Integral University, Lucknow
Integral Institute of Agricultural Science and Technology
Evaluation Scheme of Post Graduate Program
w.e.f. 2022-23
M. Sc. (Hort.) Vegetable Science
Semester-I

Course Code	Course Title	Type of Course	Periods/ Per week			Evaluation Scheme Theory Mid Sem			Evaluation Scheme Practical Mid Sem			Practical End Sem Exam	Sub Total (Theory + Practical Mid Sem Exam)	End Sem Theory Exam	Subject Total	Credit	Total Credit Points	Attributes							United Nations sustainable development goals (SDGs)
			L	T	P	CT	TA	Total	CT	TA	Total							Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
VSC 501	**Production of Cool Season Vegetable Crops**	**Major**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√	√	√		√		√	12
VSC 503	**Growth and Development of Vegetable Crops**		2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√		√				√	
VSC 510	**Systematics of Vegetable Crops**	**Optional**	1	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	1:0:1	2			√		√		√	
Total																	*								
***Major Course (Core course + Optional course) should not exceed more than 9 credit**																									
FSC 501	**Tropical Fruit Production**	**Minor**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√		√		√	√	√	12
STAT 511	**Experimental Designs**	**Supporting**	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√		√		√	√	√	
BIOCHEM 505	**Techniques in Biochemistry**		2	0	4	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:2	4	√	√	√					
MCA 512	**Information Technology in Agriculture**		1	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	1:0:1	2	√	√	√					
Total																	**								
PGS503 (e-Course)	**Intellectual Property and Its Management in Agriculture**	**Common**	1	0	0	20	10	**30**	-	-	-	0	**0**	**70**	**100**	1:0:0	1#	√	√	√				√	
PGS504	**Basic Concepts in Laboratory Techniques**		0	0	2	0	0	**0**	-	25	25	75	**25**	-	**100**	0:0:1	1#	√	√	√					
Grand Total																	***								

*Grand Total (***) = *+**, credit should not exceed more than 22 credit in one semester*

M. Sc. (Hort.) Vegetable Science
SEMESTER-I
Course Title: Production of Cool Season Vegetable Crops
Course Code: VSC 501
w.e.f. Session 2022-23

3(2+1)

Unit-I

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of Bulb and tuber crops—Onion, garlic and potato.

Unit-II

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of Cole crops—Cabbage, cauliflower, kohlrabi, broccoli, Brussels sprouts and kale.

Unit-III

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of Root crops—Carrot, radish, turnip and beetroot.

Unit-IV

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marketing), pest and disease management and production economics of Peas and beans—Garden peas and broad bean

Unit-V

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery, sowing/ planting time and methods, hydroponics and aeroponics, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management

(grading, packaging and marketing), pest and disease management and production economics of Leafy vegetables—Beet leaf, fenugreek, coriander and lettuce.

Practical:

Scientific raising of nursery and seed treatment; Sowing and transplanting; Description of commercial varieties and hybrids; Demonstration on methods of irrigation, fertilizers and micronutrients application; Mulching practices, weed management; Use of plant growth substances in cool season vegetable crops; Study of nutritional and physiological disorders; Studies on hydroponics, aeroponics and other soilless culture; Identification of important pest and diseases and their control; Preparation of cropping scheme for commercial farms; Visit to commercial farm, greenhouse/polyhouses; Visit to vegetable market; Analysis of benefit to cost ratio.

Suggested Readings:

- Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. Vegetable crops. Vols. I-III. Naya udyog.
- Bose TK, Som MG and Kabir J. (Eds.). 1993. Vegetable crops. Naya prokash.
- Chadha KL and Kalloo G. (Eds.). 1993-94. Advances in horticulture Vols. V-X. Malhotra publ. house.
- Chadha KL. (Ed.). 2002. Hand book of horticulture. ICAR.
- Chauhan DVS. (Ed.). 1986. Vegetable production in India. Ram prasad and sons.
- Fageria MS, Choudhary BR and Dhaka RS. 2000. Vegetable crops: production technology. Vol. II. Kalyani publishers.
- Gopalakrishanan TR. 2007. Vegetable crops. New India publ. agency.
- Hazra P and Banerjee MK and Chattopadhyay A. 2012. Varieties of vegetable crops in India, (Second edition), Kalyani publishers, Ludhiana, 199p.
- Hazra P. 2016. Vegetable Science. 2nd edn, Kalyani publishers, Ludhiana.
- Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi.
- Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. Modern technology for vegetable production, New India publishing agency, New Delhi, 413p
- Rana MK. 2008. Olericulture in India. Kalyani publishers, New Delhi.
- Rana MK. 2008. Scientific cultivation of vegetables. Kalyani publishers, New Delhi.
- Rana MK. 2014. Technology for vegetable production. Kalyani publishers, New Delhi.
- Rubatzky VE and Yamaguchi M. (Eds.). 1997. World vegetables: principles, production and nutritive values. Chapman and Hall.
- Saini GS. 2001. A text book of oleri and flori culture. Aman publishing house.
- Salunkhe DK and Kadam SS. (Ed.). 1998. Hand book of vegetable science and technology: production, composition, storage and processing. Marcel Dekker.
- Shanmugavelu KG. 1989. Production technology of vegetable crops. Oxford and IBH.
- Singh DK. 2007. Modern vegetable varieties and production technology. International book distributing Co.
- Singh SP. (Ed.). 1989. Production technology of vegetable crops. Agril. comm. res. centre. Thamburaj S and Singh N. (Eds.), 2004. Vegetables, tuber crops and spices. ICAR.

COURSE OBJECTIVES:

- To know about the importance and historical knowledge of cool season vegetables of bulb and tuber crops.
- Familiar with different varieties and cropping systems of different cole crops.
- Knowledge of commercial and nutritional importance, origin and distribution of different root crops.
- Knowledge of crop protection measure in different crops

COURSE OUTCOMES (CO):

After completion of course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students will be able answer about the importance, historical knowledge and production technology of bulb, tuber and cole group crops.
CO2	Can use the knowledge of production of root crops and leafy vegetables.
CO3	By the end of course students will have the idea of production methods of different cool season crops.

CO-PO-PSO mapping

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	3	3	2	1	2	2	2	3	3	2	2	1
CO2	3	3	3	3	1	1	2	1	3	2	3	2	2	1	2
CO3	3	2	3	3	3	1	1	1	1	3	3	3	2	1	1
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Hort.) Vegetable Science
SEMESTER-I
Course Title: Growth and Development of Vegetable Crops
Course Code: VSC 503
w.e.f. Session 2022-2023

3(2+1)

Unit-I
Introduction and phytohormones—Definition of growth and development; Cellular structures and their functions; Physiology of phyto-hormones functioning/ biosynthesis and mode of action; Growth analysis and its importance in vegetable production.

Unit-II
Physiology of dormancy and germination—Physiology of dormancy and germination of vegetable seeds, tubers and bulbs; Role of auxins, gibberellilns, cyktokinins and abscissic acid; Application of synthetic PGRs including plant growth retardants and inhibitors for various purposes in vegetable crops; Role and mode of action of morphactins, antitranspirants, anti-auxin, ripening retardant and plant stimulants in vegetable crop production.

Unit-III
Abiotic factors—Impact of light, temperature, photoperiod, carbon dioxide, oxygen and other gases on growth, development of underground parts, flowering and sex expression in vegetable crops; Apical dominance.

Unit-IV
Fruit physiology—Physiology of fruit set, fruit development, fruit growth, flower and fruit drop; parthenocarpy in vegetable crops; phototropism, ethylene inhibitors, senescence and abscission; fruit ripening and physiological changes associated with ripening.

Unit-V
Morphogenesis and tissue culture—Morphogenesis and tissue culture techniques in vegetable crops; Grafting techniques in different vegetable crops.

Practical:
Preparation of plant growth regulator's solutions and their application; Experiments in breaking and induction of dormancy by chemicals; Induction of parthenocarpy and fruit ripening; Application of plant growth substances for improving flower initiation, changing sex expression in cucurbits and checking flower and fruit drops and improving fruit set in Solanaceous vegetables; Growth analysis techniques in vegetable crops; Grafting techniques in tomato, brinjal, cucumber and sweet pepper.

Suggested Readings:

- Bleasdale JKA. 1984. Plant physiology in relation to horticulture (2nd Edition) MacMillan.
- Kalloo G. 2017. Vegetable grafting: Principles and practices. CAB International
- Krishnamoorti HN. 1981. Application growth substances and their uses in agriculture. Tata McGraw Hill, New Delhi.
- Leopold AC and Kriedemann PE. 1981. Plant growth and development, Tata McGraw-Hill, New Delhi.
- Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
- Peter KV. (Eds). 2008. Basics of horticulture. New India publication agency, New Delhi.
- Rana MK. 2011. Physio-biochemistry and Biotechnology of Vegetables. New India Publishing Agency, Pritam Pura, New Delhi.
- Saini et al. (Eds.). 2001. Laboratory manual of analytical techniques in horticulture. Agrobios, Jodhpur.
- Wien HC. (Eds.). 1997. The physiology of vegetable crops. CAB International.

COURSE OBJECTIVES:

- To know about growth and developmental requirement of different vegetable crops.
- Familiarization with different chemical and methods for dormancy breakage different vegetables seeds.
- Knowledge of extrinsic factors for vegetable crops.

COURSE OUTCOMES (CO):

After completion of course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Able to about growth and developmental requirement of different vegetable crops.
CO2	Can use the basic knowledge of different chemical and methods for dormancy breakage different vegetables seeds.
CO3	Students are able to know about sowing time of different varieties according to temperature.
CO4	Students will be able to various physiological conditions of different fruits and changes that occur during physiological changes associated with ripening.
CO5	By the end of course students will be able to answer about growth and development of vegetable crops.

CO-PO-PSO mapping

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	2	2	2	2	1	3	3	2	2	2	3	2
CO2	3	3	3	3	3	3	3	3	3	1	3	3	1	1	3
CO3	1	3	1	3	3	1	3	3	3	3	3	1	3	3	3
CO4	2	2	2	2	2	2	2	3	2	1	2	2	3	1	2
CO5	3	2	3	2	2	3	2	3	3	3	2	3	1	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Hort.) Vegetable Science
SEMESTER-I
Course Title: Systematics of Vegetable Crops
Course Code: VSC 510
w.e.f. Session 2022-2023

2(1+1)

Unit-I
Significance of systematic—Significance of systematics and crop diversity in vegetable crops; Principles of classification; different methods of classification; Salient features of international code of nomenclature of vegetable crops.

Unit-II
Origin and evolution—Origin, history, evolution and distribution of vegetable crops.

Unit-III
Botanical and morphological description—Botanical description of families, genera and species covering various tropical, subtropical and temperate vegetables; Morphological keys to identify important families, floral biology, floral formula and diagram; Morphological description of all parts of vegetables

Unit-IV
Cytology—Cytological level of various vegetable crops with descriptive keys

Unit-V
Molecular markers—Importance of molecular markers in evolution of vegetable crops; Molecular markers as an aid in characterization and taxonomy of vegetable crops

Practical:
Identification, description, classification and maintenance of vegetable species and varieties; Survey, collection of allied species and genera locally available; Preparation of keys to the species and varieties; Methods of preparation of herbarium and specimens.

Suggested Readings:

- Chopra GL. 1968. Angiosperms- systematics and life cycle. S. Nagin
- Dutta AC. 1986. A class book of botany. Oxford Univ. Press.
- Pandey BP. 1999. Taxonomy of angiosperm. S. Chand and Co
- Peter KV and Pradeep Kumar T. 2008. Genetics and breeding of vegetables. (Revised), ICAR.
- Peter KV and Hazra P. (Eds). 2012. Hand book of vegetables. Studium Press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 678p.
- Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume II. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 509p.
- Peter KV and Hazra P. (Eds). 2015. Hand book of vegetables Volume III. Studium press LLC, P.O. Box 722200, Houston, Texas 77072, USA, 634p.
- Simmonds NW and Smartt J. 1995. Evolution of crop plants. Wiley-Blackwell.
- Soule J. 1985. Glossary for Horticultural Crops. John Wiley and Sons.
- Srivastava U, Mahajan RK, Gangopadyay KK, Singh M and Dhillon BS. 2001. Minimal descriptors of agri-horticultural crops. Part-II: Vegetable Crops. NBPGR, New Delhi.
- Vasistha. 1998. Taxonomy of angiosperm. Kalyani Publishers, New Delhi.

COURSE OBJECTIVES:

- To know about significance of systematics and crop diversity in vegetable crops
- Knowing about the history of vegetable crops and their evolution.
- Knowledge of genetics and improvement methods for different vegetable crops.

COURSE OUTCOMES (CO):

After completion of course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Able to know what is the significance of systematics and crop diversity in vegetable crops
CO2	Students will have the idea of history of vegetable crops and their evolution
CO3	Students are able to know the genetics and improvement methods for different vegetable crops
CO4	By the end of course students will be able to Systematics of Vegetable Crops.

CO-PO-PSO mapping

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	2	2	2	2	2	2	3	1	2	2	2	3	1
CO2	3	3	3	3	3	3	3	3	3	1	3	1	3	1	1
CO3	3	3	1	3	3	1	3	3	3	3	3	3	1	3	3
CO5	2	3	3	2	2	3	2	2	3	3	2	1	3	3	3
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Hort.) Fruit Science
SEMESTER-I
Course Title: Tropical Fruit Production
Course Code: FSC 501
w.e.f. Session 2022-2023

3(2+1)

Unit-I

Importance and Background: Importance, origin and distribution, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements of Crops Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla, Ber, etc.

Unit-II

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 for Crops Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla, Ber, etc.

Unit III

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 for Crops Mango, Banana, Guava, Pineapple, Papaya, Avocado, Jackfruit, Annonas, Aonla, Ber, etc.

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 Readings:

- 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: Principles and 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 OBJECTIVES:

- Importance of fruit production, major species and varieties of Tropical fruit crops
- Knowledge about propagation of fruit crops
- Familiar the students about training, pruning and crop regulation of fruit crops.
- Knowing the principles and methods of post harvest management.

COURSE OUTCOMES (CO):

After completion of course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Aware about different species and varieties of fruit crops.
CO2	Students aware about different methods of propagation
CO3	Students also aware about the training, pruning and flowering physiology of fruit crops
CO4	Aware about the different methods of irrigation and nutrient management practices
CO5	Familiar with the important physiological disorders and their management.

CO-PO-PSO mapping

	PO											PSO			
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	3	3	1	3	1	1	1	3	3	3	3	3
CO2	2	3	1	2	3	1	2	1	1	1	2	3	3	3	2
CO3	3	2	1	1	3	1	3	1	1	1	3	3	2	3	3
CO4	3	2	1	3	3	2	2	1	1	1	1	2	3	3	3
CO5	3	2	1	3	3	1	3	1	1	1	3	3	3	3	3
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Experimental Designs
Course Code: STAT 511
w.e.f. Session 2022-23

3(2+1)

Unit-I
Experiments: Absolute Experiments, Comparative experiments, need for designing of experiments, characteristics of a good design. Treatment, experimental unit, blocks, yield, uniformity trials, size and shape of plots and blocks. Principles of design of experiment: randomization, replication and local control.

Unit-II
Designs of experiments: Completely Randomized Design, Randomized Block Design and Latin square design and their analysis of variance. factorial design; symmetrical and asymmetrical. Confounding in symmetrical factorial experiments, factorial experiments with control treatment, advantages and disadvantages of confounding.

Unit-III
Analysis of covariance for two-way classification (Randomized Block Design). Split plot design: comparison between split-plot design and factorial design, advantages and disadvantages of split plot design. Missing Plot techniques: Analysis of missing plot design (Fisher's Rule), analysis of Randomized Block Design with one missing observation, analysis of Latin Square Design with one missing observation

Unit-IV
Balanced Incomplete Block Design (BIBD), parameters of BIBD, Incidence matrix, Symmetric BIBD, Analysis of BIBD, efficiency of BIBD relative to Randomized Block Design, Response Surfaces.

Practical:
Uniformity trial data analysis, formation of plots and blocks, Analysis of data obtained from Completely Randomized Design, Randomized Block Design, Latin Square Design; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot designs; Transformation of data; Fitting of response surfaces.

Suggested Readings:

- Cochran, W.G. and Cox, G.M. Experimental Design. Asia Publishing House.
- Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
- Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.
- Goon, A.M., Gupta, M.K. and Dasgupta, B. (2005): Fundamentals of Statistics. Vol. II, 8thEdn. World Press, Kolkata.
- Casella, G, (2008). Statistical Design. Springer.
- Gupta, S.C. and Kapoor, V.K. Latest Revised Edition 2015. Fundamentals of Applied Statistics.

COURSE OBJECTIVES:
- Basic concepts of Experiments, designs and analysis of covariance
- Comparative experiments, need for designing of experiments
- In depth knowledge of principles of design of experiment: randomization, replication and local control
- Knowledge of completely randomized design, Randomized Block Design and Latin square design and their analysis of variance
- Balanced Incomplete Block Design (BIBD) and its parameters

- Analysis of missing plot design (Fisher's Rule),analysis of Randomized Block Design with one missing observation

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students will have basic knowledge of Experiments, designs and analysis of covariance
CO2	Students will have knowledge of Comparative experiments
CO3	The students will be able to prepare their experimental fields on the basis of designs
CO4	Students can have the knowledge of completely Randomized Design, Randomized Block Design and Latin square design and their analysis of variance
CO5	Students can analyze their results according to the designs

CO-PO-PSO MAPPING

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	2	2	2	2	1	1	2	2	1	3	2	2	2
CO2	2	3	2	2	2	2	1	1	1	3	1	3	2	2	2
CO3	2	3	2	2	2	2	1	1	2	3	1	3	2	2	2
CO4	2	3	2	2	2	2	1	1	2	3	1	3	3	2	2
CO5	2	3	2	2	2	2	1	1	2	3	1	3	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Techniques in Biochemistry
Course Code: BIOCHEM 505
w.e.f. Session 2022-23

4(2+2)

Unit-I
General scheme for purification of biocomponents. Methods of studying cells and organelles, sub cellular fractionation and marker enzymes. Methods for lysis of plant, animal and microbial cells. Ultra-filtration, sonication, freeze drying and fractional precipitation. Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications, subcellular fractionation.

Unit-II
Basic principles, instrumentation, working and applications of partition chromatography, paper, thin layer, ion exchange and affinity chromatography, gel permeation chromatography, HPLC and FPLC.

Unit-III
Electrophoretic techniques - slab, capillary, 2-D, pulse field, polyacrylamide/agarose gel electrophoresis. Blotting techniques: Western, Southern and Northern blotting- principle and methodology.

Unit-IV
Fundamental principles of flourescene & phosphorescence, absorption, transmission of light, Beer – Lamberts law, Colorimeter, flame photometry. Principle, instrumentation, working and application of – UV, visible and IR spectroscopy, atomic absorption spectrometry, Nuclear Magnetic Resonance (NMR), Mass spectroscopy - GC-MS, HPLC-MS and LC-MS/MS, Matrix-assisted laser desorption/ionization- Time-of-Flight Mass spectroscopy (MALDI-TOF MS), X-ray crystallography.

Unit-IV
Basic principles, instrumentation and applications of microscopy. Bright field, phase contrast, fluorescence and confocal microscopy. Electron microscope – scanning and transmission electron microscopy. Nature of radioactivity, decay and types of radiation. Radiation hazards and precautions taken while handling radioisotopes. Radiation detection and measurements: Geiger Muller counter, scintillation counter and pulse height analyzer. Application of radioisotopes in biological science- autoradiography.

Practical:
Methods for lysis of plant and microbial cells; Centrifugation; Verification of Beer-Lambert's law and determination of absorption coefficients; Paper chromatography – Separation of amino acids and carbohydrates in a mixture; Thin layer chromatography of fatty acids; Column chromatography – Separation of a mixture of proteins and salt using Sephadex column; Electrophoresis. Staining of bacteria – Simple staining, differential staining, staining of spores.

Suggested Readings:

- Principles and Techniques of Practical Biochemistry by Keith Wilson, John Walker (eds), Cambridge University Press; 5th edition.
- Principles and Techniques of Practical Biochemistry by Wilson, K., Walker, J. (eds.), Cambridge University Press, Cambridge, 2000, 5th edition.
- Lehninger Principles Of Biochemistry by David L. Nelson, Michael M. Cox, W. H. Freeman, 6th edition.

COURSE OBJECTIVES:

- Knowledge and concept of Biomolecules.
- Basic concepts and principles of different biochemical techniques.
- Applications of different bioanalytical techniques.

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Understand about the cells and apply the concept of centrifugation.
CO2	Explain classification, principle and application of chromatography.
CO3	Discuss principle and application of electrophoresis and blotting techniques
CO4	Understand working principle of spectrophotometer and able to handle different spectrophotometric techniques
CO5	Understand the concept of microscopy and radiations.

CO-PO-PSO MAPPING

	PO												PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	2	1	2	1	2	1	2	2	3	3	3	2
CO2	3	2	1	1	2	2	1	1	1	1	3	3	3	3	3
CO3	3	3	2	1	2	1	1	2	2	1	2	3	2	3	2
CO4	3	2	1	2	1	1	2	1	1	1	3	3	3	3	2
CO5	3	3	1	1	1	1	1	2	1	1	2	3	2	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Information Technology in Agriculture
Course Code: MCA 512
w.e.f. Session 2022-23

2(1+1)

Unit-I
Introduction and Applications of e-Agriculture, Introduction to Online Agricultural resources: Consortium for e-resources in Agriculture (CeRA), e-agriculture community, Agriculture: National Portal of India. Agricultural Datasets and Databases: Agricola, Agris. Need of Biological databases in Agricultural Sciences.

Unit-II
Smartphone Apps in Agriculture for farm advisory, Weather forecasting, types, methods, tools & techniques, Use of ICT in Agriculture, Computer Models for understanding plant processes.

Unit-III
Crop models, concepts & techniques, types of crop models, spatial data and their management in GIS; Remote sensing concepts and application in agriculture, Global positioning system (GPS), components and its functions.

Unit-IV
Agricultural Journalism – Meaning, Scope and Importance, Sources of news, Kisan call centers, e-chaupal, RRA, PRA tools and techniques KVK, Adopter categories, MANAGE, EEI: extension education institute.

Practical:
Uniformity trial data analysis, formation of plots and blocks, Analysis of data obtained from Completely Randomized Design, Randomized Block Design, Latin Square Design; Analysis of factorial experiments without and with confounding; Analysis with missing data; Split plot designs; Transformation of data; Fitting of response surfaces.

Suggested Readings:

- Agri Informatics: An Introduction (Industry Series), by R Chakravarthy, ICFAI University Press.
- E-Agriculture: Concepts and Applications (Agriculture Series), Rahul Gupta (Author), ICFA University Press.
- Yadav, D S, Foundations of IT, New Age, Delhi.
- Introduction to Bioinformatics by Teresa Attwood, David Parry-Smith 1st edition; Prentice Hall publications
- Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis and B. F. Francis Ouellette (Eds), 2nd Edition; Willey & Sons publications.
- Bioinformatics: Sequence, Structure, and Databanks: A Practical Approach by Des Higgins, Willie Taylor; OUP.
- BIOS Instant Notes in Bioinformatics by Charlie Hodgman, Andrew French, David Westhead, Taylor & Francis publishing; 2 edition.

COURSE OBJECTIVES:
- To gain basic knowledge of information technology in agriculture
- The aim of improving communication and learning processes between various sectors in agriculture locally, regionally and worldwide
- They gain knowledge of weather forecasting to increase the production and productivity of Agriculture
- Type of education and Agricultural Journalism
- Knowledge of Innovative Information sources.

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Use of Information and Communication Technology in Agriculture
CO2	Know about crop models concepts & techniques
CO3	Know about computer models for understanding plant processes.
CO4	Knowledge of education and their Characteristics and Agricultural Journalism
CO5	Knowledge of contact methods, Kissan Call center and e-Chaupal.

CO-PO-PSO MAPPING

	PO												PSO		
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	2	1	3	3	1	1	2	3	3	3	3	2	2
CO2	3	3	3	2	1	3	2	1	3	2	3	3	2	3	2
CO3	3	3	1	2	2	2	3	1	2	3	3	3	2	3	3
CO4	3	3	3	2	3	3	2	1	3	2	3	3	3	1	2
CO5	3	3	2	3	1	3	1	1	2	2	3	3	3	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)/MBA Agribusiness Management
SEMESTER-I
Course Title: Intellectual Property and Its Management in Agriculture
Course Code: PGS503
w.e.f. Session 2018-19

1(1+0)

Unit-I
Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs;

Unit-II
Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks.

Unit-III
Protection of plant varieties and farmers' rights and bio-diversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture.

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

Suggested Readings:

- 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.

COURSE OBJECTIVES:
- Knowledge, concept and introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement
- Basics of Legislations for the protection of various types of Intellectual Properties
- Fundamentals of patents, copyrights, geographical indications, designs and layout
- Basic concepts of Protection of plant varieties and farmers' rights and bio-diversity protection, Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture
- Study of Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement

COURSE OUTCOMES (CO):
After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Concept of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement
CO2	Knowledge of Legislations for the protection of various types of Intellectual Properties
CO3	Concepts of Protection of plant varieties and farmers' rights and bio-diversity protection, Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture
CO4	Knowledge of Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture
CO5	Knowledge of Socio-economic impact, Research collaboration Agreement, License Agreement

CO-PO-PSO MAPPING:

	PO												PSO			
CO	**POI**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	3	3	3	1	1	1	3	3	2	3	3	3	2	2	2
CO2	2	3	2	2	1	1	1	1	2	3	1	3	2	2	2	2
CO3	3	3	3	3	1	1	2	2	3	3	2	3	2	2	2	2
CO4	3	3	2	2	1	1	1	1	2	3	3	3	3	2	2	2
CO5	3	3	2	3	1	1	1	3	3	3	3	1	3	3	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution																

M. Sc. (Ag.)/M.Sc. (Hort.)
SEMESTER-I
Course Title: Basic Concepts in Laboratory Techniques
Course Code: PGS504
w.e.f. Session 2018-19

1(0+1)

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; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values; Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing; Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy.

Suggested Readings:

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

COURSE OBJECTIVES:
- Basic concepts of Safety measures while handling instruments, chemicals, glasswares, etc. in lab
- Use of different instruments, chemicals, glasswares, etc. of lab
- Preparation of different agrochemical doses in field and pot applications
- Preparation of buffers of different strengths and pH values
- Preparation of media and methods of sterilization
- Seed viability testing, testing of pollen viability

COURSE OUTCOMES (CO):
After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students will have basic knowledge of handling and safety measures of instruments, chemicals, glasswares, etc. in lab before and after use
CO2	Students will have knowledge of usage of different type of lab equipments, instruments, glasswares, plasticwares, etc.
CO3	The students will be able to prepare different agrochemical doses in field and pot applications
CO4	Students can have the knowledge to prepare media, acid and bases of different strengths and buffer solutions
CO5	Students can also perform seed and pollen viability testing

CO-PO-PSO MAPPING:

	PO												PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	2	2	2	2	1	2	1	2	2	2	1	3	2	2	2	2
CO2	2	2	2	2	1	2	1	2	1	2	1	3	2	2	2	2
CO3	3	3	3	2	1	2	1	2	2	2	1	3	2	2	2	2
CO4	3	3	3	2	1	2	1	2	2	2	1	3	2	2	2	2
CO5	3	3	3	2	2	2	1	2	2	2	1	3	2	2	2	2
3: Strong contribution, 2: average contribution, 1: Low contribution																

Integral University, Lucknow
Integral Institute of Agricultural Science and Technology
Evaluation Scheme of Post Graduate Program
w.e.f. 2022-23
M. Sc. (Hort.) Vegetable Science
Semester-II

Course Code	Course Title	Type of Course	Periods/ Per week			Evaluation Scheme Theory Mid Sem			Evaluation Scheme Practical Mid Sem			Practical End Sem Exam	Sub Total (Theory + Practical Mid Sem Exam)	End Sem Theory Exam	Subject Total	Credit	Total Credit Points	Attributes							United Nations sustainable development goals (SDGs)
			L	T	P	CT	TA	Total	CT	TA	Total							Employability	Entrepreneurship	Skill Development	Gender Equality	Environment & Sustainability	Human Value	Professional Ethics	
VSC 502	Production of Warm Season Vegetable Crops	Major	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√	√	√		√		√	12
VSC 504	Principles of Vegetable Breeding		2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√	√	√	√	√	√	√	
VSC 507	Protected Cultivation of Vegetable Crops	Optional	1	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	1:0:1	2	√	√	√	√	√	√	√	
Total																	*								
***Major Course (Core course + Optional course) should not exceed more than 9 credit**																									
FSC 502	Sub-Tropical and Temperate Fruit Production	Minor	2	0	2	20	10	**30**	-	-	-	20	**50**	**50**	**100**	2:0:1	3	√	√	√		√	√	√	12
		Supporting																							
Total																	**								
PGS502	Technical Writing and Communications Skills	Common	0	0	2	0	0	**-**	-	-	-	25	**75**	**0**	**100**	0:0:1	1	√		√				√	4
PGS505 (e-Course)	Agricultural Research, Research Ethics and Rural Development Programmes		1	0	0	20	10	**30**	-	-	-	0	**0**	**70**	**100**	1:0:0	1	√		√			√	√	4
VSC 591	Master's Seminar		-	-	-	-	-	-	-	-	-	-	-	-	**100**	0:0:1	1			√					4
VSC 599	Master's Research		-	-	-	-	-	-	-	-	-	-	-	-	S/US	0:0:5	5$	√		√			√	√	4
Grand Total																	***								

*Grand Total (***) = *+**, credit should not exceed more than 22 credit in one semester, $Master's Research credit to be counted in Final Semester examinations; S/US=Satisfactory/Unsatisfactory*

M. Sc. (Hort.) Vegetable Science
SEMESTER-III
Course Title: Production of Warm Season Vegetable Crops
Course Code: VSC 502
w.e.f. Session 2022-23

3(2+1)

Introduction, commercial and nutritional importance, origin and distribution, botany and taxonomy, area, production, productivity and constraints, soil requirements, climatic factors for yield and quality, commercial varieties/ hybrids, seed rate and seed treatment, raising of nursery including grafting technique, sowing/ planting time and methods, precision farming, cropping system, nutritional including micronutrients and irrigation requirements, intercultural operations, special horticultural practices namely hydroponics, aeroponics, weed control, mulching, role of plant growth regulators, physiological disorders, maturity indices, harvesting, yield, post-harvest management (grading, packaging and marking), pest and disease management and economics of crops in:

Unit-I
Fruit vegetables—Tomato, brinjal, hot pepper, sweet pepper and okra.

Unit-II
Beans—French bean, Indian bean (Sem), cluster bean and cowpea.

Unit-III
Cucurbits—Cucumber, melons, gourds, pumpkin, and squashes.

Unit-IV
Tuber crops—Sweet potato, elephant foot yam, tapioca, taro and yam.

Unit-V
Leafy vegetables—Amaranth and drumstick.

Practical:
Scientific raising of nursery and seed treatment; Sowing and transplanting; Description of commercial varieties and hybrids; Demonstration on methods of irrigation, fertilizers and micronutrients application; Mulching practices, weed management; Use of plant growth substances in cool season vegetable crops; Study of nutritional and physiological disorders; Studies on hydroponics, aeroponics and other soilless culture; Identification of important pest and diseases and their control; Preparation of cropping scheme for commercial farms; Visit to commercial farm, greenhouse/polyhouses; Visit to vegetable market; Analysis of benefit to cost ratio.

Suggested Readings:

- Bose TK, Kabir J, Maity TK, Parthasarathy VA and Som MG. 2003. Vegetable crops. Vols. I-III. Naya udyog.
- Bose TK, Som MG and Kabir J. (Eds.). 1993. Vegetable crops. Naya prokash.
- Chadha KL and Kalloo G. (Eds.). 1993-94. Advances in horticulture Vols. V-X. Malhotra publ. house.
- Chadha KL. (Ed.). 2002. Hand book of horticulture. ICAR.
- Chauhan DVS. (Ed.). 1986. Vegetable production in India. Ram prasad and sons.
- Fageria MS, Choudhary BR and Dhaka RS. 2000. Vegetable crops: production technology. Vol. II. Kalyani.
- Gopalakrishanan TR. 2007. Vegetable crops. New India publ. agency.
- Hazra P and Banerjee MK and Chattopadhyay A. 2012. Varieties of vegetable crops in India,
- (Second edition), Kalyani publishers, Ludhiana, 199 p.
- Hazra P. 2016. Vegetable science. 2ndedn, Kalyani publishers, Ludhiana.
- Hazra P. 2019. Vegetable production and technology. New India publishing agency, New Delhi.

- Hazra P, Chattopadhyay A, Karmakar K and Dutta S. 2011. Modern technology for vegetable
- production, New India publishing agency, New Delhi, 413p
- Rana MK. 2008. Olericulture in India. Kalyani Publishers, New Delhi.
- Rana MK. 2008. Scientific cultivation of vegetables. Kalyani Publishers, New Delhi.
- Rubatzky VE and Yamaguchi M. (Eds.). 1997. World vegetables: principles, production and nutritive values. Chapman and Hall.
- Saini GS. 2001. A text book of oleri and flori culture. Aman publishing house.
- Salunkhe DK and Kadam SS. (Ed.). 1998. Hand book of vegetable science and technology: production, composition, storage, and processing. Marcel dekker.
- Shanmugavelu KG., 1989. Production technology of vegetable crops. Oxford and IBH.
- Singh DK. 2007. Modern vegetable varieties and production technology. International book distributing Co.
- Singh SP. (Ed.). 1989. Production technology of vegetable crops. Agril. comm. res. centre.
- Thamburaj S and Singh N. (Eds.). 2004. Vegetables, tuber crops and spices. ICAR.
- Thompson HC and Kelly WC. (Eds.). 1978. Vegetable crops. Tata McGraw-Hill.

COURSE OBJECTIVES:

- To know about the importance and historical knowledge of warm season vegetables of tuber and leafy crops.
- To impart comprehensive knowledge about the scientific production technology of vegetables specially grown in warm season
- Knowledge of crop protection measure in different crops

COURSE OUTCOMES (CO):

After completion of course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	To impart basic knowledge about the importance and management of warm season vegetables grown in India. Understand the package of practices of crops
CO2	Impart knowledge of varietal importance to improve the production and quality of vegetables
CO3	By the end of course students will have the idea of production methods of different warm season crops.
C04	Calculate the agro-chemical doses to control biotic stresses
C05	Understand the package of practices of crops Identify and control of important physiological disorders

CO-PO-PSO mapping

	PO												PSO		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	3	3	2	1	2	2	2	3	3	2	2	1
CO2	3	3	3	3	1	1	2	1	3	2	3	2	2	3	2
CO3	3	2	3	3	3	1	2	2	2	3	3	3	2	1	2
CO4	3	2	2	3	3	2	1	3	3	3	3	3	2	3	2
CO5	3	2	3	3	3	1	2	2	3	3	3	3	2	1	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Hort.) Vegetable Science
SEMESTER-II
Course Title: Principles of Vegetable Breeding
Course Code: VSC 504
w.e.f. Session 2022-2023

3(2+1)

Unit-I
Importance and history- Importance, history and evolutionary aspects of vegetable breeding and its variation from cereal crop breeding.

Unit-II
Selection procedures- Techniques of selfing and crossing; Breeding systems and methods; Selection procedures and hybridization; Genetic architecture; Breeding for biotic stress (diseases, insect pests and nematode), abiotic stress (temperature, moisture and salt) resistance and quality improvement; Breeding for water use efficiency (WUE) and nutrients use efficiency (NUE).

Unit-III
Heterosis breeding- Types, mechanisms and basis of heterosis, facilitating mechanisms like male sterility, self-incompatibility and sex forms.

Unit-IV
Mutation and Polyploidy breeding; Improvement of asexually propagated vegetable crops and vegetables suitable for protected environment.

Unit-V
Ideotype breeding- Ideotype breeding; varietal release procedure; DUS testing in vegetable crops; Application of *In-vitro* and molecular techniques in vegetable improvement.

Practical:
Floral biology and pollination behaviour of different vegetables; Techniques of selfing and crossing of different vegetables *viz*., Cole crops, okra, cucurbits, tomato, eggplant, hot pepper, etc.; Breeding system and handling of filial generations of different vegetables; Exposure to biotechnological lab practices; Visit to breeding farms.

Suggested Readings:

- Allard RW. 1960. Principle of plant breeding. John Willey and Sons, USA.
- Kalloo G. 1988. Vegetable breeding (Vol. I, II, III). CRC Press, Fl, USA.
- Kole CR. 2007. Genome mapping and molecular breeding in plants-vegetables. Springer, USA.
- Peter KVand Pradeep Kumar T. 1998. Genetics and breeding of vegetables. ICAR, New Delhi, p. 488.
- Prohens J and Nuez F. 2007. Handbook of plant breeding-vegetables (Vol I and II). Springer, USA.
- Singh BD. 2007. Plant breeding- principles and methods (8th edn.). Kalyani Publishers, New Delhi.
- Singh Ram J. 2007. Genetic resources, chromosome engineering, and crop improvement-vegetable crops (Vol. 3). CRC Press, Fl, USA.

COURSE OBJECTIVES:

- To update knowledge on the recent research trends in the field of breeding of fruit crops with special emphasis on tropical, subtropical and temperate crops grown in India.
- Familiarization with different chemical and methods for dormancy breakage different vegetables seeds.
- Knowledge of extrinsic factors for vegetable crops.

COURSE OUTCOMES (CO):

After completion of course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Able to about growth and developmental requirement of different vegetable crops.
CO2	Familiarization with general knowledge of botany and crop plants
CO3	To impart theoretical knowledge and practical skills about plant breeding objectives.
CO4	To learn modes of reproduction and genetic consequences, breeding methods for crop improvement.
CO5	Conceptualize about different aspects of plant breeding, hybrid vigour and release of variety

CO-PO-PSO mapping

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	2	2	2	2	1	3	3	2	2	2	3	2
CO2	3	3	3	3	3	3	3	3	3	2	3	3	1	1	3
CO3	2	3	1	3	3	2	3	3	3	3	3	1	3	3	3
CO4	2	2	2	2	2	2	2	3	2	1	2	2	3	2	1
CO5	3	2	3	2	2	3	2	3	3	3	2	3	1	3	2
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Hort.) Vegetable Science
SEMESTER-II
Course Title: Protected Cultivation of Vegetable Crops
Course Code: VSC 507
w.e.f. Session 2022-2023

3(2+1)

Unit-I
Scope and importance- Concept, scope and importance of protected cultivation of vegetable crops; Principles, design, orientation of structure, low and high cost polyhouses/greenhouse structures.

Unit-II
Types of protected structure- Classification and types of protected structures greenhouse/polyhouses, plastic-non plastic low tunnels, plastic walk in tunnels, high roof tunnels with ventilation, insect proof net houses, shed net houses, rain shelters, NVP, climate control greenhouses, hydroponics and aeroponics; Soil and soilless media for bed preparation; Design and installation of drip irrigation and fertigation system.

Unit-III
Abiotic factors- Effect of environmental factors and manipulation of temperature, light, carbon dioxide, humidity, etc. on growth and yield of different vegetables.

Unit-IV
Nursery raising- High tech vegetable nursery raising in protected structures using plugs and portrays, different media for growing nursery under protected cultivation; Nursery problems and management technologies including fertigation.

Unit-V
Cultivation of crops- Regulation of flowering and fruiting in vegetable crops; Technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, including varieties and hybrids, training, pruning and staking in growing vegetables under protected structures.

Unit-VI
Solutions to problems- Problems of growing vegetables in protected structures and their remedies, physiological disorders, insect and disease management in protected structures; Use of protected structures for seed production; Economics of greenhouse crop production.

Practical:
Study of various types of protected structure; Study of different methods to control temperature, carbon dioxide and light; Study of different types of growing media, training and pruning systems in greenhouse crops; Study of fertigation and nutrient management under protected structures; Study of insect pests and diseases in greenhouse and its control; Use of protected structures in hybrid seed production of vegetables; Economics of protected cultivation (Any one crop); Visit to established green/polyhouses/shade net houses in the region.

Suggested Readings:

- Chadha KL and Kalloo G. (Eds.). 1993-94. Advances in horticulture. Malhotra Pub. House.
- Chandra S and Som V. 2000. Cultivating vegetables in green house. Indian horticulture 45:17-18.
- Kalloo G and Singh K. (Eds.). 2000. Emerging scenario in vegetable research and development.Research periodicals and Book publ. house.
- Parvatha RP. 2016. Sustainable crop protection under protected cultivation. E-Book Springer.
- Prasad S and Kumar U. 2005. Greenhouse management for horticultural crops. 2nd Ed.Agrobios.
- Resh HM. 2012. Hydroponic food production. 7thEdn. CRC Press.

- Singh B. 2005. Protected cultivation of vegetable crops. Kalyani publishers, New Delhi
- Singh DK and Peter KV. 2014. Protected cultivation of horticultural crops (1st Edition) New India publishing agency, New Delhi.
- Singh S, Singh B and Sabir N. 2014. Advances in protected cultivation. New India publishing agency, New Delhi.
- Tiwari GN. 2003. Green house technology for controlled environment. Narosa publ. house.

COURSE OBJECTIVES:

- Understanding the principle, theoretical aspects and developing skills in protected cultivation of horticultural crops.
- Knowing about the history of vegetable crops and their evolution.

COURSE OUTCOMES (CO):

After completion of course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Able to know what is the significance of systematics and crop diversity in vegetable crops
CO2	To acquaint with green house technology, types of Green Houses; Plant response to green house Environment.
CO3	Study of different type of green houses based on shape.
CO4	Determine the rate of air exchange in an active summer winter cooling system.
CO5	Determination of drying rate of agricultural products inside green house.

CO-PO-PSO mapping

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	2	3	2	2	2	2	3	2	2	2	2	3	2
CO2	3	3	3	3	3	3	3	3	3	3	3	1	3	1	1
CO3	3	3	1	3	3	1	3	3	3	3	3	3	1	3	3
CO5	2	3	3	2	2	3	2	2	3	3	2	1	3	3	3
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Hort.) Fruit Science
SEMESTER-II
Course Title: Subtropical and Temperate Fruit Production
Course Code: FSC 502
w.e.f. Session 2022-2023

3(2+1)

Unit-I

Importance and Background: Origin, distribution and importance, major species, rootstocks and commercial varieties of regional, national and international importance, eco-physiological requirements for Crops Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.

Unit-II

Propagation, Planting and Orchard Floor Management: 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 for Crops Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.

Unit III

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 for Crops Citrus, Grapes, Litchi, Pomegranate, Apple, Pear, Peach, Plum, Apricot, Cherries, Berries, Persimmon, Kiwifruit, Nuts- Walnut, Almond, Pecan, etc.

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 subtropical and temperate orchards. Project preparation for establishing commercial orchards.

Suggested Readings:

- 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. Grapes. 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.Backhuys 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 OBJECTIVES:

- Importance of fruit production, major species and varieties of Sub Tropical and Temperate fruit crops
- Knowledge about different species, rootstock and different methods propagation of Sub Tropical and Temperate fruit crops
- Familiar the students about training, pruning and nutrient management of fruit crops.
- To know about different physiological disorders of fruit crops.

COURSE OUTCOMES (CO):

After completion of course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Aware about different species, Rootstock and varieties of fruit crops.
CO2	Students know about different types of propagation methods
CO3	Students also aware about the flowering physiology of fruit crops
CO4	Aware about the different methods of crop regulation
CO5	Familiar with the methods of training and pruning.

CO-PO-PSO mapping

	PO											PSO			
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
CO1	3	2	1	3	3	1	3	1	1	3	3	2	3	2	3
CO2	2	3	2	2	3	2	2	1	1	1	2	3	3	3	2
CO3	3	2	1	1	3	1	3	2	1	2	3	3	2	2	3
CO4	2	2	1	3	3	2	2	1	1	1	1	2	3	3	3
CO5	3	2	1	3	3	1	3	2	1	1	3	3	3	3	3
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)/MBA Agribusiness Management
SEMESTER-II
Course Title: Technical Writing and Communications Skills
Course Code: PGS502
w.e.f. Session 2018-19

1(1+0)

Practical: Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; 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

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

COURSE OBJECTIVES:

- To give knowledge about the various forms of scientific writings
- To give knowledge about the various parts of thesis, research communications
- To give knowledge about writing of abstracts, summaries, citations etc
- To give knowledge about research communications, illustrations, photograph, drawings
- To give knowledge about pagination, scientific write ups, editing and proof reading, and writing of review article

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Learn that what are the various forms of scientific writings
CO2	Learn how to write the various parts of thesis, research communications
CO3	Learn how to do writing of abstracts, summaries and what are citations etc
CO4	Learn research communications, illustrations, photograph, drawings
CO5	Learn pagination, scientific write ups, editing and proof reading, and writing of review article

CO-PO-PSO MAPPING:

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	2	0	0	2	0	1	1	3	3	2	2	1
CO2	3	3	1	2	0	3	2	0	0	0	3	2	2	2	2
CO3	3	3	1	0	0	1	2	0	0	0	3	3	2	2	2
CO4	3	3	2	3	0	2	2	0	0	0	3	3	2	2	2
CO5	3	3	2	3	0	3	2	1	0	0	3	3	2	2	1
3: Strong contribution, 2: average contribution, 1: Low contribution															

M. Sc. (Ag.)/M.Sc. (Hort.)/MBA Agribusiness Management
SEMESTER-II
Course Title: Agricultural Research, Research Ethics and Rural Development Programmes
Course Code: PGS505 (e-Course)
w.e.f. Session 2018-19

1(0+1)

Unit-I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

Unit-II

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

Unit-III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organizations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings:

- Bhalla GS & 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 OBJECTIVES:

- To know the objective and principle of extension education
- To obtain idea on various development programmes in agriculture and allied area to help farmers.
- To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

COURSE OUTCOMES (CO):

After completion of the course, a student will be able to

COURSE OUTCOME (CO)	DESCRIPTION
CO1	Students capable, efficient, and self-reliant in character.
CO2	They gain knowledge to help rural families in better appreciation of SWOT in the village.
CO3	They know about to open new opportunities for developing talents and leadership of rural people.
CO4	To provide knowledge and help for better management of farms and increase incomes.
CO5	To promote better social, natural recreational intellectual and spiritual file among the people.

CO-PO-PSO MAPPING:

	PO												PSO		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	2	1	1	3	3	3	2	3	1	1	1	1	1
CO2	3	3	3	1	1	3	3	3	2	3	3	2	2	2	2
CO3	3	2	1	1	1	2	3	3	2	1	2	1	1	1	2
CO4	3	2	2	2	1	3	3	3	2	2	3	1	2	2	2
CO5	3	1	1	1	1	2	3	3	2	2	3	3	1	1	1
3: Strong contribution, 2: average contribution, 1: Low contribution															