HORTICULTURE SYLLABUS : AS PER REPORT OF THE ICAR 5TH DEANS' COMMITTEE

HORTICULTURE

Defining UG & PG degree for general market needs & for specialized jobs and uniformity in UG & PG nomenclature

Degree Nomenclature

UG degree :B.Sc. (Hons.) Horticulture

PG Degrees: M. Sc (Horticulture) and Ph. D (Horticulture) with following specializations:

1) Fruit Science.
2) Vegetable Science
3) Postharvest Technology
4) Floriculture and Landscape Architecture
5) Plantation Spices
6) Medicinal & Aromatic Crops
7) Molecular Biology and Biotechnology
8) Genetics and Plant Breeding
9) Plant Pathology
10) Entomology
11) Soil Science and Technology
12) Economics and Marketing
13) Extension

Restructuring of UG programmes for increased practical and practice contents

Abstract

Particulars	**Suggested**
Total No. of courses	56 + 2 (NC) = 58
Total credit hours	178
Non-credit courses	02
Non-credit courses (credit hour)	04(1+3)
Total credit hours of theory	**82**
Total credit hours for practical	**56**

Name of Departments

1. Fruit Science
2. Vegetable Science
3. Postharvest Technology
4. Floriculture and Landscape Architecture
5. Plant Protection
6. Natural Resource Management
7. Basic Sciences
8. Social Science

Department Wise Courses

1. Fruit Science

Sr. No.	Course No.	Name of Course	Credit
1	FRT 1.1	Fundamentals of Horticulture	3(2+1)
2	FRT 2.2	Plant Propagation and Nursery Management	2(1+1)
3	FRT 3.3	Temperate Fruit Crops	2(1+1)
4	FRT 4.4	Tropical and Subtropical Fruits	3(2+1)
5	FRT 4.5	Plantation Crops	3(2+1)
6	FRT 4.6	Breeding of Fruit and Plantation Crops	3(2+1)
7	FRT 5.7	Orchard and Estate Management	2(1+1)
8	FRT 5.8	Dry land Horticulture	2(1+1)
		Total	**20 (12+8)**

2. Vegetable Science

Sr. No.	Course No.	Name of Course	Credit
1	VEG 1.1	Tropical and Subtropical Vegetable crops	3(2+1)
2	VEG 3.2	Temperate Vegetable Crops	2(1+1)
3	VEG 3.3	Precision Farming and Protected Cultivation	3(2+1)
4	VEG 4.4	Spices and Condiments	3(2+1)
5	VEG 5.5	Potato and Tuber Crops	2(1+1)
6	VEG 5.6	Breeding of Vegetable, Tuber and Spice Crops	3(2+1)
7	VEG 6.7	Seed Production of Vegetable, Tuber and Spice Crops	3(2+1)
		Total	**19 (12+7)**

3. Floriculture & Landscape Architecture

Sr. No.	Course No.	Name of Course	Credit
1	FLA 2.1	Ornamental Horticulture	2(1+1)
2	FLA 3.2	Commercial Floriculture	3(2+1)
3	FLA 4.3	Principles of Landscape Architecture	2(1+1)
4	FLA 6.4	Breeding and Seed Production of Flower and Ornamental Crops	3(2+1)
5	FLA 6.5	Medicinal & Aromatic plants	3(2+1)
		Total	**13 (8+5)**

4. Post Harvest Technology

Sr. No.	Course No.	Name of Course	Credit
1	PHT 1.1	Fundamentals of Food & Nutrition	2 (1+1)
2	PHT 5.2	Postharvest Management of Horticultural Crops	3(2+1)
3	PHT 6.3	Processing of Horticultural Crops	3(1+2)
		Total	**8 (4+4)**

5. Plant Protection

Sr. No.	Course No.	Name of Course	Credit
1	PPT 2.1	Fundamentals of Plant Pathology	3(2+1)
2	PPT 3.2	Fundamentals of Entomology	3(2+1)
3	PPT 3.3	Nematode Pests of Horticultural Crops and their Management	2(1+1)
4	PPT 4.4	Diseases of Fruit, Plantation and Medicinal and Aromatic Crops	3(2+1)
5	PPT 4.5	Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops	3(2+1)
6	PPT 5.6	Diseases of Vegetable, Ornamental and Spice Crops	3(2+1)
7	PPT 5.7	Insect Pests of Vegetable, Ornamental and Spice Crops	3(2+1)
8	PPT 6.8	Apiculture, Sericulture and Lac Culture	2(1+1)
		Total	**22 (14+8)**

6. Natural Resource Management

Sr. No.	Course No.	Name of Course	Credit
1	NRMH 1.1	Fundamentals of Soil Science	3(2+1)
2	NRMH 2.2	Soil Fertility and Nutrient Management	2(1+1)
3	NRMH 2.3	Water Management in Horticultural Crops	2(1+1)
4	NRMH 2.4	Agro-meteorology and Climate Change	2(1+1)
5	NRMH 3.5	Organic Farming	2(1+1)
6	NRMH 4.6	Farm Power and Machinery	2(1+1)
7	NRMH 4.7	Soil, Water and Plant Analysis	2(1+1)
8	NRMH 5.8	Weed Management in Horticultural Crops	2(1+1)
9	NRMH 6.9	Introduction to Major Field Crops	2(1+1)
10	NRMH 6.10	Introductory Agroforestry	2(1+1)
11	NRMH 6.11	Environmental Studies and Disaster Management	3(2+1)
		Total	**24 (13+11)**

7. Basic Sciences

Sr. No.	Course No.	Name of Course	Credit
1	BSC 1.1	Elementary Plant Biochemistry	2(1+1)
2	BSC 1.2	Principles of Genetics and Cytogenetics	3(2+1)
3	BSC 1.3	Introductory Microbiology	2(1+1)
4	BSC 2.4	Introductory Crop Physiology	2(1+1)
5	BSC 2.5	Principles of Plant Breeding	3(2+1)
6	BSC 3.6	Elementary Plant Biotechnology	2(1+1)
7	BSC 3.7	Growth and Development of Horticultural Crops	2(1+1)
		Total	**16 (9+7)**

8. Social Sciences

Sr. No.	Course No.	Name of Course	Credit
1	SSC 1.1	Information and communication Technology	2(1+1)
2	SSC 1.2	Economics and Marketing	3(2+1)
3	SSC 1.3	Physical and Health Education (NC)*	1(0+1)*
4	SSC 2.4	Elementary Statistics and Computer application	3(2+1)
5	SSC 2.5	Communication Skills and Personality Development	2(1+1)
6	SSC 2.6	NSS/NCC(NC)*	1(0+1)*
7	SSC 5.7	Fundamentals of Extension Education	2(1+1)
8	SSC 6.8	Horti-Business Management	2(2+0)
9	SSC 6.9	Entrepreneurship Development and Business Management	2(1+1)
		Total	**16 (10+6)+2*=18**
		Grand Total	**82 + 56 + 2* =140**

9. Activity

STUDENT READY:

Sl. No.	Activity	Credits
1	Experiential learning (Professional Package)	0+20
2	RHWE& Placement in Industries	0+20
	Total	**0+40**

STUDENT READY-I (Seven semester)

I.Experimental Learning Programme:

Professional Packages Hands on Training /Experimental Learning Modules: Final year B.Sc. (Hons.) Horticulture students can select two modules under STUDENT READY- Experiential Learning programme depending on the facilities available at the college.

1. Protected cultivation of High Valued Horticultural Crops
2. Commercial production of Horticultural planting materials
3. Post Harvest Handling and Value addition in Horticultural crops
4. Floriculture and Landscape Architecture
5. Mass multiplication through tissue culture in horticultural crops
6. Bio fertilizers and bio pesticides

Batch of student can select two modules under STUDENT READY-ExperientialLearning Programme depending on the facilities available at the college.

Student have to select any two modules from the below listed modules

Model No.	Course No.	Title	Credit
1	**HWE 7.1**	**Protected cultivation of High Valued Horticultural Crops**	**0 +10**
	HWE 7.1.1	Production of High Valued Crops	0+6
	HWE 7.1.2	Packing and Marketing of High valued Horticultural Crops	0+4
2	**HWE 7.2**	**Commercial production of Horticultural planting materials**	**0+10**

	HWE 7.2.1	Propagation and production of propagules	0+6
	HWE 7.2.2	Packing and Marketing of planting materials	0+4
3	**HWE 7.3**	**Post Harvest Handling and Value addition in Horticultural crops**	**0+10**
	HWE 7.3.1	Preparation and evaluation of processed products	0+6
	HWE 7.3.2	Packing and Marketing of processed products	0+4
4	**HWE 7.4**	**Floriculture and Landscape Architecture**	**0+10**
	HWE 7.4.1	Planning, Layout and Design of landscape	0+6
	HWE 7.4.1	Consultancy and maintenance of garden	0+4
5	**HWE 7.5**	**Mass multiplication through tissue culture in horticultural crops**	**0+10**
	HWE 7.5.1	Production of tissue culture plants	0+6
	HWE 7.5.2	Packing and Marketing of tissue culture plants	0+4
6	**HWE 7.6**	**Bio fertilizers and bio pesticides**	**0+10**
	HWE 7.6.1	Production technology of bio fertilizers and bio pesticides	0+6
	HWE 7.6.2	Packing and Marketing of bio fertilizers and bio pesticides	0+4

Evaluation system : Work performance - 40 marks, Report writing & presentation – 20 marks and Semester End exam - 40 marks

STUDENT READY-II

Rural Horticultural Work Experience Programme (0+20)

1. **Phase wise distribution of weeks**

Sr. No.	Details of Programme	Weeks
1.	Orientation phase	2
2.	Village stay/progressive farmer's field visit	3
3.	Educational tour	2
4.	SAU's of Gujarat visit	8
5.	Industrial/NGO visit	2
6.	Report writing, presentation and End Examination	3
	Total	**20 eeks**

2. Details of course title and credit hours

Course code and title : The title of course and code will be as given below

Sr. No.	Course No.	Title	Credit
1	RHWE 8.1	Visit to progressive farmer's field and NGO	0+2
2	RHWE 8.2	Educational tour	0+2
3	RHWE 8.3	University farms (JAU) and Visit to horticulture based industries of Saurashtra region	0+4
4	RHWE 8.4	University farms (AAU) and Visit to horticulture based industries of Middle Gujarat region	0+4
5	RHWE 8.5	University farms (SDAU) and Visit to horticulture based industries of North Gujarat region	0+4
6	RHWE 8.6	University farms (NAU) and Visit to horticulture based industries of South Gujarat region	0+4

Evaluation system : Work performance - 25 marks, Report writing & presentation – 25 marks and Semester End exam - 50 marks

Semester wise courses

Semester – I

Sr. No.	Course No.	Title of the Course	Credit Hours
1	FRT 1.1	Fundamentals of Horticulture	3(2+1)
2	VEG 1.1	Tropical and Subtropical Vegetable crops	3(2+1)
3	NRMH 1.1	Fundamental of Soil Science	3(2+1)
4	PHT 1.1	Fundamentals of food and nutrition	2(1+1)
5	BSC 1.1	Elementary Plant Biochemistry	2(1+1)
6	BSC 1.2	Principles of Genetics and Cytogenetics	3(2+1)
7	BSC 1.3	Introductory Microbiology	2(1+1)
8	SSC 1.1	Information and Communication Technology	2(1+1)
9	SSC 1.2	Economics and Marketing	3(2+1)
10	SSC 1.3	Physical and Health Education	1(0+1)(NC)*
		Total	**23(14+09)+1*=24**

Semester – II

Sr. No.	Course No.	Title of the Course	Credit Hours
1	FRT 2.2	Plant Propagation and Nursery Management	2(1+1)
2	FLA 2.1	Ornamental Horticulture	2(1+1)
3	NRMH 2.2	Soil Fertility and Nutrient Management	2(1+1)
4	NRMH 2.3	Water Management in Horticultural Crops	2(1+1)
5	PPT 2.1	Fundamentals of Plant Pathology	3(2+1)
6	NRMH 2.4	Agro-meteorology and Climate Change	2 (1+1)
7	BSC 2.4	Introductory Crop Physiology	2(1+1)
8	BSC 2.5	Principles of Plant Breeding	3(2+1)
9	SSC 2.4	Elementary Statistics and Computer Application	3(2+1)
10	SSC 2.5	Communication Skills and Personality Development	2(1+1)
11	SSC 2.6	National Service Scheme/National Cadet Corp	1(0+1)(NC)*
		Total	**23(13+10)+1*=24**

Semester – III

Sr. No.	Course No.	Title of the Course	Credit Hours
1	FRT 3.3	Temperate Fruit Crops	2(1+1)
2	VEG 3.2	Temperate Vegetable Crops	2(1+1)
3	VEG 3.3	Precision Farming and Protected Cultivation	3(2+1)
4	FLA 3.2	Commercial Floriculture	3(2+1)
5	NRMH 3.5	Organic Farming	2(1+1)
6	PPT 3.2	Fundamentals of Entomology	3(2+1)
7	PPT 3.3	Nematode pests of Horticultural crops and their Management	2(1+1)
8	BSC 3.6	Elementary Plant Biotechnology	2(1+1)
9	BSC 3.7	Growth and Development of Horticultural Crops	2(1+1)
		Total	**21 (12+9)**

Semester – IV

Sr. No.	Course No.	Title of the Course	Credit Hours
1	FRT 4.4	Tropical and Subtropical Fruits	3(2+1)
2	FRT 4.5	Plantation Crops	3(2+1)
3	FRT 4.6	Breeding of Fruit and Plantation Crops	3(2+1)
4	VEG 4.4	Spices and Condiments	3(2+1)
5	FLA 4.3	Principles of Landscape Architecture	2(1+1)
6	PPT 4.4	Diseases of fruit, Plantation, Medicinal and Aromatic Crops	3(2+1)
7	PPT 4.5	Insect Pests of Fruit, Plantation, Medicinal & Aromatic Crops	3(2+1)
8	NRMH 4.6	Farm Power and Machinery	2(1+1)
9	NRMH 4.7	Soil, Water and Plant Analysis	2(1+1)
		Total	**24(15+9)**

Semester – V

Sr. No.	Course No.	Title of the Course	Credit Hours
1	FRT 5.7	Orchard and Estate Management	2(1+1)
2	FRT 5.8	Dry land Horticulture	2(1+1)
3	VEG 5.5	Potato and Tuber crops	2 (1+1)
4	VEG 5.6	Breeding of Vegetable, Tuber and Spice Crops	3 (2+1)
5	PHT 5.2	Postharvest Management of Horticultural Crops	3(2+1)
6	NRMH 5.8	Weed Management in Horticultural Crops	2 (1+1)
7	PPT 5.6	Diseases of Vegetables, Ornamentals and Spice Crops	3 (2+1)
8	PPT 5.7	Insect Pests of Vegetable, Ornamental and Spice Crops	3(2+1)
9	SSC 5.7	Fundamentals of Extension Education	2 (1+1)
		Total	**22 (13+9)**

Semester – VI

Sr. No.	Course No.	Title of the Course	Credit Hours
1	VEG 6.7	Seed production of Vegetable, Tuber and Spice Crops	3(2+1)
2	FLA 6.4	Breeding and Seed Production of Flower and Ornamental Plants	3(2+1)
3	FLA 6.5	Medicinal and Aromatic Crops	3 (2+1)
4	PHT 6.3	Processing of Horticultural Crops	3(1+2)
5	NRMH 6.9	Introduction to Major Field Crops	2 (1+1)
6	NRMH 6.10	Introductory Agroforestry	2 (1+1)
7	NRMH 6.11	Environmental Studies and Disaster Management	3(2+1)
8	PPT 6.8	Apiculture, Sericulture and Lac culture	2(1+1)
9	SSC 6.8	Horti-Business Management	2(2+0)
10	SSC 6.9	Entrepreneurship Development and Business Management	2(1+1)
		Total	**25 (15+10)**

Semester – VII

STUDENT READY-I (Seven semester)

I.Experimental Learning Programme:

Professional Packages Hands on Training /Experimental Learning Modules: Final year B.Sc. (Hons.) Horticulture students can select two modules under STUDENT READY-Experiential Learning programme depending on the facilities available at the college.

1. Protected cultivation of High Valued Horticultural Crops
2. Commercial production of Horticultural planting materials
3. Post Harvest Handling and Value addition in Horticultural crops
4. Floriculture and Landscape Architecture
5. Mass multiplication through tissue culture in horticultural crops
6. Bio fertilizers and bio pesticides

Batch of student can select two modules under STUDENT READY- Experiential Learning Programme depending on the facilities available at the college.

Student have to select any two modules from the below listed modules

Model No.	Course No.	Title	Credit
1	**HWE 7.1**	**Protected cultivation of High Valued Horticultural Crops**	**0 +10**
	HWE 7.1.1	Production of High Valued Crops	0+6
	HWE 7.1.2	Packing and Marketing of High valued Horticultural Crops	0+4
2	**HWE 7.2**	**Commercial production of Horticultural planting materials**	**0+10**
	HWE 7.2.1	Propagation and production of propagules	0+6
	HWE 7.2.2	Packing and Marketing of planting materials	0+4
3	**HWE 7.3**	**Post Harvest Handling and Value addition in Horticultural crops**	**0+10**
	HWE 7.3.1	Preparation and evaluation of processed products	0+6
	HWE 7.3.2	Packing and Marketing of processed products	0+4
4	**HWE 7.4**	**Floriculture and Landscape Architecture**	**0+10**
	HWE 7.4.1	Planning, Layout and Design of landscape	0+6
	HWE 7.4.1	Consultancy and maintenance of garden	0+4
5	**HWE 7.5**	**Mass multiplication through tissue culture in horticultural crops**	**0+10**
	HWE 7.5.1	Production of tissue culture plants	0+6
	HWE 7.5.2	Packing and Marketing of tissue culture plants	0+4
6	**HWE 7.6**	**Bio fertilizers and bio pesticides**	**0+10**
	HWE 7.6.1	Production technology of bio fertilizers and bio pesticides	0+6
	HWE 7.6.2	Packing and Marketing of bio fertilizers and bio pesticides	0+4

Evaluation system: Work performance - 40 marks, Report writing & presentation – 20 marks and Semester End exam - 40 marks

Semester – VIII

STUDENT READY-II

Rural Horticultural Work Experience Programme (0+20)

1. **Phase wise distribution of weeks**

Sr. No.	Details of Programme	Weeks
1.	Orientation phase	2
2.	Village stay/progressive farmer's field visit	3
3.	Educational tour	2
4.	SAU's of Gujarat visit	8
5.	Industrial/NGO visit	2
6.	Report writing, presentation and End Examination	3
	Total	**20 weeks**

2. Details of course title and credit hours

Course code and title : The title of course and code will be as given below

Sr. No.	Course No.	Title	Credit
1	RHWE 8.1	Visit to progressive farmer's field and NGO	0+2
2	RHWE 8.2	Educational tour	0+2
3	RHWE 8.3	University farms (JAU) and Visit to horticulture based industries of Saurashtra region	0+4
4	RHWE 8.4	University farms (AAU) and Visit to horticulture based industries of Middle Gujarat region	0+4
5	RHWE 8.5	University farms (SDAU) and Visit to horticulture based industries of North Gujarat region	0+4
6	RHWE 8.6	University farms (NAU) and Visit to horticulture based industries of South Gujarat region	0+4

Evaluation system : Work performance - 25 marks, Report writing & presentation – 25 marks and Semester End exam - 50 marks

: SYLLABUS :

FRUIT SCIENCE

Course No. : FRT. 1.1	Fundamentals of Horticulture	Credits : 3(2+1)

Theory:

Scope and importance, classification of horticultural crops and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery techniques and their management, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Production and practices for fruit, vegetable and floriculture crops. Principles objectives, types and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management– irrigation methods, merits and demerits, weed management, fertility management in horticultural crops-manures and fertilizers, different methods of application, cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits, Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness. Type of fruits- morphology. Principles of organic farming, market chain management.

Practical:

Features of orchard, planning and layout of orchard, tools and implements, identification of various horticultural crops, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits, assessment of bearing habits, maturity standards, harvesting, grading, packaging and storage.

Suggested Reading:

Prasad and Kumar, 2014. *Principles of Horticulture* 2nd Edn. Agrobios (India).

Neeraj Pratap Singh, 2005. *Basic concepts of Fruit Science* 1st Edn. IBDC Publishers.

Gardner/Bardford/Hooker. J.R., 1957. *Fundamentals of Fruit Production*. Mac Graw Hill Book Co., New York.

Edmond,J.B, Sen,T.L, Andrews,F.S and Halfacre R.G., 1963. *Fundamentals of Horticulture*. Tata Mc Graw Hill Publishing Co., New Delhi.

Kumar, N., 1990. *Introduction to Horticulture*. Rajyalakshmi publications, Nagarcoil, Tamilnadu

Jitendra Singh, 2002. *Basic Horticulture*. Kalyani Publishers, Hyderabad.

Denisen E.L.,1957. *Principles of Horticulture*. Macmillan Publishing Co., New York.

Chadha,K.L.(ICAR),2002,2001. *HandbookofHorticulture* . ICAR, NewDelhi

K.V.Peter, 2009. *Basics Horticulture.* New India Publishing Agency

Kausal Kumar Misra and Rajesh Kumar, 2014. *Fundamentals of Horticulture* Biotech Books.

D.K. Salunkhe and S.S. Kadam, 2013. *A handbook of Fruit Science and Technology*. CRC Press.

S. Prasad and U. Kumar, 2010. *A handbook of Fruit Production*. Agrobios (India).

Jitendra Singh, 2011. *Basic Horticulture*. Kalyani Publications, New Delhi.

Course No. : FRT. 2.2	Plant Propagation and Nursery Management	Credits : 2(1+1)

Theroy:

Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy types of dormancy (scarification & stratification) internal and external factors, nursery techniques nursery management, apomixes – mono-embrony, polyembrony, chimera& bud sport. Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, phytotrons nursery (tools and implements), use of growth regulators in seed, types and stages of seed germination with examples and vegetative propagation, methods and techniques of division-stolons, pseudobulbs, offsets, runners, cutting, layering, grafting, formation of graft union, factor affecting, healing of graftageand budding physiological & bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion wood stick, scion-stock relationship, and their influences, bud wood certification, techniques of propagation through specialized organs, corm, runners, suckers. Micrografting, meristem culture, callus culture, anther culture, organogenesis, somaclonal variation hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery, Cost of establishment of propagation structures.

Practical:

Media for propagation of plants in nursery beds, potting and repotting. Preparation of nursery beds and sowing of seeds. Raising of rootstock. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting. Hardening plants in the nursery. Practicing different types of cuttings, layering, graftings and buddings including opacity and grafting, top grafting and bridge grafting etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. Digging, labelling and packing of nursery fruit plants. Maintenance of nursery records. Use of different types of nursery tools and implements for general nursery and virus tested plant material in the nursery. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance. Nutrient and plant protection applications during nursery.

Suggested Reading:

Hudson T. Hartmann, Dale E. Kester, Fred T. Davies, Jr. and Robert L. Geneve. *Plant Propagation- Principles and Practices(7th Edition)*. PHI Learning Private Limited, New Delhi-110001

T.K.Bose, S.K.Mitra, M.K.Sadhu, P. Das and D.Sanyal. *Propagation of Tropical & Subtropical Horticultural Crops, Volume 1(3rd Revised edition)*. Naya Udyog, 206, Bidhan Sarani, Kolkata 700006.

Guy W. Adriance and Feed R. Brison. *Propagation of Horticultural Plants*. Axis Books (India).

S. Rajan and B. L. Markose (series editor Prof. K.V.Peter). *Propagation of Horticultural Crops- Horticulture Science Series vol.6.* New India Publishing Agency, Pitam Pura, New Delhi-110088.

Hartman,H.T and Kester,D.E.1976.*Plant Propagation Principles and practices*. Prentice hall of India Pvt.Ltd., Bombay.

Sadhu,M.K.1996. *Plant Propagation*. New age International Publishers, New Delhi.

Mukhergee,S.K. and Majumdar,P.K.1973.Propagation of fruit crops. ICAR, New Delhi.

Ganner,R.J. and Choudhri,S.A.1972.*Propagation of Tropical fruit trees*. Oxford and IBN publishing Co., New Delhi.

Sarma,R.R.2002. *Propagation of Horticultural Crops*.Kalyani Publishers,(Principles and practices) New Delhi.
Symmonds,1996. *Banana.II* edition Longman, London.
Chundawat,B.S. 1990.*Arid fruit culture*. Oxford and IBH, New Delhi.
Chadha,K.L. (ICAR)2002,2001.*Hand book of Horticulture*. ICAR, New Delhi.

Course No. : FRT 3.3	Temperate Fruit Crops	Credits : 2(1+1)

Theory:

Classification of temperate fruits, detailed study of areas, production, varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage of apple, pear, peach, apricot, plum, cherry, persimmon, strawberry, kiwi, Queens land nut (Mecademia nut), almond, walnut, pecan nut, hazel nut, chest nut and **pistachio nut**. Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures. Special production problems like alternate bearing problem and their remedies.

Practical:

Nursery management practices, description and identification of varieties of above crops, manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach and nut crops. Visit to private orchards to diagnose maladies. Working out economics for apple, pear, plum and peach.

Suggested Reading:

Chattopadhyay T.K.2009.*A text book on Pomology-IV Devoted to Temperate fruits*. Kalyani Publishers.B-1/292,Rajinder Nagar,Ludhiana-141008
Banday F.A. and Sharma M.K.2010.*Advances in Temperate Fruit Production*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.
Kaushal Kumar Misra.2014.*Text book of Advanced Pomology. Biotech Books.*4762-63, Ansari Road, Darya Ganj, New delhi-11002.
Das B.C and Das S.N .*Cultivation of Minor Fruits*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.
Pal J.S.2010. *Fruit Growing* .2010. Kalyani Publishers.B-1/292,Rajinder Nagar, Ludhiana-141008.
Mitra S.K, Rathore D.S and Bose T .K. 1992. *Temperate Fruit Crops. Horticulture and Allied* Publishers, Calcutta.
Chattopadhya, T.K. 2000. *A Text Book on Pomology (Temperate Fruits)* Vol. IV Kalyani Publishers, Hyderabad
Chadha, T.R, 2001. *Text Book of Temperate Fruits*. Indian Council of Agricultural Research, New Delhi.
David Jackson & N E Laone, 1999 *Subtropical and Temperate Fruit Production*. CABI, Publications.
W S Dhillon. 2013. *Fruit Production In India*. Narendra Publishing House. New Delhi

Course No. : FRT 4.4	Tropical and Sub-Tropical Fruits	Credits : 3(2+1)

Theroy:

Horticultural classification of fruits including genome classification. Horticultural zones of India, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds, special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops. Mango, banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael,ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola, durian, rambutan, bilimbi, loquat, rose apple breadfruit and passion fruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures. Seediness and kokkan disease in banana, citrus decline and casual factors and their management. Bud forecasting in grapes, sex expression and seed production in papaya, latex extraction and crude papain production, economic of production.

Practical:

Description and identification of varieties based on flower and fruit morphology in above crops. Training and pruning of grapes, mango, guava and citrus. Selection of site and planting system, pre-treatment of banana suckers, desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Visit to commercial orchards and diagnosis of maladies. Manure and fertilizer application including bio-fertilizer in fruit crops, preparation and application of growth regulators in banana, grapes and mango. Seed production in papaya, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits. Mapping of arid and semi-arid zones of India. Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, West Indian cherry, tamarind, aonla, bael and annona.

Suggested Reading:

H.P.Singh and M.M.Mustafa, 2009. *Banana*-new innovations. Westville PublishingHouse, New Delhi.

M.S.Ladaniya, 2013. *Citrus Fruits*. Elsevier, India post ltd.

Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. *Tropical and Sub-Tropical*-Vol-I. Naya udyog-Kolkata

Rajput, CBS and Srihari babu, R., 1985. *Citriculture*. Kalyani Publishers, New Delhi.

Chundawat, B.S., 1990. *Arid fruit culture*. Oxford and IBH, New Delhi.

Chadha,K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi.

Symmonds, 1996. *Banana*. II Edn. Longman, London.

Radha T and Mathew L., 2007. *Fruit crops*. New India Publishing Agency.

W S Dhillon, 2013. *Fruit Productionin India.* Narendra Publishing House, New Delhi

T.K.Chattopadhyay, 1997. *Text book on pomology*. Kalyani Publishers, New Delhi.

R.E.Litz, 2009. *The Mango* 2nd Edn. Cabi Publishing, Willingford, U.K.

K.L.Chadda, 2009. *Advanced in Horticulture*. Malhotra Publishing House, New Delhi.

S.P. Singh, 2004. *Commercial fruits.* Kalyani Publishers, New Delhi.

F.S. Davies and L.G.Albrigo, 2001. *Citrus*, Cab International.

Course No. : FRT 4.5	Plantation Crops	Credits : 3(2+1)

Theory:

History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by products utilization, soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea and rubber.

Practical:

Description and identification of coconut varieties, selection of coconut and arecanut mother palm and seed nut, planting of seed nuts in nursery, layout and planting of coconut, arecanut, oil palm, cashew nut, cacao gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao. Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee, epicotyl, softwood, grafting and top working in cashew, working out the economics and project preparation for coconut, arecanut, oil palm, cashew nut, cacao, etc. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea.

Suggested Reading:

Kumar, N.J.B. M. Md. Abdul Khaddar, Ranga Swamy, P. and Irrulappan, I. 1997. *Introduction to spices, Plantation crops and Aromatic plants*. Oxford & IBH, New Delhi.

Thampan, P.K. 1981.*Hand Book of Coconut Palm*. Oxford IBH, New Delhi.

Nair 1979. *Cashew*. CPCRI, Kerala

Wood, GAR, 1975. *Cacao*. Longmen, London

Ranganadhan, V. 1979. *Hand Book of Tea Cultivation*. UPASI Tea Research Station, Cinchona.

Thompson, P.K. 1980. *Coconut.* Oxford & IBH Publishing Co. Ltd., New Delhi.

Course No. : FRT 4.6	Breeding of Fruit and Plantation Crops	Credits : 3(2+1)

Theory:

Fruit breeding - History, importance in fruit production, distribution, domestication and adaptation of commercially important fruits, variability for economic traits, breeding strategies, clonal selection, bud mutations, mutagenesis and its application in crop improvement – policy manipulations – *in vitro* breeding tools (important fruit and plantation crops).

Practical:

Exercises on floral biology, pollen viability; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy in major crops like Mango, Banana, Citrus, Grapes, Guava, Sapota, Papaya, Custard apple, Aonla, Ber, Litchi, Pomegranate, Jamun, Arecanut, Coconut, Pistchonut, Apple, Pear, Plum, Peach, Apricot and Strawberry.

Suggested Reading:

Nijar 1985.*Fruit breeding in India*,Oxford & IBH Publishing Co. New Delhi

Anil Kumar Shukla 2004. *Fruit breeding approaches & Achievements*. International Book Distributing Co. New Delhi.
Kumar, N. 1997. *Breeding of Horticultural Crops, Principles and Practices*. New India Publishing Agency, New Delhi.
Singh, B.D. 1983.*Plant Breeding Principles and methods*. Kalyani Publishers, New Delhi.

Course No. : FRT 5.7	Orchard and Estate Management	Credits : 2(1+1)

Theroy:

Orchard & estate management, importance, objectives, merits and demerits, clean cultivation, sod culture, Sod mulch, herbicides and inorganic and organic mulches. Tropical, sub-tropical and temperate horticultural systems, competitive and complimentary effect of root and shoot systems. Biological efficiency of cropping systems in horticulture, systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties. Factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, Integrated nutrient and pest management. Utilization of resources constraints in existing systems. Crop model and crop regulation in relation to cropping systems. Climate aberrations and mitigation measures of Horticultural crops.

Practical:

Layout of different systems of orchard and estate, soil management, clean, inter, cover and mixed cropping, fillers. Use of mulch materials, organic and inorganic, moisture conservation, weed control. Layout of various irrigation systems.

Suggested Reading:

Kumar, 1990. *Introduction to Horticulture crops*. Rajyalakshmi Publications, Nagercoil, Tamilnadu.
Palaniappan, S.P. and Sivaraman, K. 1996. *Cropping systems in the Tropics*. New age International (P) Ltd., Publishers, New Delhi.
Shanmugavelu, K.G.1989. *Production Technology of Fruit Crops*. Oxford & IBH Publishing Co. Pvt.Ltd., New Delhi.
WS. Dhillon and Bhatt. 2011. *Fruit Tree Physiology*. Narendra Publishing House, New Delhi.
B .C. Mazumdar. 2004. *Principles and Methods of Orchard Establishment*. Daya Publishing House, New Delhi.
T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008. *Management of Horticultural Crops*. New India Publishing Agency, New Delhi.
B .C. Mazumdar. 2004. *Orchard Irrigation and Soil Management Practices* Daya Publishing Agency, New Delhi. Daya Publishing Agency, New Delhi.

Course No. : FRT 5.8	Dry land Horticulture	Credits : 2(1+1)

Theory:

Definition, importance and limitation of dry land horticulture, present status and future scope. Constraints encounter in dry lands. Agro-climatic features in rain shadow areas, scarse water resources, high temperature, soil erosion, run-off losses etc. Techniques and management of dry land horticulture. watershed development, soil and water conservation methods-terraces, contour bunds,etc. Methods of control and impounding of run-off water-farm ponds, trenches, macro catch pitsetc.,*in-situ* water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, antitranspirants, growth regulators, etc. water use efficiency-need

based, economic and conjunctive use of water, micro systems of irrigation etc. Selection of plants having drought resistance. Special techniques, planting and after care-use of seedling races, root stocks, *in-situ* grafting, deep pitting/planting, canopy management etc. Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

Practical:

Study of rainfall patterns. Contour bunding/trenching, micro catchments, soil erosion and its control. Study of evapotranspiration, mulches and micro irrigation systems. Special techniques of planting and aftercare in dry lands. Study of morphological and anatomical features of drought tolerant fruit crops.

Suggested reading:

Chundawat, B.S. 1990. *Arid Fruit Culture*. Oxford and IBH, New Delhi.

P.L. Taroj, B.B. Vashishtha, D.G.Dhandar. 2004. *Advances in Arid Horticulture*. Internal Book Distributing Co., Lucknow.

T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Sathesan. 2008. *Management of Horticultural Crops*. New India Publishing Agency.

VEGETABLE SCIENCE

Course No.: VEG 1.1	Tropical and Sub-tropical Vegetable crops	Credits : 3 (2+1)

Theory:

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting of vegetable crops and planting for directly sown/transplanted vegetable crops. Spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, harvest, yield. Economic of cultivation of tropical and sub-tropical vegetable crops; post-harvest handling and storage. Marketing of tomato, brinjal, chillies, capsicum, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, portulaca, basella, sorrel and roselle.

Practical:

Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation. Field visit to commercial farms.

Suggested Reading:

S. Thamburaj, 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi

B.R.Choudhary, 2009.*AText book on production technology of vegetables*. Kalyani Publishers. Ludhiana.

T.K.Bose, 2002.*Vegetable Crops*. Nayaprakash. Kolkata

P.Hazra, 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.

T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.

K.V.Kamath, 2007.*Vegetable Crop Production*. Oxford Book Company. Jaipur

M.S.Dhaliwal, 2008. *Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana

Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.

K S Yawalkar, 2008. *Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur. 2004
M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana
P.Hazra, 2006.*Vegetable science*. Kalyani Publishers. Ludhiana
Pratibha Sharma, 2007.*Vegetables : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur
Uma Shankar,2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.
Nath Prem, 1994.*Vegetables for the Tropical Regions*. ICAR New Delhi
K.L.Chadha, 1993. *Advances in Horticulture*. Malhotra publishing house. New Delhi
Shanmugavelu, K.G., 1989. *Production Technology of Vegetable Crops*. Oxford &IBH Publishing Co. Pvt. Ltd, New Delhi.
Choudhury, B. (ICAR). 1990. Vegetables. 8th edition, National Book Trust, New Delhi.
Singh, D.K., 2007. *Modern Vegetable varieties and production*. IBN publishers, Technology International Book Distributing Co, Lucknow.
Premnath, Sundari Velayudhan and Singh, D.P., 1987. *Vegetables for the tropical region*. ICAR, New Delhi.

Course No.: VEG 3.2	**Temperate Vegetable Crops**	**Credits: 2 (1+1)**

Theory:

Importance of cool season vegetable crops in nutrition and national economy. Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology. Marketing of cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels' sprout, Kale, lettuce, palak, Chinese cabbage, spinach, garlic, onion, leek, radish, carrot, turnip, beet root, peas, broad beans, rhubarb, asparagus, globe artichoke.

Practical:

Identification and description of varieties/hybrids; propagation methods, nursery management; preparation of field, sowing/transplanting; identification of physiological and nutritional disorders and their corrections; post-harvest handling; cost of cultivation and field visits to commercial farms. Field visit to commercial farms.

Suggested Reading:

S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.
B.R.Choudhary 2009.*AText book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
T.K.Bose. 2002.*Vegetable Crops*. Nayaprakash. Kolkata
P.Hazra. 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.
K.V.Kamath. 2007.*Vegetable Crop Production*. Oxford Book Company. Jaipur
M.S.Dhaliwal, 2008.*Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana
Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.
K S Yawalkar, 2004.*Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur.
M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana
P.Hazra. 2006.*Vegetable science*. Kalyani Publishers .Ludhiana
Pratibha Sharma, 2007. *Vegetables : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur
Uma Shankar. 2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.
Nath Prem. 1994.*Vegetables for the Tropical Regions*. ICAR New Delhi
K.L.Chadha. 1993.*Advances in Horticulture*. Malhotra publishing house. New Delhi

Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.
Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.
Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.

Course No.: VEG 3.3	Precision Farming and Protected Cultivation	Credits: 3(2+1)

Theory:

Precision farming– laser leveling, mechanized direct seed sowing; seedling and sapling transplanting, mapping of soils and plant attributes, site specific input application, weed management, insect pests and disease management, Good Agricultural Practices in precision farming, yield mapping in horticultural crops. Green house technology, Introduction, Types of Green Houses; Plant response to Greenhouse environment, planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Green house equipments, materials of construction for traditional and low cost greenhouses. Irrigation systems used in greenhouses, Typical applications. Passive solar greenhouse, Temperature Control Mechanism- heating and cooling systems, High–tech nursery raising, Choice of crops for cultivation under greenhouses: tomato, capsicum, cucumber, melons. Problems/constraints of green house cultivation and future strategies. Growing media, soil culture, Selection Criteria for soil media, soil pasteurization. Peat moss and mixtures, rock wool and other inert media for soilless culture, nutrient film technique (NFT)/ hydroponics. Cost estimation and economic analysis.

Practical:

Study of different types of greenhouses based on shape, construction and cladding materials; Calculation of air exchange rate in a greenhouse; Estimation of drying rate of agricultural products inside greenhouse; Testing of soil and water to study its suitability for growing crops in greenhouses; The study of fertigation requirements for greenhouse crops and estimation of E.C. in the fertigation solution; The study of various growing media used in greenhouse crops and their preparation and pasteurization/sterilization. Visit to commercial greenhouses. Economics of protected cultivation.

Suggested Reading:

Balraj Singh. 2006. *Protected cultivation of vegetable crops*. Kalyani Publishers, Ludhiana.
Brahma Singh, 2014.*Advances in Protected Cultivation*. New India Publishing Agency. New Delhi.
Reddy P. Parvatha, 2003. *Protected Cultivation*. Springer Publications. USA.
Reddy**,** P. Parvatha. 2011. *Sustainable crop protection under Protected Cultivation*. Springer Publications. USA.
Jitendra Singh, 2015.*Precision Farming in Horticulture*. New India Publishing Agency. New Delhi.
Prasad S. 2005. *Greenhouse Management for Horticultural Crops*. Agrobios. Jodhpur.
Jitendra Singh, S.K. Jain, L.K. Dashora, B.S. Cundawat.2013. *Precision forming in Horticulture*. New India Publishing Agency, New Delhi.
T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008. *Management of Horticultural crops*. New India Publishing Agency, New Delhi.
Aldrich RA & Bartok JW. 1994. NRAES,Riley, Robb Hall. *Green House Engineering*. Cornell University, Ithaca, New York.
Pant V Nelson. 1991.*Green House Operation and Management*. Bali Publ

Course No. : VEG 4.4	Spices and Condiments	Credits : 3 (2+1)

Theory:

History, scope and importance, Present status, area and production, uses, export potential and role in national economy. Classification, soil and climate, propagation-seed, vegetative and micro-propagation systems and methods of planting. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation. Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction of essential oil and oleoresins. Economics of cultivation, role of Spice Board and Pepper Export Promotion Council, institutions and research centers in R&D. Crops: Cardamom, pepper, ginger, turmeric, clove, nutmeg, cinnamon, all spice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, saffron, vanilla, thyme and rosemary.

Practical:

Identification of varieties: propagation, seed treatment – sowing; layout, planting; hoeing and earthing up; manuring and use of weedicides, training and pruning; fixing maturity standards, harvesting, curing, processing, grading and extraction of essential oils and oleoresins. Visit to commercial plantations.

Suggested Reading:

Shanmugavelu, K.G. Kumar, N and Peter, K.V., 2005. *Production technology of spices and plantation crops*. . Agrosis, Jodhpur

Shanmugavelu, K.G. and Madhava Rao, 1977. *Spices and Plantation Crops*. Madras Popular Book Depot.

Kumar, N. J.B. M. Md. Abdul khaddar, Ranga Swamy, P. and Irulappan, I., 1997. *Introduction to Spices, Plantation Crops, and aromatic crops*. Oxford & IBH, New Delhi.

Pruthi, J.S., 1980. *Spices and Condiments*. Academic Press, New York.

Pruthi, J.S., 1993. *Major Spices of India- Crop Management Postharvest Technology*. ICAR, New Delhi.

Pruthi, J.S., 2001. *Minor Spices and Condiments-Crop ManagementPost Harvest Technology.* ICAR, New Delhi.

Purseglove, Brown, E.G. Green, G.Z. Robbins, S.R.J. London, Longman, 1981. *Spices* Vol.I & II.

Course No.: VEG 5.5	Potato and Tuber crops	Credits : 2 (1+1)

Theory:

Origin, area, production, economic importance and export potential of potato and tropical, sub-tropical and temperate tuber crops; description of varieties and hybrids. Climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems. Harvesting practices yield; economic of cultivation. Post-harvest handling and storage, marketing. Crops to be covered-potato, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke, horse radish and other under exploited tuber crops.

Practical:

Identification and description of potato and tropical, sub-tropical and temperate tuber crops; planting systems and practices; field preparation and sowing/planting. Top dressing of fertilizers and interculture and use of herbicides and growth regulators; identification of nutrient deficiencies, physiological disorders; harvest indices and maturity standards, post-harvest handling and storage, marketing. Seed collection, working out cost of cultivation, project preparation of commercial cultivation.

Suggested reading:

S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.
B.R.Choudhary 2009.*AText book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
T.K.Bose. 2002.*Vegetable Crops*. Nayaprakash. Kolkata
P.Hazra. 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.
K.V.Kamath. 2007.*Vegetable Crop Production*. Oxford Book Company. Jaipur
M.S.Dhaliwal, 2008.*Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana
Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.
K S Yawalkar, 2004.*Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur.
M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana
P.Hazra. 2006.*Vegetable science*. Kalyani Publishers .Ludhiana
Pratibha Sharma, 2007.*Vegetables : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur
Uma Shankar. 2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.
Nath Prem. 1994.*Vegetables for the Tropical Regions*. ICAR New Delhi
K.L.Chadha. 1993.*Advances in Horticulture*. Malhotra publishing house. New Delhi
Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.
Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.
Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.
Vincent Lebot, 2008.*Tropical roots and tuber crops*. CAVI.
J.E. Bradashaw, 2010. Root and tuber crops. Springer Publications.

Course No.: VEG 5.6	**Breeding of Vegetable, Tuber and Spice Crops**	**Credits : 3 (2+1)**

Theory:

Vegetable Breeding- History and importance of vegetables, tubers and spices production, distribution, domestication and adaptation of commercially important vegetables, tubers and spices, variability for economic traits, breeding strategies, clonal selection, mutation, mutagenesis and its application in crop improvement-ploidy manipulations-*in vitro* breeding tools (important vegetables, tubers and spices crops). Centres of origin, plant bio-diversity and its conservation. Models of reproduction, pollination systems and genetics of important vegetable, tuber and spice crops. Self-incompatibility and male sterility, its classification and application in vegetable crop improvement. Principles of breeding self-pollinated crops, pure line selection, mass selection, heterosis breeding, hybridization, pedigree method, mass pedigree method, bulk method, modified bulk method, single seed descent method and back cross method. Polyploidy breeding. Mutation breeding. Principles of breeding cross pollinated crops, mass selection, recurrent selection, heterosis breeding, synthetics and composits. Application of biotechnology in crop improvement. Crops: Solanaceous vegetables, cole crops, cucurbits, bulb crops, root crops, leafy vegetables, okra, leguminous crops, Seed Spices**.**

Practical:

Floral biology and pollination mechanism in self and cross pollinated vegetables, tuber crops and spices. Working out phenotypic and genotypic heritability, genetic advance. GCA, SCA, combining ability, heterosis, heterobeltosis, standard heterosis, GxE interactions

(stability analysis) Preparation and uses of chemical and physical mutagens. Polyploidy breeding and chromosomal studies. Techniques of F1 hybrid seed production. Maintenance of breeding records.

Suggested Reading:

Hari Hara Ram, 2013.*Vegetable Breeding: Principle and Practices*. Kalyani Publishers. Ludhiana.

Vishnu Swaroop, 2014. *Vegetable Science &Technology in India*. Kalyani Publishers. Ludhiana.

Kallo.G, 1998. *Vegetable Breeding (Vol.I to IV).* CRC Press. Florida. 1988.

H.P. Singh, 2009.*Vegetable Varieties of India*. Studium Press (India) Pvt Ltd. New Delhi.

M.S. Dhaliwal.2012. *Techniques of Developing Hybrids in Vegetable Crops*.Agrobios. Jodhpur.

P.K.Singh, 2005. *Hybrid Vegetable Development*. CRC Press. Florida.

M.S.Dhaliwal, 2009. *Vegetable Seed Production & Hybrid Technology*. Kalyani Publishers. Ludhiana.

Fageria, M.S., 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani Publishers, Ludhiana.

Course No.: VEG 6.7	**Seed Production of Vegetable, Tuber and Spice Crops**	**Credits: 3 (2+1)**

Theory:

Introduction and history of seed industry in India. Definition of seed. Differences between grain and seed. Importance and scope of vegetable seed production in India. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production. Methods of seed production of cole crops, root vegetables, solanaceous vegetables, cucurbits, leafy vegetables, bulb crops, leguminous vegetables, Tuber crops, Spice Crops and exotic vegetables. Seed germination and purity analysis. Field and seed standards. Seed drying and extraction. Seed legislation.

Practical:

Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Seed processing machines. Visit to seed production units.

Suggested Reading:

G.N. Kulkarni, 2002. *Principles of Seed Technology*. Kalyani Publishers, Ludhiana.

L.O. Copeland, 1999. *Principles of Seed Science and Technology*. Springer Publications.

N.P. Nema, 1988. *Principles of seed certification and Testing*. Allied Publications.

P. Hazra and M.G. Som, 2009. *Vegetable seed production and Hybrid Technology*. Kalyani Publishers, Ludhiana.

Agarwal, P. K. 2010. *Techniques in Seed Science and Technology*. South Asian Publishers. New Delhi.

Agrawal R. L. 1999. *Seed Technology*. Oxford and IBH Publicity Company, New Delhi.

Arya, Prem Singh. 2003. *Vegetable seed Production Principles*. Kalyani Publishers. Ludhiana.

Fageria, M. S. 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani Publishers. Ludhiana.

Geetharani, P. 2007. *Seed Technology in Horticultural Crops*. NPH Publications. Jodhpur.

Singh, S.P. 2001. *Seed Production in Commercial Vegetables*. Agrotech Publishing Academy, Udaipur.

Vanangamudi, K.2010. *Vegetable Hybrid Seed Production and Management*. Agrobios. Jodhpur.

Singh, Prabhakar.2015.*Seed Production Technology of vegetable*. Daya Publishing House. New Delhi.
Raymond A.T., 2000. *Vegetable Seed Production*. Oxford University Press, USA
Prem Singh Arya, 2003. *Vegetable breeding, production and seed production*. Kalyani publishers, New Delhi.
Rattan lal Agarwal, 1995. *Seed technology*. Oxford & IBH, New Delhi
Singh, S.P. 2001. 1st edition, *Seed production of commercial vegetables*. Agrotech Publishing, Udaipur
Vanangamudi, K. 2006. Natarajan, P. Srimathi, N.Natarajan, T. Saravanan, M. Bhaskaran, A. Bharathi, P. Nateshan, K. Malarkodi. *Advances in Seed Science*. Agrobios (India), Jodhpur.
Nemgal Singh, P.K. Singh, Y.K. Singh and Virendra kumar, 2006. *Vegetable Seed Production Technology*. International book distributing co., Lucknow.

Khare, D. and Bhole, M.S. 2000. *Seed Technology*. Scientific Publishers (India) Jodhpur.

FLORICULTURE & LANDSCAPE ARCHITECTURE

Course No.: FLA 2.1	**Ornamental Horticulture**	**Credits : 2 (1+1)**

Theory:

History, definitions, scope and importance of ornamental horticulture, aesthetic values, Floriculture industry, area and production, industrial importance of ornamental plants and flowers. Classification, design values and general cultivation aspects for ornamental plants *viz*. Annuals, biennales herbaceous perennials, grasses and bulbous ornamentals. shrubs, climbers, trees, indoor plants, palms and cycads, ferns and sellagenellas, cacti and succulents, Importance, design and establishment of garden features/components viz. hedge, edge, borders, flower beds, bridges, paths, drives, fences, garden walls, gates, carpet bed, arbour, Patio, decking, retaining walls, shade garden, sunken garden, roof garden, terrace garden, pebble garden, rockery, pools, waterfalls, fountains, bog garden, avenue planting and children garden. Lawn types, establishment and maintenance. Importance of Garden adornments viz. floral clock, bird bath, statutes, sculptures, lanterns, water basins, garden benches etc.. Importance of flower arrangement, Ikebana, techniques, types, suitable flowers and cut foliage, importance and application vertical garden, bottle garden, terrariums, art of making bonsai, culture of bonsai and maintenance.

Practical:

Identification and description of annuals, herbaceous, perennials, climbers, creepers, foliage flowering shrubs, trees, palms, ferns, ornamental grasses; cacti succulents. Planning and designing gardens, layout of location of components of garden study, functional uses of plants in the landscape. Planning design of house garden, roadside planting, avenues for new colonies, traffic islands, preparation of land for lawn and planting. Description and design of garden structures, layout of rockery, water garden, terrace garden, and Japanese gardens, recreational and children's corner. Layout of terrarium, traffic islands, bottle garden, dish garden. Flower arrangement, bonsai practicing and training. Visit to nearby gardens. Identification and description of species/varieties of jasmine, chrysanthemum, marigold, dahlia, gladiolus, carnation, aster and their important inter-culture practices.

Suggested Reading:

Bose, T. K. and Chowdhury, B. 1991.Tropical Garden Plants in colour .Horticulture and allied publishers, 3D Madhab Chatterjee street Kolkata.
K.V.Peter.2009.Ornamental plants. New India publishing agency, Pitampura, New Delhi.

Richard Bird. 2002. Flowering trees and shrubs. Printed in Singapore by Star Standard Industries pvt. Ltd.
Bimaldas Chowdhury and Balai Lal Jana.2014.Flowering Garden trees. Pointer publishers, Jaipur. India.
Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana
Randhawa, G.S. Amitabha Mukhopadhyay, 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.
Bose, T.K. Mukherjee, D. 2004. Gardening in India. Oxford & IBH Publishers.
Chadha, K.L. and Chaudhary, B. 1986. Ornamental Horticulture in India. Publication and Informationdivision. ICAR,NewDelhi.

Course No.: FLA 3.2	Commercial Floriculture	Credits : 3 (2+1)

Theory:

Scope and importance of commercial floriculture in India, production techniques of commercial flower crops like rose, marigold, chrysanthemum, orchid, carnation, gladiolus, Spider lily, jasmine, crossandra, anthurium, dahlia, tuberose, bird of paradise, china aster and gerbera for domestic and export market, production techniques of major cut flowers, foliage and filler materials under protected environments such as glass house, Poly house etc., postharvest technology of cut flowers in respect of commercial flower crops, Techniques of flower drying, production techniques for bulbous crops.

Practical:

Identification of commercially important floricultural crops. Propagation practices in chrysanthemum, sowing of seeds and raising of seedlings of annuals. Propagation by cutting, layering, budding and grafting. Crop specific practices like pinching, disbudding, stacking, bud netting, training and pruning in different crops. Use of chemicals and other compounds for prolonging the vase life of cut flowers. Drying and preservation of flowers. Flower arrangement practices.

Suggested Reading:

A.K.Singh.2006.*Flower crops, cultivation and management*. New India publishing agency, Pitampura, New Delhi.
T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy.2003.*Commercial flowers.* Partha Sankar Basu, Nayaudyog,206, Bidhan Sarani, Kolkata-700006
S.K. Bhattacharjee and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.
Dewasish Choudhary and Amal Mehta. 2010. *Flower crops cultivation and management*. Oxford book company Jaipur, India.
Randhawa, G.S. Amitabha Mukhopadhyay, 2004. Floriculture in India. Allied Publishers Pvt. Ltd:
Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana - 141 008.
Prof. Bhattacharjee, S.K. Advanced Commercial Floriculture. Aavishkar Publishers Distributors, Jaipur - 320 003
Prof. V.L. Sheela, 2008. Flower for trade . New India Publishing Agency, Pitampura, New Delhi-110088.

Course No.: FLA 4.3	Principles of Landscape Architecture	Credits: 2 (1 +1)

Theory:

Historical Importance of Indian gardens, Gardens of ancient world, Definitions, Famous gardens of India and abroad, formal, informal, free style and wild gardens, basic themes of gardens viz. circular, rectangular and diagonal themes, Steps in preparation of garden design. Use of Auto CAD and Arch CAD in designing gardens. Factors affecting landscape design viz. intial approach, view, human choice, simplicity, topography etc., Principles of Landscape gardens viz. Axis, rhythm, balance, time and light, space, texture, form, mass effect, focal point, mobility, emphasis, unity and harmony etc.. Elements of landscape gardens viz. tangible and intangible elements. Bio-aesthetic planning, definition, objectives, Planning and designing of home gardens, colonies, country planning, urban landscape, Development of institutional gardens, planning and planting of avenues, public parks, beautifying schools, railway lines, railway stations, factories, bus stands, air ports corporate buildings, dams, hydro electric stations, river banks, play grounds, Gardens for places of religious importance viz. temples, churches, mosques, tombs etc, Importance, features and establishment of English garden , Japanese gardens , Mughal, gardens, French and Persian garden, Italian gardens, Hindu gardens and Buddhist gardens, Xeriscaping, definition, principles and practice.

Practical:

Study of garden layout, components and equipments. Study of Graphic language, Use of drawing equipments, graphic symbols and notations in landscaping designing, Study and designing of different styles of gardens, Study and designing of gardens based on different themes, Designing gardens using graphical drafting on paper, Auto-cad/ archi-cad, Designing gardens for home, traffic islands, schools and colleges, public buildings, factories, railway stations, air ports, temples, churches, play grounds, corporate buildings/ malls. Designing and planting of avenues for state and National highways, Design and establishment of Japanese, English and Mughal gardens. Visit to public, Industrial institutional and botanical gardens.

Suggested Reading:

A.K. Tiwari and R. Kumar. 2012. *Fundamentals of ornamental horticulture and landscape gardening*. New India.

H.S.Grewal and Parminder Singh. 2014. *Landscape designing and ornamental plants*

R.K. Roy. *Fundamentals of Garden designing*.2013.New India publishing agency, Pitampura, New Delhi.

Rajesh Srivastava. 2014. *Fundamentals of Garden designing*. Agrotech press, Jaipur, New Delhi.

L.C. De. *Nursery and landscaping*.2013. Pointer publishers, Jaipur India.

Bose, T.K. Malti, R.G. Dhua, R.S. & Das, P. 2004. Nayaprakash, Calcutta. Floriculture and Landscaping

Arora, J.S. 2006. Kalyani publishers, Ludhiana. Introductory Ornamental Horticulture. Kalyani publishers, Ludhiana.

Randhawa, G.S. and Amitabha Mukhopadhyay 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.

Course No.: FLA 6.4	Breeding and Seed Production of Flower and Ornamental Crops	Credits : 3 (2+1)

Theory:

History of improvements of ornamental plants, Centre of origin of flower crops and ornamental crops, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for Major Ornamental flower crops *viz.* rose, chrysanthemum, gladiolus, tuberose, jasmine, marigold, crossandra, dahlia, lilium, gerbera, petunia, pansy, china aster, orchids, carnation, antirrhinum, hibiscus, bougainvillea and annuals.. Breeding for disease resistance. Development of promising cultivars of important ornamentals and flower crops. Role of heterosis and its exploitation, production of F1 hybrids and utilization of male sterility, production of open pollinated seed. Harvesting processing and storage of seeds, seed certification.

Practical:

Study of floral biology of commercial flower crops and annuals and pollination in important species and cultivars. Techniques of inducing polyploidy and mutation. Production of pure and hybrid seeds. Harvesting, conditioning and testing of seeds. Practice in seed production methods.

Suggested Reading:

De. L. C. and Bhattacharjee, S. K. 2011. Ornamental crop breeding. Aavishkar Publishers, Distributors, Jaipur.

B.P. Pal. *The Rose in India*.1966.Directorate of Knowledge management in Agriculture, Indian council of Agriculture Research-New Delhi.

T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy. 2003. *Commercial flowers.* Partha Sankar Basu, Nayaudyog, 206, Bidhan Sarani, Kolkata-700006.

S.K. Bhattacharjee and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.

D.J. Callaway and M.B. Callaway. 2000. Breeding Ornamental Plants. Timber Press

J. Harding, F.Singh and J.N. Mol. 1991. Genetics and Breeding of Ornamental Species. Springer Publishers

A. Vainstein. 2002. Breeding for Ornamental: Classical and Molecular Approaches. Springer Publishers

Singh,B.D. 1983. BreedingPrinciplesandMethods. KalyaniPublishers,NewDelhi.

R.L. Agarwal. 1996. Seed Technology. Oxford&IBHPublishers, New Delhi

P.K. Agarwal. 1994. Principles of Seed Technology. ICAR Publication, NewDelhi

Course No. : FLA 6.5	Medicinal and Aromatic Crops	Credits : 3 (2+1)

Theory:

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants. Therapeutic and pharmaceutical uses of important species. Methods of oil extraction**,**Storage techniques of essential oils. Medicinal Plants: *Withania*, periwinkle, Rauvolfia, Dioscorea, Isabgol, opium poppy *Ammi majus*, Belladonna, Cinchona, Pyrethrum and other species relevant to

local conditions. Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, menthe, musk, ocimum and other species relevant to the local conditions. Marketing.

Practical:

Collection of medicinal and aromatic plants from their natural habitat and study their morphological description, nursery techniques, harvesting, curing and processing techniques and extraction of essential oils.

Suggested Reading:

Chadha, K.L. ICAR, 2001. Hand Book of Horticulture. Directorate of Information and Publications of Agriculture, Pusa, New Delhi.

Azhar Ali Farooqui and Sreeramu, B.S. 2001. Cultivation of medicinal and aromatic plants. United Press Limited.

Atal, E.K. and Kapur, B. 1982. Cultivation and Utilization of Medicinal and Aromatic plants. CSIR, New Delhi.

Kumar, N. J.B.M. Md. Abdul Khaddar, Ranga Swamy, P. and Irulappan, I. 1997. Introduction to Spices, Plantation Crops Medicinal and Aromatic Plants.Oxford & IBH, New Delhi.

Jain, S.K. 1968. Medicinal Plants .National Book Trust New Delhi. Oxford & IBH, New Delhi.

Dastur, J.F. 1982. Medicinal plants of India Pakistan Taraprevala soms and co-private Ltd, Bombay.

POST HARVEST TECHNOLOGY

Course No.: PHT- 1.1	**FUNDAMENTALS OF FOOD AND NUTRITION**	**Credits : 2(1+1)**

Theory:

Food and its function, physico-chemical properties of foods, food preparation techniques.Nutrition, relation of nutrition to good health. Energy: definition, determination of energy requirements, food energy and total energy needs of the body. Carbohydrates: functions, source, requirements, digestion, absorption and utilization. Protein: functions, sources, requirements, digestion, absorption, essential and non-essential amino acids, quality of proteins, PER/NPR/NPU, supplementary value of proteins and deficiency. Lipids: functions, sources, requirements, digestion, absorption and utilization, saturated and unsaturated fatty acids, deficiency. Mineral nutrition: macro and micro-minerals, function, utilization, requirements, sources, effects of deficiency. Vitamins (of water soluble and fat-soluble vitamins): functions, sources, effects of deficiency, requirements. Balanced diet: recommended dietary allowances for various age groups, common disorders associated due to malnutrition in population. Food Additives, adulterants and contaminants.

Practical:

Acquaintance with equipments used in food technology, Methods of measuring food ingredients, effect of cooking on volume and weight, determination of percentage of edible portion. Browning reactions of fruits and vegetables. Microscopic examination of starches, estimation of energy value, protein and fats content of foods. Identification of contaminants in food.

Suggested Readings:

Manay, N. Shakuntala and Shadaksharaswamy, M. *Foods: Facts & Principles,* New Age International (P) Limited Publishers, New Delhi.

Mudambi, Sumati R. and Rajagopal, M.V. *Fundamentals of Foods & Nutrition, Third Edition,* New Age International (P) Limited Publishers, New Delhi.
Potter, Norman N. and Hotchkiss, Joseph H. *Food Science, Fifth Edition*, CBS Publishers & Distributors, New Delhi.
Dev Raj, Rakesh Sharma and Patel, N. L. (2016). Handbook of Food Science and technology. Vol 1 Chemistry and Safety. *Studium Press (India) Pvt Ltd New Delhi 110002* 542p.
Dev Raj, Sharma R and Joshi VK 2011. Quality control for value addition in food processing. New India Publishing Agency, New Delhi, pp 324.
Dev Raj 2011. Food Science and Technology: Glossary of preeminence. New India Publishing Agency, New Delhi, pp 388.
Dev Raj 2012. Post Harvest Technology and Engineering: An Illustrated Guide. New India Publishing Agency, New Delhi, pp 302.
Dev Raj, Patel, J. M. and Patel, N. L. (2012). *Practical Manual on Fundamentals of Food Technology*. ACHF, NAU, Navsari, 76p.

Course No.: PHT- 5.2	**POST HARVEST MANAGEMENT OF HORTICULTURAL CROPS**	**Credits : 3(2+1)**

Theory:

Importance & scope of post-harvest management of horticultural crops in India. Structure of fruits, vegetables and cut flowers related to physiological changes after harvest. Maturity indices, harvesting, pre cooling, sorting and grading of fruit, vegetables, cut flowers, plantation crops, spices, medicinal and aromatic plants. Pre-harvest factors affecting quality. Factors responsible for deterioration of horticultural produce. Quality parameters and specification. Physiological and bio-chemical changes during ripening. Hastening and delaying ripening process. Pre and Post harvest treatments of Horticultural crop viz. pre harvest sprays, curing, degreening, pre cooling, waxing, fumigation, irradiations, HWT, VHT, etc. Different systems/methods of storage including cold storage, CA & MA storage, low cost cooling structures, etc. Packaging methods (vacuum packaging, poly shrink packaging, grape guard packing), types of packages and recent advances in packaging. Types of containers and cushioning materials. Transportation of fresh horticultural produce to local and distant market.

Practical:

Identification of various equipment for the post-harvest management of horticultural crops. Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Sorting and grading of horticultural produce. Post-harvest treatments of horticultural crops: physical and chemical methods. Identification of various packaging materials and packaging studies in fruits, vegetables and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce. Identification of storage pests and diseases in horticultural crops. Visit to markets, pack houses and cold storage units.

Suggested Readings:

S. K. Mitra. Post Harvest Physiology and storage of tropical and subtropical fruits, CABI Publishing.
Saraswathy,S., Preethi,T.L., Balasubramanyan, S., Suresh, J., Revathy, N. and Natarajan, S. 2008. *Post Harvest Management of Horticultural Crops,* Agribios (India), Jodhpur.
Thompson, A.K. *Post Harvest Technology of fruits and vegetables*, Blackwell Science.
Wills, R.B.H., McGlasson, W.B., Graham, D., Lee, T.H. and Hall, E.G. 1996. *Post Harvest: An Introduction to the Physiology and Handling of Fruits and vegetables,* CBS Publishers and Distributors, New Delhi.

Dev Raj, Rakesh Sharma and Patel, N. L. (2016). Handbook of Food Science and technology. Vol 1 Chemistry and Safety. *Studium Press (India) Pvt Ltd New Delhi 110002* 542p.
Dev Raj, Rakesh Sharma and Patel, N. L. (2016). Handbook of Food Science and technology. Vol 2 Processing Techniques. *Studium Press (India) Pvt Ltd New Delhi 110002* 516p.
Dev Raj, Sharma R and Joshi VK 2011. Quality control for value addition in food processing. New India Publishing Agency, New Delhi, pp 324.
Dev Raj 2011. Food Science and Technology: Glossary of preeminence. New India Publishing Agency, New Delhi, pp 388.
Dev Raj 2012. Post Harvest Technology and Engineering: An Illustrated Guide. New India Publishing Agency, New Delhi, pp 302.
Mayani, J. M., Patel, N. V. and Dev Raj (2016). *Practical Manual forPost-Harvest Management of Horticultural Crops*. ACHF, NAU, Navsari, 100p.
Mayani, J. M., Desai, C. S. and Vagadia P. S. (2016). *Post-Harvest Management of Horticultural Crops*. Narendra Publishing House, New Delhi. 978-93-84337-45-2.

Course No.: PHT-6.3	**Processing of Horticultural Crops**	**Credits : 3(1+2)**

Theory:

Importance and scope of fruit and vegetable preservation industry in India. Food pipe line, losses in post harvest operations and unit operations in food processing. Principles and methods of preservation of fruits and vegetables. Preservation by thermal treatments: mild heat, pasteurization and sterilization, canning and bottling of fruits and vegetables. Preservation by chemical preservatives: Methods for preparation of unfermented beverages viz. juices, RTS, nectar, squashes, syrups, cordials and fermented beverages. Preservation by sugar: Jam, jelly and marmalade, preserves, candies, crystallized fruits etc. Preservation with salt, spices, oil and vinegar: pickling, chutneys and tomato products. Preservation by freezing, drying & dehydration of fruits & vegetables. Minimal processing of fruits and vegetables, Processing of Plantation crops. Spoilage in processed foods, quality control of processed products. Govt. policy on import and export of processed products. Food laws. Principles and guidelines for the establishment of processing units.

Practical:

Instruments and Equipment used in food processing units. Canning of fruits and vegetables, preparation of juice, squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles. Tomato products, dehydration and freezing. Minimal processing of fruits and vegetables. Processing of plantation crops. Visit to processing units. Quality control of processed products (physico-chemical and sensory analysis).

Suggested Readings:

Kalia, Manoranjan and Sood, Sangita. *Food Preservation and Processing*, Kalyani Publishers, Ludhiana.
Lal, GirdhariSiddappaa, G.S. and Tandon, G.L.*Preservation of fruits & vegetables,* ICAR, New Delhi.
Srivastava, R.P. and Sanjeev Kumar.*Fruit & Vegetable Preservation: Principles and Practices, 3rd Edition,* International Book Distributing Co., Lucknow.
Dev Raj, Rakesh Sharma and Patel, N. L. (2016). Handbook of Food Science and technology. Vol 2 Processing Techniques. *Studium Press (India) Pvt Ltd New Delhi 110002* 516p.
Dev Raj, Sharma R and Joshi VK 2011. Quality control for value addition in food processing. New India Publishing Agency, New Delhi, pp 324.
Dev Raj 2011. Food Science and Technology: Glossary of preeminence. New India Publishing Agency, New Delhi, pp 388.

Dev Raj 2012. Post Harvest Technology and Engineering: An Illustrated Guide. New India Publishing Agency, New Delhi, pp 302.

Mayani, J. M., Patel, N. V. and Dev Raj (2016). *Practical Manual for Processing of Horticultural Crops*. ACHF, NAU, Navsari, 114p.

PLANT PROTECTION

Course No.: PPT 2.1	Fundamentals of Plant Pathology	Credits : 3(2+1)

Theory:

Introduction to the science of phytopathology, its objectives, scope and historical background. Classification of plant diseases, symptoms, signs, and related terminology. Parasitic causes of plant diseases (fungi, bacteria, viruses, phytoplasma, protozoa, algae and flowering parasitic plants), their characteristics and classification. Non-parasitic causes of plant diseases. Infection process. Survival and dispersal of plant pathogens. Plant disease epidemiology, forecasting and disease assessment. Principles and methods of plant disease management. Integrated plant disease management. Fungicides classification based on chemical nature, Commonly used fungicides, bactericides and nematicides.

Practical:

Familiarity with general plant pathological laboratory and field equipments. Study of disease symptoms and signs and host parasite relationship. Identification and isolation of plant pathogens. Koch's postulates. Preparation of fungicidal solutions, slurries, pastes and their applications.

Suggested Readings:

N.G. Ravichandra, 2013.Fundamentals of Plant Pathology. PHI Hall of India, New Delhi

R.S. Mehrohtra, Ashok Agarwal. *Fundamental of Plant Pathology*- Sambamurthy *A textbook of Plant Pathology*- R.S.Singh *Introduction to principles of plant pathology*

Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 1996. Introduction to Mycology Wiley Eastern Ltd., New York.

Mandahar,C.L. 1987. Introduction to Plant Viruses. Chand and Co. Pvt. Ltd., New Delhi.

Mehrotra, R.S. and Aneja, K.R. 1990. . An Introduction to Mycology. New Age International (P) Ltd., New Delhi.

Singh, R.S. 1982. Plant Pathogens - The Fungi. Oxford and IBH Publishing Co., New Delhi.

Singh, R.S. 1989. Plant Pathogens - The Prokaryotes .Oxford and IBH Publishing Co., New Delhi.

Dhingra and Sinclair 1993. Basic Plant Pathology Methods. CBS, Publishers & Distributors, New Delhi.

Agrios, G.N. 2006. Plant Pathology. Elsevier Academic press, London.

Course No.: PPT 3.2	Fundamentals of Entomology	Credits : 3(2+1)

Theory:

Introduction to phylum arthropoda. Importance of class Insecta. Insect dominance. History of entomology in India, Importance of entomology in different fields. Definition, division and scope of entomology. Comparative account of external morphonology-types of mouth parts, antennae, legs, wings and genetalia. Structure, function of cuticle & moulting and body segmentation, Anatomy of digestive, Circulatory, Sensory, respiratory, glandular, excretory, nervous and reproductive systems. Types of reproduction. Postembryonic development-eclosion. Matamorphosis. Types of egg larvae and pupa. Classification of

insects upto orders, sub-order and families of economic importance and their distinguished characters. Plant mites – morphological features, important families with examples.

Practical:

Insect collection and preservation. Identification of important insects. General body organization of insects. Study on morphology of grasshopper or cockroach. Preparation of permanent mounts of mouth parts, antennae, legs and wings. Dissection of grasshopper and caterpillar for study of internal morphology. Observations on metamorphosis of larvae and pupae. Dissection of cockroaches.

Suggested Reading:

Awasthi, V.B. 1997. *Introduction to general and applied entomology*. Scientific Publishers, Jodhpur, 379 p.

Borror, D.J., C.A. Triple Horn and N.F.Johnson. 1987. *An introduction to the study of insects (VI Edition)*. Harcourt Brace College Publishers, New York, 875p.

Chapman, R.F. 1981. The Insects: Structure and function. Edward Arnold (Publishers) Ltd, London, 919p.

Gullan, P.J. and Cranston, P.S. 2001. *The insects- An outline of entomology*, II edition, Chapman & Hall, Madras, 491p.

Mani, M.S. 1968. *General entomology*. Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 912p.

Nayar, K.K., T.N.Ananthakrishnan and B.V. David. 1976. *General and applied entomology*, Tata McGraw Hill Publishing Company Limited, New Delhi, 589p.

Richards, O.W. and R.G. Davies. 1977. *Imm's general text book of entomology*, Vol.1&2, Chapman and Hall Publication, London, 1345p.

Romoser, W.S. 1988. *The Science of Entomology*, McMillan, New York, 449p.

Saxena, S.C. 1992. *Biology of insects.* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 366p.

Srivastava, P.D. and R.P.Singh. 1997. *An introduction to entomology*, Concept Publishing Company, New Delhi, 269p.

Tembhare, D.B. 1997. *Modern Entomology*. Himalaya Publishing House, Mumbai, 623p.

Pedigo, L.P. 1999. *Entomology and pest management*. III Edition. Prentice Hall, New Jersey, USA, 691p.

H. Lewin and Devasahayam. Practical manual of entomology insect and non-insect pests.

Pant, N.C. and Ghai, S. 1981Insect physiology and anatomy, ICAR, New Delhi .

Snodgrass, R.E. 2001.Principles of Insect Morphology.CBS Publishers and Distributors, New Delhi

James, L, Nation. CRC Press, Insect Physiology and Biochemistry.Washington.

Course No.:PPT 3.3	**Nematode Pests of Horticultural Crops and their Management**	**Credits : 2(1+1)**

Theory:

History and development of nematology - definition, economic importance. General characters of plant parasitic nematodes, their morphology, taxonomy, classification, biology, symptomatology and control of important plant parasitic nematodes of fruits – (tropical, sub-tropical and temperate) vegetables, tuber, ornamental, spice and plantation crops. Role of nematodes in plant disease complex. Integrated nematode management.

Practical:

Methods of sampling and extraction of nematodes from soil and plant parts, killing, fixing and preparation of temporary and permanent nematode mounts. Nematicides and their

use. Collection and preservation of 20 plant species/parts damaged by plant parasitic nematodes.

Suggested Reading:

Upadhyay, K.D and Dwivedi, K. 1997. A text book of plant nematology. Amman Publishing House Aman publishing house, Meerut.

Vasanth Raju David, B. 2001. Elements of economic entomology. Popular book Depot, Chennai.

Gopal Swaroop and Das Gupta 1986.ICAR, New Delhi. Plant Parasitic Nematodes of India Problems and Progress.

Nair, M.R.G.K. 1975. Insects and Mites of Crops in India. ICAR, New Delhi

Metcalf, R.L and Luckman, W.H. 1982. Introduction to Insect pest management Wiley Inter Science Publishing, New York.

Butani, D.K. 1984. Insects and Fruits. Periodical Expert Book Agency, New Delhi

E.I.Jonathan, I. Cannayane, K. Devrajan, S. Kumar, S. Ramakrishan, Agricultural Nematology. TNAU, Coimbatore.

Course No.: PPT 4.4	**Diseases of Fruits, Plantation and Medicinal and Aromatic Crops**	**Credits : 3(2+1)**

Theory:

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops *viz* mango, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, Aonla, datepalm, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum* , Isabgul, Aswagandha, Aloevera and guggle eand Tephrosia. Important post-harvest diseases of fruit, plantation and medicinal and aromatic crops and their management.

Practical:

Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of fruits, plantation, medicinal and aromatic crops.

Suggested Reading:

L.R. Verma and R.C. Sharma. *Diseases of horticultural Crops*-, Indus Publishers

Srikant Kulkarni, Yashoda R. Hedge, *Diseases of Plantation crops and their management*-Agrotech publication Academy.

S.L. Godara, BBS Kapoor, B.S. Rathore *Disease management of spice crops*-, Madhu Publications.

Alfred Steferud *Diseases of Plantation Crops*-, Biotech books.

R.S.Singh, *Plant diseases* –Oxford and IBH Publishing Co. Pvt. Ltd.

L.Darwin Christdhar Henry and H. Lewin Devasahayam. *Crop diseases: Identification, Treatment and Management*. An Illustrated Handbook, New India publishing. Agency.

Anna L *A colour atlas of Post Harvest Diseases and Disorders of fruits and vegetables* -. Snowdon, CRC Press.

Pathak, V.N. 1980.*Diseases of Fruit Crops*.Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.

Ranga Swamy, G. 1988.*Diseases of Crop Plants in India*. Prentice Hall of India Pvt. Ltd., New Delhi.

Singh, R.S. 1996.*Plant Diseases*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.
Saha, L.R. 2002.*Hand Book of Plant Diseases*. Kalyani Publishers, New Delhi.
Arjunan, Karthikeyan, Dinakaran, Raghuchander, 1999.*Diseases of Horticultural Crops*. Dept. of Plant Pathology, TNAU, Coimbatore
Chadha, K.L. 2002.*Hand Book of Horticulture*. ICAR, New Delhi.
Anna L.Snowdon *A colour atlas of Post Harvest Diseases and Disorders of fruits and vegetables* .CRC Press, New Delhi.
L.R. Verma and R.C. Sharma. *Diseases of horticultural Crops*., Indus Publishers,New Delhi.
Yashoda R. Hedge. *Diseases of Plantation crops and their managemen*t .Srikant Kulkarni, Agrotech publication Academy.
S.L. Godara, BBS Kapoor, B.S. Rathore. *Disease management of spice crops*., Madhu Publications.
Ranga Swamy, G. 1988.*Diseases of crop plants in India*. Prentice Hall of India Pvt. Ltd., New Delhi
R.S.Singh, *Plant diseases*. Oxford and IBH Publishing Co. Pvt. Ltd.
L. Darwin Christdhar Henry and H. Lewin Devasahayam, *An Illustrated Handbook*. New India publishing.Agency.

Course No.: PPT 4.5	**Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops**	**Credits : 3(2+1)**

Theory:

General – IPM and its componants, economic classification of insects; Bio-ecology and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops; pest surveillance. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits (Fruit crops: Mango, Banana, Chiku, Custardapple, Guava, Pomogranate,grapes,ber,Aonala, papaya, jamun) Temperate fruits: Apple, Peach, pears), plantation, medicinal and aromatic crops like coconut, areca nut, oil palm, cashew, cacao, tea, coffee, cinchona, rubber, betel vine senna, neem, belladonna, pyrethrum, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum,* Aswagandha, yam, and. Storage insects – distribution, host range, bio-ecology, injury, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products. Insecticide residue problems in fruit, plantation, medicinal and aromatic crops and their maximum residue limits (MRLs), insect -pests of stored foods.

Practical:

Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of important insect – pests affecting fruits, plantation, medicinal and aromatic crops in field and storage.

Suggested Reading:

Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur.
Ranjit, P., 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.
Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.
Ayyar, T.V.R. 1963. Hand book of entomology for south India. Govt. press Madras, 516p.
David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book Department, Madras, 536p.
David. V. Alford. Pest of fruit crops. A. M. Ranjith. Identification and management of Horticultural pest.
Rachna and Benna kumari. Pest management and residual analysis in horticultural crop

K. P. Srivastav and Y. S. Ahawat. Pest management in citrus.
Ramnivas sharma. Identification and management of horticulture pest.
Fryer. Insect pest of fruit crops
A. S. Atwal. Agricultural pests of south Asia and their management
Mark Vernon Slingerland and C. R. Crosby. Manual of fruit insects
Metcalf,R.LandLuckman,W.H.1982. IntroductiontoInsectpestmanagement. WileyInterSciencePublishing,NewYork
Butani, D.K.1984. InsectsandFruits. PeriodicalExpertBookAgency, NewDelhi

Course No.: PPT 5.6	Diseases of Vegetable, Ornamental and Spice Crops	Credits : 3(2+1)

Theory:

Etiology, symptoms, mode of spread, epidemiology and integrated management of diseases of the following vegetables, ornamental and spice crops: tomato, brinjal, chilli, bhindi, cabbage, cauliflower, radish, knol-khol, pea, beans, beet root, onion, garlic, fenugreek, ginger, potato, fennel, cucurbits, colocasia, Yam, leafy vegetables, orchid, marigold, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon, jasmine, rose, crossandra, tuberose, gerebera, anthurium, geranium. Important post-harvest diseases of vegetables and ornamental crops and their management.

Practical:

Observations of symptoms, causal organisms and host parasitic relationship of important diseases, examination of cultures of important pathogens of vegetables, ornamental and spice crops in field as well as in protected cultivation.

Suggested Reading:

Srikant Kulkarni, Yashoda R. Hedge. *Diseases of Plantation crops and their management*-, Agrotech publication Academy
S.L. Godara, BBS Kapoor, B.S. Rathore. *Disease management of spice crops*-, Madhu Publications
L.Darwin Christdhar Henry and H.Lewin Devasahayam *Crop diseases: Identification, Treatment and Management*. An Illustrated Handbook –, New India publishing Agency
Singh, R.S. 1994. *Diseases of Vegetable Crops*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
Singh, R.S 1996. *Plant Diseases*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi
Sohi, H.S. 1992. *Diseases of Ornamental plants in India*. ICAR, New Delhi
Ranga Swamy, G. 1988. *Diseases of Crop Plants in India*.Prentice Hall of India Pvt. Ltd., New Delhi.
Saha, L.R. 2002. *Hand Book of Plant Diseases*. Kalyani Publishers
Arjunan, G. Karthikeyan, G. Dinakaran, D. Raguchander, T. 1999. *Diseases of Horticultural Crops.* .Dept. of Plant Pathology,Tamilnadu Agricultural University Coimbatore.

Course No.: PPT 5.7	Insect Pests of Vegetable, Ornamental and Spice Crops	Credits: 3(2+1)

Theory:

Economic importance of insects in vegetable, ornamental and spice crops -ecology and pest management with reference to these crops. Pest surveillance in important vegetable, {solanaceous vegetable-Brinjal,tomato,potato,sweet potato, chilli, malvaceous vegetable-okra, root vegetable crop-onion and garlic ,tapioca, raaddish, beetroot,carrot,pest of leafy

vegetable crops-amaranthus, spinach pest of cucurbitaceous crops , all gourds ,pest of leguminous crops-Pea, Beans, pigeon pea, pest of cole crops-Cabbage, cauliflower, knol-khol,pest of drumstick (moringa)}, ornamental {rose,jasmine, anthurium, carnation chrysanthemum, croton,gerbera,gladiolus,lily,nerium,orchid, tube rose} and spice crops {onion, turmeric, coriander,curry leaf pepper,cardamom,beetlevien, cinnamon, fenugreek, cumin, fennel. Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetable, ornamental and spice crops. Important storage insect-pests of vegetable, ornamental and spice crops, their host range, bio-ecology, injury and integrated management. Insect –pests of processed vegetables and ornamental crops, their host range, bio-ecology, injury and integrated management. Insecticidal residue problems in vegetables and ornamental crops, tolerance limits etc.

Practical:

Study of symptoms, damage, collection, identification, preservation, assessment of damage/population of important insect-pests affecting vegetable, ornamental and spice crops in field and during storage.

Suggested reading:

Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur

Ranjit, P., 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.

Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.

Ayyar, T.V.R. 1963. Hand book of entomology for south India. Govt. press Madras, 516p.

David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book Department, Madras, 536p.

P. Srivastava, Dhamo K. Butani Pest management in vegetables – Part1. Researcho Book Centre, 1998

K.P. Srivastava, Dhamo K. Butani Pest management in vegetables – Part-2. Researcho Book Centre, 1998.

Rachna and Benna kumari. Pest management and residual analysis in horticultural crop.

Ramnivas sharma. Identification and management of horticulture pest.

T. V. Sathe. Pests of ornamental plants.

A. S. Atwal. Agricultural pests of south Asia and their management.

Butani, D.K. 1984.Insects and Fruits. Periodical Expert Book Agency, New Delhi.

Butani, D.K. 1984.Insects and Fruits. Periodical Expert Book Agency, New Delhi

Metcalf,R.LandLuckman,W.H.1982. Introduction to Insect pest management. WileyInterSciencePublishing,NewYork

Dhalinal, .G.S. and Ramesh Arora Integrated Pest Management Concept and Approaches. Kalyani Publishers, Ludhiana.

K.P.Srivastava .A Text Book on Applied Entomology Vol. I&II. , Kalyani Publishers, Ludhiyana

Emmanuel, N, A. Sujatha, T.S.K. K. Kiran Patro, MLN Reddy, B. Srinivasulu, TSSK Sammuel Patro. Text Book on Integrated Pest Management of Horticultural Crops Astral International Publishers, New Delhi.

Course No.: PPT 6.8	Apiculture, Sericulture and Lac culture	Credits: 2(1+1)

Theory:

Introduction to beneficial insects. Importance and History of apiculture. Species of honey bees, Rock bee, Little bee, Indian bee, European bee, Italian bee and Dammar bee, lifecycle and caste determination. Bee colony maintenance, bee colony activities, starting of new colony, location site, transferring colony, replacement of queen, combining colonies,

swarm prevention, colony management in different seasons, Equipment for apiary, types of bee hives and their description. Bee pasturage. Honey extraction, honey composition and value, bee wax and tissues.. Importance, History and development in India, silkworms kinds and their hosts, systematic position, distribution, lifecycles in brief, Silk glands. Mulberry silkworm-morphological features, races, rearing house and equipments, disinfection and hygiene. Grainage acid treatment, packing and transportation of eggs, Incubation, black boxing, hatching of eggs. Silkworm rearing young age /chawki rearing and old age rearing of silkworms. Feeding, spacing, environmental conditions and sanitation. Cocoon characters colour, shape, hardiness and shell ratio. Defective cocoons and stifling of cocoons. Uses of silk and by-products. Economics of silk production. Moriculture-Mulberry varieties, package of practices, Pests and diseases and their management. Lac growing areas in India, Lac insects, biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac-insects.

Practical:

Honey bee colony, different bee hives and apiculture equipment. Summer and Winter management of colony. Honey extraction and bottling. Study of pests and diseases of honeybees. Establishment of mulberry garden. Preparation of mulberry cuttings, planting methods under irrigated and rainfed conditions. Maintenance of mulberry garden-pruning, fertilization, irrigation and leaf harvest. Mulberry pests and diseases and their management and nutritional disorders. Study of different kinds of silkworms and mulberry silkworm morphology, silk glands. Sericulture equipments for silkworm rearing. Mulberry silkworm rearing room requirements. Rearing of silkworms-chalky rearing. Rearing of silkworms late age silkworm rearing and study of mountages. Study of silkworm pests and their management. Study of silkworm diseases and its management. Lac insects-biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac

Suggested Reading:

Singh, S., 1975. Bee keeping in India – ICAR, New Delhi., 214p.

Sunita, N.D, Guled ,M.B, Mulla S.R and Jagginavar,2003, Beekeeping, UAS Dharwad.

Mishra, R.C. and Rajesh Gar. 2002. Prospective in Indian Apiculture. Agrobios, Jodhpur.

Singh, D and Singh, D.P. 2006. A hand book of Beekeeping, Agrobios (India).

Paul DeBach and Devid Rosen 1991. Biological control by natural enemies. Cambridge University Press; 2 edition (27 June 1991)

YA Shinde and BR Patel. Sericulture in India

Tribhuwan Singh. Principles and Techniques of Silkworm Seed Production, Discovery publishing House Pvt. Ltd

M.L. Narasaiah. Problems and Prospects of Sericulture. discovery publishing House Pvt. Ltd.

Ganga,G. and Sulochana Chetty, J. 1997. An introduction to Sericulture (2nd Edn.). Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.

Krishnaswamy, S. (Ed). 1978. Sericulture Manual - Silkworm Rearing. FAO Agrl. Services bulletin, Rome.

Singh, S. 1975. Bee keeping in India. ICAR, New Delhi.

Glover, P.M. 1937. Lac cultivation in India. Indian Lac Research Institute, Ranchi.

Jolly, M.S. 1987. "Appropriate sericulture techniques" International centre for training and ResearchinTropicalSericulture,Mysore,209.

K.P.Srivastava .A Text Book on Applied Entomology Vol. I&II. , Kalyani Publishers, Ludhiyana

B.r. David and V.V.Ramamurthy. Elements of Economic Entomology, 7th Edition. Namrutha Publications, Chennai.

Course No.: NRMH 1.1	Fundamentals of Soil Science	Credits: 3(2+1)

Theory:

Composition of earth's crust, soil as a natural body – major components. Eluviations and alleviations formation of various soils. Physical parameters; texture – definition, methods of textural analysis, stock's law, assumption, limitations, textural classes, use of textural triangle; absolute specific gravity/particle density, definition, apparent specific gravity/bulk density – factors influencing, field bulk density. Relation between BD (bulk density), AD – practical problems. Pore space – definition, factors affecting capillary and non-capillary porosity, soil colour – definition, its significance, colour variable, value hue and chroma. Munsellcolour chart, factors influencing, parent material, soil moisture, organic matter, soil structure, definition, classification, clay prism like structure, factors influencing genesis of soil structure, soil consistency, plasticity, Atterberg's constants. Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal, soil temperature, sources and distribution of heat, factors influencing, measurement, chemical properties, soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion importance, soil water, forms, hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale, measurement, classification – aerial photography – satellite of soil features – their interpretation; soil orders; land capability classification; soil of different eco-systems and their properties, Pedogenic process. Objectives of soil science research institute in India (NBSS&LUP, ISSS, LTFE & NSSTL). Management of Soil Crusting, Soil Compaction and Soil Compression. Soil Biology benefits and harmful effects. Methods and objective of soil survey, Remote sensing application in soil and plant Studies, Soil degradation.

Practical:

Collection and preparation of soil samples, estimation of moisture, EC, pH and bulk density. Textural analysis of soil by Robinson's pipette method. Description of soil profile in the field. Determination of Soil colour using Munsell Chart. Estimation of water holding capacity and hydraulic conductivity of soils. Estimation of Infiltration rate using double ring infiltrometer method. Determination of pore space of soil. Determination of filed capacity and permanent wilting point of soil. Aggregate size distribution analysis of soil. Air capacity of soil by field method.

Suggested reading:

Brady Nyle C and Ray R Well, 2014. *Nature and properties of soils*. Pearson Education Inc., New Delhi.

Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. IARI, New Delhi.

Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers New Delhi.

Dilip Kumar Das, 2015. Introductory Soil Science. Kalyani Publishers, Ludhiana.

Biswas, T.D. and Mukharjee, S.K., 2015. *Text Book of Soil science*. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.

Brady, N.C., 1995. *The Nature and properties of Soils*. Macmillan Publishing Co, New York.

Ghildyal, B.P. and Tripathi, R.P., 1987. *Soil Physics*. Acad. Press. New York.

Kolay, A.K., 1983. *Basic concepts of Soil Science*. Wiley Eastern Ltd., New Delhi

Brady, N. C. and Weil, R. R., 2010. *Elements of the Nature and Properties of Soils* (3rd Edition), Pearson Education, New Delhi.

Foth, H.D., 1991. *Fundamentals of Soil Science* (8th Edition), John Wiley & Sons, New Delhi.
Das, D .K., 2011. *Introductory Soil Science* (3rd Edition), Kalyani publisher, Ludhiana (India).
Khan, T. O. 2013 Forest Soils: *Properties and Management*. Springer International Publishing, Switzerland
Pritchett and Fisher RF, 1987. *Properties and Management of Forest Soils*. John Wiley, New York.
Gupta, P.K. 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).
Jaiswal, P.C. 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
Jackson, M. L. 2012. Soil Chemical Analysis: Advanced Course, Scientific Publisher

Course No.: NRMH 2.2	**Soil Fertility and Nutrient Management**	**Credits: 2(1+1)**

Theory:

Introduction to soil fertility and productivity- factors affecting. Essential plant nutrient elements- functions, deficiency systems, transformations and availability. Acid, calcareous and salt affected soils – characteristics and management. Soil organic matter, pH in plant nutrition, soil buffering capacity. Integrated plant nutrient management. Soil fertility evaluation methods, critical limits of plant nutrient elements and hunger signs. NPK fertilizers: composition and application methodology, luxury consumption, nutrient interactions, deficiency symptoms, visual diagnosis. Plant nutrient toxicity symptoms and remedies measures. Soil test crop response and targeted yield concept. Nutrient use efficiency and management. Secondary and micronutrient fertilizer. Fertilizer control order. Manures and fertilizers classification and manufacturing process. Properties and fate of major and micronutrient in soils. Fertilizer use efficiency and management. Effect of potential toxic elements in soil productivity.

Practical:

Analysis of available N,P,K and Micronutrients and interpretations. Gypsum requirement of alkali soils. Lime requirement of acid soils. Determination of Boron and chlorine content in soil. Sampling of fertilizer for chemical analysis. Physical properties of fertilizers. Estimation of ammonical nitrogen and nitrate nitrogen in fertilizer. Estimation of water soluble P_2O_5, Ca and S in SSP, Lime and Gypsum. Estimation of Potassium in MOP/SOP and Zinc in zinc sulphate. Visiting of fertilizer testing laboratory.

Suggested reading:

Yawalkar K S, Agarwal JP and Bokde S, 1992. *Manures and Fertilizers.* Agri. Horticultural Publishing House, Nagpur.
Tandon HLS, 1994. *Fertilizers Guide.* Fertilizers Development Consultation Organization, New Delhi.
Seetharaman S, Biswas B C, Yadav D S and Matheswaru S. Usage 1996. *Hand Bookon Fertilizers*. Oxford and IBH Publishing Company, New Delhi.
The fertilizer Association of India, Shaheed Jit singh marg, New Delhi, 1985. Fertilizer control order
Ranjan Kumar Basak , 2000. *Fertilizers A Text book.* Kalyani publishers, New Delhi.
British Crop Production Council, U.K., 1995. The Pesticide Manual, A – World Compendium.
Sree Ramulu US, 1991. *Chemistry of Insecticides*. Oxford and IBH Publishing and Fungicides Company, New Delhi.

Nene Y L and Thapliyal P N, 1991. *Fungicides in plant disease control*. Oxford and IBH Publishing company, New Delhi.
Havlin *et al.* 2014. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management* (8th Edition), PHI Learning Pvt. Ltd., Delhi.
Binkley, D. and R. Fisher, 2012. *Ecology and Management of Forest Soils* (4th Edition), John Wiley & Sons Singapore Pvt. Ltd., Singapore
Reddy M. V., 2001. *Management of Tropical Plantation Forests and Their Soil Litter System- Litter, Biota and Soil Nutrient Dynamics*, Science Publishers, U. S.
Khan, T. O., 2013. *Forest Soils: Properties and Management*. Springer International Publishing, Switzerland
Brady, N. C. and Weil, R. R., 2010. E*lements of the Nature and Properties of Soils* (3rd Edition.), Pearson Education, New Delhi
Das, D .K., 2011. Introductory Soil Science (3rd Edition), Kalyani Publisher, Ludhiana (India).
Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. Indian Society of Soil Science, IARI, New Delhi.
Pritchett and Fisher RF, 1987. *Properties and Management of Forest Soils*. John Wiley, New York.
Gupta, P.K., 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).
Jaiswal, P.C., 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
Jackson, M. L., 2012. Soil Chemical Analysis: Advanced Course, Scientific Publisher
J. Benton Jones, Jr., 2012. *Plant Nutrition and Soil Fertility Manual* (2nd Edition), CRC Press, USA.
Mengel, *et al.,* 2001. *Principles of Plant Nutrition* (5th Edition), Springer
Kanwar,J.S.(Ed).,1976. *SoilFertility:TheoryandPractice*, ICAR,NewDelhi
Bear,F.E.,1964. *ChemistryoftheSoil.* OxfordandIBHPublishingCo.,NewDelhi
Richards,L.A.,1968. *Diagnosis and Improvement of SalineandAlkalinesoils*. Oxford&IBHPublishingCo.NewDelhi(USDAHandBookNo.60)
Chopra,S.CandKanwar,J.S.,1976. *Analytical Agricultural Chemistry* . KalyaniPublishers,Ludhiana.
Tisdale,S.L.Nelson,W.L.andBeaton,J.D.,1993. *Soil Fertility and Fertilizers*. MacmillanPublishingCompany,New York
Yawalkar,K.S.Agarwal,J.P.andBokde,S.,1977. *Manures and Fertilizers*. Agri-HorticulturalPublishingHouse,Nagpur
Seetharamaan,S.Biswas,B.C.Maheswari,S.and Yadav,D.S., 1986. *HandBookonFertilizersTechnology*.TheFertilizersAssociationofIndia,NewDelhi.

Course No.: NRMH 2.3	**Water Management in Horticultural Crops**	**Credits: 2(1+1)**

Theory:

Importance of water, water resources in India. Area of different crops under irrigation, function of water for plant growth, effect of moisture stress on crop growth. Available and unavailable soil moisture – distribution of soil moisture – water budgeting – rooting characteristics – moisture extraction pattern. Water requirement of horticultural crops – lysimeter studies – Plant water potential climatological approach – use of pan evaporimeter – factor for crop growth stages – critical stages of crop growth for irrigation. Irrigation scheduling – different approaches – methods of irrigation – surface and sub-surface pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water. Water management problem, soils quality of irrigation water, irrigation management practices for different soils and crops.

Layout of different irrigation systems, drip, sprinkler. Layout of underground pipeline system.

Practical:

Measurements of irrigation water by using water measuring devices, use of common formula in irrigation practices, practicing of land leveling and land shaping implements, layout for different methods of irrigation. Estimation of soil moisture constants and soil moisture by using different, methods and instruments, scheduling of irrigation, different approaches, practicing use of instruments, estimation of irrigation efficiency and water requirements of horticultural crops, irrigation planning and scheduling, soil moisture conservation practices.

Suggested Reading:

Rao, Y.P. and Bhaskar, S.R. 2008. *Irrigation technology. Theory and practice*. Agrotech publishing Academy, Udaipur.

Dilip Kumar Mujmdar. 2004. *Irrigation water management: Principles and Practices*. Prentice Hall of India Pvt. Ltd.,

S.V. Patil & Rajakumar, G. R., 2016. *Water Management in Agriculture and Horticultural Crops*. Satish serial publishing House, Delhi.

Carr M. K. V. and Elias Fereres. 2012. *Advances in Irrigation Agronomy*. Cambridge University Press.

Michael, A.M. 2015. *Irrigation Theory and practices*. Vikas publishing house Pvt., Ltd.

Course No.: NRMH 2.4	Agro-meteorology and Climate Change	Credits: 2(1+1)

Theory:

Agricultural Meteorology- Introduction, definition of meteorology, scope and practical utility of Agricultural meteorology. Composition and structure of atmosphere and definition of weather and climate, aspects involved in weather and climate, atmospheric temperature, soil temperature, solar radiation, atmospheric pressure, atmospheric humidity, evaporation and transpiration, monsoons, rainfall, clouds, drought. Basics of weather forecasting. Climate change-causes. Global warming-causes and remote sensing. Effect of climate change on horticulture Past and future changes in greenhouse gases within the atmosphere. Sources and sinks for greenhouse gases. Plants sense and respond to changes in CO2 concentration. Measurement of short-term effects and mechanisms underlying the observed responses in C3 and C4 species. plant development affected by growth in elevated CO2. Physiology of rising CO2 on nitrogen use and soil fertility, its implication for production. Methodology for studying effect of CO2. Change in secondary metabolites and pest disease reaction of plants. The mechanisms of ozone and UV damage and tolerance in plants. Increased temperature and plants in tropical/sub-tropical climates- effect on growing season, timing of flowering, duration of fruit development and impacts on crop yields and potential species ranges, interaction of temperature with other abiotic/biotic stress. Mitigation strategies and prospects for genetic manipulation of crops to maximize production in the future atmosphere. Modifying Rubisco, acclimation, metabolism of oxidizing radicals, and sink capacity as potential strategies,Heat unit concept; Air circulation: Primary, Secondary and Tertiary. Air masses and fronts. Stability and instability of atmosphere, Adiabatic process. Agro-climatic zones of India and Gujarat.

Practical:

Measurement of temperature; Measurement of rainfall; Measurement of evaporation (atmospheric/soil); Measurement of atmospheric pressure; Measurement of sunshine duration and solar radiation; Measurement of wind direction and speed and relative

humidity; Study of weather forecasting and synoptic charts., Lay out of an agromet observatory and types , Measurement vapour pressure ;Analysis of weather parameter.

Suggested Reading:

A. K. Srivastava and P. K. Tyagi, 2011. *Practical Agricultural Meteorology*. New Delhi Publishing Agency, New Delhi.

D.Lenka, 2006. *Climate, Weather and Crops in India*. Kalyani Publishers, New Delhi.

G. S. L. H. V. Prasad Rao, 2008. *Agricultural Meteorology*. Prentice Hall of India Pvt. Ltd., New Delhi.

H.S.Mavi and Graeme J. Tupper, 2005. *Agrometeorology – Principles and applications of climate studies in agriculture*. International Book Publishing Co., Lucknow.

H.S.Mavi, 1994. *Introduction to Agrometeorology*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

H.V.Nanjappa and B.K.Ramachandrappa, 2007. *Manual on Practical Agricultural Meteorology*. Agrobios India. Jodhpur.

S.R.Reddy, 1999. *Principles of Agronomy*. Kalyani Publishers, New Delhi.

T.Yellamanda Reddy and G.H.Sankara Reddi, 2010. *Principles of Agronomy*. Kalyani Publishers, New Delhi.

Pattersen,S.1958. *IntroductiontoMeteorology*. Mc. GrawHillBookCo.Inc.,NewYork .

Tailor,J.T.1967. *AgriculturalClimatology*. PergmanPressLtd.,HeadingtonHillHall, Oxford,England

Trewarthe,T.G.1968. *AnIntroductiontoClimate*. McGrawHillBookCo.Inc.,NewYork.

Mavi,H.S.1985. *IntroductiontoAgrometeorology*. Oxford&IBHPublishingCo.,NewDelhi.

Course No.: NRMH 3.5	**Organic Farming**	**Credits: 2(1+1)**

Theory:

Introduction, concept, relevance in present context; Organic production requirements; Biological intensive nutrient management-organic manures, vermicomposting, green manuring, recycling of organic residues, biofertilizers; Soil improvement and amendments; Integrated diseases and pest management – use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labeling and accreditation processors, marketing, exports. Role of microorganisms in organic matter- decomposition – humus formation. Importance of C:N ratio.

Practical:

Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, postharvest management, Analysis of soil for organic matter, Sampling of organic manure & organic manure analysis.

Suggested Reading:

A.K.Dahama. 2007. *Organic farming for sustainable agriculture*. Agrobios (India), Jodhpur.

Arun. K. Sharma. 2011. *Handbook of Organic farming*. Agrobios (India), Jodhpur.

S.P. Palaniappan and K.Annadurai. 2010. *Organic farming – Theory and Practice*. Scientific Publishers. Jodhpur.

U.Thapa and P. Tripathy. 2006. *Organic farming in India- Problems and Prospects*. Agrotech publishing agency, Udaipur.

G.K.Veeresh. 2006. *Organic farming*. Foundation Books. New Delhi.

Purshit,S.S.2006.*TrendsinOrganicFarminginIndia*. AgrosBios(INDIA), Jodhpur.

Thampan,P. K.1995.*OrganicAgriculture*. PeckaytreeCropsDevelopmentFoundation, Cochin,Kerala.

Sathe,T.V.2004.*Vermiculture and Organic Farming*. Days PublishingHouse, NewDelhi.

Course No.: NRMH 4.6	Farm Power and Machinery	Credits: 2(1+1)

Theory:

Basic concepts of various forms of energy, unit and dimensions of force energy and power, calculations with realistic examples. IC Engines: Basic principles of operation of compression, ignition and spark ignition engines, two stroke and four stroke engines, cooling and lubrication system, power transmission system, broad understanding of performance and efficiency, tractors, power tillers and their types and uses. Electric motors: types, construction and performance comparison. Tillage: objectives, method of ploughing. Primary tillage implements: construction and function of indigenous ploughs, improved indigenous ploughs, mould board ploughs, disc and rotary ploughs. Secondary tillage implements: construction and function of tillers, harrows, levelers, ridgers and bund formers. Sowing and transplanting equipment: seed drills, potato planters, seedling transplanter. Grafting, pruning and training tools and equipment. Inter-culture equipment: sweep. Junior hoe, weeders, long handle weeders. Crop harvesting equipments: potato diggers, fruit pluckers, tapioca puller and hoists. Scope of mechanization in horticulture, Operation and maintenance of farm equipments.

Practical:

Calculation on force, power and energy. IC engines – showing the components of dismantled engines and motors. Primary and secondary tillage implements, hitching, adjustments and operations. Spraying equipment, calibration and operation. Plant protection equipment, calculation of dilution ratio and operation.

Suggested reading:

T. P. Ojhaand A.M.Michael. 2005. *Principles of Agricultural Engineering* (Volume - 1), Jain Brothers

Manoj Kumar Ghoshal and Dhirendra Kumar Das. 2008. *Farm Power*,Kalyani Publishers.

Surendra Singh. 2007.*Farm Machinery Principles and Applications*. ICAR Publications

Roth / Field. 1992. *Introduction to Agricultural Engineering - Problem Solving Approaches,* 2nd. Edition. CBS publishers & distributors Pvt. Ltd.

Surendra Singh & Verma. 2009. *Farm Machinery Maintenance & Management*. ICAR Publication.

M.M. Pandey & Others. 2012. *Handbook of Agricultural Engineering*. ICAR publication

JagadishwarSahay.1992. *Elementsof Agricultural Engineering*. Agro Book Agency, Patna.

MichalAMandOjhaTP.1993.*VolI. Principlesof AgriculturalEngineering*.Jain Brothers,NewDelhi.

KepnerRARoyBainerandBargerBL.1978. *Principles of Farm Machinery*. CBSPublisherandDistributors,Delhi.

JainS C. 2003.*FarmMachinery-Anapproach.*StandardPublishersandDistributors,NewDelhi

Nakra,C.P.1986. *FarmMachineryandEquipment*. DhanpatRaiandSons,NewDelhi

Klenin,N.I.Popov,I.F.andSakun,V.A.1985. *AgriculturalMachines*. AmerindpublishingCo.Pvt.Ltd.,NewDelhi.

Course No.: NRMH 4.7	Soil, Water and Plant Analysis	Credits: 2(1+1)

Theory:

Methods of soil and plant sampling and processing for analysis. Characterization of hydraulic mobility – diffusion and mass flow. Renewal of gases in soil and their abundance.

Methods of estimation of oxygen diffusion rate and redox potential. Use of radio tracer techniques in soil fertility evaluation. Soil micro-organisms and their importance. Saline, alkali, acid, waterlogged and sandy soils, their appraisal and management. Chemical and mineral composition of horticultural crops. Leaf analysis standards, index tissue, interpretation of leaf analysis values Quality of irrigation water. Rapid tissue tests for soil and plant. Management of poor quality irrigation water in crop management. Soil and Water pollution. Rock & Minerals classification, Quantification of minerals and their abundance. Estimation of soil moisture.

Practical:

Introduction to analytical chemistry, Collection and preparation of soil, water and plant samples for analysis. Sodium adsorption ratio and exchangeable sodium percentage of soils. Estimation of nutrient elements in soils and their contents in plants. Irrigation water quality analysis. Determination of pH and EC in irrigation water samples, Determination of Carbonates and bicarbonates in soil and irrigation water, Determination of N, P, K, Ca, Mg, S and micronutrients in plant samples. Determination of Sodium, Potassium, Chlorine and Boron in irrigation water.

Suggested Reading:

H.L.S. Tandon. 2013, *Methods of analysis of soil, plant, water and fertilizers*. FDCO, New Delhi.

Yawalkar,K.S.Agarwal,J.P.andBokde,S.,1977. *ManuresandFertilizers*. Agri-HorticulturalPublishingHouse,Nagpur.

Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.

Jaiswal, P.C., 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.

Jackson M. L, 1967. *Soil Chemical Analysis*, Oxford and IBH Publishing Co., New Delhi.

Richards L A, 1968. *Diagnosis and Improvement of Saline and Alkaline Soils*. Oxford and IBH publishing Co. New Delhi(USDA Hand Book No. 60)

Chopra S.C. and Kanwar, J. S 1976. *Analytical Agricultural Chemistry*, Kalyani Publishers, Ludhiana.

C. S. Piper. 2014, *Soil and plant analysis*, Scientific publishers India.

Mushtaq A. Wan., 2014, *Soil, plant and water analysis manual*. Agrotech publishing company, Udaipur.

P. K. Gupta., 2013, *Soil, plant, water and fertilizer analysis*. Agrobios, India.

M. V. Durai., 2014, *Hand book of Soil, plant, water, fertilizers and manure analysis*. New India publishing agency.

Course No. : NRMH 5.8	**Weed Management in Horticultural Crops**	**Credits: 2(1+1)**

Theory:

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop weed competition and allelopathy Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management; Herbicides: advantages and limitation of herbicide usage in India, Herbicide classification, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Compatibility of herbicides with other agro chemicals; Weed management in major field and horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control.

Practical:

Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information; Computation of herbicide doses; Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

Suggested reading:

Crafts, A.S. and Robbins, W.W. 1973. *Weed Control*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

Gupta, O.P. 1984. *Scientific Weed Management*. Today and Tomorrow Printers and Publishers, New Delhi.

Gupta, O.P. 2015. *Modern Weed Management*. Agro Bios (India), Jodhpur. Naidu, V.S.G.R., *Handbook of Weed Identification*. Directorate of Weed Research, Jabalpur.

Rajagopal, A., Aravindan, R. and Shanmugavelu, K.G., 2015. *Weed management of Horticultural Crops.* Agrobios (India), Jodhpur.

Ramamoorthy, K. and Subbian, P., *Predominant Weed flora in hill –ecosystems*. Agrobios (India), Jodhpur.

Rao, V.S. 2000. *Principles of Weed Science*. Oxford & IBH Publishing Co., New Delhi.

Subramanian, S., Mohammed Ali, A. and Jayakumar, R. 1991. *All About Weed Control*. Kalyani Publishers, Ludhiana.

Tadulingam, C. and Venkatnarayana, D. 1955. *A Handbook of Some South Indian Weeds.* Government Press, Madras.

Thakur, C. 1977. *Weed Science*. Metropolitan Book Co. Pvt. Ltd., New Delhi.

Course No.: NRMH 6.9	**Introduction to Major Field Crops**	**Credits: 2(1+1)**

Theory:

Classification and distribution of field crops, definitions and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping, cultural practices for raising major cereals, pulses, oil seeds and fodder crops, green manuring, crop rotation.

Practical:

Identification of crop plants, seeds and weeds. Preparation of cropping scheme. Application of herbicides in field crops.

Suggested Reading:

B. Gurarajan, R.Balasubramanian and V.Swaminathan. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.

Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICAR Publication.

Rajendra Prasad. Textbook of Field Crops Production - Foodgrain Crops. Volume I ICAR Publication.

S.R.Reddy. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.

S.S.Singh. 2005. Crop Management. Kalyani Publishers, New Delhi.

UAS, Bangalore. 2011. Package of Practice. UAS, Bangalore.

Chidda Singh 1983. Modern Techniques of raising Field crops.Oxford & IBH, Publishing Co., New Delhi
Rajendra Prasad 2002. Text Book of Field crops Production,ICAR, New Delhi.
Reddy, S.R. 2004. Agronomy of Field crops, Kalyani Publishers, Ludhiana.
Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production South Asian Publishers, New Delhi.

Course No.: NRMH 6.10	Introductory Agro-forestry	Credits: 2(1+1)

Theory:

Agroforestry – definition, objectives and potential. Distinction between agroforestry and social forestry. Status of Indian forests and role in India farming systems. Agroforestry system, sub-system and practice: agri-silviculture, silvipastoral, horti-silviculture, horti-silvipastoral, shifting cultivation, taungya, home gardens, alley cropping, intercropping, wind breaks, shelterbelts and energy plantations. Planning for agroforestry – constraints, diagnosis and design methodology, selection of tree crop species for agro-forestry. Agroforestry projects – national, overseas, MPTS – their management practices, economics of cultivation – nursery and planting (*Acacia catechu*, *Dalbergiasissoo*, Tectona, Populus, Morus, Grewia, Eucalyptus, Quercus spp. and bamboo, tamarind, neem etc.), Neem Azadirachta indica, Tamarind (Tamarindus indica) and melia dubia as per local prevalence.

Practical:

Identification and seeds and seedlings of multipurpose tree species. Nursery practices for poplar, Grewiaoptiva, Morus alba, Acacia catechu, *Dalbergiasissoo*, robinia, leucaena etc. Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops: silvipastoral, alley cropping, horti-silviculture, agro-silvipasture, fuel and fodder blocks. Visit to social forestry plantations – railway line plantations, canal plantations, roadside plantations, industrial plantations and shelterbelts. Rapid assessment of farmers needs for green manure, fodder, fuel wood in selected villages. Economics and marketing of products raised in agro-forestry systems.

Suggested Readings:

A. K. Patra, 2013. *Agroforestry – Principles and Practices*. New India publishing agency.
A. P. Dwivedi, 1992. *Agroforestry – Principles and Practices*. Oxfird and IBH Publishing company.
Dadhwal et al., 2014. *Practical Manual on Agroforestry.* Jaya publishing house, Delhi.
L.K. Jha, 2015. *Advances in Agroforestry*. APH Publishing corporation, New Delhi.
Linford, Jenny, 2007. *A concise guide to Trees*. Parragon books service limited, Parragon.
Negi, S.S., 2007. *Agroforestry Hand book*. International book distributer, New Delhi.
P.S. Pathak and Ram Newaj, 2010. *Agroforestry – Potentials and Opportunities.* Agrobios, Jodhpur
Pankaj Panwar & Sunil Puri, 2007. *Agroforestry: Systems & Practices.* New India publishing agency, New Delhi.
Ramesh Umrani and C.K. Jain, 2010. *Agroforestry – Systems & Practices*. ABD Publishers, New Delhi.
RamachandranNair, P.K.1993. *AnIntroductionto Agroforestry*. FirstreprintinIndia–2008. Springer International Edition
Tejawani, K.G.1994. *Agroforestry in India*. Oxford& IBH, Publishing Co. Pvt. Ltd., NewDelhi
Luna,R.K.1989. *Plantation forestry in India*. InternationalBookDistributors,Dehradun.
Leda Satish.2006. *Biodiesel and Jatropha Plantations*. AGROBIOS,Jodhpur.
Chaturvedi, A.N. and Khanna, L.S.1982. *Forest Menstruation*. Reprinted in 2006. International Book Distributors, Dehradun.

Negi,S.S.2006. *ForestTreeSeed*. PrashantGahlotatValleyprintersandpublishers, Dehradun.
Chundawat and S K Gautam.1996. *A text book of Agroforestry*. Oxford and IBH Publishing company Pvt.Ltd.

Course No.: NRMH 6.11	Environmental Studies and Disaster Management	Credits: 3(2+1)

Theory:

Multidisciplinary nature of environmental studies Definition, scope and importance. Natural Resources: Renewable and non-renewable resources. Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles. Ecosystems, Concept of an ecosystem. Structure and function of an ecosystem. Producers, consumers and decomposers. Energy flow in the ecosystem. Ecological succession. Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem:- a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity - habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Environmental Pollution: definition, cause, effects and control measures of - Air, Water, Soil, Marine, Noise and Thermal pollution and Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust dies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air, Water, Wildlife and Forest Conservation Acts, Issues involved in enforcement of environmental legislation and Public awareness. Human Population and the Environment: population growth, variation among nations, population explosion, Family Welfare Programme. Environment and human health: Human Rights, Value Education, HIV/AIDS. Women and Child Welfare. Role of Information Technology in Environment and human health. Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management

framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical:

Field work: Visit to a local area to document environmental assets river/forest/grassland/hill/mountain, visit to a local polluted site-Urban/Rural/Industrial/Agricultural, study of common plants, insects, birds and study of simple ecosystems-pond, river, hill slopes, etc. Study of common plants, insects, birds and animals. Visit to industries to study pollution abatement techniques and case studies - solid waste management, Human population and the Environment. Analysis of hydro chemical properties of waste water viz. pH, EC, TDS, BOD, COD, Nitrate, Phosphate, etc

Suggested Reading:

A. Nandini, N. Suneetha and Sucharitha Tandon. *Environmental Studies*.

Aswathanarayana, U. 1999. *Soil resources and the environment*. Oxford and IBH publishing Co., New Delhi. P. 173-195.

D. D. Misra. *Fundamental Concepts in Environmental Studies*.

Diwan, P. and P. Diwan. 1998. *Environmental Management Law and Administration*. Variety Books International, New Delhi.

Krishnamurthy. *An Advanced Textbook on Biodiversity*.

S. Deshwal A. Deshwal. *A Basic Course in Environmental Science.*

Erach Bharucha 2005.Textbook of environmental studies for under graduate courses.UGC, University press, Hyderabad.

Manohara Chary and Jayaram Reddy 2004.Principles of Environmental studies BB publishers, Hyderabad.

William, P. Cunning Ham and Mary Ann. Inquiry and applications Cunningham 2005.Principles of Environmental science. Tata MCG raw-hill publishing company limited, New Delhi.

Gupta, P.K. 2004 Methods in environmental analysis-water, soil and Air. Agro Bios (India). Jodhpur.

Spencer R. Weart. The discovery of global warming.

Daniel B. Botkin, Edward A. Keller. Environmental Science.

Richard T. Wright and Bernard J. Nebel Environmental science: toward a sustainable agriculture.

Linfield C.Brown. Pollution prevention and control.

BASIC SCIENCES

Course No.: BSC 1.1	Elementary Plant Biochemistry	Credits: 2(1+1)

Theory:

Carbohydrates: Occurrence classification and structure, physical and chemical properties of carbohydrates, isomerism, optical activity, reducing property, reaction with acids and alkalis, ozone formation. Lipids: Classification, important fatty acids and triglycerides, essential fatty acids. Physical and chemical control of oils, their rancidity, phospholipids, types and importance. Plant pigments – structure and function of chlorophyll and carotenoids, sterols, basic structure, role of brassino sterols in plants. Proteins: Classification, function and solubility, amino acids – classification and structure, essential amino acids, properties of amino acids, color reactions, amphoteric nature and isomerism; structure of proteins –primary, secondary tertiary and quaternary properties and reaction of proteins. Enzymes: Classification and mechanism of action; factors affecting enzyme action,

co-factors and coenzymes. Vitamins and minerals as co-enzymes/co-factors. Carbohydrate metabolism – glycolysis and TCA-cycle; metabolism of lipids, fatty acid oxidation, biosynthesis of fatty acids, electron transport chain, bioenergetics of glucose and fatty acids.

Practical:

Preparation of standard solutions and reagents; Carbohydrates: Qualitative reactions; Estimation of starch; Estimation of reducing and non reducing sugars from fruits; Amino acids: Reactions of amino acids; Proteins: Estimation of proteins by Lowry's method; Fatty acids: Estimation of free fatty acids; Determination of iodine number of vegetable oils; Vitamins: Estimation of Ascorbic acid; Techniques: Paper chromatography, Thin layer chromatography; Isolation of DNA from onions, Electrophoresis of nucleic acid from flowers, Extraction of oil from oil seeds; Enzymes: Enzyme assay.

Suggested Reading:

Lehninger, Nelson, D. L. and Michael, M. C. 2004. *Principles of Biochemistry.* Freeman Publishers

Narayanan L M. Biochemistry. Saras Publications

Bose. Developments in Physiology Biochemistry & Molecular Biology of Plants Vol.-1. New India Publications.

Voet, D and Voet J. G. 2004. Biochemistry 4th Edn. Wiley & sons Publishers. USA.

Sadashiv, S and Manickam, A. 1996. Biochemical methods for Agricultural sciences. New age Interantional publishers, New Delhi.

Voet, D. and Voet, J.G. 2004. (3rd edit). Biochemistry. John Wiley & sons Incl.USA.

Rameshwar, A. 2006. (3rd edit). Practical Biochemistry. Kalyani Publishers, NewDelhi.

Buchanan, B. B., Gruissem, W. and Jones, R. L. 2002. Biochemistry and molecular biology of plants. 2nd edition. Blackwell publications, UK.

Course No.: BSC 1.2	Principles of Genetics and Cytogenetics	Credits: 3(2+1)

Theory:

Historical background of genetics, theories and hypothesis. Physical basis of heredity, cell reproduction, mitosis, meiosis and its significance. Gametogenesis and syngamy in plants. Mendelian genetics–Mendel's principles of heredity, deviation from Mendelian inheritance, pleiotropy, threshold characters, co-dominance, penetrance and expressivity. Chromosome theory of inheritance, gene interaction. Modification of monohybrid and dihybrid rations. Multiple alleles, quantitative inheritance linkage and crossing over, sex linked inheritance and characters. Cytoplasmic inheritance and maternal effects, **Genetic code,** chemical basis of heredity, structure of DNA and its replication. Evidence to prove DNA and RNA – as genetic material. Mutations and their classification. Chromosomal aberrations, changes in chromosome structure and number.

Practical:

Study of fixatives and stains. Squash and smear techniques. Demonstrations of permanent slides and cell division, illustration in plant cells, pollen fertility and viability, determination of gametes, Solving problems of monohybrid, dihybrid, and test cross ratios using chi-square test, gene interactions, estimation of linkages using three point test cross from F_2 data and construction of linkage maps. Genetics variation in pea.

Suggested Reading:

Gardner E J, Simmons M J &Snustard D P. *Principles of Genetics (VIII Edn)*. John Wiley & Sons, New York.

Strickberger. *Genetics*. Macmillan Publishing Company, New York.

William D. Stansfield. *Theory and Problems of Genetics (3rd Ed).* Schaum's Outline series - McGraw-Hill Inc.
Benjamin Lewin. *Genes (II edn)*. John Wiley & Sons, New York.
Phundan Singh. *Elements of Genetics*. Kalyani publishers, New Delhi.
Swanson & Webster. *The Cell* (V edn). Prentice Hall of India Pvt. Ltd, New Delhi
Norman,V. Rothwell. *Understanding Genetics* (IV Ed.). Oxford University Press, Oxford.
Sinnut, Dunn & Dobzhansky. *Principles of Genetics* XIX reprint. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
Griffiths, Miller, Suzuki Lewontin & Gelbart. *An introduction to Genetic Analysis* (V *Ed.).* W.H.Freeman & Company, Newyork
Robert Schieif. *Genetics & Molecular Biology* (1986). The Benjamin/cummings publishing Co, Inc, California.
Swanson, Merz & Young. *Cytogenetics* (II ed.). Prentice Hall of India Pvt. Ltd. New Delhi.
Joseph Jahier& INRA working group. *Techniques of Plant Cytogenetics* (1986). Oxford & IBH Publishing Co Pvt.Ltd., New Delhi
Loewy & Siekevitz. *Cell Structure & Function* (II Ed.). Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.
Stent & Calendar. *Molecular Genetics* (II Ed.). CBS Publishers, New Delhi
Singh B D. *Fundamentals of Genetics*. Kalyani Publishers, New Delhi
Srivastava&Tyagi. *Selected Problems in Genetics* (Vol.1-3). Anmol Publications Pvt. Ltd., New Delhi
Khanna VK. Genetics–*Numerical Problems*. Kalyani Publishers, New Delhi.
Farook& Khan. *Genetics & Cytogenetics* (I Ed.). Premier Publishing House, Hyderabad.
Shukla. *Cell Biology* (2001). Dominant publishers, New Delhi
George Acquaah. *Principles of Plant Genetics and Breeding*. Blackwell
B.D. Singh. *Fundamental of Genetics*. Kalyani. India
Gupta, P.K. 1985.*Cytology, genetics and cytogenetics*. Rastogi Publication, India.

Course No.: BSC 1.3	**Introductory Microbiology**	**Credits: 2(1+1)**

Theory:

History and Scope of Microbiology: The discovery of micro-organism, spontaneous generation conflict, germ theory of diseases, microbial effect on organic and inorganic matter. Development of microbiology in India and composition of microbial world. Microscopy and Specimen Preparation: The bright field microscope, fixation, dyes and simple staining, differential staining. Difference between prokaryotic and eukaryotic cells. Prokaryotic cell structure and functions. Types of culture media and pre-culture techniques. Microbial growth in models of bacterial, yeast and mycelia growth curve. Measurement of bacterial growth. General properties of viruses and brief description of bacteriophages. General principle of bacterial genetics, DNA as genetic material. Antibiosis, symbiosis, intra-microbial and extra-microbial association. Sterilization methods – Physical and chemical, Isolation of pure cultures and preservation of cultures, Plant growth promoting microorganisms and mushrooms – Economical importance, Industrially important microorganisms in large scale production and common microbial fermentations. Mushrooms- edible and poisonous types, nutritive values Culturing and production techniques.

Practical:

Examination of natural infusion and living bacteria; examination of stained cells by simple staining and Gram staining. Methods for sterilization and nutrient agar preparation. Broth culture, agar slopes, streak plates and pour plats, turbid metric estimation of microbial growth, mushroom culture- Spawn production, Culture and production techniques, harvesting, packing and storage.

Suggested Reading:

M T Madigan, and J M Martinko, 2014. *Brock Biology of Microorganisms* 14th Edn. Pearson.
M J Pelczer, 1998. *Microbiology* 5th Edn. Tata McGrow Hill Education Pvt. Ltd.
Stainer, R, 1987. *General Microbiology*. Palgrave Macmillan.
Edward Alchano, 2002. *Introduction to Microbiology.* Jones and Bartlett hearing.
R P Singh, 2007. *General Microbiology*. Kalyani Publishers.
J Heritage, E G V Evans, R A Killington, 2008. *Introductory Microbiology*. Cambridge University press P. date.
Pelczar, jr. M.J.E.C.S.Chan and Krieg, N.R. 1996. *Microbiology*. Mc Graw Hill Publishers, Newyork.
Prescott, L.M. Harley, J.P. and Klein, D.A (5ed) 2002. *Microbiology*. Mc Graw Hill Publishers, Newyork.
Madigan, M. Martinkoj, M. and Parker (10 ed.) 2003. *Biology of Microorganisms*. Prentice Hall of India Pvt. Ltd., New Delhi.
Jamaluddin, M. Malvidya, N. and Sharma, A. 2006. *General Microbiology*. Scientific Publishers, Washington.
Sullia, S.B, and Shantaram 1998. *General Microbiology*. Oxford and IBH.

Course No.: BSC 2.4	Introductory Crop Physiology	Credits: 2(1+1)

Theory:

Water Relations in Plants: Role of water in plant metabolism, osmosis, imbitions, diffusion, water potential and its components, measurement of water potential in plants, absorption of water, mechanism of absorption and ascent of sap. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, guttation, stem bleeding; transpiration methods and mechanism and factors affecting transpiration. Drought: Different types of stresses; water, heat and cold tolerance; mechanism of tolerance. Plant Nutrition: Essentiality, mechanism of absorption and its role in plant metabolism. Biological Nitrogen Fixation, Photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and non-cyclic electron transfer, CO2 fixation – C3, C4 and CAM metabolism, advantages of C4 pathway. Photorespiration and its implications, factors affecting photosynthesis. Mode of herbicide action, Secondary metabolites and plant defence.

Practical:

Measurement of water potential, osmosis, root pressure, structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpirational pull demonstration. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops and studying the enzyme activity of catalase, estimation of phenols, studying plant movements, root initiation in cuttings.

Suggested Reading:

Salisbulry. 2007. *Plant Physiology.* CBS. New Delhi.
Taiz, L. 2010.Plant Physiology. SINAUR. USA.
Zeiger. 2003.Plant Physiology. PANIMA. New Delhi.
Edward E. Durna. 2014. Principles Of Horticultural Physiology. CABI, UK.
Delvin, R.M . 1986. Plant Physiology. CBS. Delhi.
Richard, N. Arteca. 2004. Plant Growth Substances. CBS. New Delhi.
Jacobs, W. P. 1979. Plant Hormones And Plant Development. Cambridge Univ. London.
Basra, A. S. 2004. Plant Growth Regulators in Agriculture & Horticulture. HAWARTH press. New York.
Lincoln Taiz and Eduards Zeiger (5th Edition). Plant physiology

Noggle G.R and Fritz T.G. Introductory Plant Physiology
Pandey and Sinha. Plant Physiology
Salisbury and Ross. Plant Physiology
Carl fedtke. Biochemistry and Physiology of Herbicide Action
Aswani pareek, S.K. Sopory, Hans Bohnert Govindjee. Abiotic stress adaptation in plants: Physiological, Molecular and Genomic foundation
Horst Marschner, Mineral Nutrition of Higher plants

Course No.: BSC 2.5	Principles of Plant Breeding	Credits: 3(2+1)

Theory:

Plant breeding as a dynamic science, genetic basis of Plant Breeding – classical, quantitative and molecular, Plant Breeding in India – limitations, major achievements, goal setting for future. Sexual reproduction (cross and self-pollination), asexual reproduction, pollination control mechanism (incompatibility and sterility and implications of reproductive systems on population structure). Genetic components of polygenic variation and breeding strategies, selection as a basis of crop breeding and marker assisted selection Hybridization and selection – goals of hybridization, selection of plants; population developed by hybridization – simple crosses, bulk crosses and complex crosses. General and special breeding techniques. Heterosis – concepts, estimation and its genetic basis. Calculation of heterosis, heterobeltosis, GCA, SCA, inbreeding depression, heritability and genetic advance. Emasculation, pollination techniques in important horticultural crops. Breeding for resistance of biotic and abiotic stresses. Polyploidy breeding. Mutation breeding.

Practical:

Breeding objectives and techniques in important horticultural crops. Floral biology – its measurement, emasculation, crossing and selfing techniques in major crops. Determination of mode of reproduction in crop plants, handling of breeding material, segregating generations (pedigree, bulk and back cross methods), Field layout, and maintenance of experimental records in self and cross pollinated crops. Demonstration of hybrid variation and production techniques. Hardy Weinberg Law and calculation, male sterility and incompatibility studies in horticultural crops calculation of inbreeding depression, heterosis, heterobeltioses, GCA, SCA, GA, heritability.

Suggested Reading:

R.W. Allard. *Principles of plant breeding*. John Wiley & Sons, New York**.**
V.L. Chopra. *Plant breeding: Theory and Practice.* Oxford & IBH Publishing CO. Pvt. Ltd., New Delhi.
Phundan Singh. *Essentials of plant breeding*. Kalyani Publishers
J.R. Sharma. *Principles and practices of plant breeding*. Tata McGraw Publishing Company Ltd., New Delhi
B.D. Singh. *Plant breeding : principles and methods*. Kalyani Publishers, Ludhiana.
R.C. Chaudhary. *Plant Breeding*
Hays and Garber. *Breeding crop plants*. Mc Graw Hill Publications, New York
G K Kallo. *Breeding of vegetables*. Panima publishers, New Delhi
W.R. Fehr. *Principles of cultivar development: theory and technique (Vol. 1).* Macmillan Publishing Company, New York.
D.S. Falconer. *Introduction to quantitative genetics*. Longman Scientific & Technical, Longman Group, UK, Ltd., England.
R.K. Singh and B.D. Chaudhary. *Biometrical methods in quantitative genetic analysis.* Kalyani Publishers, Ludhiana.
K. Mather and J.L Jinks. *Introduction to Biometrical genetics*. Chapman and Hall, London
B D Singh. *Fundamental of Plant breeding*. Kalyani. India.

Pundan Singh. *Essentials of plant breeding*. Kalyani. India
G. S. Chahal and S.S. Gosal. 2002. *Principles and Procedures of Plant Breeding*. Narosa Publishing House, New Delhi.
Poehlman, J.M. and Borthakar, D. 1995. *Breeding Asian Field Crops*. Oxford& IBH Publishing Co., New Delhi

Course No.: BSC 3.6	Elementary Plant Biotechnology	Credits: 2 (1+1)

Theory:

Concepts of Plant Biotechnology: History of Plant Tissue Culture and Plant Genetic Engineering; Scope and importance in Crop Improvement: Totipotency and Morphogenesis ,Nutritional requirements of in-vitro cultures; Techniques of In-vitro cultures, Micropropagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture; Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications in crop improvement. Structure and function of nucleic acid replication, transcription and translation, Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants and their applications. Blotting techniques – DNA finger printing – DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in crop improvement. Nanotechnology: Definition and scope, types of nano material and their synthesis, green synthesis. Tools and techniques to characterize the nano particles. Nano-biotechnological applications with examples, Nano toxicology and safety.

Practical:

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of PCR and Restriction digestion technique. Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods.

Suggested Reading:

Singh, B D, 2004. *Biotechnology Expanding Horizons* 2nd Edn. Kalyani Publishers, New Delhi.
Gupta, P.K., 2015. *Elements of Biotechnology* 2nd Edn. Rastogi and Co., Meerut.
Razdan M K, 2014. *Introduction to plant Tissue Culture* 2nd Edn. Science Publishers, inc. USA.
Gautam V K, 2005. *Agricultural Biotechnology*. Sublime Publications
Thomar, R.S., Parakhia, M.V., Patel, S.V. and Golakia, B.A., 2010. *Molecular markers and Plant biotechnology*, New Publishers, New Delhi.
Purohit, S.S., 2004. *A Laboratory Manual of Plant Biotechnology* 2nd Edn. Agribios, India.
Singh, B.D. 2012. *Plant biotechnology*. Kalyani publishers, Ludhiana
Bilgrami, K.S. and Pandey, A.K.1992. *Introduction to biotechnology*. CBS Pub. New Delhi
Gupta, P.K. 1994. *Elements of biotechnology*. Rastogi Pub. Meerut.
Chahal, G.S. and Gosal, S.S.2003. *Principles and procedures of plant approaches breeding Biotechnological and conventional*. Narosa Publishing House, New Delhi

Course No.: BSC 3.7	Growth and Development of Horticultural Crops	Credits: 2 (1+1)

Theory:

Growth and development-definitions, components, photosynthetic productivity, Canopy photosynthesis and productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, Crop development and dynamics (Case studies of annual/perennial horticultural crops), growth analysis in horticultural crops. Plant bio-regulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop, and fruit ripening. Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neutral plants, vernalisation and its application in horticulture, pruning and training physiological basis of training and pruning-source and sink relationship, translocation of assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climacteric and non-climacteric fruits. Physiology of fruits under post-harvest storage.

Practical:

Estimation of photosynthetic potential of horticultural crops, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, identification of synthetic plant hormones and growth retardants, preparations of hormonal solution and induction of rooting in cuttings, ripening of fruits and control of flower and fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables, rapid tissue test, seed dormancy, seed viability by tetrazolium test, seed germination and breaking seed dormancy with chemicals and growth regulators.

Suggested Reading:

Salisbulry. 2007. *Plant Physiology.* CBS. New Delhi.

Taiz, L. 2010.Plant Physiology. SINAUR. USA.

Zeiger. 2003.Plant Physiology. PANIMA. New Delhi.

Edward E. Durna. 2014. Principles of Horticultural Physiology. CABI, UK.

Delvin, R.M . 1986. Plant Physiology. CBS. Delhi.

Richard, N. Arteca. 2004. Plant Growth Substances. CBS. New Delhi.

Jacobs, W. P. 1979. Plant Hormones And Plant Development. Cambridge Univ. London.

Basra, A. S. 2004. Plant Growth Regulators In Agriculture & Horticulture. HAWARTH press. New York.

Lincoln Taiz and Eduards Zeiger (5th Edition). Plant physiology. Sinauer Associates, Inc.

Noggle G.R and Fritz T.G.1944. Introductory Plant Physiology.

Pandey and Sinha. Plant Physiology.

JKA Bleasdale, Plant Physiology in relation to Horticulture

Amarjit Basra, Plant Growth Regulators in Agriculture and Horticulture: Their role & Commercial Uses

C.Rajendran, K.Ramamoorthy and S. Juliet Hepziba, Nutritional and Physiological Disorders in Crop Plants

SOCIAL SCIENCES

Subject: **Agricultural Statistics**

Course No.: SSC 1.1	Information and Communication Technology	Credits: 2(1+1)

Theory:

IT and its importance. IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; word and character representation; features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Teleconferencing; ICT in Extension education, ICT use in rural India.

Practical:

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of horticulture data using MS Excel. Demonstration of video conferencing / teleconferencing system.

Suggested Readings:

Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. *Fundamentals of Computer Programming and Information Technology.* Kalyani Publishers.

Harshawardhan P. Bal. 2003. *Perl Programming for Bioinformatics*. Tata McGraw-Hill Education.

Kumar A 2015. *Computer Basics with Office Automation*. IK International Publishing House Pvt Ltd.

Rajaraman V & Adabala N. 2015. *Fundamentals of Computers*. PHI.

Subject: Agricultural Economics

Course No.: SSC 1.2	Economics and Marketing	Credits: 3(2+1)

Theory:

Nature and scope of economics, definition and concepts, divisions of economics, economic systems, approaches to the study of economics. Consumption – theory of consumer behaviour, laws of consumption, classification of goods. Wants – their characteristics and classification, utility and its measurement, cardinal and ordinal, law of diminishing marginal utility, law of equi-marginal utility, indifference curve and its properties, consumer equilibrium. Theory of demand, demand schedule and curve, market demand. Price, income and cross elasticities, Engel's law of family expenditure – consumer's surplus. Theory of firm, factors of production – land and its characteristics, labour and division of labour, theories of population. Capital and its characteristics – classification and capital formation. Enterprises – forms of business organization – merits and demerits. Laws of return – law of diminishing marginal return – cost concepts. Law of supply – supply schedule and curve elasticities. Market equilibrium, distribution – theories of rent, wage, interest and profit. Price determination and forecasting under various market structures. Marketing- definition – Marketing Process – Need for marketing – Role of

marketing — Marketing functions – Classification of markets – Identification of various marketing channels – Price spread – Marketing Efficiency –Integration – Constraints in marketing of horticultural/agricultural produce. Market intelligence.

Practical:

Demand and supply analysis, Farm cost concept and calculation.Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets. Exercise on market integration and marketing efficiency.

Suggested Reading:

H L Ahuja. S. Chand and Company Limited. *Advanced Economic Theory*. Micro Economic Analysis.

Chandra P. 1984. *Projects: Preparation, Appraisal & Implementation*. McGraw Hill Inc.

Dewett, K.K. and Chand, A.1979. *Modern Economic Theory*. S.Chand and Co., New Delhi

Dewett, K.K. and Varma, J.D. 1986. Elementary Economics. S.Chand and Co., New Delhi.

Gupta RD & Lekhi RK. 1982. Elementary Economic Theory. Kalyani Publishers. Kotler Philip and Armstrong. Principles of Marketing. Prentice-Hall.

Jhingan, M.L. 2012. Macro Economic Theory. Vrinda publishers, New Delhi .

Kotler Philip and Armstrong. Principles of Marketing. Prentice-Hall.

SS Acharya and N L Agarwal. 2005. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd

Sampat Mukherjee. 2002. *Modern Economic Theory*. New Age International.

Subba Reddy, S., Raghu ram, P., Neelakanta Sastry T.V., Bhavani Devi. I., 2010, *Agricultural Economics*, Oxford & IBH Publishing Co. Private Limited, New Delhi

Willium J. Stanton. 1984. *Fundamentals of Marketing*. Tata McGraw-Hill Publication, New Delhi.

C.N. Sontakki. Marketing Management. Kalyani Publishers, New Delhi.

John Daniels, Lee Radebaugh, Brigham, Daniel Sullivan. International Business, 15th Ed., Pearson Education

Aswathappa. International Business. Tata McGraw-Hill Education, New Delhi

Fransis Cherunilam. International Business: Text and Cases, 5th Ed. PHI Learning, New Delhi.

Prasanna Chandra. Projects. Tata McGraw-Hill Pu blication, New Delhi

John M. Nicholas. *Project Management for Business and Technology* – Principles and Practices. Pearson Prentice Hall

Harold Kerzner. Project Management – A System Approach to Planning, Scheduling, *and Controlling.* CBS Publishers & Distributors.

Prasanna Chandra. *Projects – Planning, Analysis, Selection, Financing, Implementation, and Review.* Tata McGraw-Hill Publishing Company Ltd.

P. Gopalakrishnan and V.E. Rama Moorthy. *Textbook of Project Management*. Macmillan.

Course No.: SSC 1.3	Physical and Health Education (NC)	Credits: 1(0+1)

Practical:

Physical Education: Introduction to physical education. Posture, exercise for good posture, physical fitness exercises for agility, strength, coordination, endurance and speed. Rules are regulations of important games, skill development in any one of the games – football, hockey, cricket, volleyball, ball badminton, throw ball, tennikoit. Participation in one of the indoor games – shuttle badminton, chess and table tennis. Rules and regulations of athletic events, participation in any one of the athletic events – broad jump, high jump, triple jump, javelin throw, discuss throw, shot put, short and long distance running, Safety education, movement education, effective way of doing day-today activities. First-aid

training, coaching for major games and indoor games. Asans and indigenous ways for physical fitness and curative exercises. Exercises and games for leisure time, use and experience. Importance of Asanas and Surya namaskar. Free hand exercises and Yoga. Recreation: definition, agencies promoting recreation, camping and recreation. Note: Warming up and conditioning exercises are compulsory before the commencement of each class.

Suggested Reading:

O.P. Aneja. Encyclopaedia of Physical education, sports and exercise science (4 volumes).
Anil Sharma. Encyclopaedia of Health and Physical Education (7 Volumes).
N V Chaudhery, R Jain. Encyclopedia of Yoga Health and Physical Education (7 Volumes).
Pintu Modak, O P Sharma, Deepak Jain. Encyclopaedia of Sports and Games with latest rules and regulations (8 volumes).
Edwin F Bryant. Yoga sutrap of Patanjali.

Subject: Agricultural Statistics

Course No.: SSC 2.4	Elementary Statistics and Computer Application	Credits: 3(2+1)

Theory:

Introduction to statistics, limitations of statistics. Basic concepts: Variable statistics, types and sources of data, classification and tabulation of data, construction of frequency distribution, tables, graphic representation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve average and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and quadrilles, for raw and grouped data. Dispersion: Range, standard deviation, variance, standard error of mean, coefficient of variation for raw and grouped data. Probability: Basic concept, additive and multiplicative laws. Theoretical distributions, binominal, poisson and normal distributions, sampling, basic concepts, sampling vs. complete enumeration parameter and statistic, sampling methods, simple random sampling and stratified random sampling. Tests of Significance: Basic concepts, tests for equality of means, and independent and paired t-tests, chi-square test for application of attributes and test for goodness of fit of Mendalian ratios. Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of simple linear regression, test of significance of correlation and regression coefficient. Experimental designs: Basic concepts, completely randomized design, randomized block design, latin square design, factorial experiments, basic concepts, analysis of factorial experiments up to 3 factors – split plot design, strip plot design, long term experiments, plot size, guard rows.

Computer application: for calculation of various measures of central tendency, various measures of dispersion, correlation coefficient, regression coefficient, graphical presentation of data, t-test, chi-square test, completely randomized design, randomized block design.

Practical:

Construction of frequency distribution table and its graphical representation, histogram, frequency polygon, frequency curve, bar chart, simple, multiple, component and percentage bar charts, pie chart, mean, mode for row and grouped data, percentiles, quadrille, and median for row and grouped data, coefficient of variation, ‘t’ test for independent, with equal and unequal variants, paired ‘t’ test, chi-square test for contingency tables and theoretical ratios, correlation and linear regression. Studies on computer for calculation of various measures of central tendency, various measures of dispersion, correlation coefficient,

regression coefficient, graphical presentation of data, t-test, chi-square test, completely randomized design, and randomized block design.

Suggested Reading:

Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan chand and sons. New Delhi

NageswaraRao,G.2007.*Statisticsfor AgriculturalSciences*. BSPublications,Hyderabad.

Rangaswamy,R.1995.*ATextBookofAgriculturalStatistics*. NewAgeInternationalPublishingLimited, Hyderabad.

Gupta, V.,2002. *ComdexComputerKit*. DreamTechPress,NewDelhi.

Parmar,A.Mathur,N.DeeptiP.U.andPrasanna, V. B.,2000.*WorkingwithWINDOWS A HandsonTutorials*. TataMcGrawHillPublishingCo.,NewDelhi.

Bandari, V. B., 2012. *Fundamentals of Information Technology*. Pearson Education,New Delhi.

Fundamentals of Computers. 2011. Pearson Education-ITL ESL, New Delhi,

Subject: ENGLISH

Course No.: SSC 2.5	Communication Skills and Personality Development	Credits: 2 (1+1)

Theory:

Structural Grammar: Introduction of Word Classes; Structure of Verb in English; Uses of Tenses; Study of Voice; Study of Conjunctions and Prepositions; Sentence Patterns in English. Spoken English: Conversations of different situations in everyday life; the concept of stress; stress shift in words and sentences; silent letters in words and pronunciation of words with silent letters, the basic intonation patterns. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical:

Structural Grammar: Exercises in word classes, identification and study of verbs in sentences, application of tenses and voice, exercises in conjunctions and prepositions, other structural grammar exercises, report writing, letter writing (different types of letters). Spoken English: Conversations of everyday life, the concept of stress; stress shift. Silent letters in words, basic intonation patterns, preparing and address.

Suggested Reading:

Balasubramanian T. 1989. *A Text book of Phonetics for Indian Students*. Orient Longman, New Delhi.

Balasubrmanyam M. 1985. *Business Communication*. Vani Educational Books, New Delhi.

Naterop, Jean, B. and Rod Revell. 1997. *Telephoning in English*. Cambridge University Press, Cambridge.

Mohan Krishna and Meera Banerjee. 1990. *Developing Communication Skills*. Macmillan India Ltd. New Delhi.

Krishnaswamy,. N and Sriraman, T. 1995. *Current English for Colleges*. Macmillan India Ltd. Madras.

Narayanaswamy V R. 1979. *Strengthen your writing*. Orient Longman, New Delhi.

Sharma R C and Krishna Mohan. 1978. *Business Correspondence*. Tata Mc Graw Hill publishing Company, New Delhi.

Carnegie, Dale. 2012. *How to Win Friends and Influence People in the Digital Age*. Simon & Schuster.

Covey Stephen R. 1989. *The Seven Habits of Highly Successful People*. Free Press.
Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. *Human Communication: Motivation, Knowledge & Skills*. Wadsworth.
Verma, KC. 2013. *The Art of Communication.* Kalpaz.
Dr. T. Bharati, Dr. M. Hariprasad and Pro. V. Prakasam, Personality Development and Communicative English. Neelkamal Publications Pvt. Ltd, New Delhi.
Wren and Martin, S. Key to High School English Grammar and Composition- Chand and Company Ltd., New Delhi
Wren and Martin, S. High School English Grammar and Composition- Chand and Company Ltd., New Delhi
Raymond Murphy, English Grammar in Use. Cambridge University Press
The Official Guide to the TOEFL Test-IV Edition, Educational Testing Services. Mc Graw Hill, New Delhi.
Balasubramanyam,M.1985. Businesscommunication. VaniEducationalBooksAnsariroad,NewDelhi.
KrishnaMohanandMeeraBanerjee1990. DevelopingCommunicationSkills. MacmillanIndiaLtd.

Course No.: SSC 2.6	National Service Scheme/National Cadet Corps (NC)	Credits:1(0+1)

Practical:

NSS: Orientation of students in national problems, study of philosophy of NSS, fundamentals rights, directive principles of state policy, socio-economic structure of Indian society, population problems, brief of five year plan. Functional literacy, non-formal education of rural youth, eradication of social evils, awareness programmes, consumer awareness, highlights of consumer act. Environment enrichment and conservation, health, family welfare and nutrition. NCC: Introduction to NCC, defense services, system of NCCtraining, foot drill, sizing, forming up in three ranks, open and close order march, dressing, getting on parade, dismissing and falling out, saluting, marching, arms drill, shoulder arm, order arm, present arm, guard of honour, ceremonial drill, weapon training – rifle bayonet, light machine gun, sten machine carbine, introduction and characteristic stripping, assembling and cleaning, loading, unloading and firing. Field craft, visual training, targets, judging distance, fire discipline and fire control orders, battle craft, field signals, description of ground, section formation, section battle drill, scouts and patrols, ambush, field engineering, map reading, conventional signs, grid systems, use of service protractor, prismatic compass and its use, self-defense, general principles, precautions and training, attacks and counter attacks, marching and searching, first aid, hygiene and sanitation, civil defense, leadership and NCC song**.**

Subject: **AGRICULTURAL EXTENSION EDUCATION**

Course No.: SSC 5.7	Fundamentals of Extension Education	Credits: 2(1+1)

Theory:

Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Horticulture extension: process, principles and selected programmes of leading national and international horticultural / forest institutes. People's participation in Horticulture programmes. Motivation of Farmers, rural youth and voluntary organizations for Horticulture extension work Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national

demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP), ATMA, ATIC, NHM, NABARD etc. of ICAR. Communication: meaning, definition, elements and selected models and process. Audio – visual aids: importance, classification and selection. Adoption and diffusion process, Teaching and learning-concepts and principles, Teaching steps, Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA). rural leadership.

Practical:

Visits to study structure, functions, linkages and extension programmes of ICFRE institutes/voluntary organizations/Mahila Mandal, Village Panchayat, State Dept. of Horticulture /All India Radio (AIR). Exercises on distortion of message, script writing for farm broadcasts and telecasts, planning, preparation & use of NPVA like poster, chart, flash cards, folders etc. and AVA like PA system, LCD projector, OHP & 35 mm slide projector transparencies. Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of horticultural / forestry extension programmes. Preparation of Village Agricultural productions plan.

Suggested Reading:

Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.

Dahama, O. P. and Bhatnagar, O.P., 1998, *Education and Communication for Development*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.

Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.

Muthaiah Manoraharan, P. and Arunachalam, R., *Agricultural Extension*, Himalaya Publishing House (Mumbai).

Sagar Mondal and Ray, G. L., *Text Book On Rural Development, Entrepreneurship And Communication Skills*, Kalyani Publications.

Rathore, O. S. *et al.*, 2012, *Handbook of Extension Education*, Agrotech Publishing Academy, Udaipur.

Ray, G. L., 1991 (1st Edition), *Extension Communication and Management*, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.

Supe, S. V., 2013 (2nd Edition), *A Text Book of Extension Education*, Agrotech Publishing Academy, Udaipur.

Van Den Ban, A. W. and Hawkins, H. S., *Agricultural Extension*, S. K .Jain for CBS Publishers & Distributors, New Delhi.

M Hilaris Indian agriculture and information: Soundari, New century Publications, 2011and communication technology (ICT)

Subject: **Agricultural Economics**

Course No.: SSC 6.8	**Horti-Business Management**	**Credits: 2(2+0)**

Theory:

Farm management - definition, nature, characteristics and scope. Farm management principles and decision making, production function, technical relationships, cost concepts, curves and functions – factors, product, relationship – factors relationship, product relationship, optimum conditions, principles of opportunity cost-equi-marginal returns and comparative advantages, time value of money, economic of scale, returns to scale, cost of cultivation and production, break even analysis, decision making under risk and uncertainty. Farming systems and types. Planning – meaning, steps and methods of planning, types of plan, characteristics of effective plans. Organizations – forms of business organizations,

organizational principles, division of labour. Unity of command, scalar pattern, job design, span of control responsibility, power authority and accountability. Direction – guiding, leading, motivating, supervising, coordination – meaning, types and methods of controlling – evaluation, control systems and devices. Budgeting as a tool for planning and control. Record keeping as a tool of control. Management and administration: meaning, definition, principles and functions. Functional areas of management – operations management – physical facilities, implementing the plan, scheduling the work, controlling production in terms of quantity and quality. Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Personnel management – recruitment, selection and training, job specialization. Marketing management – definitions, planning the marketing programmes, marketing mix and four P's. Financial management – financial statements and ratios, capital budgeting. Bank norms – Insurance.

Suggested Reading:

Heady Earl O and Herald R. Jenson,1954, *Farm Management Economics*. Prentice Hall, New Delhi

S.S. Johl, J.R. Kapur ,2006, *Fundamentals of Farm Business Management*.

Kalyani Publishers, New Delhi

Karan Singh and Kahlon A S. *Economics of Farm Management in India*. Theory and Practice. New Delhi. Allied

L.M. Prasad. 2001. *Principles and Practices of Management*, 9th Ed. S. Chand & Sons, New Delhi.

Koontz Harold. *Principles of Managemen*t. Tata McGraw-Hill Education Private Limited, New Delhi.

P.C. *Thomas. Managerial Economics*, 9th Ed. Kalyani Publishers.

K.K. Dewett and M.H. Navalur. *Modern Economic Theory*. S. Chand & Sons, New Delhi.

P. Subba Rao. *Human Resource Management*. Himalaya Publications.

S.P. Jain. *Financial Accounting*. Kalyani Publications, Ludhiana.

Shapiro E. *Macroeconomic analysis*. Galgotia Publications Delhi

Barry P J, Hopkins J A and Baker C B. *Financial Management in Agriculture*, 6th ed. Danville, IL Interstate Publishers.

Gittiner, J P., *Economic analysis of agricultural projects*. The John Hopkins University Press Baltimore, USA, 1982

Benjamin Mc Donald P 1985. *Investment Projects in Agriculture- Principles and Case studies*. Longman Group Limited. Essex. UK

Pandey U K 1990. *An Introduction to Agricultural Finance* .Kalyani Publishers New Delhi.

Subject: **Agricultural Extension Education**

Course No.: SSC 6.9	**Entrepreneurship Development and Business Management**	**2(1+1)**

Theory:

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Supply chain management

and total quality management. Overview of horti inputs industry. Characteristics of Indian horticultural processing and export industry. Social Responsibility of Business. Communication Skills: meaning and process of communication, verbal and non-verbal communication; Types of entrepreneur, National level entrepreneurship development institutes, role of financial institutions for funding enterprises

Practical:

Conducting market survey to the demand for product, preparing advertisements for popularization of product, news writing, preparing project proposals, individual, group presentation, features of oral presentation, presentation, evaluation of presentation and evaluation of sheet, dyadic communication-face to face conversation, telephone conversation, rate of speech and clarity of voice, speaking and listening politeness, telephone etiquettes, organising general and group meeting, salient features of participation in seminars and conferences, conducting and participating in mock interviews.

Study of preparing balance sheet, SWOT analysis of an enterprise, Visit to Successful Entrepreneur/ enterprises. Preparation of project report.

Suggested Reading:

Benjamin MC Donald P. 1985, *Investment Projects in Agriculture- Principles and Case studies*. Longman Group Limited. Essex. UK.

Chole, R. R. *et al.*, 2012, *Entrepreneurship Development and Communication skills*, Scientific publishers, Jodhpur.

Gittiner, J P., 1982, *Economic Analysis of Agricultural Projects*, The John Hopkins University Press Baltimore, USA.

Hopkins J A and Baker C B Danville, *Financial Management in Agriculture*, 6th ed Barry P J, IL Interstate Publishers.

Kotler Philip and Armstrong, *Principles of Marketing*. Prentice-Hall.

Pandey U. K., *An Introduction to Agricultural Finance.*

Sagar Mondal and G. L. Ray, *Text Book on Rural Development, Entrepreneurship and Communication Skills,* Kalyani Publications.

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IX. STUDENT READY-EXPERIMENTAL LEARNING PROGRAMME/ ELP+RHWE 40 (0+40)

Practical:

Students will practically gain hands on expertise for a semester in any two options out of commercial horticulture, protective cultivation of high value horticulture crops, processing of fruits and vegetables for value addition, floriculture and landscape gardening, production of bioinputs-biofertilizers and biopesticides, mass multiplication of plants and bio-molecules through tissue culture, mushroom culture and bee keeping. In one semester students will be working with horticulture farmers/horticulture based industries in collaboration with developmental departments, extension functionaries, input suppliers, marketing and procurement functionaries, processing industries.

1) EXPERIENTIAL LEARNING PROGRAMME 20 (0+20)

1. **Module-I. Protected Cultivation of high Value Horticulture Crops (0 + 10)**:

HWE 7.1.1	Production of High Valued Crops	0+6
HWE 7.1.2	Packing and Marketing of High valued Horticultural Crops	0+4

Visit to commercial polyhouses, Project preparation and planning. Specialised lectures by commercial export house. Study of designs of green- house structures for cultivation of crops. Land preparation and soil treatment. Planting and production: Visit to export houses; Market intelligence; Marketing of produce; cost analysis; Visit to export houses; Market intelligence; Marketing of produce; cost analysis; institutional management. Report writing and viva-voce.

2. **Module-II. Commercial production of Horticultural planting materials (0 + 10)**:

HWE 7.2.1	Propagation and production of propagules	0+6
HWE 7.2.2	Packing and Marketing of planting materials	0+4

Nursery production of fruit crops: Raising of rootstocks, grafting and budding of rootstocks, management of grafted plants, plant certification, packaging and marketing, quality control. Nursery production of ornamentals: Production of plantlets, production of potted plants, management and maintenance, sale and marketing. Protected cultivation of vegetables and flowers: Nursery raising/procurement and transplanting, management and maintenance of the crop, postharvest handling, quality control and marketing.

3. **Module-III. Post Harvest Handling and Value addition in Horticultural crops (0 + 10)** :

HWE 7.3.1	Preparation and evaluation of processed products	0+6
HWE 7.3.2	Packing and Marketing of processed products	0+4

Planning and execution of a market survey, preparation of processing schedule, preparation of project module based on market information, calculation of capital costs, source of finance, assessment of working capital requirements and other financial aspects, identification of sources for procurement of raw material, production and quality analysis of fruits and vegetables products at commercial scale, packaging, labelling, pricing and marketing of product.

4. **Module-IV. Floriculture and landscape architecture (0 + 10)**:

HWE 7.4.1	Planning, Layout and Design of landscape	0+6
HWE 7.4.1	Consultancy and maintenance of garden	0+4

Preparation of project report, soil and water analysis, preparation of land and layout. Production and Management of commercial flowers. Harvesting and postharvest handling of produce. Marketing of produce, Cost Analysis, Institutional Management, Visit to Flower growing areas and Export House, Attachment with private landscape agencies. Planning and designing, site analysis, selection and use of plant material for landscaping. Formal and informal garden, features, styles, principles and elements of landscaping. Preparation of landscape plans of home gardens, farm complexes, public parks, institutions, high ways, dams and avenues. Making of lawns, use of software in landscape. Making of bouquets, button hole,

wreath, veni and gazaras, car and marriage palaces. Dry flower Technology (identification of suitable species, drying, packaging and forwarding techniques).

5. **Module-V. Mass multiplication through tissue culture in horticultural crops (0 + 10)**:

HWE 7.5.1	Production of tissue culture plants	0+6
HWE 7.5.2	Packing and Marketing of tissue culture plants	0+4

Preparation of sock solutions of tissue culture media. Preparation of solid media and liquid media. Initiation of in vitro culture and multiplication (preparation of explant, inoculation and culturing) (crop to selected). Sub-culturing, Hardening and establishment, Initiation of callus cultures – suspension cultures, Induction of selected biomolecules in callus, Harvesting and extraction of biomolecule, Marketing and cost analysis.

6. **Module-VI. Bio-inputs: Bio-fertilizers and bio-pesticides (0 + 10)**:

HWE 7.6.1	Production technology of bio fertilizers and bio pesticides	0+6
HWE 7.6.2	Packing and Marketing of bio fertilizers and bio pesticides	0+4

Isolation and pure culture establishment of fertilisers and bio-pesticides. Culture methods and substrates. Scale of methods for bio-fertilizers and bio-pesticides. Substrate preparation and mixing techniques. Quality analysis of bio-fertilizers and bio-pesticides. Testing the final product in small scale level. Storage, marketing and cost analysis of bio-fertilizers and pesticides.

Evaluation system for ELP

Work performance - 40 marks, Report writing & presentation – 20 marks and Semester End exam - 40 marks

2) RURAL HORTICULTURAL WORK EXPERIENCE PROGRAMME (0+20)

Sr. No.	Course No.	Title	Credit
1	RHWE 8.1	Visit to progressive farmer's field and NGO	0+2
2	RHWE 8.2	Educational tour	0+2
3	RHWE 8.3	University farms (JAU) and Visit to horticulture based industries of Saurashtra region	0+4
4	RHWE 8.4	University farms (AAU) and Visit to horticulture based industries of Middle Gujarat region	0+4
5	RHWE 8.5	University farms (SDAU) and Visit to horticulture based industries of North Gujarat region	0+4
6	RHWE 8.6	University farms (NAU) and Visit to horticulture based industries of South Gujarat region	0+4

Evaluation system for RHWE : Work performance - 25 marks, Report writing & presentation – 25 marks and Semester End exam - 50 marks

Examination and Evaluation System (Faculty of Horticulture)

1. **Examination (100 %)**
   - **Internal Theory as well as Internal Practical (50 %)**
   - **External theory (50 %)**

No	Nature of Exam/ Categories of Courses	Courses with theory and practical		Courses with theory only		Courses with practical only	
		Marks	Duration	Marks	Duration	Marks	Duration
1	Mid-term Exam	**30 (10-objective and 20 subjective)**	One hour	**40+10*(15-objective and 25 subjective)**	One and halfhour	**-----**	**----**
2	Internal Practical	**15+5* (3-viva voce, 2-journal and 10 practical)**	**Two hours**	**----**	**----**	**100#**	**Three hours**
3	Semester end Theory Exam	**50(15-objective and 35subjective)**	**Two hours**	**50 (15-objective and 35 subjective)**	**Two hours**	**----**	**----**
	Total	**100**	**-**	**100**	**-**	**100**	**-**

*Marks of assignments

For PCP (80 Marks for periodical operation, 15 Marks for practical works and 05 Marks for report) for other courses (80 Marks for actual practical, 10 Marks for viva voce and 10 Marks for journal)

2. **Evaluation**

Degree	Percentage of Marks Obtained	Conversion into Points
All	100	10 Points
	90 to <100	9 to <10
	80 to <90	8 to <9
	70 to <80	7 to <8
	60 to <70	6 to <7
	50 to <60	5 to <6
	<50 (Fail)	<5
	Eg. 80.76	8.076
	43.60	4.360
	72.50 (but shortage in attendance)	**Fail (1 point)**

Allotment of division

OGPA	Division
5.000 – 5.999	Pass
6.000 – 6.999	II division
7.000 – 7.999	I division
8.000 and above	I division with distinction

GPA = Total points scored / Total credits (for 1 semester)

CGPA = ∑ Total points scored / Course credits

OGPA = ∑ Total points scored (after excluding failure points)/ Course credits

% of Marks = OGPA x 100/10