamentals.

Section-D: Respiration: respiratory climacteric, its significance. Transpiration and water stress during postharvest. Postharvest oxidative stress: active oxygen species, AOS generation, physiological effects on horticultural commodity, control of oxidative injury.

Practical:

Determination of physical parameters like specific gravity, fruit firmness, etc. Determination of physiological loss in weight. Determination of chemical constituents like sugar, starch, pigments, Vitamin C, acidity during maturation and ripening in fruits/ vegetables. Estimation of ethylene evolved from ripening fruits. Delay/ Hastening of ripening by ethylene treatments. Determination of firmness, TSS, moisture, Titratable acid, sugar, protein, starch, fats, chlorophyll, carotene, anthocyanin, phenols and tannins. Measurement of respiration and ethylene evaluation.

Suggested Reading

- Chadha KL and Pal RK. 2015. *Managing postharvest quality and losses in horticultural crops*. Vol-1: General Issues, 1-231p Astral International (P) Ltd., New Delhi
- Chadha KL and Pal RK. 2015. *Managing postharvest quality and losses in horticultural crops*. Vol-2: Fruit Crops, 253-561p Astral International (P) Ltd., New Delhi
- Chadha KL and Pal RK. (2015) *Managing postharvest quality and losses in horticultural crops*. Vol-3: Vegetables, Flowers and Plantation Crops, 581-727p Astral International (P) Ltd., New Delhi.
- Hodges DM. 2003. *Postharvest Oxidative Stress in Horticultural Crops*, 1st Edition, ISBN 9781560229636
- Paliyath G, Murr DP, Handa AK and Lurie S. 2008. *Postharvest Biology and Technology of Fruits, Vegetables and Flowers*, Wiley-Blackwell, ISBN: 9780813804088.
- Sunil Pareek (Ed.) 2016. *Postharvest Ripening Physiology of Crops*,CRC Press, ISBN 9781498703802.
- Thompson AK. 1995. *Post harvest Technology of fruits and vegetables*. Blackwell Sciences
- Verma LR and Joshi VK. 2000. *Postharvest Technology of Fruits and Vegetables: Handling, Processing, Fermentation and Waste Management*. Indus Publishing Company, New Delhi, India. ISBN 8173871086.
- Wills RBH and Golding J. 2017. *Advances in Postharvest Fruit and Vegetable Technology*, CRC Press, ISBN 9781138894051.
- Wills RBH and Golding J. 2016. *Postharvest: an introduction to the physiology and handling of fruit and vegetables*, CABI Publishing, ISBN 9781786391483.

Websites:

- Food and Agriculture Organization http://www.fao.org/home/en/
- Respiration in plants http://ncert.nic.in/ncerts/l/kebo114.pdf
-
- Ethylene biosynthesis and its response http://www.biologydiscussion.com/plants/hormonesplants/ethylene-biosynthesis-and-its-responses-plant-hormones/25986

Course Title : Post Harvest Physiology and Biochemistry of Perishables (Minor)
Course Code : PHM-521

Sr.no.	On completing the course, the students will be able to
CO1	Understand about different factors affecting shelf life
CO2	Learn processes of respiration and ripening
CO3	Know biosynthesis of ethylene and its action on ripening

SEMESTER-II

STAT-521: Experimental Designs

Time: 3 Hours **Maximum marks: 100**
Theory: 50
Practical: 25
Internal assessment: 25
Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All question will carry equal marks (10).

Course Objectives:

- The aim of this course is to understand the basics of statistical methods and their applications in agriculture.
- It helps the students in understanding, analyzing and interpreting the agricultural data.
- It also helps in making appropriate decisions in agricultural research findings.

Theory:

Section-A: Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control.

Section-B: Uniformity trials, size and shape of plots and blocks, Analysis of variance, Completely randomized design, randomized block design and Latin square design.

Section-C: Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom. Concept of confounding.

Section-D: Split plot and strip plot designs, analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, Balanced Incomplete Block Design, resolvable designs and their applications, Lattice design, alpha design - concepts, randomization procedure, analysis and interpretation of results. Response surfaces. Combined analysis.

Practical:

Uniformity trial data analysis, formation of plots and blocks, Fairfield Smith Law, Analysis of data obtained from CRD, RBD, LSD, Analysis of factorial experiments, Analysis with missing data, Split plot and strip plot designs

Note: Students shall be trained to use computer to analysis the data, using available softwares. However, during university examination students are allowed to use scientific calculators to analysis is the data.

Note: Students are allowed to use scientific calculator in University examinations; statistical tables will be provided to students in examinations. No rigorous mathematical proofs are expected from students; stress will be on application only.

Suggested Reading:

- Cochran WG and Cox GM. 1957. Experimental Designs. 2nd Ed. John Wiley.
- Dean AM and Voss D. 1999. Design and Analysis of Experiments. Springer.
- Montgomery DC. 2012. Design and Analysis of Experiments, 8th Ed. John Wiley.
- Federer WT. 1985. Experimental Designs. MacMillan.
- Fisher RA. 1953. Design and Analysis of Experiments. Oliver & Boyd.
- Nigam AK and Gupta VK. 1979. Handbook on Analysis of Agricultural Experiments. IASRI Publ.
- Pearce SC. 1983. The Agricultural Field Experiment: A Statistical Examination of Theoryand Practice. John Wiley.
- www.drs.icar.gov.in.

Course Title : Experimental Designs **Course Code : STAT--521**

Sr.no.	**On completing the course, the students will be able to**
CO1	Get knowledge on the designs, their principles, analysis of variance and interpretation of data.
CO2	Study various mechanical errors in field experiments, methods of reducing them and presentation of research results.

SEMESTER-II

PGS-521 Agricultural Research, Research Ethics and Rural Development Programmes

Time: 3.00 Hours **Maximum Marks: 100**
Theory: 100
Credit hours: 1 (1+0)

Instructions for the paper setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of nine questions out of which first question of 20 marks (Comprising of 10 short answer type questions of 2 marks each) covering the whole syllabus will be compulsory.
4. Out of remaining eight questions, two questions will be asked from each Section out of which the candidates are required to attempt one question from each section. All questions will carry equal marks (20).

Course Objectives

- The aim of this course is to understand the moral judgment and reactions.
- Identify the publication misconduct, scientific misconduct, complaints and appeals.

Theory:

Section-A: History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR)

Section-B: International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility. Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

Section-C: Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme,

Section-D: Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes

Suggested Reading

- Bhalla GS and Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.

- Punia MS. *Manual on International Research and Research Ethics*. CCS Haryana Agricultural
- University, Hisar.
- Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives.* Mittal Publ.
- Singh K. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.

Course Title: Agricultural Research, Research Ethics and Rural Development Programmes
Course Code: *PGS-521

Sr.no.	**On completing the course, the students will be able to**
CO1	Understand the moral judgment and reactions
CO2	Identify the publication misconduct, scientific misconduct, complaints and appeals

SEMESTER-II

***FSC-599 Masters' Research**

S/US
Credit hours : 5(0+5)

SEMESTER-III

FSC-531: Systematics of Fruit Crops

Time: 3 Hours **Maximum Marks: 100**
Theory: 50
Practical: 25
Internal assessment : 25
Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. Each question will carry equal marks (10).

Course Objective

- To acquaint with the classification, nomenclature and description of various fruit crops

Theory

Section-A: Nomenclature and Classification: Biosystematics – introduction and significance; history of nomenclature of cultivated plants, classification and nomenclature systems; International code of nomenclature for cultivated plants.

Section-B: Identification and Description: Methods of identification and description of cultivated fruit and nut species and their wild relatives features; development of plant keys for systematic identification and classification.

Section-C: Development of fruit crop descriptors- based upon Biodiversity. International Descriptors and UPOV/ DUS test guidelines, botanical and pomological description of major cultivars and rootstocks of tropical, subtropical and temperate fruits and nut crops.

Section-D: Registration and Modern Systematics: Registration, Use of chemotaxonomy, biochemical and molecular markers in modern systematics.

Practical

Exercises on identification and pomological description of various fruit species and cultivars. Development of descriptive blanks vis-a-vis UPOV/ DUS test guidelines and Biodiversity International. Descriptors for developing fruit species and cultivar descriptive databases. Visits to major germplasm centres and field gene banks.

Suggested Reading

- ASHS. 1997. The Brooks and Olmo Register of Fruit and Nut Varieties. 3rd Ed. ASHS Press.
- Bhattacharya B and Johri BM. 2004. Flowering Plants: Taxonomy and Phylogeny. Narosa Pub. House, New Delhi.
- Pandey BP. 1999. Taxonomy of Angiosperms. S. Chand & Co. New Delhi.
- Pareek OP and Sharma S. 2017. Systematic Pomology. Scientific Publishers, Jodhpur.
- Sharma G, Sharma OC and Thakur BS. 2009. Systematics of Fruit Crops. NIPA, New Delhi.
- Simpson M. 2010. Plant Systematics. 2ndEdn. Elsevier.
- Spencer RR, Cross R and Lumley P. 2003. Plant Names. 3rd Ed. A Guide to Botanical Nomenclature, CISRO, Australia.
- Srivastava U, Mahajan RK, Gangopadyay KK, Singh M and Dhillon BS. 2001. Minimal Descriptors of Agri-Horticultural Crops. I: Fruits. NBPGR, New Delhi.
- Zielinski QB. 1955. Modern Systematic Pomology. Wm. C. Brown Co., Iowa, USA.

Course Title: Systematics of Fruit Crops **Course Code: FSC-531**

Sr.no.	**On completing the course, the students will be able to**
CO1	Categorize different fruit species into broad groups.
CO2	Identify various fruit cultivars on basis of distinguishing features
CO3	Characterize fruit cultivars for description, registration and protection

SEMESTER-III

FSC-532: Organic Fruit Culture

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment : 25

Credit hours: 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. Each question will carry equal marks (10).

Course Objective

- To develop understanding on organic production of fruit crops.

Theory:

Section-A: Principles and Current Scenario: Organic horticulture, scope, area, production and world trade, definition, principles, methods and SWOT analysis. Farming System and Practices: Organic farming systems including biodynamic farming, natural farming, homa organic farming, rishi krishi, EM technology, cosmic farming; on-farm and off-farm production of organic inputs, role of bio-fertilizers, bio enhancers, legumes, inter cropping, cover crops, green manuring, zero tillage, mulching and their role in organic nutrition management.

Section-B: Organic seeds and planting materials, soil health management in organic production, weed management practices in organic farming, biological management of pests and diseases, trap crops, quality improvement in organic production of fruit crops.

Section-C: Inspection, Control Measures and Certification: Inspection and certification of organic produce, participatory guarantee system (PGS), NPOP, documentation and control, development of internal control system (ICS), Concept of group certification, constitution of grower group as per NPOP, preparation of ICS manual, internal and external inspection, concept of third party verification, certification of small farmer groups (Group Certification), transaction certificate, group certificate, critical control points (CCP) and HACCP, IFOAM guidelines on certification scope and chain of custody,

Section-D: certification trademark –The Logo, accredited certification bodies under NPOP. Constraints in certification, IFOAM and global scenario of organic movement, postharvest management of organic produce. Economics of organic fruit production.

Practical

Design of organic orchards/ farms management. Conversion plan . Nutrient management and microbial assessment of composts and bio-enhancers. Preparation and application of composts, bio-enhancers and bio-pesticides. Organic nursery raising . Application of composts, bio-enhancers, bio-fertilisers and bio-pesticides, green manure, cover, mulching. Preparation and use of neem based products. Biodynamic preparations and their role in organic agriculture, EM technology and products, biological/ natural management of pests and diseases . Soil solarisation . Frame work for GAP. Documentation for certification.

Suggested Reading

- Claude A. 2004. *The Organic Farming Sourcebook*. Other India Press, Mapusa, Goa, India.
- Dabholkar SA. 2001. *Plenty for All.* Mehta Publishing House, Pune, Maharashtra.
- Das HC and Yadav AK. 2018. *Advances in Organic Production of Fruit Crops*.
- Westville Publishing House, New Delhi. Deshpande MS. 2003. *Organic Farming with respect to Cosmic Farming.* Mrs. Pushpa Mohan Deshpandey, Kolhapur, Maharashtra.
- Deshpande WR. 2009. *Basics of Organic Farming.* All India Biodynamic and Organic Farming Association, Indore.
- MP. Gaur AC, Neblakantan S and Dargan KS. 1984 *Organic Manures.* ICAR, New Delhi.
- Lampkin, N. and Ipswich, S. 1990. *Organic Farming*. Farming Press. London, UK.
- Lind K, Lafer G, Schloffer K, Innershofer G and Meister H. 2003. *Organic Fruit Growing*. CAB International.
- Palaniappan SP and Annadurai K. 2008. *Organic Farming*- Theory and Practice. Scientific Publishers, Jodhpur, Rajasthan, India.
- Palekar S. 2004. *The Technique of Spritual Farming*. Chandra Smaritee, Sai Nagar, Amrawati, Maharashtra.
- Proctor P. 2008. *Biodynamic Farming and Gardening*. Other India Press, Mapusa, Goa. Ram RA and Pathak RK. 2017. Bioenhancers. Lap Lambert Academic Publishing, A.P.

Course Title: Organic Fruit Culture **Course Code: FSC-542**

Sr.no.	**On completing the course, the students will be able to**
CO1	Familiarize with the concepts and practices of organic and other natural farming systems
CO2	Generate know-how on procedures, policies and regulation for inspection and certification of organic produce

SEMESTER-III

FSC-533 : Growth and Development of Fruit Crops

Time: 3 Hours **Maximum Marks: 100**

Theory: 50

Practical: 25

Internal assessment: 25

Credit hours : 3(2+1)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. Each question will carry equal marks (10).

Course Objectives

- The students are expected to gain knowledge on brief outline of the physiology of horticultural crops
- To understand the concept of different plant growth regulators and their uses, seed dormancy and germination.
- To know the biotic and abiotic stresses on crop plants.

Theory:

Section-A: General Concepts and Principles: Growth and development- definition, parameters of growth and development, growth dynamics and morphogenesis.

Section-B: Climatic Factors, Hormones and Developmental Physiology: Environmental impact on growth and development- effect of light, temperature, photosynthesis and photoperiodism, vernalisation, heat units and thermoperiodism. Assimilate partitioning, influence of water and mineral nutrition in growth and development.

Section-C : Concepts of plant hormone and bio regulators, history, biosynthesis and physiological role of auxins, gibberellins, cytokinins, abscissic acid, ethylene, growth inhibitors and retardant, brasssinosteroids, other New PGRs. Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.

Section-D : Strategies for Overcoming Stress: Growth and developmental process during stress – manipulation of growth and development, impact of pruning and training, chemical manipulations and Commercial application of PGRs in fruit crops, molecular and genetic approaches in plant growth and development.

Practical:

Understanding dormancy mechanisms in fruit crops and seed stratification. Techniques of growth analysis .Evaluation of photosynthetic efficiency under different environments. Exercises on hormone assays. Practicals on use of growth regulators .Understanding ripening phenomenon in fruits. Study on impact of physical manipulations on growth and development. Study on

chemical manipulations on growth and development. Understanding stress impact on growth and development.

Suggested Reading

- Bhatnagar P. 2017. Physiology of Growth and Development of Horticultural Crops. Agrobios(India).
- Buchanan B, Gruiessam W and Jones R. 2002. Biochemistry and Molecular Biology of Plants.John Wiley & Sons, NY, USA.
- Dhillon WS and Bhatt ZA. 2011. Fruit Tree Physiology. Narendra Publishing House, New Delhi.
- Epstein E. 1972. Mineral Nutrition of Plants: Principles and Perspectives. John Wiley & Sons,NY, USA.
- Faust M. 1989. Physiology of Temperate Zone Fruit Trees. John Willey & Sons, NY, USA.
- Fosket DE. 1994. Plant Growth and Development: a Molecular Approach. Academic Press, USA.
- Leopold AC and Kriedermann PE. 1985. Plant Growth and Development. 3rd Ed. McGraw-Hill,New Delhi.
- Roberts J, Downs S and Parker P. 2002. Plant Growth Development. In: Salisbury FB and Ross CW. (Eds.) Plant Physiology. 4th Ed.Wadsworth Publications, USA.
- Schafeer, B. and Anderson, P. 1994. Handbook of Environmental Physiology of Fruit Crops.Vol. 1 & 2. CRC Press. USA.
- Seymour GB, Taylor JE and Tucker GA. 1993. Biochemistry of Fruit Ripening. Chapman &Hall, London.

Course Title Growth and Development of Fruit Crops Course Code FSC-533

Sr.no.	On completing the course, the students will be able to have
CO1	Equipped with understanding of various growth and development processes
CO2	Learned about the role of environment and growth substances
CO3	Acquired the skills to realize optimum growth and development under stress conditions

SEMESTER-III

FSC-591 CREDIT SEMINAR

Maximum marks : 100
Credits hours: 1(1+0))

SEMESTER-III

***PGS-531 Intellectual Property and its management in Agriculture**

Time: 3 Hours **Maximum marks: 100**
Theory: 100
Credit hours: 1 (1+0)

Instructions for the Paper Setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. There will be total of five questions, out of which first question of 20 marks (Comprising of 10 short answer type questions of 2 mark each) covering the whole syllabus will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. All questions will carry equal marks (20).

Course objectives:

- To equip students with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance
- Use of IPR as a tool for wealth and value creation in a knowledge based economy.

Theory:

Section A: Historical perspectives and need for the introduction of Intellectual Property Right TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs;

Section B: Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection;

Section C: Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity;

Section D: International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement,License Agreement.

Suggested Reading:

- Erbisch FH and Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
- Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
- Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.
- Ministry of Agriculture, Government of India. 2004. State of Indian Farmer. Vol. V. Technology Generation and IPR Issues. Academic Foundation.
- Rothschild M and Scott N. (Ed.). 2003. Intellectual Property Rights in Animal Breeding and Genetics. CABI.
- Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.

CourseTitle: Intellectual Property& its Management in Agriculture Course Code: PGS 504

Sr.no.	**On completing the course, the students will be able to**
CO1	The students will have acquaintance of intellectual property rights
CO2	Will have knowledge of National and international laws on biodiversity and sustainable use of plant genetic resources through transfer and sharing.
CO3	Can assist in follow up of various treatises and laws for research collaborations at international levels.

SEMESTER-III

FSC-599 Masters' Research

S/US

Credits hours: 10(0+10)

SEMESTER-IV

FSC-541: Propagation and Nursery Management in Fruit Crops
Time: 3 Hours

Maximum marks: 100
Theory: 50
Practical: 25
Internal assessment: 25
Credit hours: 3(2+1)

Instructions for the paper setters:

1. Question paper should be set strictly according to the syllabus.
2. The language of questions should be straight & simple.
3. In all nine questions should be asked, of which first question of 10 marks (Comprising of 10 short answer type questions covering the whole syllabus) will be compulsory.
4. Out of remaining eight questions, two questions should be asked from each section, out of which the candidates are required to attempt one question from each section. Each question will carry equal marks (10).

Course Objective

• To understand the principles and methods of propagation and nursery management in fruit crops

Theory:

Section-A: Introduction, understanding cellular basis for propagation, sexual and asexual propagation, apomixis, polyembryony, chimeras. Factors influencing seed germination of fruit crops, dormancy, hormonal regulation of seed germination and seedling growth. Seed quality, treatment, packing, storage, certification and testing.

Section-B: Cutting– methods, rooting of soft and hardwood cuttings under mist and hotbeds. Use of PGR in propagation, Physiological, anatomical and biochemical aspects of root induction in

cuttings. Layering – principle and methods. Budding and grafting – principles and methods, establishment and management of bud wood bank. Stock, scion and inter stock relationship – graft incompatibility, physiology of rootstock and top working.

Section-C: Micro-propagation – principles and concepts, commercial exploitation in horticultural crops. Techniques – in-vitro clonal propagation, direct organogenesis, embryogenesis, micrografting, meristem culture, genetic fidelity testing. Hardening, packaging and transport of micro-propagules.

Section-D: Management Practices and Regulation: Nursery – types, structures, components, planning and layout. Nursery management practices for healthy propagule production. Nursery Act, nursery accreditation, import and export of seeds and planting material and quarantine.

Practical:
Hands on practices on rooting of dormant and summer cuttings. Anatomical studies in rooting of cutting and graft union. Hands on practices on various methods of budding and grafting . Propagation by layering and stooling . Micropropagation- explant preparation, media preparation, culturing – meristem tip culture, axillary bud culture, micro-grafting, hardening . Visit to commercial tissue culture laboratories and accredited nurseries.

Suggested Reading

- Bose TK, Mitra SK and Sadhu MK. 1991. *Propagation of Tropical and Subtropical Horticultural Crops.* Naya Prokash, Kolkatta.
- Davies FT, Geneve RL and *Wilson SB. 2018. Hartmann and Kester's Plant PropagationPrinciples and Practices*. Pearson, USA/ PrenticeHall of India. New Delhi.
- Gill SS, Bal JS and Sandhu AS. 2016. *Raising Fruit Nursery*. Kalyani Publishers,New Delhi.
- Jain S and Ishil K. 2003. *Micropropagation of Woody Trees and Fruits.* Springer.
- Jain S and Hoggmann H. 2007. *Protocols for Micropropagation of Woody Trees and Fruits*. Springer.
- Joshi P. 2015. *Nursery Management of Fruit Crops in India.* NIPA, New Delhi.
- Love et al. 2017. *Tropical Fruit Tree Propagation Guide. UH*-CTAHR F_N_49. College of Tropical Agriculture and Human Resources University of Hawaii at Manwa, USA.
- Peter KV, eds. 2008. *Basics of Horticulture*. New India Publishing Agency, New Delhi.
- Rajan S and Baby LM. 2007. *Propagation of Horticultural Crops*. NIPA, New Delhi.
- Sharma RR. 2014. *Propagation of Horticultural Crops*. Kalyani Publishers, New Delhi.
- Sharma RR and Srivastav M. 2004. *Propagation and Nursery Management*. Intl. Book Publishing Co., Lucknow.
- Singh SP. 1989. *Mist Propagation*. Metropolitan Book Co.
- Singh RS. 2014. *Propagation of Horticultural Plants: Arid and Semi-Arid Regions*. NIPA, New Delhi.
- Tyagi S. 2019. *Hi-Tech Horticulture. Vol I*: Crop Improvement, Nursery and Rootstock Management. NIPA, New Delhi.

Course Title: Propagation and Nursery Management in Fruit Crops
Course Code : FSC-541

Sr.no.	On completing the course, the students will be able to
CO1	Acquire skills and knowledge on principles and practices of macro and micropropagation techniques
CO2	Handle propagated material in the nursery

SEMESTER-IV

***PGS-541 Basic Concepts in Laboratory Techniques**

Time: 3 Hours **Maximum marks: 100**
Practical: 100
Credit hours: 1(0+1)

Instructions for the Paper Setters:
1. The question paper will consist of nine skill-oriented questions.
2. The first 5 questions carry 8 marks each. There will be internal choice wherever possible. The answer should be in 50-80 words. (5×8=40 Marks)
3. There will be four essay type questions from the entire syllabus. There will be internal choice wherever possible. The answer should be in 250 words. (4×15= 60 Marks)

Course objective

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

Practical:

Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; Washing, drying and sterilization of glassware; Drying of solvents/ chemicals; Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values; Use and handling of microscope, laminar flow, vacuum pumps, viscometer thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electric wiring and earthing; Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Reading:

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

Course Title: Basic Concepts in Laboratory Techniques Course Code: PGS 541

Sr.no.	On completing the course, the students will be able to
CO1	Know about the use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers and micropipettes.
CO2	Know about different solutes, solvents and agrochemicals
CO3	Know about media preparation, handling techniques of solutions and preparation of media and methods of sterilization.

SEMESTER-IV

***FSC-599 *Masters' Research**

S/US

Credits hours: 10 (0+10)