

Revised Course Curriculum and Syllabus of B. Sc. (Hons) Horticulture

**As Per Recommendations of V Deans
Committee ICAR, New Delhi**

For

**State Agricultural Universities of Maharashtra
from**

Academic Year 2017-18

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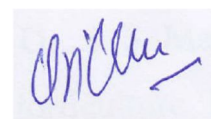
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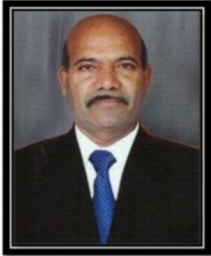
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(P. M. Haldankar)

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14.	Dr. Shivkumar Kareppa, Head, Dept. of Statistics, MPKV, Rahuri	Discipline Course Coordinator, Statistics	

15.	Dr. Arun Mane, Asst. Prof., Agril. Botany, Dr.BSKKV, Dapoli	Discipline Course Coordinator, NCC	
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Department-wise Layout of Courses for B.Sc. (Hons) Horticulture

I	Fruit Science	Credits	Semester
1	Fundamentals of Horticulture	(2+1)=3	I
2	Plant Propagation and Nursery Management	(1+1)=2	II
3	Tropical and Subtropical Fruits	(2+1)=3	III
4	Orchard and Estate Management	(1+1)=2	V
5	Plantation Crops	(2+1)=3	V
6	Temperate Fruit crops	(1+1)=2	III
7	Weed Management in Horticultural Crops	(1+1)=2	III
8	Principles of Plant Breeding	(2+1)=3	II
9	Principles of Genetics and Cytogenetics	(2+1)=3	I
10	Breeding of Fruit and Plantation Crops	(2+1)=3	IV
11	Dryland Horticulture	(1+1)=2	IV
	Total	<u>17+ 11=28</u>	
II	Vegetable Science		
1	Tropical and Subtropical Vegetable crops	(2+1)=3	III
2	Spices and Condiments	(2+1)=3	IV
3	Breeding of Vegetable Tuber and Spice Crops	(2+1)=3	V
4	Seed Production of Vegetable Tuber and Spice Crops	(2+1)=3	VI
5	Temperate Vegetable crops	(1+1)=2	IV
6	Potato and Tuber Crops	(1+1)=2	II
7	Precision Farming and Protected Cultivation	(2+1)=3	IV
	Total	<u>12+7=19</u>	
III	Post-harvest Technology		
1	Post-harvest Management of Horticultural Crops	(2+1)=3	VI
2	Processing of Horticultural Crops	(1+2)=3	VI
3	Fundamentals of Food and Nutrition	(1+1)=2	III
	Total	<u>4+4= 8</u>	
IV	Floriculture & Landscape Architecture		
1	Ornamental Horticulture	(2+1)=3	IV
2	Breeding and Seed Production of Ornamental Crops	(2+1)=3	VI
3	Principles of Landscape Architecture	(0+1)=1	V
4	Commercial Floriculture	(2+1)=3	III
	Total	<u>6+4=10</u>	
V	Plant Protection		
1	Fundamentals of Plant Pathology	(1+1)=2	III
2	Diseases of Fruit, Plantation and Medicinal and Aromatic Crops	(2+1)=3	V
3	Diseases of Vegetable, Ornamental and Spice Crops	(2+1)=3	VI
4	Mushroom Production Technology	(0+1)=1	VI
5	Fundamentals of Entomology	(2+1)=3	II
6	Nematode Pests of Horticultural Crops and their Management	(1+1)=2	VI
7	Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops	(2+1)=3	IV
8	Apiculture, Sericulture and Lac Culture	(1+1)=2	V
9	Insect Pests of Vegetable, Ornamental and Spice Crops	(2+1)=3	III
	Total	<u>13+9=22</u>	

VI	Natural Resource Management	Credits	Semester
1	Fundamentals of Soil Science	(1+1)=2	I
2	Soil Fertility and Nutrient Management	(1+1)=2	II
3	Environmental Studies and Disaster Management [#]	(2+1)=3	II
4	Soil, Water and Plant Analysis	(1+1)=2	IV
5	Farm Machinery and Power Engineering	(1+1)=2	VI
6	Water Management in Horticultural Crops	(1+1)=2	II
7	Organic Farming	(1+1)=2	V
8	Agro-meteorology and Climate Change	(1+1)=2	I
	Total	<u>9+8=17</u>	
VII	Basic Sciences		
1	Elementary Statistics and Computer Application	(2+1)=3	I
2	Elementary Plant Biochemistry	(1+1)=2	I
3	Elementary Plant Biotechnology	(1+1)=2	III
4	Introductory Crop Physiology	(1+1)=2	I
5	Economics and Marketing [#]	(2+1)=3	I
6	Horti-Business Management	(2+0)=2	VI
7	Fundamentals of Extension Education	(1+1)=2	III
8	Entrepreneurship Development and Business Management [#]	(1+1)=2	VI
9	Growth and Development of Horticultural Crops	(1+1)=2	II
10	Communication Skills and Personality Development [#]	(1+1)=2	V
11	Introductory Microbiology	(1+1)=2	II
12	Information and Communication Technology ^{#*}	(1+1)=2	II
	Total	<u>15+11=26</u>	
VIII	Others		
1	Introductory Agro-forestry	(1+1)=2	V
2	Medicinal and Aromatic Crops	(2+1)=3	V
3	Introduction to Major Field Crops	(1+1)=2	IV
4	Livestock production and management	(1+0)=1	IV
5	Maths/ Botany	(1+1)=2	I
6	Physical and Health Education (NC)*	(0+1)=1	II
7	NSS/NCC(NC)*	(0+1)=1	I
8	Democracy, Elections and Good Governance (NC)*	(1+0)=1	I
	Total	<u>7+6=13</u>	
	Grand Total	<u>83+60=143</u>	

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

Sr. No.	RHWE & Placement in Industries schedule	Proposed Duration
1	Orientation Programme	1 weeks
2	Village attachment	9 weeks
3	Placement Programme	9 weeks
4	Report writing & Final Examination	2 weeks
	Total	21 Weeks

Semester wise Layout of Courses for B.Sc. (Hons) Horticulture

Semester – I

Course No.	Courses	Credits		
		Theory	Practical	Total
A)	Core courses			
H/FS-111	Fundamentals of Horticulture	2	1	3
H/BOT-112	Principles of Genetics and Cytogenetics	2	1	3
	Sub total	4	2	6
B)	Basic science			
H/STAT-111	Elementary Statistics and Computer Application	2	1	3
H/ECON-111	Economics and Marketing	2	1	3
H/BIOCHEM-111	Elementary Plant Biochemistry	1	1	2
H/BOT-111	Introductory Crop Physiology	1	1	2
	Sub total	6	4	10
C)	Natural Resource Management			
H/SSAC-111	Fundamental of Soil Science	1	1	2
H/AGROMET-111	Agro-meteorology and Climate Change	1	1	2
	Sub total	2	2	4
D)	Remedial Courses			
MATH 111/ BOT 111	Mathematics / Botany	1	1	2
	Sub total	1	1	2
E)	Non-Gradial Courses			
NCC 111/ NSS 111	NCC/ NSS	0	1	1
DEG 111	Democracy, Elections and Good Governance	1	0	1
	Sub total	1	1	2
	Total Credits (A+B+C+D+E)	14	10	24

Semester – II

Course No.	Courses	Credits		
		Theory	Practical	Total
A)	Core courses			
H/FS-122	Plant Propagation and Nursery Management	1	1	2
H/ VS-121	Potato and Tuber crops	1	1	2
	Sub total	2	2	4
B)	Basic science			
H/MIBO-121	Introductory Microbiology	1	1	2
H/HORT-121	Growth and Development of Horticultural Crops	1	1	2
H/BOT-123	Principles of plant Breeding	2	1	3
	Sub total	4	3	7
C)	Natural Resource Management			
H/SSAC-122	Soil Fertility and Nutrient Management	1	1	2
H/ ENGG-121	Water Management in Horticultural Crops	1	1	2
	Sub total	2	2	4
D)	Non-Gradiual Courses			
H/ PHEY- 121	Physical Education and Yoga	0	1	1
H/IT-121	Information and Communication technology	1	1	2
	Sub total	1	2	3
E)	Plant protection			
H/ENTO-121	Fundamentals of Entomology	2	1	3
	Sub total	2	1	3
F)	Common Courses			
H/EVS-121	Environmental Studies and Disaster Management	2	1	3
	Sub total	2	1	3
	Total Credits (A+B+C+D+E+F)	13	11	24

Semester – III

Course No.	Courses	Credits		
		Theory	Practical	Total
A)	Core courses			
H/FS-233	Tropical and Subtropical Fruits	2	1	3
H/FS-234	Temperate Fruit Crops	1	1	2
H/FS-235	Weed Management in Horticultural Crops	1	1	2
H/ VS-232	Tropical and Subtropical Vegetables	2	1	3
H/PHT-231	Fundamentals of Food and Nutrition	1	1	2
H/FL-231	Commercial Floriculture	2	1	3
	Sub total	9	6	15
B)	Basic science			
H/BIOT-231	Elementary plant Biotechnology	1	1	2
H/EXTN-231	Fundamentals Of Extension Education	1	1	2
	Sub total	2	2	4
C)	Plant protection			
H/ENTO-121	Fundamentals of Pathology	1	1	2
H/ENTO-232	Insect Pests of Vegetable, Ornamental and Spice Crops	2	1	3
	Sub total	3	2	5
	Total Credits (A+B+C)	13	11	24

Semester – IV

Course No.	Courses	Credits		
		Theory	Practical	Total
A)	Core courses			
H/FS-246	Breeding OF Fruit and Plantation crops	2	1	3
H/FS-247	Dry Land Horticulture	1	1	2
H/ VS-243	Spices and Condiments	2	1	3
H/ VS-244	Precision Farming and Protected Cultivation	2	1	3
H/ VS-245	Temperate Vegetables	1	1	2
H/FL-242	Ornamental Horticulture	2	1	3
	Sub total	10	6	16
B)	Natural Resource Management			
H/SSAC-243	Soil, Water and Plant analysis	1	1	2
	Sub total	1	1	2
C)	Plant protection			
H/ENTO-121	Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops	2	1	3
	Sub total	2	1	3
D)	Other Courses			
H/AHDS-241	Livestock Production and management	1	0	1
H/AGRO-242	Introduction to Major Field Crops	1	1	2
	Sub total	2	1	3
	Total Credits (A+B+C+D)	15	09	24

Semester – V

Course No.	Courses	Credits		
		Theory	Practical	Total
A)	Core courses			
H/FS-358	Plantation Crops	2	1	3
H/FS-359	Orchard and Estate Management	1	1	2
H/ VS-356	Breeding of Vegetables, Tuber and spice Crop	2	1	3
H/FL-353	Principles of Landscape Architecture	0	1	1
	Sub total	5	4	9
B)	Basic science			
H/EXTN-352	Communication Skill and Personality Development	1	1	2
	Sub total	1	1	2
C)	Natural Resource Management			
H/AGRO-351	Organic Farming	1	1	2
	Sub total	1	1	2
D)	Plant protection			
H/ENTO-354	Apiculture, Sericulture and Lac culture	1	1	2
H/PATH-352	Diseases of Fruit, Plantation, Medicinal and Aromatic Crops	2	1	3
	Sub total	3	2	5
E)	Other Courses			
H/MAP-351	Medicinal and Aromatic Crops	2	1	3
H/HORT-352	Introductory Agroforestry	1	1	2
	Sub total	3	2	5
	Total Credits (A+B+C+D+E)	13	10	23

Semester – VI

Course No.	Courses	Credits		
		Theory	Practical	Total
A)	Core courses			
H/ VS-367	Seed Production of Vegetables, Tuber and Spice Crops	2	1	3
H/PHT-362	Postharvest Management of Horticultural Crops	2	1	3
H/PHT-363	Processing of Horticultural Crops	1	2	3
H/FL-364	Breeding and Seed Production of Ornamental Plants	2	1	3
	Sub total	7	5	12
B)	Basic science			
H/ECON-362	Horti-Business Management	2	0	2
H/EXTN-363	Entrepreneurship Development and Business Management	1	1	2
	Sub total	3	1	4
C)	Natural Resource Management			
H/ENGG-362	Farm Machinery and Power Engineering	1	1	2
	Sub total	1	1	2
D)	Plant Protection			
H/PATH-363	Diseases of Vegetables, Ornamentals and Spice Crops	2	1	3
H/PATH-364	Mushroom Production Technology	0	1	1
H/ENTO-365	Nematode Pests of Horticultural crops and their Management	1	1	2
	Sub total	3	3	6
	Total Credits (A+B+C+D)	14	10	24

Semester – VII

Rural Horticultural Work Experience Programme

Sr.No.	Title of the Course	Credits
1	STUDENT READY - Placement in Industries	0+10
2	STUDENT READY- Placement in Villages	0+10
	Total	20 (0+20)

Placement in Villages

1	Registration, Orientation and Placement	1 week
2	Actual RHWE work in villages	8 weeks
3	Examination	1 week
	Total	10 weeks

Sr. No.	Course No	Course Title	Credits
1	RHWE (H)-471	Fruit, vegetable and flower Production and Post-harvest management and technology of Horticulture crops.	0 + 5 = 5
2	RHWE ECON-471	Economics of Horticultural crops.	0 + 1 = 1
3	RHWE EXTN-471	Extension education & Rural Sociology	0 + 1 = 1
4	RHWE ENT-471	Integrated Pest and disease Management.	0 + 2 = 2
5	RHWE SSAC-471	Soil test & Integrated Nutrient Management	0 + 1 = 1
		Total	0 + 10 = 10

Placement in Industry

Placement in Industries

1	Orientation and Placement	1 week
2	Actual work in Industry	8 weeks
3	Examination	1 week
	Total	10 weeks

Nursery Production & Management

Sr. No.	Course No	Course Title	Credits
1	IND (H)-472	Nursery Production	0 + 5 = 5
2	IND (H)-473	Economics of Horticultural crops.	0 + 1 = 1
3	IND (H)-474	Extension education & Rural Sociology	0 + 1 = 1
4	IND (H)-475	Integrated Pest and disease Management.	0 + 2 = 2
5	IND (H)-476	Soil test & Integrated Nutrient Management	0 + 1 = 1
		Total	0 + 10 = 10

Semester – VIII

STUDENT READY: Experiential Learning programme

Sr.No.	Course No.	Title of the Course	Credits
1	HORT EL-481	Commercial Horticulture	
	HORT EL-481/1	Nursery Management of Horticultural Crops	(0+10)=10
	OR		
	HORT EL-481/2	Nursery Management of Horticultural Crops	(0+10)=10
2	HORT EL-482	Protective Cultivation of High Value Horticulture Crops	(0+10)=10
3	HORT EL-483	Processing of Fruits and Vegetables for Value Addition	(0+10)=10
4	HORT EL-484	Floriculture and Landscape Architecture	(0+10)=10
		Total	(0+20)=20

The student undergoing ELP may be allowed to register for a maximum two courses in which they have failed but completed requisite percentage of attendance.

DEPARTMENT OF FRUIT
SCIENCE

DEPARTMENT OF FRUIT SCIENCE

Course No. H/FS - 111
hours - (2+1) 3

Course Title: Fundamentals of Horticulture Credit
Semester: I

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. Principles of organic farming.

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.

Lesson/Course Plan-Theory

Lecture No.	Topic	Weightage (%)
1-2	Economic importance and classification of horticultural crops	10
3	Culture and nutritive value, area and production, exports and imports	5
4-5	Fruit and vegetable zones of India and of different states, soil and climate,	10
6-8	Vegetable gardens, nutrition and kitchen garden and other types of gardens	10
9-10	Principles, planning and layout, management of orchards, planting systems and planting densities	10
11-12	Production and practices for fruit, vegetable and floriculture crops, nursery techniques and their management.	10
13-14	Principles objectives, types and methods of pruning and training of fruit crops	5
15-16	Types and use of growth regulators in horticulture	5
17	Water management– irrigation methods, merits and demerits	5
18 -20	Weed management	3
15 -16	Fertility management in horticultural crops-manures and fertilizers, different methods of application	8
17-20	Cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits,	8
21-23	Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness.	5
24 -28	Principles of organic farming	4
29- 32	Recommendations of Joint Agresco	2

	Total	100
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Practical programme:

P. No.	Practical
1	Features of orchard, planning and layout of orchard
2	Identification of tools and implements
3	Layout of nutrition garden.
4	preparation of nursery beds for sowing of vegetable seeds
5	Digging of pits for fruit plants
6	Study of planting systems
7	Training and pruning of orchard trees.
8	Preparation of fertilizer mixtures and field application.
9	Preparation and application of growth regulators (Powder form).
10	Preparation and application of growth regulators (Lanolin Paste)
11	Layout of different irrigation systems.
12	Identification and management of nutritional disorder in fruits.
13	Assessment of bearing habits.
14	Maturity standards of horticultural crops,
15	Study of harvesting and grading of horticultural crops
16	Study of packaging and storage of horticultural crops

Suggested Reading:

Reference Books:

- Chadha, K.L. (ICAR), 2002, 2001. *Handbook of Horticulture*, ICAR, New Delhi
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- Prasad and Kumar, 2014. *Principles of Horticulture* 2ndEdn. Agrobios (India).
- S. Prasad and U. Kumar, 2010. *A handbook of Fruit Production*. Agrobios (India).

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/FS–122

Course Title: Plant Propagation and Nursery Management

Credit hours - (1+1) 2

Semester: II

Theory: 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-embryony, polyembryony, 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 graftage and 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, Nursery registration act. Insect/pest/disease control in nursery Cost of establishment of propagation structures.

Practical: Media for propagation of plants in nursery beds, pot and mist chamber. 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 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. Top grafting, bridge grafting and nursery management. Nutrient and plant protection applications during nursery.

Lesson/Course Plan- Theory

Lectures No.	Topic	Weightage (%)
1	Definition and need of plant propagation, potentials of plant multiplication.	10
2	Sexual and asexual methods of plant propagation and their advantages and disadvantages.	10
3	Seed germination and dormancy - internal and external factors affecting seed dormancy and seed treatment (Scarification and stratification)	10
4	Apomixis - definition, monoembryony, polyembryony, chimera etc.	5
5	Nursery techniques and nursery management cuttings, layerings grafting, budding, runners, tubers, corms, rhizomes off sets, stolons and other specification organs.	10
6	Propagations structures - mist chamber, humidifiers, green house, glass house, cold frames, hot beds, polyhouses, etc. and cost of establishment of structure.	5
7	Use of growth regulators in plant propagation.	5
8	Selection of mother trees, maintenance of mother trees & budwood certification.	10
9	Factors affecting vegetative propagation,	5
10	Anatomical study of bud union and rooting (Physiological and biochemical basis)	3

11	Scion stock relationship	5
12	Micrografting	5
13	Hardening of plants in nurseries.	4
14	Insect - pest & disease control in nursery	5
15	Nursery registration act and record keeping	5
16	Cost of establishment of propagation structures.	3
	Total	100

Practical programme

Practical No.	Particulars
1	Study of different media for plant propagation.
2	Preparation of nursery beds and sowing seeds.
3	Seed treatments for breaking seed dormancy, including germination and growth of seedlings.
4	Raising root stock in various containers.
5	Potting reporting and preparation of plant material for potting.
6	Practicing different types of cutting, layering
7	Practicing different types of runner, offsets and other specialized plant organs for propagation.
8	Practicing different budding method.
9	Practicing different grafting methods.
10	Preparation growth regulators for seed germination and vegetative propagation.
11	Use of mist chamber in plant propagation and hardening of plants.
12	Digging, labeling and packing of nursery plant.
13	Nutrients application and plant protection measures in nursery.
14	Raising, maintenance and cost of different nursery structure.
15	Maintenance of nursery record.
16	Visit to tissue culture laboratory. Visit to established model Govt. and Private Nurseries of adjoining areas

Suggested readings :

Reference Books:

- Chadha, K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi.
- Chundawat, B.S. 1990. *Arid fruit culture*. Oxford and IBH, New Delhi.
- Ganner, R.J. and Choudhri, S.A. 1972. *Propagation of Tropical fruit trees*. Oxford and IBN publishing Co., New Delhi.
- Guy W. Adriance and Feed R. Brison. *Propagation of Horticultural Plants*. Axis Books (India).
- Hartman, H.T and Kester, D.E. 1976. *Plant Propagation Principles and practices*. Prentice hall of India Pvt.Ltd., Bombay.
- 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
- Mukherjee, S.K. and Majumdar, P.K. 1973. *Propagation of fruit crops*. ICAR, New Delhi.
- 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, Pitampura, New Delhi-110088.
- Sadhu, M.K. 1996. *Plant Propagation*. New age International Publishers, New Delhi.
- Sarma, R.R. 2002. *Propagation of Horticultural Crops*. Kalyani Publishers, (Principles and practices) New Delhi.
- Symmonds, 1996. *Banana. II edition* Longman, London.

- 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)*.NayaUdyog, 206, BidhanSarani, Kolkata 700006.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/FS- 233

Course Title: Tropical and Sub-Tropical Fruits

Credit hours - (2+1) 3

Semester: III

Theory- 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, pineapple, jackfruit, avocado, mangosteen, kokum, litchi, carambola, durian, rambutan, bilimbi, loquat, rose apple, breadfruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome, control measures. Seediness and kokan 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 pomegranate, carissa, West Indian cherry.

Lesson/Course Plan -

Lectures No.	Topics	Weightage (%)
1	Scope and importance of fruit growing in India and Maharashtra	10
2	Horticultural classification of fruits including genome classification	5
3	Horticultural zones of India and Maharashtra 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.	5
4-5	Mango, Banana	10
6-7	Grapes, Citrus	10
8-10	Papaya, Sapota, Guava	10
11-13	Pomegranate, Litchi, Pineapple	5
14-15	Amla, Bael, Anona and Ber	5
16-17	Fig, Jackfruit, Avocado and Mangosteen	5
18-19	Carambola, Durian, Rambutan and Bilimbi	5
20-21	Loquat and Rose apple, Breadfruit and Passion fruit.	5
22	Special production problems in mango (Spongy tissue, Black tip, Malformation, etc and their control measures	4

23	Bearing in mango, causes: Alternate and irregular bearing, control measures.	4
24	Seediness and kokan disease in banana.	4
25	Citrus decline and casual factors and their management.	3
26	Bud forecasting in grapes	3
27-28	Sex expression and seed production in papaya Latex extraction and crude papain production in papaya and economics of production	4
29	Rainfed horticulture	4
30	Importance and scope of arid and semi-arid zones of India.	3
31	Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate.	3
32	Characters and special adaptation of crops: Carissa, date palm, phalsa, fig, west Indian cherry and tamarind and Joint Agresco recommendations	3
Total		100

Practical programme

Practical No.	Topics
1	Description and identification of varieties based on flower and fruit morphology in tropical crops.
2	Description and identification of varieties based on flower and fruit morphology in subtropical crops.
3	Training and pruning of grapes, mango, guava and citrus.
4	Selection of site and planting system
5	Pre-treatment of banana suckers, desuckering in banana
6	Sex forms in papaya, seed production in papaya, latex extraction and preparation of crude papain
7	Use of plastics in fruit production
8	Visit to commercial orchards and diagnosis of maladies
9	Manure and fertilizer application including bio-fertilizer in fruit crops
10	Preparation and application of growth regulators in banana, grapes and mango.
11	Ripening of fruits
12	Grading and packaging,
13	Production economics for tropical and sub-tropical fruits.
14	Mapping of arid and semi-arid zones of India.
15	Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa
16	Botanical description and identification of wood apple, West Indian cherry, tamarind, aonla, bael and annona

Suggested Reading:

Text Books:

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

Reference Books:

- Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. *Tropical and Sub-Tropical-Vol-I*. Naya
- Chadha, K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi.
- Chundawat, B.S., 1990. *Arid fruit culture*. Oxford and IBH, New Delhi.
- F.S. Davies and L.G. Albrigo, 2001. *Citrus*, Cab International.

- H.P.Singh and M.M.Mustafa, 2009. *Banana*-new innovations. Westville PublishingHouse, New Delhi.
- K.L.Chadda, 2009. *Advanced in Horticulture*. Malhotra Publishing House, New Delhi.
- M.S.Ladaniya, 2013. *Citrus Fruits*. Elsevier, India post ltd, New Delhi
- R.E.Litz, 2009. *The Mango* 2nd Edn. Cabi Publishing, Willingford, U.K.
- Radha T and Mathew L., 2007. *Fruit crops*. New India Publishing Agency.
- Rajput, CBS and Srihari babu, R., 1985. *Citriculture*. Kalyani Publishers, New Delhi.
- S.P. Singh, 2004. *Commercial fruits*. Kalyani Publishers, New Delhi.
- Symmonds, 1996. *Banana*. II Edn. Longman, London.
- W.S. Dhillon, 2013. *Fruit Productionin India*. Narendra Publishing House.

e-reading: <http://ecourses.iasri.res.in/>

Course No: H/ FS -359

Course Title: Orchard and Estate Management

Credit hours: (1+1) 2

Semester: V

Theory: Orchard and 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.

Lesson/Course Plan- Theory

Lecture No.	Topics	Weightage (%)
1	Orchard and estate management, importance, objectives, merits and demerits	10
2	Clean cultivation, sod culture, Sod mulch, herbicides and inorganic and organic mulches.	8
3	Wind break and Shelter belts	5
4	Tropical, sub-tropical and temperate horticultural planting systems,	8
5	High Density Planting, Use of rootstocks	5
6	Competitive and complimentary effect of root and shoot systems.	5
7	Biological efficiency of cropping systems in horticulture,	5
8	Systems of irrigation.	8
9	Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties.	8
10	Factors influencing the fruitfulness and unfruitfulness	8
11	Special Horticulture Practices	5
12	Rejuvenation of old orchards, top working, frame working,	8
13	Integrated nutrient and pest management.	5
14	Utilization of resources constraints in existing systems.	4
15	Crop model and crop regulation in relation to cropping systems.	4
16	Climate aberrations and mitigation measures of Horticultural crops.	4
Total		100

Practical programme -

Practical No.	Topics
1	Layout of different systems of orchard
2	Layout of different systems of estate
3	Soil management Practices
4	Study of Clean cropping
5	Study of Inter cropping and Fillers crop
6	Study of Cover cropping
7	Study of Mixed cropping
8	Moisture conservation measures
9	Study of methods of weed control
10	Use of organic and inorganic mulch materials
11	Types of weed and weed control
12	In situ grafting
13	Layout of various irrigation systems.
14	Integrated nutrient pest management
15	Rejuvenation of old orchards, top working and frame working
16	Visit to GAP orchard/Estate

Suggested Reading:

Reference Books:

- B .C. Mazumdar. 2004. *Principles and Methods of Orchard Establishment*. DayaPublishing House, New Delhi.
- Chadha,K.L. (ICAR)2002,2001.*Hand book of Horticulture*. ICAR, New Delhi
- 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.
- T. Pradeep Kumar, B. Suma, JyothiBhaskar and K.N.Satheson. 2008. *Management of Horticultural Crops*.New India Publishing Agency, New Delhi.
- W. S. Dhillon and Bhatt. 2011. *Fruit Tree Physiology*. Narendra Publishing House, New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

Course No: H/ FS -358

Credit hours: (2+1) 3

Course Title: Plantation crops

Semester: V

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, beetel vine and rubber.

Practicals- 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.

Lesson/Course plan- Theory

Lecture No.	Topics	Weightage (%)
1-2	History, definition , importance and scope of plantation crops in India	8
3-4	Export, import, by-products industrial uses	8
	Study of following plantation crops in respect to their 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 including Joint Agresco Recommendation	
5-9	i) Coconut	15
10-11	ii) Arecanut	08
12-13	iii) Oil palm	05
14	iv) Palmyrah palm	05
15-17	v) Cocoa	10
18-21	vi) Cashew nut	10
22-24	vii) Coffee	10
25-26	viii) Tea	08
27-29	ix) beetel vine	05
30-32	x) Rubber	08
Total		100

Practical programme-

Practical No.	Topics
1	Identification and description of plantation crops
2	Propagation methods and nursery techniques in coconut and arecanut.
3	Propagation methods and nursery techniques in datepalm, oilpalm & palmyrah palm
4	Propagation methods and nursery techniques in cocoa, coffee, tea.
5	Propagation methods and nursery techniques in cashew nut and rubber.
6	Description of coconut and arecanut varieties.
7	Description of oil palm, palmyrah palm and date palm varieties.
8	Description of coffee, cocoa and tea varieties.
9	Description of cashewnut, rubber varieties.
10	Harvesting, processing, grading in Arecanut, coconut.
11	Harvesting, processing and grading in oil palm, palmyrah palm, beetel vine.
12	Harvesting, processing and grading in cocoa , coffee and tea
13	Tapping and processing of latex in rubber.
14	Harvesting, processing and grading in cashewnut.
15	Insect-pests and Diseases their control measures in plantation crops.
16	Visit to processing unit

Suggested Reading:

Reference Books:

- Chadha, K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi
- Kumar, N.J.B. M. Md. Abdul Khaddar, RangaSwamy, P. and Irrulappan, I. 1997. *Introduction to spices, Plantation crops and Aromatic plants*. Oxford & IBH, New Delhi.
- Nair 1979. *Cashew*. CPCRI, Kerala
- Ranganadhan, V. 1979. *Hand Book of Tea Cultivation*. UPASI Tea Research Station, Cinchona.
- Thampan, P.K. 1981. *Hand Book of Coconut Palm*. Oxford IBH, New Delhi.
- Thompson, P.K. 1980. *Coconut*. Oxford & IBH Publishing Co. Ltd., New Delhi.
- Wood, GAR, 1975. *Cacao*. Longmen, London

e-reading: <http://ecourses.iasri.res.in/>

Course No. : H/ FS -234

Course Title: Temperate Fruit Crops

Credit hours–(1+1) 2

Semester: III

Theory- Importance, Scope, 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 pollinizers, 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 and chest 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. Low productivity of apples in India and their remedial measures.

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. Working out economics for apple, pear, plum and peach.

Lesson /Course Plan: Theory

Lectures No.	Topic	Weightage (%)
1	Importance, scope and Classification of temperate fruits detailed study of areas, production, varieties, climate and soil requirements, Propagation in temperate fruits, planting density & cropping systems, After care of orchard, Training and pruning, Self-incompatibility and pollinizers, Use of growth regulators, Nutrient and weed management, harvesting, post-harvest handling and storage of following crops.	8
2–3	Apple	10
4	Pear	8
5	Peach	8
6	Apricot	8
7	Plum	5
8	Cheery	5
9	Persimmon	5
10	Strawberry	10
11	Kiwi	4
12	Queens land nut (Macadamia nut)	
13	Almond, walnut, pecan nut, hazel nut and chest nut	8
14	Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders	8
15	important insect – pests and diseases and their control measures	5
16	Special production problems like alternate bearing problem and their remedies. Low productivity of apples in India and their remedial measures	8
	Total	100

Practical programme:

Practical No.	Topics
1	Nursery management practices
2	Description and identification of varieties of temperate fruits crops (Pome and Nut)
3	Description and identification of varieties of temperate fruits crops (Berry and others)
4	Manuring and fertilization of temperate fruits (Pome and Nut)
5	Manuring and fertilization of temperate fruits (Berry and others)
6	Planting systems
7	Preparation and use of growth regulators (Powder form)
8	Preparation and use of growth regulators (Lanolin Paste)
9	Intercultural operations, plum, peach and nut crops
10	Training in apple, pear
11	Pruning in apple, pear
12	Training in plum, peach and nut crops
13	Pruning in plum, peach and nut crops
14	Working out economics for apple, pear,
15	Working out economics for plum and peach
16	Working out economics for nut crops

Suggested Reading:

Text Books:

- Chattopadhyaya, T.K. 2000. *A Text Book on Pomology (Temperate Fruits)* Vol. IV Kalyani Publishers, Hyderabad
- Chattopadhyay T.K.2009.*A text book on Pomology-IV Devoted to Temperate fruits.* Kalyani Publishers.B-1/292,Rajinder Nagar,Ludhiana-141008

Reference Books:

- Banday F.A. and Sharma M.K.2010.*Advances in Temperate Fruit Production.* Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.
- Chadha, T.R, 2001. *Text Book of Temperate Fruits.* Indian Council of Agricultural Research, New Delhi.
- Das B.C and Das S.N .*Cultivation of Minor Fruits.* Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.
- David Jackson & N.E. Laone, 1999 *Subtropical and Temperate Fruit Production.* CABI, Publications.
- Handbook of Horticulture, ICAR(2011)
- Kaushal Kumar Misra.2014.*Text book of Advanced Pomology.* Biotech Books.4762-63, Ansari Road, Darya Ganj, New delhi-11002.
- Mitra S.K, Rathore D.S and Bose T .K. 1992. *Temperate Fruit Crops.* Horticulture and Allied Publishers, Calcutta.
- Pal J.S.2010. *Fruit Growing* .2010. Kalyani Publishers.B-1/292,Rajinder Nagar, Ludhiana-141008.
- W S Dhillon. 2013. *Fruit Production In India.* Narendra Publishing House. New Delhi

e-reading: <http://ecourses.iasri.res.in/>

Course No: H/ FS -235

Course Title: Weed Management in Horticultural Crops

Credit hours: (1+1) 2

Semester-III

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 problematic weed areas .

Lesson/Course Plan- Theory

Lecture No.	Topic	Weightage (%)
1	Weeds: Introduction, harmful and beneficial effects	08
2	Classification of weeds	08
3	Propagation and dissemination of weeds	5
4	Weed biology and ecology, crop weed association	08
5	Crop weed competition and allelopathy	08
6	Concepts of weed prevention, control and eradication	5
7	Methods of weed control: physical, cultural, chemical and biological methods	08
8	Integrated weed management	08
9	Herbicides: advantages and limitation of herbicide usage in India	08
10	Herbicide classification, formulations, methods of application;;	08
11	Introduction to Adjuvants and their use in herbicides	5
12	Introduction to selectivity of herbicides;	5
13	Compatibility of herbicides with other agro chemicals	5
14	Weed management in major field and horticultural crops,	5
15-16	Shift of weed flora in cropping systems, aquatic and problematic weeds and their control.	06
Total		100

Practical programme

Practical No.	Topics
1	Identification of weeds;
2	Survey of weeds in orchard other habitats
3	Survey of weeds in other habitats
4	Preparation of herbarium of weeds
5	Calculations on weed control efficiency and weed index
6	Herbicide label information;
7	Computation of herbicide doses and use of Herbicides
8	Study of herbicide application equipment and calibration
9	Demonstration of methods of herbicide application
10	Various methods of weed control in orchard
11	Mechanical method of weed control
12	Chemical method of weed control
13	Biological method of weed control
14	Study of phytotoxicity symptoms of herbicides in different crops
15	Biology of nut sedge, bermuda grass, parthenium and celosia
16	Economics of weed control practices

Suggested reading:

Reference Books:

- Crafts, A.S. and Robbins, W.W. 1973. *Weed Control*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- Chadha, K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, 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.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/BOT-123

Course title- Principles of Plant Breeding

Credits- (2+1) 3

Semester-II

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.

Lesson/Course plan - Theory

Lecture No.	Topic	Weightage (%)
1,2	Plant Breeding - a dynamic science	5
3,4	Genetic basis for Plant Breeding classical, quantitative and molecular.	5
5-7	Plant Breeding in India- limitations, major achievement and goal setting for future.	5
8-10	Mode of reproduction-sexual reproduction.	10
11-13	Mode of pollination- self and cross pollination.	10
14-16	Mechanism of pollination control.	10
17-19	Genetic components of polygenic variation and Breeding strategies.	10
20	Selection of basis of crop breeding	5
21-22	Hybridization and goals of hybridization	05
23	Hybridization and selection of plants	05
24	Population developed by hybridization- Simple crosses	5
25	Population developed by hybridization- Bulk crosses	5
26-27	Population developed by hybridization- Complex crosses	5
28-29	General and special Breeding techniques.	5
30-31	Heterosis- Concept and types	05
32	Heterosis- Estimation and genetic basis.	05
Total		100

Practical programme

Practical No.	Title
1	Field equipments for plant breeders
2	Selfing methods
3	Floral biology and hybridization technique
4	Floral biology – its measurement, emasculation,
5	Crossing techniques in major crops.
6	Selfing techniques in major crops.
7	Determination of mode of reproduction in crop plants, handling of breeding material, segregating generations (pedigree, bulk and back cross methods),
8	Field layout, and maintenance of experimental records in self and cross pollinated crops.
9	Demonstration of hybrid variation and production techniques.
10	Hardy Weinberg Law and calculation,
11	Male sterility studies in horticultural crops
12	Incompatibility studies in horticultural crops
13	Calculation of inbreeding depression
14	Calculation of heterosis, heterobeltioses
15	Computation of GCA, SCA,.
16	Computation of GA, heritability

Suggested Reading:

Reference books:

- B D Singh. *Fundamental of Plant breeding*. Kalyani. India.
- B.D. Singh. *Plant breeding : principles and methods*. Kalyani Publishers, Ludhiana.
- D.S. Falconer. *Introduction to quantitative genetics*. Longman Scientific & Technical, Longman Group, UK, Ltd., England.
- G K Kallo. *Breeding of vegetables*. Panima publishers, New Delhi
- G. S. Chahal and S.S. Gosal. 2002. *Principles and Procedures of Plant Breeding*. Narosa Publishing House, New Delhi.
- Hays and Garber. *Breeding crop plants*. Mc Graw Hill Publications, New York
- J.R. Sharma. *Principles and practices of plant breeding*. Tata McGraw Publishing Company Ltd., New Delhi
- K. Mather and J.L Jinks. *Introduction to Biometrical genetics*. Chapman and Hall, London
- Phundan Singh. *Essentials of plant breeding*. Kalyani Publishers
- Poehlman, J.M. and Borthakar, D. 1995. *Breeding Asian Field Crops*. Oxford& IBH Publishing Co., New Delhi
- Pundan Singh. *Essentials of plant breeding*. Kalyani. India
- R.C. Chaudhary. *Plant Breeding*
- R.K. Singh and B.D. Chaudhary. *Biometrical methods in quantitative genetic analysis*. Kalyani Publishers, Ludhiana.
- 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.
- W.R. Fehr. *Principles of cultivar development: theory and technique (Vol. 1)*. Macmillan Publishing Company, New York.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/BOT 112

Course title- Principles of Genetics and Cytogenetic

Credit hours - (2+1) 3

Semester- I

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 ratios. Multiple alleles, quantitative inheritance linkage and crossing over, sex linked inheritance and characters. Cytoplasmic inheritance and maternal effects. 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 F₂ data and construction of linkage maps. Genetics variation in pea.

Lesson /Course plan - Theory

Lect. No.	Topic	Weightage (%)
1	History of Genetics, relation of Genetic with other fields of science, scope and importance	5
2	Ultra structure of cell, cell organelles and their functions.	5
3	Study of Chromosome structure, morphology, number, types, karyotypes and ideogram	5
4	Mitosis: Stages, importance/ significance	4
5	Meiosis: Stages, importance, difference between mitosis & meiosis	5
6	Mendel’s contribution -Mendel’s law of Segregation, monohybrid	5
7	Mendel’s Laws of inheritance : Di & tri-hybrid ratio, deviation from Mendelian inheritance	5
8	Gene interactions different types with example and test cross ratio	4
9	Types of gene action, Multiple Alleles-its characteristics, pseudoalleles	4
10	Pleiotropism, penetrance- complete and incomplete, expressivity, Atavism with examples	4
12	Quantitative and qualitative traits; difference between them	4
13	Multiple factor hypothesis with example-ear length in maize	4
14-15	Cytoplasmic inheritances-its characteristics features;	4

	Examples of Cytoplasmic inheritance, difference between chromosomal and cytoplasmic inheritance.	
16-17	Linkage – definition, phases, linkage map, linkage group, number of linkage groups, types of linkage, linkage value, detection of linkage, significance of linkage.	4
19-20	Crossing over – types, theories, mechanism, factors affecting crossing over, coincidence & interference, calculation of crossing over percentage from test cross data, cytological basis of crossing over-experiment of stern in <i>Drosophilla</i> .	5
21	Chromosomal aberration : Numerical:	4
22	Chromosomal aberration : Structural	4
23-24	DNA & its structure, functions, types, modes of replication & repair : Components of DNA, DNA double helix structure, forms of DNA- A,B,C & Z form; modes of replication- theories of DNA replication-conservative, Semi-conservative & dispersive, DNA repair-direct repair of DNA, Excision repair of DNA, very short patch repair, short patch repair, long patch repair, functions of DNA.	4
25	RNA & its structure, function & types; components of RNA, types & functions of RNA-rRNA, mRNA	4
26-27	Transcription, Translation, Genetic code & Outline of Protein Synthesis – Central Dogma, Process of Transcription, Genetic code – codon, characteristic of Genetic code, Process of Translation, Protein synthesis – ribosomes, process – initiation, elongation & termination.	4
28-29	Gene expression – Promoter gene, operator gene, induction gene, operon constitutive gene, Operon Model, Components of Operon- Regulator, Promoter, operator & structure gene, Model-induction & repression, example of lac operon; fine structure of gene-cistron, recon, muton.	5
30-31	Mutation: Introduction, types of mutation, Characteristics of mutation, classification of mutations; induction of mutation-physical and chemical mutagenesis, classification of mutagens, Detection of mutations – CIB method & attached X-chromosome technique, significance of mutations.	4
32	Sex determination: Definition, Sex chromosomes & different methods of sex determination, Sex linked, sex influenced & sex limited characters & their significance	4
Total		100

Practical programme

Practical No.	Title
1	Simple compound, phase contrast, fluorescent and electron microscope
2	Preparation of stains and fixatives
3	Preparation of microscopic slide of mitosis-onion root tips and identification
4	Preparation of microscopic slide of meiosis- <i>Tradescantia</i> / Bajra. Identification of stages of meiosis.
5	Microphotography: Conventional and digital.
6	Methods of finding out the gametes and gametic recombinations.
7	Monohybrid ratio and its modifications.

8	Di-hybrid ratio and its modifications.
9	Trihybrid ratio
10	Chi-square test
11	Interaction of genes- I, Without modification of F2 ratio, Complementary
12	Gene interactions-II, Supplementary, Epistasis, & Inhibitory
13	Gene interactions-III, Additive, Duplicate and Lethal
14	Inheritance of multiple alleles
15	Study of linkage of genes
16	Induction of polyploidy using colchicines, Induction of mutation by using chemicals

Suggested Reading:

Reference books:

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

e-reading: <http://ecourses.iasri.res.in/>

Course No : H/FS-247

Course title- Breeding of Fruit and Plantation crops

Credit hours: (2+1) 3

Semester-IV

Theroy- Fruit breeding - History, importance, scope in fruit production, distribution, domestication and adaptation of commercially important fruits and plantation crop, 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.

Lesson / Course Plan–

Lectures No.	Particulars	Weightages (%)
1-2	History of Fruit Breeding and Importance and scope of Fruit breeding	8
3	Objectives of breeding of fruit crops & plantation crops	8
	Centres of origin, Distribution, domestication and adaptation of commercially important fruits, Modes of Reproduction, Apomixis and its types, Self incompatibility, Male sterility, Specific Breeding objectives, Floral Biology, inheritance pattern and achievements by different breeding methods	
4-5	Mango	8
6-8	Banana, Mandarin, Sweet orange, Acid lime, Grapes	8
9-11	Guava, Sapota, Papaya	8
12-14	Ber, Annona, Aonla	8
15	Tea and Coffee	8
16	Pomogranate	4
17-18	Coconut	8
19-21	Cashew, Rubberand Pistchonut	4
22-23	Date palm, Arecanut, Oil palm	4
24-25	Karonda Jackfruit and Jamun	4
26	Apple	4
27-29	Pear, Plum, Peach Apricot and Strawberry	4
30	Mutagenesis and its applications	4
31	Invitro breeding tools in fruit plantation crops.	4
32	Recommendations of Joint Agresco	4
	Total	100

Practical programme -

Practical No.	Particulars
1	Study of Breeding kit
2	Methods of emasculation and pollination procedures
	Floral biology -
3	Mango
4	Banana andMandarin, Sweet orange, Acid lime
5	Grape and Papaya

6	Cashew nut, Pomegranate and Fig
7	Ber and Aonla
8	Aonla and Tamarind
9	Areca nut and Coconut
10	Apple, Apricot
11	Pear, Plum, Peach
12	Pistachio and Strawberry
13	Pollen viability
14	Hybrid seed germination
15	Raising of segregating populations.
16	Evaluation of segregation population. Use of mutagens to induce. Mutagens and polyploidy.

Suggested Reading:

Reference Books:

- Anil Kumar Shukla 2004. *Fruit breeding approaches & Achievements*. India Publishing Agency, New Delhi. International Book Distributing Co. New Delhi.
- Chadha, K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi
- Kumar, N. 1997. *Breeding of Horticultural Crops, Principles and Practices*. New Delhi.
- Nijar 1985. *Fruit breeding in India*, Oxford & IBH Publishing Co. New Delhi
- Singh, B.D. 1983. *Plant Breeding Principles and methods*. Kalyani Publishers
- Abraham, Z. 2017. *Fruit Breeding*. Astral International (P) Ltd., New Delhi.
- Ray, P.K. 2002. *Breeding of Tropical and Subtropical Fruits*. Narosa Publishing House, New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

Course No. : H/FS-248
Credit hours: (1+1) 2

Course Title: Dryland Horticulture
Semester: IV

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, scarce 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 pits, etc., *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 horticultural features of dry land horticultural crops,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, date palm, phalsa, fig, and tamarind, Markingnut , Charoli , Passion fruit & Jackfruit, Pomegranate.

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.

Lesson/Course Plan

Lecture No.	Topic	Weightage (%)
1	Definition, importance and limitation of dry land horticulture	10
2	Present status and future scope. Constraints encounter in dry lands.	10
3	Agro-climatic features in rain shadow areas, scarce water resources, high temperature, soil erosion, run-off losses etc.	05
4,5	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 pits,etc <i>in-situ</i> water harvesting methods, micro catchment, different types of tree basins etc	05
6	Methods of reducing evapotranspiration, use of shelter belts, mulches, antitranspirants, growth regulators, etc	05
	Water use efficiency-need based, economic and conjunctive use of water, Micro systems of irrigation etc. Special techniques, planting and after care-use of seedling races, root stocks, <i>in-situ</i> grafting, deep pitting/planting, canopy management etc drought resistance Characters and special adaptation of the following crop	
7	Ber and Aonla	10
8	Annona and Jamun	10
9	Pomegranate	5
10	Tamarind and Loquat	5
11	Fig and Phalsa	10
12	Wood apple, bael	5
13	Date palm	5
14	Charoli	5
15	Carambola, Durian, Marking Nut	5
16	Rambutan, Bilimbi	5

	Total	100
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Practical programme

Practical No.	Topics
1	Study of rainfall patterns
2	Contour bunding
3	Trenching
4	Micro catchments
5	Soil erosion and its control.
6	Study of evapotranspiration,
7	Mulching
8	Irrigation systems-Surface
9	Irrigation systems-Sub Surface
10	Micro irrigation
11	Special techniques of planting and aftercare in dry lands
12	Special horticultural practices in dry land plants
13	Training in dry land plants
14	Pruning in dry land plants
15	Study of morphological and anatomical features of drought tolerant fruit crops.
16	Study of morphological and anatomical features of salinity tolerant fruit crops.

Suggested reading:

Reference Books:

- Chadha, K. L. (ICAR)2002, 2001.*Hand book of Horticulture*. ICAR, New Delhi
 - 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 Bhaskarand K.N.Sathesan. 2008. *Management of Horticultural Crops*. New India Publishing Agency.
 - Fruit culture in India , Shyam Singh , S. Krishnamurthy & S. L. Katyal .
 - Production technology of fruit crops, K. G. Shanmmugavellu .
- e-reading:* <http://ecourses.iasri.res.in/>

DEPARTMENT OF
VEGETABLE SCIENCE

DEPARTMENT OF VEGETABLE SCIENCE

Course No.- H/VS – 232

Course title:- Tropical and sub-tropical vegetables

Credit hours: (2+1) 3

Semester- III

Theroy- Area, production, economic importance, scope and export potential of tropical and sub-tropical vegetable crops. Types of Vegetable Farming, Classification of vegetables, 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, post-harvest handling, economics and marketing of tropical and sub-tropical vegetable crops such as tomato, brinjal, chillies, capsicum, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, curry leaf, agathi, 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, cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation.

Lesson / Course Plan- Theory

Lectures No.	Particulars	Weightages (%)
1	Introduction, scope and importance of vegetable.	8
2	Area, production, economic importance and export potential of tropical and subtropical vegetables and tuber crops.	5
3	Types of vegetable farming.	5
4	Vegetable classification.	5
	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, post-harvest handling, economics and marketing of	
5-10	Tomato, chilli, brinjal, capsicum.	10
11	Okra	5
12	Cucumber	8
13	Pumpkin and squashes.	
14-18	Bitter gourd, ridge gourd snake, gourd, bottle gourd, sponge gourd.	8
19-20	Musk melon and water melon	8
21-24	Beans-French bear, cluster bean cowpea, yard long bean and dolichos bean	10
25-26	Leafy vegetables - Amaranthus, Mustard, Coriander, Methi.	5
27	Under exploited cucurbits - sweet gourd, pointed gourd, little gourd.	5
28-29	Moringa and curry leaf,	8
30	Agathi, Basella, Portulaca.	4
31	Sorelle and Rooselle	3
32	Recommendations of joint Agresco.	3
Total		100

Practical programme

Practical.No.	Particulars
1	Identification of tropical vegetable crops
2	Identification of subtropical vegetable crops
3	Raising vegetable seedlings of improved varieties
5	Field preparation and lay out for vegetable crops
6	Seed treatment and sowing of vegetable crops.
7	Planting and transplanting of vegetable crops
8	Integrated weed management in veg crops.
9	Methods of irrigation and manuring
10	Use of plant growth regulators in veg. production.
11	Identification of nutritional deficiencies in veg. crops and remedies.
12	Identification of physiological disorders in veg. crops.
13	Harvesting indices and maturity standards.
14	Harvesting of vegetables.
15	Packaging and storage of vegetable crops.
16	Project preparation and cost of cultivation of any two vegetables.

Suggested readings:

Text book:

- B.R.Choudhary, 2009. *A Text book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
- S. Thamburaj, 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi

Reference Books:

- Choudhury, B. (ICAR). 1990. *Vegetables*. 8th edition, National Book Trust, New Delhi.
- Haldavnekar, P.C.; Parulekar, Y.R.; Mali, P.C. and Haldankar, P.M, 2015. *Vegetables – Production Technology*, Astral International.
- K S Yawalkar, 2008. *Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur. 2004
- K.L.Chadha, 1993. *Advances in Horticulture*. Malhotra publishing house. New Delhi
- K.V.Kamath, 2007. *Vegetable Crop Production*. Oxford Book Company. Jaipur
- M.K.Rana, 2008. *Olericulture in India*. Kalyani Publishers. Ludhiana
- M.S.Dhaliwal, 2008. *Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana
- Nath Prem, 1994. *Vegetables for the Tropical Regions*. ICAR New Delhi
- P.Hazra, 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
- Pratibha Sharma, 2007. *Vegetable : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur
- Premnath, Sundari Velayudhan and Singh, D.P., 1987. *Vegetables for the tropical region*. ICAR, New Delhi. Publishing Co. Pvt. Ltd, New Delhi.
- Shanmugavelu, K.G., 1989. *Production Technology of Vegetable Crops*. Oxford & IBH
- Singh, D.K., 2007. *Modern Vegetable varieties and production*. IBN publishers, Technology International Book Distributing Co, Lucknow.
- Singh, Umashankar, 2008. *Indian Vegetables*. Anmol Publications. Pvt.Ltd .New Delhi.
- T.K.Bose, 2002. *Vegetable Crops*. Nayaprakash. Kolkata
- T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

Course No.- H/VS-243

Title: Spices and condiments

Credit hours-(2+1) 3

Semester- IV

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 micropropagation, 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 rosemary, Oregano, Mint- Sweet and Sour.

Practicals - 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.

Lesson/Course plan- Theory

Lecture No.	Topics	Weightage (%)
1-2	History, difference in spices and condiments, importance of spices and condiments. Scope of spices and condiments in India and their export potential	15
3-8	Climate and soil requirements, area, production, propagation method including micro propagation, varieties, planting, aftercares, irrigation, nutrient and weed management, cover cropping mulching, training and pruning, use of growth regulators, shade regulation, harvesting, curing, packaging, storage, extraction of oil and oleoresins, economics of the following crops	
9-10	Tree Spices: Black pepper, Clove, Nutmeg, Cinnamon, Allspice	10
11-14	Cardamom	10
15-16	Condiments: Turmeric Ginger	10
17	Kokum,	5
18-22	Curry leaf	05
23-24	Seed spices: Coriander, Fenugreek, Fennel, cumin, Celery	10
25-26	Bishop's weed, Dill	
27	Saffron, Vanilla	10
28-29	Herbal specis: Thyme, Rose merry, Oregano	5
30-31	Mint Sweet and Sour	5
32	Role of spice board and pepper export promotion	5
	Institutions and Research stations in R & D of spice crop	5
	Recommendations of Joint Agresco	5
Total		100

Practical programme-

Practical No.	Topic
1	Identification and description of different spices.
2	Identification and description of different condiments
3	Study of varieties of different spices and condiments

4	Propagation methods and nursery management in spices.
5	Propagation methods and nursery management in condiments
6	Special horticultural practices in spices and condiments
7	Intercultural Operations in spice gardens
8	Intercultural Operations in condiments gardens
9	Harvesting, maturity indices, grading of spices
10	Harvesting, maturity indices, grading of condiments
11	Storage of spices and condiments
12	Processing of spices and condiments
13	Extraction of essential oil and oleoresin from spices and condiments.
14	Integrated pest management of spices and condiments
15	Integrated disease management of spices and condiments
16	Visit to commercial plantations of spices and condiments.

Suggested Reading:

Reference Books:

- 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 Management Post Harvest Technology*. ICAR, New Delhi.
- Purseglove, Brown, E.G. Green, G.Z. Robbins, S.R.J. London, Longman, 1981. *Spices Vol.I & II*.
- Shanmugavelu, K.G. and Madhava Rao, 1977. *Spices and Plantation Crops*. Madras Popular Book Depot.
- Shanmugavelu, K.G. Kumar, N and Peter, K.V., 2005. *Production technology of spices and plantation crops*. Agrosis, Jodhpur.

e-reading: <http://ecourses.iasri.res.in/>

Course No : H/VS-356

Course title: Breeding of Vegetable, Tuber and Spice Crops

Credit hours : (2+1) 3

Semester : V

Theory- Breeding objectives and important concepts of breeding self pollinated cross pollinated and vegetatively propagated crops. Plant genetic resources, their conservation and utilization in crop improvement. Breeding for insect resistance, breeding for disease resistance, breeding for abiotic resistance, Male sterility and incompatibility and their utilization in development of hybrids. Origin, distribution of species, wild relatives and forms of vegetable crops viz., Solanaceous vegetables: Tomato, Brinjal, Capsicum, Chilli, Okra, Cucurbits: Cucumber, Watermelon, Bitter gourd, Bottle gourd, Cole crops: Cabbage, Cauliflower, Tuber crops: Potato, Sweet potato, Cassava, Discordia, Root crops: Carrot, Radish, Spice crops: Ginger, Turmeric, Leafy vegetables: Amaranthus, Fenugreek and Spinach, Legume vegetables: Pea, Dolichus bean, Cluster bean. Breeding procedures for development of hybrids/varieties in various crops viz., Introduction, Selection, Hybridization, Mutation, Polyploidy and Heterosis. Application of biotechnology in vegetable crop improvement. Genetic basis of adoptability and stability.

Practical - Breeder kit, 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, G x E 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.

Lesson plan- Theory

Lecture No.	Topic	Weightage (%)
1	Breeding objectives	5
2	Important concepts of breeding self pollinated cross pollinated and vegetatively propagated crops.	10
3	Plant genetic resources, their conservation and utilization in crop improvement.	5
4-5	Breeding for insect resistance, breeding for disease resistance	5
6-7	Breeding for abiotic resistance	5
8-9	Male sterility and incompatibility and their utilization in development of hybrids.	10
	Origin, distribution of species, wild relatives and forms and breeding procedures for development of hybrids/varieties in various crops	
10-12	Solanaceous vegetables: Tomato, Brinjal, Capsicum, Chilli	10
13	Okra	5
14-17	Cucurbits: Cucumber, Watermelon, Bitter gourd, Bottle gourd	5
18-19	Cole Crops: Cabbage, Cauliflower	05
20	Tuber crops: Potato, Sweet potato, Cassava, Discordia	05
21-22	Bulb Crops : Onion and Garlic	5
23-24	Root crops: Carrot, Radish	5
25-26	Leafy vegetables- Amaranthus, Fenugreek and Spinach	5
27	Legume Vegetables: Pea, Dolichus bean, Cluster bean.	5
28-29	Spice crops: Ginger, Turmeric	5
30-31	Genetic basis of adoptability and stability	5

32	Recommendations of Joint Agresco	5
Total		100

Practical programme

Practical No.	Topics
1	Field equipment for Plant Breeders, Breeder kit
2	Selfing Methods
3	Floral Biology and Hybridization Techniques in solanaceous vegetable
4	Floral Biology and Hybridization Techniques in crucifers
5	Floral Biology and Hybridization Techniques in cucurbitaceous
6	Floral Biology and Hybridization Techniques in leguminous vegetable
7	Floral Biology and Hybridization Techniques in root vegetables
8	Floral Biology and Hybridization Techniques in alliums
9	Floral Biology and Hybridization Techniques in tuber crops
10	Floral Biology and Hybridization Techniques in spices
11	Working out phenotypic and genotypic heritability, genetic advance. GCA, SCA, combining ability.
12	Heterosis, heterobeltosis, standard heterosis, GxE interactions (stability analysis)
13	Preparation and uses of chemical and physical mutagens.
14	Polyploidy breeding and chromosomal studies.
15	Techniques of F ₁ hybrid seed production.
16	Maintenance of breeding records.

Suggested Reading:

Reference Books:

- Fageria, M.S., 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani Publishers, Ludhiana.
- H.P. Singh, 2009. *Vegetable Varieties of India*. Studium Press (India) Pvt Ltd. New Delhi.
- Hari Hara Ram, 2013. *Vegetable Breeding: Principle and Practices*. Kalyani Publishers. Ludhiana.
- Kallo G, 1998. *Vegetable Breeding (Vol.I to IV)*. CRC Press. Florida. 1988.
- M.S. Dhaliwal.2012. [Techniques of Developing Hybrids in Vegetable Crops](#). Agrobios. Jodhpur.
- M.S.Dhaliwal, 2009. *Vegetable Seed Production & Hybrid Technology*. Kalyani Publishers. Ludhiana.
- P.K.Singh, 2005. *Hybrid Vegetable Development*. CRC Press. Florida.
- Vishnu Swaroop, 2014. *Vegetable Science & Technology in India*. Kalyani Publishers. Ludhiana.

e-reading: <http://ecourses.iasri.res.in/>

Course No.- H/VS-367
Credit hours– (2+1) 3

Title: Seed production of vegetable, Tuber and spice crops
Semester-VI

Theory- Introduction and history of seed industry in India. Definition of seed, classes-types 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, land requirements, climate, season, planting time, nursery management, seed rate, rouging, seed extraction and storage of cole crops, root vegetables, solanaceous vegetables, cucurbits, okra, leafy vegetables, bulb crops, leguminous vegetables 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. Methods of seed production, Seed certification in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, okra, leafy vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units.

Lesson/course plan

Lecture No.	Topics	Weightage (%)
1-2	History of seed industry in India, Definition of seed and difference between grain and seed and classes, types of seed	8
3-4	Importance and scope of seed production in india, Principles of seed production	8
5-6	Role of climate (Light, humidity, temp. etc) on vegetable seed production.	4
7	Agencies of pollination and isolation distance in vegetable seed production.	4
8	Field standards and seed standards.	4
9-10	Seed production methods in cole crops. (cabbage, cauliflower, knolkhol, broccoli)	8
11-12	Seed production methods in solanaceous crops (tomato, chilli, brinjal, bellpeper)	8
13-15	Seed production methods in cucurbits (cucumber, Bitter gourds, pumpkin, Watermelon)	8
16-17	Seed production methods in leafy vegetables (fenugreek, amaranthus, palak)	4
18-21	Seed production methods in beans and peas (pea, french bean, dolichos bean)	4
22-23	Seed production methods in bulb crops (onion, garlic)	7
24-25	Seed production methods in tuber crops (potato, sweet potato)	4
26-27	Seed production in root vegetables (radish, carrot)	4
28-29	Seed extraction, drying, processing and storage of seed.	7
30	Seed testing for germination, viability and purity.	7
31	Seed production in seed spice crops(Coriander)	7
32	Seed act / legislation Recommendations of Joint Agresco.	4
Total		100

Practicals programme

Practical No.	Topics
1	Study of seed structure, size, shape etc.

2	Objectives and practices of field inspection.
3	Objectives and practices in rouging.
4	Seed sampling techniques and types of seed samples
5	Seed testing techniques for determination of percent germination,viability, purity.
6	Seed classes or types on the basis of physical and genetical purity
7	Harvesting, extraction, processing, drying of seeds.
8	Packaging, labelling and storage of Seeds.
9	Methods of seed production in cole crops.
10	Methods of seed production in root vegetables.
11	Methods of seed production in bulb crops.
12	Methods of seed production in solanaceous crops
13	Methods of seed production in cucurbitaceous crops.
14	Methods of seed production in leafy vegetables.
15	Methods of seed production in leguminous vegetables.
16	Visit to seed production plots, seed processing units and seed testing laboratory.

Suggested Reading:

Reference Books:

- Agarwal, P. K. 2010. *Techniques in Seed Science and Technology*. South Asian
- Agrawal R. L. 1999. *Seed Technology*. Oxford and IBH Publicity Company, New Delhi.
- Arya, Prem Singh. 2003. *Vegetable seed Production Principles*. Kalyani Publishers.
- Fageria, M. S. 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani
- G.N. Kulkarni, 2002. *Principles of Seed Technology*. Kalyani Publishers, Ludhiana.
- Geetharani, P. 2007. *Seed Technology in Horticultural Crops*. NPH Publications. Jodhpur.
- Khare, D. and Bhole, M.S. 2000. *Seed Technology*. Scientific Publishers (India) Jodhpur.
- L.O. Copeland, 1999. *Principles of Seed Science and Technology*. Springer Publications. Ludhiana.
- N.P. Nema, 1988. *Principles of seed certification and Testing*. Allied Publications.
- Nemgal Singh, P.K. Singh, Y.K. Singh and Virendrakumar, 2006. *Vegetable Seed Production Technology*. International book distributing co., Lucknow.
- P. Hazra and M.G. Som, 2009. *Vegetable seed production and Hybrid Technology*. Kalyani Publishers, Ludhiana.
- Prem Singh Arya, 2003. *Vegetable breeding, production and seed production*. Kalyani publishers, New Delhi.
- Rattan LalAgarwal, 1995. *Seed technology*. Oxford & IBH, New Delhi
- [Raymond A.T.](#), 2000. *Vegetable Seed Production*. Oxford University Press, USA
- Singh, Prabhakar.2015.*Seed Production Technology of vegetable*.Daya Publishing House. New Delhi.
- Singh, S.P. 2001. *Seed Production in Commercial Vegetables*. Agrotech Publishing Academy, 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.
- Vanangamudi, K.2010. *Vegetable Hybrid Seed Production and Management*. Agrobios. Jodhpur.

e-reading: <http://ecourses.iasri.res.in/>

Course No.- H/VS-245

Credit hours: (1+1) 2

Course title:- Temperate Vegetable crops

Semester- IV

Theory – Scope and 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 and Marketing of cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels ‘sprout, lettuce, palak, Chinese cabbage, spinach, garlic, onion, leek, radish, carrot, turnip, beet root, peas, broad beans, rhubarb, asparagus, globe artichoke, Vegetable kale, fenugreek and coriander.

Practical - Identification and description of varieties/hybrids; propagation methods, nursery management; preparation of field, sowing/transplanting; use of plant growth regulators; identification of physiological and nutritional disorders and their corrections; important pest and diseases; post-harvest handling; cost of cultivation and field visits to commercial farms.

Lesson/Course Plan - Theory

Lecture No.	Particulars	Weightages (%)
1	Scope and Importance of cool season vegetable crops in nutrition and national economy.	10
2	Area, production, export potential, description of Temperate Vegetables	10
	Description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and marketing of	
3	Cabbage	8
4	Cauliflower	8
5	Sprouting Brocoli	8
6	Chinesse cabbage	4
7	Knol Khol	4
8	Brussel’s Sprout, Lettuce	4
9-10	Radish, Carrot, Turnip, Beet root	8
11	Pea, Broad Bean	8
12	Palak, Spinach, coriander, fenugreek	8
13	Onion	8
14	Garlic	4
15	Asparagus, Leek, Globe artichoke, Kale, fenugreek, coriander	4
16	Recommendations of Joint Agresco	4
	Total	100

Practical Programme

Practical No.	Particulars
1	Identification temperate Vegetables
2	Botanical description of temperate vegetables
3	Identification and description of commercially important varieties of temperate vegetables.
4	Botanical description commercially important varieties of temperate vegetables.
5	Propagation methods, nursery management Raising seedlings of temperate

	vegetables,
6	Use of Plant Growth Regulators in temperate vegetables
7	Land preparation and layout of planting
8	Transplanting of temperate vegetables
9	Identification of physiological disorders in temperate vegetables and remedies
10	Methods of irrigation
11	Manures and Fertilizer application
12	Identification of nutritional deficiencies in temperate vegetables and their control measures
13	Maturity indices and harvesting of temperate vegetables, Packaging and storage of temperate vegetables.
14	Estimation of cost of cultivation of temperate vegetables.
15	Important Pest and diseases in vegetables
16	Field visit to vegetable farms and vegetable market

Suggested Reading:

Text books:

- B.R.Choudhary 2009. *A Text book on production technology of vegetables*. Kalyani Publishers. Ludhiana.
- S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.

Reference Books:

- Bose, T.K. 2003. *Vegetable Crops*. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.
- Choudhery, B., 1990. *Vegetables*. 8th edition. National Book Trust, New Delhi.
- Haldavnekar, P.C.; Parulekar, Y.R.; Mali, P.C. and Haldankar, P.M, 2015. *Vegetables – Production Technology*, Astral International.
- K S Yawalkar, 2004. *Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur.
- K.L.Chadha. 1993. *Advances in Horticulture*. Malhotra publishing house. New Delhi
- K.V.Kamath. 2007. *Vegetable Crop Production*. Oxford Book Company. Jaipur
- M.K.Rana, 2008. *Olericulture in India*. Kalyani Publishers. Ludhiana
- M.S.Dhaliwal, 2008. *Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana
- Nath Prem. 1994. *Vegetables for the Tropical Regions*. ICAR New Delhi
- P.Hazra. 2006. *Vegetable science*. Kalyani Publishers .Ludhiana
- P.Hazra. 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.
- Pratibha Sharma, 2007. *Vegetables: Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur
- Prem Singh Arya, 1999. *Vegetable Seed Production Principles*. Kalyani Publishers, New Delhi.
- Shanmugavelu, K.G. 1989. *Production technology of vegetable crops*. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.
- Singh, Umashankar, 2008. *Indian Vegetables*. Anmol Publications. Pvt.Ltd. New Delhi.
- T.K.Bose. 2002. *Vegetable Crops*. Nayaprakash. Kolkata
- T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.
- Uma Shankar. 2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.

e-reading: <http://ecourses.iasri.res.in/>

Course No.- H/V/S -121

Course title:- Potato and Tuber Crops

Credit hours: (1+1) 2

Semester- II

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, field and seed standards, 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.

Lesson/Course Plan -Theory

Lectures No.	Particulars	Weightages (%)
1	Scope and importance of potato and other tuber crops	10
2	Nutritional importance of Potato and tuber crops.	4
3	Area, Production and export potential of various tuber crops, cultivation practices including soil and climate, season, seed rate, preparation of field planting, spacing, water, nutrient and weed management. Deficiencies and their management, Use of PGR'S and chemicals, Special intercultural operations, cropping system, Harvesting and yield. Economics of cultivation, Post-harvest handling, field and seed standards and marketing of	10
4-5	Potato	10
6	Sweet potato	10
7	Cassava	8
8	Colocasia	4
9	Xanthosoma	4
10	Amorphophallus	8
11	Greater yam	4
12	Aerial Yam	8
13	Lesser yam	8
14-15	Jerusalem artichoke, Horse Raddish, Yam bean, Arrow root and Chinese potato and other under exploited tubers	8
16	Recommendations of Joint Agresco.	4
Total		100

Practical programme

Practical No.	Particulars
1	Identification and description of various tuber crops.
2	Study of various propagation methods in tuber crops
3	Field preparation and planting of Sweet potato, Potato,
4	Field preparation and planting of Amorphophallus, Colocasia,
5	Field preparation and planting of Cassava,
6	Field preparation and planting of Aerial Yam, Lesser yam etc.
7	Nutrient management in tuber crops.
8	Intercultural operations in potato.
9	Intercultural operations in tuber crops
10	Nutrient deficiencies and physiological disorders in tuber crops.
11	Study of maturity indices and harvesting of various tuber crops
12	Post-harvest handling curing to storage of tuber crops.
13	Marketing of tuber crops.
14	Working of cost of cultivation of important tubers.
15	Preparation of commercially viable project proposal.
16	Visit to tuber research station /farmers field.

Suggested Reading:

Text books:

- S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.
- B.R.Choudhary 2009. *A Text book on production technology of vegetables*. Kalyani Publishers. Ludhiana.

Reference Books:

- 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. Bradshaw, 2010. Root and tuber crops. Springer Publications.

e-reading: <http://ecourses.iasri.res.in/>

Course No : H/VS- 244

Course title -Precision Farming and Protected Cultivation

Credit hours : (2+1)3

Semester : IV

Theory-Precision farming – laser levelling, 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, yield mapping in horticultural crops. Green house technology, Introduction, Importance,scope,advantages and dis-advantages, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes.Green house equipment, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, Typical applications, passive solar green house, hot air greenhouse heating systems, green house drying. Cost estimation and economic analysis. Choice of crops for cultivation under greenhouses, problems / constraints of greenhouse cultivation and future strategies. Growing media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT) / hydroponics.

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

Lesson/Course Plan- Theory

Lecture No.	Topics	Weightage (%)
1	Precision farming – Introduction and history	8
2	Precision farming – Importance and Scope	
3	Laser leveling, mechanized direct seed sowing seedling and sapling transplanting	3
4	Mapping of soils and plant attributes	4
5	Site specific input application	8
6	Weed management	4
7	Insect pests and disease management	4
8	Yield mapping in horticultural crops.	4
9	Green house technology – Introduction viz. Importance,scope, advantages and dis-advantages.	8
10	Types of Green Houses based on shape, utility, construction and cladding materials;	
11	Plant response to Greenhouse environment	4
12	Planning and design of greenhouses	4
13	Design criteria of greenhouse for cooling and heating purposes	8
14	Green house equipment	
15	Materials of construction for traditional and low cost green houses.	
16	Irrigation systems used in greenhouses	
17	Net house cultivation	8
18	Passive solar green house	3
19	Hot air greenhouse heating systems	
20	Green house drying	
21-25	Choice of crops for cultivation under greenhouses Tomato, Capsicum,	16

	Cabbage, Cauliflower, Cucumber, Broccoli, Chinese cabbage, Spinach, Lettuce	
26-27	Cost estimation and economic analysis	4
28	Problems / constraints of greenhouse cultivation and future strategies.	4
29	Growing media, Soil culture- type of soil required	3
30	Drainage - flooding and leaching	
31	Soil pasteurization in peat moss and mixtures, Rock wool and other inert media	3
32	Nutrient film technique (NFT) Hydroponics Recommendations of joint Agresco	
Total		100

Practical programme

Practical No.	Topics
1	Study of different types of greenhouses based on shape, utility,
2	Study of different types of greenhouses based on construction and cladding materials
3	Calculation of air rate exchange in an active summer winter cooling system;
4	Estimation of drying rate of agricultural products inside green house;
5	Testing of soil and water to study its suitability for growing crops in greenhouses;
6	The study of fertigation requirements for greenhouses crops and estimation of E.C. in the fertigation solution;
7	The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization / sterilization;
8	Visit to commercial greenhouses;
9	Cultivation of Capsicum under protected cultivation
10	Cultivation of Tomato under protected cultivation
11	Cultivation of Cucumber under protected cultivation
12	Cultivation of Cucurbits under protected cultivation with mulches
13	Cultivation of Summer squash under protected cultivation with mulches
14	Cultivation of melons and beans under protected cultivation with mulches
15	Cultivation of spinach, coriander
16	Economics of protected cultivation

Suggested Reading:

Reference Books:

- Aldrich R A and Bartok J W. 1994. NRAES, Riley, Robb Hall. Green House Engineering. Cornell University, Ithaca, New York.
- Balraj Singh. 2006. Protected cultivation of vegetable crops. Kalyani Publishers, Ludhiana.
- Brahma Singh, 2014. Advances in Protected Cultivation. New India Publishing Agency. New Delhi.
- Jitendra Singh, 2015. Precision Farming in Horticulture. New India Publishing Agency. New Delhi.
- Jitendra Singh, S.K. Jain, L.K. Dashora, B.S. Cundawat. 2013. Precision forming in Horticulture. New India Publishing Agency, New Delhi.
- Pant V Nelson. 1991. Green House Operation and Management. Bali Publication.
- Prasad S. 2005. Greenhouse Management for Horticultural Crops. Agrobios. Jodhpur.
- Reddy P. Parvatha, 2003. Protected Cultivation. Springer Publications. USA.
- Reddy, P. Parvatha. 2011. Sustainable crop protection under Protected Cultivation. Springer Publications. USA.

- T. Pradeep Kumar, B. Suma, JyothiBhaskar and K.N.Satheson. 2008. Management of Horticultural crops. New India Publishing Agency, New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

DEPARTMENT OF POST
HARVEST TECHNOLOGY

DEPARTMENT OF POST HARVEST TECHNOLOGY

Course No.- H/PHT-362 Course title:Post-harvest Management of Horticulture Crops

Credit hours: (2+1) 3 Semester- VI

Theory-Importance of postharvest technology in horticultural crops. Maturity, types of maturity and factors affecting maturity of horticultural crops, maturity indices, harvesting, handling, grading of fruits, vegetables, cut flowers, plantation crops, medicinal and aromatic plants.Pre-harvest factors affecting quality, factors responsible for deterioration of horticultural produce, physiological and bio-chemical changes, hardening and delaying ripening process.Postharvest treatments of horticultural crops.Quality parameters and specification. Structure of fruits, vegetables and cut flowers related to physiological changes after harvest. Methods of storage for local market and export.Pre-harvest treatment and pre-cooling, pre-storage treatments.Different systems of storage, packaging methods and types of packages, recent advances in packaging.Types of containers and cushioning materials, vacuum packaging, cold storage, poly shrink packaging, grape guard packing treatments. Modes of transport.

Practical-Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality.Grading of horticultural produce, post-harvest treatment of horticultural crops, physical and chemical methods. Packaging studies in fruits, vegetables, plantation crops and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce.Identification of storage pests and diseases in spices.Visit to markets, packaging houses and cold storage units.

Lesson/Course Plan - Theory

Lecture No.	Topics	Weightage (%)
1	Importance of Postharvest Technology in horticultural crops.	8
	Maturity, types of maturity and factors affecting maturity of horticultural crops,	
	Maturity indices, harvesting, handling, grading of	
2-3	Fruits (Mango, Banana, Papaya, Citrus, Guava, Annona, Aonla, Grape, Sapota, Pomegranate, Pine apple, Litchi, Strawberry)	8
4-5	Vegetables (Tomato, Brinjal, Chilli, Potato, Cabbage, Cauliflower, Onion, Okra, Peas, Watermelon/Muskmelon, Cucumber, Turmeric)	8
6	Cut flowers (Rose, chrysanthemum, Gladiolus, Carnation, Tuberosa, Gerbera)	4
7-8	Plantation crops and spices (Coconut, Cashew nut, Arecanut, Tea, Coffee)	4
9-10	Medicinal and aromatic plants(Aswagandha, Safed musali, Aloe vera, Lemon grass, Citronella, Khus, Mentha, Osimum)	4
11	Pre-harvest factors affecting quality	4
12-14	Factors responsible for deterioration of fruits, vegetables, cut flowers	4
15-16	Physiological and bio-chemical changes during ripening	4
17	Hastening and delaying ripening process.	4
18-20	Postharvest treatments of horticultural crops –VHT, HWT, irradiation, fungicidal and chemical	8
21-23	Quality parameters and specification in fruits, vegetables and cut flowers	4
24-25	Structure of fruits, vegetables and cut flowers related to physiological changes after harvest.	4
26	Methods of storage for local market and export.	4
27	Pre-harvest treatment and pre-cooling, pre-storage treatments	4
28	Different systems of storage.	4

29	Packaging methods and types of packages, recent advances in packaging-vacuum packaging, poly shrink packaging, grape guard	7
30	Types of containers and cushioning materials, packing treatments and cold storage.	7
31	Modes of transport	3
32	Recommendations of Joint Agresco	3
Total		100

Practical programme

Practical No.	Topics
1	Maturity indices of fruits
2	Maturity indices of vegetables
3	Maturity indices of flowers
4	Maturity indices of Plantation crop
5	Maturity indices of Spices
6	Determination of physiological loss in weight and quality
7	Grading of horticultural produce (manual)
8	Grading of horticultural produce(Mechanical)
9	Post-harvest treatment of horticultural crops, physical and chemical methods.
10	Packaging in fruits, vegetables by using different packaging materials,
11	Packaging in plantation crops and cut flowers by using different packaging materials
12	Methods of storage
13	Post-harvest disorders in horticultural produce
14	Identification of storage pests and diseases in Horticulture crops
15	Visit to packaging houses
16	Visit to cold storage

Suggested reading:

Reference Books:

- Battacharjee, S. K. and De, L. C. 2005. Post Harvest Technology of Flowers and Ornamentals Plants. Ponteer Publisher, Jaipur, India.
- Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi.
- Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.
- Hulme, A.C. 1970. Food Science & Technology - A Series of Monograph. The Biochemistry of Fruits and their Products. Vol.-1. Academic Press London & New York.
- Jacob John, P. 2008. A Handbook on Post Harvest management of Fruits and vegetables. Daya Publishing House, Delhi-1081-7035-532-X.
- Kitinoja, L. and Kader, A. A. 2003. Small-Scale Postharvest Handling practice: A Manual for Horticulture crops (4th edt.). US Davis, PHT Research and information Center.
- Kitinoja, L. and Kader, A. A. 2003. Small-Scale Postharvest Handling practice: A Manual for Horticulture crops (4 edt). US Davis, PHT Research and information Center.
- Mitra, S. K. 1997. Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits. CAB International.
- Neetu Sharma and Mashkoo Alam, M. 1998. Post Harvest Diseases of Horticultural Perishables. International Book Distributing Co., Lucknow.
- Pruthi, J. S. 2001. Minor Spices and Condiments – Crop Managements and Post Harvest Technology. ICAR, New Delhi.
- Saraswathy, S. *et. al.* 2008. Post harvest Management of Horticultural Crops. Agribios (India).81-7754-322-9.
- Shanmugavelu, K. G., Kumar, N. and Peter K.V. 2002. Production Technology of Spices and Plantation Crops. Agrobios (India).
- Stanley, J. K. 1998. Post Harvest Physiology of Perishable Plant Products. CBS, New Delhi.

- Thomposon, A. K. 1996. Post harvest Technology of Fruits and Vegetables. Blackwell Science.
- Verma, L. R. and Joshi, V. K. 2000. Post Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi
- Wiils, McGlasson and Graham, J. 2007. Post Harvest- An Introduction to the Physiology and Handling of Fruits, Vegetables and ornamentals. Cab International

e-reading: <http://ecourses.iasri.res.in/>
www.postharvest.ucdavis.edu
http://www.fao.org/infoods/index_en.stm
<http://www.postharvest.com.au>

Course No.- H/PHT-363

Course title:- Processing of Horticultural Crops

Credit hours: (1+2) 3

Semester- VI

Theory- Importance and scope of fruit and vegetable preservation industry in India, food pipeline, losses in post-harvest operations, unit operation in food processing. Principles and guidelines for the location of processing units. Principles and methods of preservation by heat pasteurization, canning, bottling. Methods of preparation of juices, squashes, syrups, cordials and fermented beverages viz., wine, cider and neera. Jam, jelly and marmalade. Preservation by sugar and chemicals, candies, crystallized fruits, preserves chemical preservatives, preservation with salt and vinegar, pickling, chutneys and sauces, tomato and mushrooms, freezing preservation. Processing of plantation crops, products, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws.

Practical - Equipment used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables–tomato product dehydration, refrigeration and freezing, cut out analysis of processed foods. Processing of plantation crops. Types of containers for processing of fruits and vegetables. Visit to processing units.

Lesson/Course Plan

Lecture No.	Topics	Weightage (%)
1	Importance and scope of fruit and vegetable preservation industry in India	10
2	Food pipe line, losses in post-harvest operations	4
3	Unit operations in food processing, guidelines for the location of processing unit	8
4	Principles of food preservation, methods of preservation- refrigeration, freezing preservation, pasteurization, sterilization	4
5	Methods of preservation-sun drying, dehydration (freeze drying, foam mat drying, spray drying, low temperature evaporation or concentration)	4
6	Methods of preservation-by salt, vinegar, sugar, chemical preservatives	4
7	Preparation of juices, squashes, syrups	10
8	Cordial, fermented beverages (wine, cider and neera)	8
9	Jam , jelly, marmalade	8
10	Preserve, candy, crystallized fruits	4
11	Pickle, chutney, tomato ketchup	8
12	Mushroom processing	4
13	Processing of plantation crops (cashew, coconut, Arecanut, tea, coffee, cocoa, rubber)	8
14	Spoilage in processed food products, quality control of processed products including HACCP and GMP	8
15	Govt. policy on import and export of processed products Food laws (FSS Act)	4
16	Recommendations of Joint Agresco	4
Total		100

Practical programme

Practical No.	Topics
1	Equipments used in food processing units

2	Physico-chemical analysis of fruits and vegetables-TSS and Acidity
3	Physico-chemical analysis of fruits and vegetables- Vitamin C/Ascorbic acid and carotene
4	Physico-chemical analysis of fruits and vegetables- Reducing and Total sugars
5	Canning of fruits- mango, pineapple, guava etc
6	Canning of vegetables- peas, tomato etc.
7	Preparation of RTS
8	Preparation of squash
9	Preparation of syrup
10	Preparation of cordial
11	Preparation of jam
12	Preparation of jelly
13	Preparation of marmalade
14	Preparation of preserves
15	Preparation of candies
16	Preparation of chutneys
17	Preparation of tomato ketchup
18	Preparation of hot pickles
19	Preparation of sweet pickles
20	Dehydration of fruits
21	Dehydration of vegetables
22	Refrigeration and freezing
23	Dehydrofreezing of fruits and vegetables
24	Cut out analysis of processed food- TSS and Acidity
25	Cut out analysis of processed food- Vitamin C/Ascorbic acid and carotene
26	Cut out analysis of processed food- Reducing and Total sugars
27	Processing of plantation crops- Nut crops
28	Processing of plantation crops- Beverage crops
29	Processing of plantation crops- Rubber, Oil Palm
30	Spoilage of processed products
31	Types of containers used for processing of fruits and vegetables
32	Visit to processing units

Suggested reading:

Reference Books:

- Bhatti, S. 1995. Vame, Fruit and vegetable processing. CBS Publishers, Distributors, NewDelhi.
- Chadha, K. L. 2003. Hand book of horticulture, ICAR, New Delhi.
- Chadha, K. L. and Kalloo, G.1993. Advances in Horticulture. Vol. 4 to 10. MPH, New Delhi
- DauthyandMircea,E.1995. Fruitandvegetablesprocessing.InternationalBookDistributionCo, Lucknow.
- Dauthy, M. E. 1995. Fruits and Vegetables Processing- FAO Bulletin 119. International Book Distributing Co., Lucknow.
- FAO - Training Manual No.17/2. 2007. Prevention of post-harvest food losses: Fruits, Vegetables and Root crops. Daya Publishing House, Delhi.
- Fellows, P. J. 1998. Food Processing Technology – principles and Practices. Ellis Horwood.

- Girdharilal, Siddappa, G. S. and Tandon, G. L. 1998. Preservation of fruits and vegetables. ICAR, New Delhi.
- Kays and Stanely, J. 1998. Post-harvest physiology of perishable plant products. CBS Publishers, Distributors, New Delhi
- Manoranjan, K and Sangita, S. 1996. Food Preservation & Processing. Kalyani Publishers, India.
- Neetu Sharma and Mashkooor Alam, M. 1998. Post-Harvest Disease of Horticultural Perishable. International Book Distributing Co., Lucknow
- Ranganna, S. 1986. Handbook of analysis and quality control for fruit and vegetable product, II edition, Tata McGraw-Hill publishing company limited, New Delhi.
- Salunkhe, D.K., Bolin, H. R. and Reddy, N. R. 1991. Storage, Processing and Nutritional Quality of Fruits and Vegetables. 2nd Edition. Vol. II. CRC Press, 0849356245
- Siddappaa, G. S., Girdhari Lal and Tandon, G.L. 1998. Preservation of Fruits and Vegetables. ICAR, New Delhi
- Srivastava, R. P. & Sanjeev Kumar. 2002. Fruits and vegetable Preservation – Principles and Practice. International Book Distributing Co., Lucknow.
- Srivastava, R. P. and Sanjeev K. 1998. Fruit and vegetable preservation principles practice. International Book Distributing Co., Lucknow.
- Verma, L. R. and Joshi, V. K. 2000. Post-Harvest Technology of Fruits and Vegetables. Vol. I & II. Indus Publishing Co., New Delhi.
- Vijay, K. 2001. Text Book of Food Sciences and Technology. ICAR, New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

www.fssai.org

http://www.fao.org/infoods/index_en.stm

<http://www.postharvest.com.au>

Course No. - H/PHT-231

Course title- Fundamentals of Food technology

Credit hours-(1+1) 2

Semester – III

Theory- Food and its function, physico-chemical properties of foods, food preparation techniques, Nutrition: relation of nutrition of good health. Characteristics of well and malnourished population. Energy: definition, determination of energy requirements, food energy, total energy needs of the body. Mineral nutrition: macro and micro-minerals (Ca, Fe and P), function, utilization, requirements, sources, effects of deficiency. Vitamins: functions, sources, effects of deficiency, requirements of water soluble and fat-soluble vitamins. Balanced diet: recommended dietary allowances for various age groups, assessment of nutritional status of the population.

Practical- 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 proteins and fats of foods. Planning diet for various age groups.

Lesson/ Course plan

Lecture No	Topic	Weightage (%)
1-2	Food - Definition, Basic food groups. Nutritive value of food Functions and physico-chemical properties of foods.	15
3-4	Food preparation techniques – Effect of cooking on various nutrients. Different cooking methods – explain in detail the methods, their advantages and limitations.	20
5-6	Nutrition - Definition, relation of nutrition to health. Over and under Nutrition. Characteristics of well and malnourished population.	10
7-8	Energy - Definition, determination of gross energy, value of foods, total energy requirements of the body.	10
10 – 12	Mineral nutrition: macro and micro-minerals (Ca, Fe and P), function, utilization, requirements, sources, effects of deficiency.	15
13-14	Vitamins-Definition, classification, co-enzyme derivatives of water soluble vitamins, sources, metabolic functions and deficiency disorders of vitamins. Requirements of water soluble and fat-soluble vitamins.	10
15	Balanced diet -Definition, Recommended nutrient and dietary allowances for various age groups of both sexes.	10
16	Nutritional status - Definition, Methods of assessment of nutritional status of the population, their advantages and limitations.	10
Total		100

Practical programme:

Practical No.	Topic
1	Methods of measuring food ingredients
2	Methods of measuring food ingredients
3-4	Determination of percentage of edible portion.
5-6	Effect of cooking on volume and weight
7	Browning reactions of fruits

8	Browning reactions of vegetables
9-10	Microscopic examination of starches.
11-12	Estimation of energy value of foods.
13	Estimation of protein and fat content of foods.
14	Planning diet for various age groups (Age group I- Children)
15	Planning diet for various age groups (Age group II- Youth)
16	Planning diet for various age groups (Age group III- Old peoples)

Suggested Reading:

Reference Books:

- Anita, T. 1996. Food and Nutrition. Oxford 0198327668.
- Devendra, K. B. and Priyanka, T. 2006. An Introduction to Food Science and technology and Quality Management. Kalyani Publishers 81-272-2521-5.
- Dr. Swaminathan, M. 1985. Essential of Food and Nutrition Vol. II. BAPPCO, Bangalore.
- Dr. Swaminathan, M. 1985. Food and Nutrition Vol. I & II. BAPPCO, Bangalore.
- George, I. S. and Dennis, D. L. 1994. Chemistry for the Health Science. MacMillan.
- Gopalan, G., Ramasastri, B.V. and Balasubramnian, S. C. 1989. Nutritive value of the Indian Foods. National Institute of Nutrition, ICMR, Hyderabad.
- Manay, S.N, Shadaksharaswamy, M. 1998. Food-facts & Principles .New Age International
- Manoranjan, K. and Sangita, S. 1996. Food Preservation and Processing. Kalyani Publishers 978-81-272-4262-6.
- Monoranjam, K. and Sangita, S. 2008. Food Preservation and Processing. Kalyani Publishers
- Passmore, R. and Eastwood, M. A. 1986. Human Nutrition & Dietetics. ELBSPublishers, New Delhi
- Shankunthala, M. 1972. Foods-Facts, Principles & Procedure. The Eastern Press, Bengaluru.
- Srilakshmi, B. 1995. Food Science. New Age International Publishers, New Delhi.
- Srilakshmi. 2005. Dietetics. New age International 978-81-224-1611-4.
- Srilakshmi. 2010. Food Science. New age International 978-81-224-2724-0.
- Swaminathan, M. 1988. Hand book of Food Science & Experimental Foods. Bappco publishers, Bangalore.

e-reading: <http://ecourses.iasri.res.in/>
<http://www.fao.org/infoods/>

DEPARTMENT OF
FLORICULTURE AND
LANDSCAPE ARCHITECTURE

DEPARTMENT OF FLORICULTURE AND LANDSCAPE ARCHITECTURE

Course No.- H/FL-242
Credit hours: (2+1) 3

Course title:- Ornamental Horticulture
Semester- IV

Theory- History, definitions, scope of ornamental horticulture, aesthetic values, Floriculture industry, Importance, area and production, industrial importance of ornamental plants and flowers. Importance, 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, uses of vertical garden, bottle garden, terrariums, art of making bonsai, culture of bonsai and maintenance.

Practical- Identification and description of annuals, biennials, herbaceous perennials, climbers, shrubs, trees, indoor plants, ferns and sellagenellas, Palms and cycads and Cacti and succulents. Planning and designing and establishment of garden features viz. lawn, hedge and edge, rockery, water garden, carpet bedding, shade garden, roof garden, Study and creation of terrariums, vertical garden, study and practice of different types of flower arrangements, preparation of floral bouquets, preparation of floral rangoli, veni etc., Study of Bonsai techniques, Bonsai practicing and training. Visit to nurseries and floriculture units.

Lesson/Course Plan

Lecture No.	Topics	Weightage (%)
1	History, Definition, scope of gardening Aesthetic values	4
2-3	Types of gardens in India.	8
4	Floriculture industry: importance, area and production, industrial importance in India	4
5-6	Landscaping, basic principles and basic components.	4
7-8	Principles of gardening, Garden components & adornments	8
9	Lawn making	8
10	methods of designing rockery and water garden	4
11-13	Special types of gardens, trees, their design, their walk-paths, bridges, constructed features	8
14	Garden structures –Greenhouse, Glass house, Net house	4
15	Values in landscaping	4
16-18	Propagation-planting shrubs and herbaceous perennials	8
19-20	Importance, design values, propagation, planting, climbers, creepers	4
21-22	Importance, design values, propagation, planting, palms and ferns.	4
23-24	Importance, design values, propagation, planting, grasses, cacti succulents.	4
25-26	cultural operations in ornamental plants	4
27-28	Bio-aesthetic planning, definition, need, Round country planning, Urban planning & Planting avenues, schools, villages.	4

29	Beautifying railway stations, dam sites, hydroelectric stations, colonies, river banks, Planting material for play grounds.	4
30	Vertical gardens, Roof gardens	4
31	Culture of bonsai, art of making bonsai.	4
32	Recommandations of Joint Agresco	4
Total		100

Practical programme

Practical No.	Topics
1	Identification and description of annuals, herbaceous, perennials.
2	Identification and description of climbers, creepers, foliage flowering shrubs
3	Identification and description of trees, palms, ferns.
4	Identification and description of ornamental grasses; cacti succulents.
5	Planning and designing gardens-Formal
6	Planning and designing gardens- Informal
7	Functional uses of plants in the landscape
8	Planning design of house garden, roadside planting, avenues for new colonies, traffic islands
9	Preparation of land for lawn and planting.
10	Maintenance of Lawn
11	Description and design of garden structures
12	Layout of rockery,terrace garden, Japanese gardens and water garden
13	Layout of recreational and children's corner, terrarium,
14	Layout of traffic islands, bottle garden, dish garden.
15	Flower arrangement practices
16	Bonsai practicing and training

Suggested Reading:

Reference Books:

- Arora, J.S. 2006. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana
- Bimaldas Chowdhury and Balai Lal Jana.2014.Flowering Garden trees. Pointer publishers, Jaipur. India.
- Bose, Chowdhury and Sharma.1991.Tropical Garden Plants in colour .Horticulture and allied publishers, 3D Madhab Chatterjee street Kolkata.
- Bose, T.K. Mukherjee, D. 2004. Gardening in India. Oxford & IBH Publishers.
- Chadha, K.L. and Chaudhary, B. 1986. Ornamental Horticulture in India. Publication andInformationdivision. ICAR, New Delhi.
- K.V.Peter.2009.Ornamental plants. New India publishing agency, Pitampura, New Delhi.
- Randhawa, G.S. Amitabha Mukhopadhyay, 2004. Floriculture in India. Allied Publishers Pvt. Ltd., New Delhi.
- Richard Bird. 2002. Flowering trees and shrubs. Printed in Singapore by Star Standard Industries pvt. Ltd.

e-reading: <http://ecourses.iasri.res.in/>

Course No.- H/FL-364 Title:- Breeding and seed production of ornamental crops

Credit hours: 3(2+1) Semester- VI

Theory-History of improvements of ornamental plants, scope and importance of breeding of ornamental crops. Centre of origin of flower crops and ornamental crops, objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental and flower crops viz., rose, jasmine, chrysanthemum, tuberose, gerbera, gladiolus, dahlia heliconia, liliun, gaillardia, petunia, hibiscus, bouganvillea, zinnia, cosmos, dianthus, snapdragon, pansy, crossandra, marigold, geranium, antirrhinium, china aster, orchids, anthurium, carnation, etc. 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 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.

Lesson/Course Plan- Theory

Lecture No.	Topics	Weightage (%)
1-2	History of improvements of ornamental plants Scope and importance of breeding of ornamental crops.	8
3-4	Objectives and techniques in ornamental plant breeding	8
	Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental and flower crops viz.	
5-7	Rose	8
8-10	Jasmine, Hibiscus, Bouganvillea	8
11-16	Chrysanthemum, Gerbera, China Aster, Gaillardia, Dehlia, Zinnia, Carnation, Marigold, Cosmos	10
17-19	Tuberose, Gladiolus, Liliun,	8
20-21	Orchid, Anthurium, Heliconia, Antirrhinium,	8
22-23	Petunia, Dianthus, Snapdragon, Pansy, Crossandra, Geranium	4
24	Breeding for disease resistance.	4
25-26	Development of promising cultivars of important ornamentals and flower crops.	4
27	Role of heterosis and its exploitation	8
28	Production of F1 hybrids and utilization of male sterility	8
29	Production of open pollinated seed.	8
30	Harvesting processing and storage of seeds	
31	Seed certification.	3
32	Recommendations of Joint Agresco	3
Total		100

Practical programme

Practical No.	Topics
1	Acquaintance with breeding tools for floricultural crops
2	Methods of emasculation and pollination, selfing

3	Study of floral biology and pollination of rose, jasmine, chrysanthemum, tuberose
4	Study of floral biology and pollination of gerbera, gladiolus, dahlia heliconia, liliium, gaillardia
5	Study of floral biology and pollination of petunia, hibiscus, bouganvillea, zinnia, cosmos
6	Study of floral biology and pollination of dianthus, snapdragon, pansy, crossandra, marigold, geranium
7	Study of floral biology and pollination of china aster, orchids, anthurium, carnation
8	Techniques of inducing polyploidy and mutation.
9	Production of pure and hybrid seeds rose, jasmine, chrysanthemum, tuberose
10	Production of pure and hybrid seeds gerbera, gladiolus, dahlia heliconia, liliium, gaillardia
11	Production of pure and hybrid seeds petunia, hibiscus, bouganvillea, zinnia, cosmos
12	Production of pure and hybrid seeds china aster, orchids, anthurium, carnation
13	Harvesting, conditioning and testing of seeds
14	Harvesting, conditioning and testing of seeds
15	Practice in seed production methods.
16	Practice in seed production methods.

Suggested Reading:

Reference Books:

- Agarwal, P. K 1994. Principles of Seed Technology. ICAR Publication, NewDelhi.
- Agarwal, R. L. 1996. Seed Technology. Oxford&IBHPublishers, New Delhi.
- Bhattacharjee, S.K. and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.
- Bose, T. K., L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy. 2003. *Commercial flowers*. Partha Sankar Basu, Nayaudyog, 206, Bidhan Sarani, Kolkata-700006.
- Callaway D.J. and M.B. Callaway. 2000. Breeding Ornamental Plants. Timber Press.
- Harding, J., F.Singh and J.N. Mol. 1991. Genetics and Breeding of Ornamental Species. Springer Publishers.
- Pal, B. P. 1966.*The Rose in India*.Directorate of Knowledge management in Agriculture, Indian council of Agriculture Research-New Delhi.
- Singh, B. D. 1983. Breeding Principles and Methods. KalyaniPublishers,New Delhi.
- Vainstein, A. 2002. Breeding for Ornamental: Classical and Molecular Approaches. Springer Publishers.

e-reading: <http://ecourses.iasri.res.in/>

Course No.- H/ FL –353
Credit hours: (0+1)1

Course title:- Principles of Landscape Architecture
Semester- V

Practical- Study of garden 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 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, institutional and botanical gardens.

Practicals programme

Practical No.	Topics
1	Identifications of Plant materials for landscaping
2	Planning, designing and layout of formal gardens
3	Planning, designing and layout of formal gardens
4	Planning, designing and layout of informal gardens
5	Planning, designing and layout of informal gardens
6	Planning, designing and layout special gardens.
7	Planning, designing and layout special gardens.
8	Planning, designing and layout special gardens.
9	Symbols, tools, implements use in landscape designing.
10	Symbols, tools, implements use in landscape designing.
11	Maintenance and repairs of potted plants
12	Planting of Lawn by different methods
13	Maintenance of Lawn
14	Landscape design for specific areas-Schools, Churches, Highway
15	Landscape design for specific areas- Public places, Temples, railway station
16	Visit to Landscape gardens.

Suggested Reading:

Reference Books:

- A.K. Tiwari and R. Kumar. 2012. *Fundamentals of ornamental horticulture and landscape gardening*. New India.
- Arora, J.S. 2006. Kalyani publishers, Ludhiana. *Introductory Ornamental Horticulture*. Kalyani publishers, Ludhiana.
- Bose, T.K. Malti, R.G. Dhua, R.S. & Das, P. 2004. Nayaprakash, Calcutta. *Floriculture and Landscaping*
- H.S.Grewal and Parminder Singh. 2014. *Landscape designing and ornamental plants*
- L.C. De. *Nursery and landscaping*.2013. Pointer publishers, Jaipur India.
- 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.
- Randhawa, G.S. and Amitabha Mukhopadhyay 2004. *Floriculture in India*. Allied Publishers Pvt. Ltd., New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

Course No. - H/FL-231

Course title-Commercial Floriculture

Credits hours: (2+1) 3

Semester – III

Theory-Scope and importance of commercial floriculture in India,Production techniques of ornamental plants for domestic and export market for following flower crops,Rose,Marigold, Chrysanthemum,Anthurium, Gladiolus,Jasmine,Dahlia,Tuberose,Bird of Paradise,China Aster, gaillardia , Gerbera,Orchid,Crossandra, Growing of flowers under protected environments such as glass house, plastic house, net house, etc.,Post harvest technology of cut and loose flowers in respect of commercial flower crops,Dehydration techniques for drying of flowers, scope importance and status,Production techniques for bulbous crops

Practical-Identification of commercially important floricultural crops, Propagation technique in gladiolus, carnation, chrysanthemum and tuberose, Sowing of seeds and raising of seedlings of annuals, Propagation of ornamental plants with particular reference to cottage, layerage and budding, Training and pruning of roses, Drying and preservation of flowers, Use of chemicals and other compounds for prolonging the vase life of cut flowers, Flower arrangement practices.

Lesson/Course plan - Theory

Lecture No.	Particulars	Weighthages (%)
1-2	Scope and importance of commercial floriculture in India	8
	Production techniques of ornamental plants for domestic and export market for following flower crops	
3-4	Rose	8
5	Chrysanthemum	8
6-7	Anthurium and Orchid	8
8-9	Carnation and Gerbera	8
10-11	Gladiolus and Tuberose	8
12-13	Jasmine	8
14	Dahlia	8
15-18	Marigold, Crossandra, Gaillardia and China Aster	4
19-21	Michelia, Heliconia and Bird of Paradise	4
22	Domestic and export marketing of flowers.	4
23-25	Growing of flowering plants under protected environments such as glass house, plastic house, net house, etc.	4
26-27	Post-harvest technology of cut and loose flowers in respect of commercial flower crops.	8
28-29	Dehydration techniques for drying of flowers, scope importance and status	4
30-31	Production techniques for liliun,canna, spider lily, etc.	4
32	Recommendations of Joint Agresco	4
Total		100

Practical Schedule

Practical No.	Particulars
1	Identification of commercially important floricultural crops.
2	Propagation technique in gladiolus, carnation.

3	Propagation technique in chrysanthemum and tuberose.
4	Sowing of seeds and raising of seedlings of annuals.
5	Sowing of seeds and raising of seedlings of annuals.
6	Propagation of ornamental plants with particular reference to cutting
7	Propagation of ornamental plants with particular reference to layering
8	Propagation of ornamental plants with particular reference to budding
9	Training and pruning of roses.
10	Drying and preservation of flowers.
11	Intercultural operations
12	Intercultural operations
13	Use of chemicals and other compounds for prolonging the vase life of cut flowers.
14	Flower arrangement practices.
15	Preparation of garland, veni and gajara.
16	Visit to commercial floriculture unit

Suggested Reading:

Reference Books:

- A.K.Singh.2006.*Flower crops, cultivation and management*. New India publishing agency, Pitampura, New Delhi.
- Arora, J.S. 2006. *Introductory Ornamental Horticulture*. Kalyani Publishers, Ludhiana - 141 008.
- Bhattacharjee, S.K. *Advanced Commercial Floriculture*. Aavishkar Publishers Distributors, Jaipur - 320 003
- 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:
- S.K. Bhattacharjee and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.
- 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
- V.L. Sheela, 2008. *Flower for trade* . New India Publishing Agency, Pitampura, New Delhi-11008

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DEPARTMENT OF PLANT
PROTECTION

DEPARTMENT OF PLANT PROTECTION

Course No. H/PATH-231

Course title: Fundamentals of Plant Pathology

Credits: (1+1) 2

Semester: III

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.

Lesson plan

Lecture no.	Topic	Weightages/Marks
1	Importance of plant diseases, scope and objectives of Plant Pathology in relation to the diseases Late blight of Potato, Coffee Rust, Downy mildew of Grapes, Dutch elm disease. Terms and concepts in Plant Pathology, Pathogenesis	5
2	History of Plant Pathology with special reference to Indian work History of Plant Pathology: History and development of Plant Pathology in ancient, dark, premodern, modern present eras. Contribution made by– Surpal, Theophrastus, Pliny, Iwanowski, Robert Hook, Anton van Leeuwenhoek, Needham, Linnaeus, Tillet, Prevost Robert Loch, Marshal Ward, Millardet, Jenson, Meyar, Burril, E.F. Smith, Erikson, Biffen, Iwanwasky, Stakman, Cragie, Luthra, Stanley, Bowden and Pierie, Doi and Asuyama, Butler, Mehta, Mundkur, Dastur, Kulkarni, Bhide, Uppal, Tirumalachar, Patel and Rangaswamy.	5
3	Classification of plant diseases (Classification of the plant basis of mode of survival. dispersal, plant parts affected, occurrence, cause etc. Causes of Plant Disease Biotic (fungi, bacteria, fastidious vesicular bacteria, Phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa and nematodes) and abiotic causes with examples of diseases caused by them. Study of phanerogamic plant parasites. (Phanerogamic plant parasites Cuscutaceae (stem parasite) Genus: Cuscuta, the dodders 2. Viscaceae (stem parasites) Genus: Arceuthobium, the dwarf mistletoes of conifers Phoradendron, the American true mistletoes of broad leaved trees Viscum, the European tree mistletoes Dendrophthoe, the giant mistletoes 3. Orobanchaceae (root parasite) Genus: Orobanche, the broomrapes 4. Scrophulariaceae (root parasite) Genus: Striga, the witchweeds)	10
4	Symptoms of plant diseases Sign and symptoms, Classification of symptoms (Hyperplasia, Hypoplasia, Necrosis, with categorization of different symptoms with	10

	<p>suitable example), Diseases and symptoms due to abiotic causes. Deficiencies or excess of nutrients (e.g. 'Khaira' disease of rice due to Zn deficiency), Light, Moisture, Temperature, Air pollutants (e.g. black tip of mango), Lack of oxygen (e.g. hollow and black heart of potato), Toxicity of pesticides, Improper cultural practices, Abnormality in soil conditions (acidity, alkalinity, PH)</p>	
5-6	<p>Fungi general characters, definition of fungus, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, Fungi, General morphology, characters and somatic structures of fungi: Thallus, Branching habit of mycelium: Dichotomous, sympodial, lateral, opposite, verticillate, monopodial etc. somatic structures: Rhizoides (rootlike), appressorium (pl. appressoria), haustorium (pl. haustoria), hyphopodium (pl. hyphopodia). Hyphal aggregations and tissues: <i>Plectenchyma</i> (i.e. woven tissue), <i>Prosenchyma</i> (i.e. approaching a tissue) and <i>pseudoparenchyma</i> (a type of plant tissue). <i>Stroma</i> (mattress), <i>sclerotium</i> (hard structure) and <i>rhizomorph</i> (root shaped).</p> <p>Reproduction (asexual and sexual): Reproduction in fungi (asexual and sexual).</p> <p>Reproduction in fungi: Fungi reproduce by three processes viz., (A) Vegetative, (B) Asexual and (C) Sexual reproduction.</p> <p>Vegetative reproduction (Fragmentation, Rhizomorph, Fission, Chlamydo spores, Budding, Sclerotium etc.</p> <p>Asexual reproduction a. Exogenous. b. Endogenous:</p> <p>Sexual reproduction a. Monoecious or hermaphroditic, b. Dioecious: Four distinct phases of sexual reproduction are: somatogamy, plasmogamy, karyogamy and meiosis. These phases occur by any one of the following five general methods of sexual reproduction, (Gametic copulation – (a) Isogamy and (b) Anisogamy, Gametangial contact, Gametangial copulation, Spermatization, Somatogamy (Anastomosis)</p>	10
7	<p>Classification of fungi. Key to divisions, sub-divisions, orders and classes. (Classification of fungi. Key to divisions, sub-divisions, orders and classes)</p> <p>The classification of Ainsworth (1966 and 1972) be thought along with the distinguishing characters for the classification of Division, Sub-division, class, orders, family and each important genera of family</p>	5
8-9	<p>Bacteria: general morphological characters, Classification and reproduction: General morphological characters Shape Size, Reproduction (Sexual and Asexual).</p> <p>Basic methods of classification Major divisions of bacteria on the basis of cell wall structure Kingdom : Prokaryotae Division I : Gracilicutes Division II : Firmicutes, Division III : Tenericutes, Division IV : Mendosicutes and Classification on the basis of Bergey's Manual of Systematical Bacteriology (1984). Sexual and Asexual reproduction in bacteria (Binary fission, Transformation, Transduction and Conjugation)</p> <p>Viruses: nature, architecture, multiplication and transmission</p> <p>Viruses: nature, architecture, multiplication and transmission</p> <p>Architecture of viruses and virioids</p> <p>Morphologically, virus particles are (i) isometric (spherical, polyhedral) and (ii) anisometric</p>	10

	<p>Classification of viruses</p> <p>Mollicutes: general morphological characters. A. Mycoplasma and Spiroplasma</p> <p>Kingdom : Prokaryotae, Division : Tenericutes, Class : Mollicutes, Order : Mycoplasmatales</p> <p>Family : 1. Mycoplasmataceae Genus: <i>Mycoplasma</i> 2. Spiroplasmataceae Genus: <i>Spiroplasma</i></p> <p>3. Acholeplasmataceae Genus: <i>Acholeplasma</i></p> <p>B. Fastidious vascular bacteria : There is no well accepted classification (taxonomy) made so far for these organisms. Hence classification for Rickettsia (RLO) and Fastidious bacteria (e.g. Xellevella) are mentioned below:</p> <p>B1: Rickettsia (RLO) Kingdom : Prokaryotae, Division : Gracilicutes (Gram-ve bacteria), Class : Proteobacteria ,Sub-class : Alpha Proteobacteria ,Order : Rickettsiales ,Family : Rickettsiaceae</p> <p>Tribe : Rickettsiae</p> <p>B2. Fastidious vascular bacteria ,Kingdom : Prokaryotiae ,Division : Gracilicutes (Gram-ve bacteria) ,Class : Proteobacteria ,Sub-class : Gamma Proteobacteria, Order : Not classified, Family : Not classified ,Tribe : Not classified ,</p>	
10	Survival and dispersal of plant pathogen	10
11	Mechanism of infection- Penetration and avenues of penetration	8
12	Epidemiology and factors influencing epidemic development and forecasting of plant diseases	10
13-14	<p>Principles and methods of plant disease management</p> <p>A. Principles of plant disease management: There is six basic concept or principles or objectives lying under plant disease management. (Avoidance of the pathogen, Exclusion of the pathogen, Eradication of the pathogen, Protection of the host , Disease resistance, Therapy)</p> <p>B. Methods of plant disease management</p> <p>1. Avoidance of the pathogen (Choice of geographical area, Selection of a field, Adjustment of time of sowing, Use of disease escaping varieties, Use of pathogen-free seed and planting material Modification of cultural practices)</p> <p>2. Exclusion of inoculum of the pathogen (Treatment of seed and plating materials, Inspection and certification, Quarantine regulations, Eradication of insect vector)</p> <p>3. Eradication of the pathogen (Biological control of plant pathogens, Eradication of alternate and collateral hosts, Cultural methods, Crop rotation, Sanitation of field by destroying/burning crop debris, Removal and destruction of diseased plants or plant parts, Rouging, Heat and chemical treatment of diseased plants, Soil treatment: by use of chemicals, heat energy, flooding and fallowing)</p> <p>4. Protection of the host (Chemical control: application of chemicals (fungicides, antibiotics) by seed treatment, dusting and spraying, Chemical control of insect vectors, Modifications of environment, Modification of host nutrition</p> <p>5. Disease resistance (Use of resistant varieties: Development of resistance in host is done by Selection and hybridization for disease resistance, Chemotherapy, Host nutrition, Genetic engineering, tissue</p>	10

	culture) 6. Therapy Therapy of diseased plants can be done by Chemotherapy, Heat therapy, Tree-surgery	
15-16	Nature, chemical combination, classification fungicides group (sulphur compounds Inorganic and organic (dithio - carbomates)), mercurial compound, heterocyclic nitrogenous compounds, organophosphorus compounds, oxathins , benzimidazoies , morpholines , organophosphorus , phenol derivatives chloroneb , triezoles triedimefon and antibiotics Mode of action of fungicides of group (sulphur compounds Inorganic and organic (dithio - carbomates)), mercurial compound, heterocyclic nitrogenous compounds, organophosphorus compounds, oxathins , benzimidazoies , morpholines , organophosphorus , phenol derivatives chloroneb , triezoles triedimefon and formulations of fungicides (Characteristic of an ideal fungicide, formulations of fungicides (Wettable powder , Dust , Granules Emulsified concentrates, Solutions, Slurries or suspensions) and antibiotics	7
	Total	100

Practical Schedule

Ex. No.	Practical
1.	Acquaintance with various laboratory equipments and microscopy
2.	General study of different structures of fungi.
3.	Study of symptoms of various plant diseases.
4.	Study of representative fungal genera
5.	Staining and identification of plant pathogenic bacteria
6	Study of phanerogamic plant parasites
7	Transmission of plant viruses
8	Study of morphological features and identification of plant parasitic nematodes.
9	Preparation of media
10	Isolation and purification of fungi and bacteria
11	Extraction of nematodes from soil
12	Koch's postulates
13	Study of fungicides and their formulations
14	Methods of pesticide application and their safe use
15	Calculation of fungicide sprays concentrations.
16	Collection and preservation of disease specimen

Text books:

1. Walia RK & Bajaj HK. 2003. *Text Book on Introductory Plant Nematology*. ICAR, New Delhi

Reference books:

1. Pathak, V. N. *Essentials of Plant Pathology*. Prakash Pub., Jaipur
2. Agrios, GN. 2010. *Plant Pathology*. Acad. Press.
3. Kamat, M. N. *Introductory Plant Pathology*. Prakash Pub, Jaipur
4. Singh RS. 2008. *Plant Diseases*. 8th Ed. Oxford & IBH.Pub.Co.
5. Singh RS. 2013. *Introduction to Principles of Plant Pathology*. Oxford and IBH Pub.Co.
6. Alexopoulos, Mims and Blackwel. *Introductory Mycology*
7. Mehrotra RS & Aggarwal A. 2007. *Plant Pathology*. 7th Ed. Tata Mc Graw Hill Publ. Co. Ltd.
8. Gibbs A & Harrison B. 1976. *Plant Virology - The Principles*. Edward Arnold, London.
9. Hull R. 2002. *Mathew.s Plant Virology*. 4th Ed. Academic Press, New York.
10. Verma JP. 1998. *The Bacteria*. Malhotra Publ. House, New Delhi.
11. Goto M. 1990. *Fundamentals of Plant Bacteriology*. Academic Press, New York.
12. Dhingra OD & Sinclair JB. 1986. *Basic Plant Pathology Methods*. CRC Press, London, Tokyo.

13. Nene YL & Thapliyal PN. 1993. *Fungicides in Plant Disease Control*. 3rd Ed. Oxford & IBH, New Delhi.
14. Vyas SC. 1993. *Handbook of Systemic Fungicides*. Vols. I-III. Tata McGraw Hill, New Delhi.
15. Rajeev K & Mukherjee RC. 1996. Role of Plant Quarantine in IPM. Aditya Books.
16. Rhowar GG. 1991. Regulatory Plant Pest Management. In: *Handbook of Pest Management in Agriculture*. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.
17. Singh RS & Sitaramaiah K. 1994. *Plant Pathogens – Nematodes*. Oxford & IBH, New Delhi.
18. Thorne G. 1961. *Principles of Nematology*. McGraw Hill, New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/PATH-352 Course title: Diseases of fruit, plantation, medicinal and Aromatic crops

Credits: (2+1) 3

Semester: V

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, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, *Solanum khasianum* and Tephrosia. Important post-harvest diseases of fruit, plantation, 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.

Teaching (Lecture) Schedule and weightages

Lecture No.	Topic	Weightages
	Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of	
	Fruit Crops viz.,	
1, 2	Mango	10
3, 4	Banana	10
5, 6	Grape	10
7, 8	Citrus	10
9, 10	Guava, sapota, fig	5
11	Papaya	5
12, 13	Pomegranate	5
14	Ber, custard apple, aonla, jamun	5
15	Jackfruit , pineapple,	5
16, 17	Strawberry, almond, cashew, walnut,	5
18, 19	Apple, pear, peach, plum	5
	Plantation Crops viz.,	
20, 21	Betelvine, arecanut, coconut, oil palm	5
22, 23	Coffee, tea, cocoa, rubber	5
	Medicinal and Aromatic Crops viz.,	
24, 25	Senna, neem, hemp, belladonna, pyrethrum	5
26, 27,28	Camphor, costus, crotalaria, datura, discorea, mint, opium, <i>Solanium khasianum</i> and tephrosia	5
29,30,31,32	Important post -harvest diseases of fruit, plantation, medicinal and aromatic plants and their management.	5
	Total	100

Lesson Plan

Lesson No.	Topic
	Etiology, Symptoms, Mode of Spread, Epidemiology and Integrated Management of the Diseases of :
	Fruit Crops viz:
1, 2	Mango: Malformation, Anthracnose, Powdary mildew, Bacterial blight Stone graft mortality, Red Rust Giant Mistletoe (<i>Loranthus</i>)
3, 4	Banana: Wilt, Sigatoka, Anthracnose, Erwinia rot, Bunchy top, Heart Rot

	Infectious chlorosis, Cigar end rot
5, 6	Grape: Downey mildew, Powdery mildew, Anthracnose, Bacterial Blight, Grape Fan Leaf Virus
7, 8	Citrus: Gummosis, Leaf fall and Fruit Rot , Anthracnose, <i>Diplodia</i> , <i>Ganoderma</i> root rot , Powdery mildew , Canker, Mottling Greening, Tristeza, Psorosis, Citrus Exocortis Quick and Slow Decline, <i>Khaira</i> Disease (Zinc Deficiency)
9	<i>Papaya</i> : <i>Pythium</i> soft rot, Powdery midew, Anthracnose, Fruit rot, Viruses: Ring spot ,leaf curl and mosaic
10	a) Guava: Wilt, Canker, <i>Pestotatia</i> leaf spot, Anthracnose
10	b) Sapota: Root rot, Leaf spots, Fruit rots
10	c) Fig: Fig rust
11	Pomegtanate: <i>Alternaria</i> , <i>Helminthosporium</i> and <i>Colletotrichum</i> <i>Cercospora</i> leaf and fruit spots, Wilt, Bacterial Blight
12	a) Ber: Powdery mildew
12	b) Custard Apple: <i>Pythium</i> Seedling Mortality and Fruit Rots
12	c) Aonla: Emblica Rust (<i>Ravenalia</i> sp.)
12	d) Jamun: Fruit rot and foliage diseases
13	a)Jackfruit: Die Back , Fruit Rot
13	b) Pineapple: Heart rot, Base rot and Wilt
14	a) Strawberry: Leaf spots
14	b) Almond: Leaf spots
14	c) Cashew: Leaf spots
14	d) Walnut: Leaf spots
15	a)Apple: Fire blight , Root and Collar rot, Cankers, Powdery mildew, Scab, Fruit Rots, Crown Gall, Mosaic
15	b)Pear: Rust , Leaf spots and Blight, Scab, Mosaic
15	c) Peach: Rust, Blight, Scab and Leaf Curl
15	d) Plum: Bacterial Canker, Wilt, Mosaic and Leaf Curl
15	e) Stone Fruit: Crown gall
	Plantation Crops viz:
16	a)Betelvine: <i>Phytophthora</i> wilt, <i>Sclerotium</i> foot rot, Powdery mildew
16	b) Arecanut: Koleroga,
17	c) Coconut: Wilt, Stem bleeding, Stem rot, Bud rot, Cadang –cadang disease, Lethal yellow
17	d) Oil Palm: Major foliage diseases
18	e) Cofee: Rust
18	f) Tea: Rust
18	e) Cocoa: Major diseases
19	f) Rubber: Major diseases
	Medicinal and Aromatic crops viz.
20, 21	a)Senna, Neem, Hemp, Belladona, Pyrethrum: Major Diseases
22, 23	b) Camphor, Costus, Crotolaria: Major Diseases
24, 25,26	c) Datura, Discorea, Mint, Opium: Major Diseases
27,28,29	d) <i>Solanum khasianum</i> and Tephrosia: Major Diseases
30,31,32	Important Post Harvest Diseases of above Fruit, Plantation, Medicinal and Aromatic Plants and Their Management.

Practical

Practical No.	Crop	Syllabus
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	Observations of disease Symptoms, identification of Causal Organism and Host- parasite relationship and Integrated Disease Management of following important diseases of:	
	Fruit Crops viz.,	
1	Mango	Malformation, anthracnose, powdery mildew, bacterial blight stone graft mortality, red rust giant mistletoe (<i>Ioranthus</i>)
2, 3	Banana	Wilt, sigatoka, anthracnose, <i>erwinia</i> rot, bunchy top, heart rot infectious chlorosis, cigar end rot
4, 5	Grape	Downey mildew, powdery mildew, anthracnose, bacterial blight, grape fan leaf virus
6, 7	Citrus	Gummosis, leaf fall and fruit rot , anthracnose, <i>Diplodia</i> , <i>Ganoderma</i> root rot , powdery mildew, canker, mottling greening, tristeza, psorosis, citrus exocortis quick and slow decline, <i>Khaira</i> Disease (Zinc Deficiency)
8	Papaya	<i>Pythium soft rot, powdery midew, anthracnose, fruit rot, viruses: ring spot ,leaf curl and mosaic</i>
9	Guava	Wilt, canker, <i>Pestolatia</i> leaf spot, anthracnose
9	Sapota	Root rot, leaf spots, fruit rots
9	Fig	Fig rust
10	Pomegranate	<i>Alternaria, Helminthosporium</i> and <i>ColletotrichumCercospora</i> leaf and fruit spots, wilt, bacterial blight
11	Ber	Powdery mildew
11	Custard Apple	<i>Pythium</i> seedling mortality and fruit rots
11	Aonla	Emblica rust (<i>Ravenalia</i> sp.)
11	Jamun	Fruit rot and foliage diseases
12	Jackfruit	Die back , fruit rot
12	Pineapple	Heart rot, base rot and wilt
12	Strawberry	Leaf spots
12	Almond	Leaf spots
12	Cashew:	Leaf spots
12	Walnut	Leaf spots
13	Apple	Fire blight , root and collar rot, cankers, powdery mildew, scab, fruit rots, crown gall, mosaic
13	Pear	Rust , leaf spots and blight, scab, mosaic
13	Peach	Rust, blight, scab and leaf curl
13	Plum	Bacterial canker, wilt, mosaic and leaf curl
13	Stone Fruit	Crown gall
	Plantation Crops viz.,	
14	Betelvine	<i>Phytophthora</i> wilt, <i>Sclerotium</i> foot rot, Powdery mildew
14	Arecanut	Koleroga
14	Coconut	Wilt, stem bleeding, stem rot, bud rot, cadang –cadang disease, lethal yellow
14	Oil Palm	Major foliage diseases
14	Coffee	Rust
14	Tea	Rust
14	Cocoa	Major diseases
14	Rubber	Major diseases
	Medicinal and Aromatic crops viz.,	
15	a) Senna, neem, hemp, belladonna, pyrethrum: major diseases	
15	b) Camphor, costus, crotolaria: major diseases	
15	c) Datura, discorea, mint, opium: major diseases	
15	d) <i>Solanum khasianum</i> and tephrosia: major diseases	
16	Important post harvest diseases of above fruit, plantation, medicinal and aromatic plants and their management	
	Total: 16	

Reference books:

1. Agrios, GN. 2010. *Plant Pathology*. Acad. Press

2. Diseases of Horticultural Crops fruits (1999) By Verma L.R and Sharma R.c, Indus Publishing company, New Delhi
3. Diseases of fruit crops (1986) By V.N.Pathak ,Oxford & IBH publication, New Delhi
4. Diseases of fruit crops (1986) By R.S.Singh ,Oxford & IBH publication, New Delhi
5. Diseases of Fruits and vegetables (2007) S.A.M.H. Naqvi, Springer Science & Business Media
6. Diseases of Plantation Crops (2014) By P.Chowdappa, Pratibha Sharma IPS 263pp
7. Diseases of Horticulture Crops and their management ,ICAR e-book for B.Sc.(Agri) & B.Tech (Agri) By TNAU pp172
8. Advances in the diseases of Plantation crops & spices (2004) P.Santha Kumari, International Book Distributing Company , 247 pp
9. Mehrotra RS & Aggarwal A. 2007. *Plant Pathology*. 7th Ed. Tata Mc Graw Hill Publ. Co. Ltd

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/PATH-363

Course title: Disease of Vegetable, Ornamental and Spices crops

Credits: (2+1) 3

Semester: VI

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, turmeric, pepper, cumin, cardamom, nutmeg, coriander, clove, cinnamon, jasmine, rose, crossandra, tuberose, gerbera, 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.

Teaching (Lecture) schedule and weightages

Sr. No.	Topic	Lecture No.	Weightages
	Etiology , symptoms, mode of spread, epidemiology and integrated disease management in diseases of :		
	Vegetables crops viz.,		
1	Potato, tomato	1,2,3,	12
2	Brinjal, chilli	4,5,	08
3	Cabbage, cauliflower, broccoli	6,7,	09
4	Radish, knol-khol, beetroot	8,9,	06
5	Ladies finger (bhendi/okra)	10,	05
6	fenugreek and other leafy vegetables	11,	05
7	pea, beans	12,13,	07
8	Onion garlic	14,15,	06
9	Ginger ,turmeric	16,17,	06
	Ornamental crops viz.,		
10	Rose, chrysanthemum	18,19,	06
11	Gerbera, marigold, jasmine	20,21,	04
12	Gladiolus, carnation	22,23,	04
13	Crossandra, geranium	24,25,	04
	Spice crops viz.,		
14	Pepper, cumin, cardamom	26,27,	07
15	Nutmeg, coriander, clove, cinnamon	28,29,	05
16	Important post-harvest diseases of vegetables and ornamental crops and their management	30,31, 32	06
	Total	32	100

Lesson Plan

Sr. No.	Lesson
	Etiology, symptoms, mode of spread, epidemiology and integrated disease management in diseases of :
	Vegetables crops viz.,
1, 2, 3	Potato: Early & late blight, wart, scab, bacterial ring rot, viruses: X, Y, roll, rugose, crinkle Tomato: Damping off, early & late blight, wilts: <i>Fusarial</i> , <i>Verticillium</i> , bacterial, virus: mosaic, spotted wilt virus
4, 5	Brinjal: Damping off,wilt, <i>Alternaria</i> & <i>Phomopsis</i> blight, rust, little leaf chili: damping off, powdery mildew, dieback, <i>Churda Murda</i> , little leaf
6, 7	Cabbage, cauliflower, broccoli: club root, <i>Alternaria</i> blight, wilt, downy mildew, molybdenum and

	boron deficiency	
8, 9	Radish: White rust Knol-khol, beetroot: major diseases	
10	Ladies finger (bhendi/okra): powdery mildew, <i>Alternaria</i> , yellow vein mosaic virus	
11	Fenugreek and other leafy vegetables: powdery and downy mildew and <i>Alternaria</i> blights	
12, 13	Pea: Powdery mildew, wilt, root rot, enation and necrosis virus Beans: Powdery mildew in cluster and other beans, bacterial and <i>Alternaria</i> blight, anthracnose	
14, 15	Onion: <i>Alternaria</i> blight, smudge, downey mildew <i>Alternaria</i> blight	Garlic:
16, 17	Ginger: Rhizome rot, <i>Colletotrichum</i> leaf spot leaf spot, anthracnose	Turmeric: <i>Taphrina</i>
	Ornamental Crops viz.,	
18, 19	Rose: Powdery mildew, rust, die back, stem canker Powdery mildew	Chrysanthemum:
20, 21	Merigold: Powdery mildew	Jasmine: Rust, <i>Alternaria</i>
22, 23	Gladiolus, carnation: major diseases Gerbera: Powdery mildew	
24, 25	Crossandra: Wilt Geranium: Major diseases	
	Spice Crops viz:	
26, 27	Pepper: Phytophthora foot rot, anthracnose, slow wilt Cumin: Wilt, powdery mildew	Cardamum: Major diseases
28, 29	Nutmeg: Die back, wilt Coriander: Powdery mildew, wilt, stem gall <i>Colletotrichum</i>	Clove: Die back, Cinnamom: Leaf spot, die back
30, 31, 32	Important post-harvest diseases of vegetables and ornamental crops and their management.	

Practical Schedule

Exercise No.	Exercise
1	Club root of crucifers viz., cabbage, cauliflower
2	Damping off diseases of tomato, brinjal, chilli, cabbage, cauliflower, bhendi Rhizome rot of ginger, white rust of radish
3	Late blight of potato, tomato
4	Downey mildew of onion, cucurbits, fenugreek, aster
5	<i>Taphrina</i> leaf spot of turmeric
6	Ectophytic powdery mildew of cucurbits, <i>bhendi</i> , pea, beans, fenugreek, coriander, rose, cumin
7	Endophytic powdery mildew of cluster bean, chili
8	<i>Alternaria</i> blight of bhendi, garlic, potato, tomato, cabbage, beans, onion, jasmine
9	Anthracnose of chilli, turmeric, beans, pepper, nutmeg, clove.
10	Fusarial wilt of tomato, brinjal, <i>bhendi</i> , pea, cabbage, crossandra, cumin, <i>Verticillium</i> wilt of brinjal, tomato
11	Root rots in vegetables viz., tomato, brinjal, and pea. <i>Macrophomina</i> leaf spot in vegetables & spices viz., brinjal, pea
12	Rusts of brinjal, beans, roses, jasmine and onion smudge
13	Bacterial wilts of brinjal, tomato. Phytoplasma diseases viz., little leaf of brinjal, aster yellows, <i>Orobanche</i> and <i>Cuscuta</i> sp. on brinjal
14	Virus disease of potato: mosaic - X, Y, roll and crinkle virus, viruses of tomato, cucurbits, <i>Churda-murda</i> of chilli.
15	Viral disease bhendi: yellow vein mosaic

	Pea viruses: Enations and top necrotic virus
16	Deficiency diseases viz., black heart of potato, boron and molybdenum deficiency in cabbage & cauliflower, important post harvest diseases of vegetables, ornamentals, spices & their management.

Reference books:

1. Agrios, GN. 2010. *Plant Pathology*. Acad. Press
2. Vegetable Diseases : A Colour full Hand book (2006) by Steven T.Koike ,Peter Gladers and Albert Paulus ,Academic Press, pp448
3. Diseases of Vegetables crops by R.S.Singh (1987) Oxford & IBH publication, New Delhi
4. Plant Diseases.(2008) Singh RS. 2008th Ed. Oxford & IBH. Pub. Co.
5. Diseases of Crops Plants in India (2009) By PHI learning Pvt. Ltd, pp 548
6. Diseases of Vegetable crops (2005) by Alferd Steferud ,Biotech Books ,New Delhi
7. Mehrotra RS & Aggarwal A. 2007. *Plant Pathology*. 7th Ed. Tata Mc Graw Hill Publ. Co. Ltd
8. Diseases of Vegetable Crops ,Diagonosis and Management (2014) Dinesh Singh and P.Chodappa, Today and Tomorrow Printers ,pp734
9. Singh H. 1984. *House-hold and Kitchen Garden Pests - Principles and Practices*. Kalyani Publishers.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/PATH-364
Credits: (0+1) 1

Course Title: Mushroom Production Technology
Semester: VI

Practical:

Introduction to mushroom, Nutritional and medicinal value of mushroom. Morphology and types of mushroom. Material equipment and basic facilities required for mushroom entrepreneurship. Preparation of mushroom culture by tissue isolation method. Spawn production: Types of spawn and method of spawn production. Preparation of compost for button mushroom production. Preparation of substrate for oyster mushroom production. Spawning and methods of spawning. Casing for button mushroom production and after care during spawn run. In button and oyster mushroom production. Harvesting indices, packing and preservation of Button. Harvesting indices, packing and preservation of oyster mushroom. Preparation of mushroom recipes. Disease management in mushroom production. Pest management in mushroom production. Methods of disinfection and fumigation in Mushroom house. Visit to nearby Mushroom Unit.

Practical No.	Topics
1	Introduction to mushroom, Nutritional and medicinal value of mushroom.
2	Morphology and types of mushroom
3	Material equipment and basic facilities required for mushroom entrepreneurship.
4	Preparation of mushroom culture by tissue isolation method
5	Spawn production: Types of spawn and method of spawn production
6	Preparation of compost for button mushroom production.
7	Preparation of substrate for oyster mushroom production.
8	Spawning and methods of spawning.
9	Casing for button mushroom production and after care during spawn run. In button and oyster mushroom production.
10	Harvesting indices, packing and preservation of Button
11	Harvesting indices, packing and preservation of oyster mushroom.
12	Preparation of mushroom recipes.
13	Disease management in mushroom production
14	Pest management in mushroom production
15	Methods of disinfection and fumigation in Mushroom house.
16	Visit to nearby Mushroom Unit.

Reference Books:

1. Mushroom cultivation Technology- S. T. Change

e-reading: <http://ecourses.iasri.res.in/>

Course No.: H/ ENTO-121

Title: Fundamentals of Entomology

Credits: (2+1) 3

Semester: II

Theory:

Introduction and History of Entomology in India including contribution of scientists in brief. Definitions: Insect, Entomology, Horticultural Entomology. Classification of phylum Arthropoda up to classes. Relationship of class Insecta with other classes of Arthropoda. Insect Dominance. Economic importance of insects: Harmful, Beneficial and productive insects. Premier institutes concerned with Entomology. Insect Integument: Structure and Functions. Cuticular appendages and processes. Moulting: Definition and steps in moulting. Body segmentation: Structure of head, thorax and abdomen. Insect Head Capsule: Important sclerites and sutures. Positions of head. Structure and modifications (with examples) of insect antennae, mouth parts, legs and wings (wing venation, wing coupling apparatus with examples). Structure of thorax and abdomen: segmentation, appendages and processes, pregenital and post genital appendages and structure of male and female genital organ. Metamorphosis: Definition and Types of metamorphosis with examples. Post embryonic development: Eclosion. Insect egg: General structure, Types of egg with examples (at least one). Types of larva and pupa with examples. Structure and functions of digestive, nervous, circulatory, respiratory, excretory, secretory and reproductive system in insects. Types of reproduction in insects. Sensory and Sound producing organs.

Systematics: Definitions: Taxonomy, Systematics, Binomial nomenclature, Order, Family, Genus, Species, Subspecies, Biotype. Binomial nomenclature: Definition and Rules. Classification of Class Insecta upto Orders. Important orders: Important distinguishing/taxonomic characters of orders. Families of horticultural importance with examples. Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Aleurodidae, Pseudococcidae, Lophopidae, Lacciferidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturniidae, Bombycidae; Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae.

Trichogrammatidae, Ichneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Plant mites: Morphological/general features of phytophagous mites, important families with examples (Tetranychidae, Tarsonomidae, Tenuipalpidae and Eriophyidae).

Practical:

Methods of collection and preservation of insects including immature stages. Identification of important insect. External features of Cockroach/Grasshopper. Study of Types of insect antennae, mouthparts (dissection) and legs. Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae. Study and Dissection of digestive system in insects (Cockroach (caterpillar) /Grasshopper). Study and Dissection of Central nervous system in insects (Cockroach/Grasshopper). Study and Dissection of male and female reproductive systems in insects (Cockroach/Grasshopper). Study of distinguishing/taxonomic characters of orders: Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera. Families of horticultural importance with examples.

Teaching Schedule: Theory -

Lecture No.	Topic	Weightage (%)
1-3	<ul style="list-style-type: none"> ➤ Introduction and History of Entomology in India including contribution of scientists in brief. Definitions: Insect, Entomology, Horticultural Entomology. ➤ Classification of phylum Arthropoda up to classes. ➤ Relationship of class Insecta with other classes of Arthropoda. ➤ Insect Dominance. ➤ Economic importance of insects: Harmful, Beneficial and productive insects. ➤ Premier institutes concerned with Entomology. 	10
4-5	<ul style="list-style-type: none"> ➤ Insect Integument: Structure and Functions. Cuticular appendages and processes. Moulting: Definition and steps in moulting. ➤ Body segmentation: Structure of head, thorax and abdomen. 	10
6-10	<ul style="list-style-type: none"> ➤ Insect Head Capsule: Important sclerites and sutures. Positions of 	10

	<p>head.</p> <ul style="list-style-type: none"> ➤ Structure and modifications (with examples) of insect antennae, mouth parts, legs and wings (wing venation, wing coupling apparatus with examples). ➤ Structure of thorax and abdomen: segmentation, appendages and processes, pregenital and post genital appendages and structure of male and female genital organ. 	
11-13	<ul style="list-style-type: none"> ➤ Metamorphosis: Definition and Types of metamorphosis with examples. ➤ Insect egg: General structure, Types of egg with examples (at least one) ➤ Types of larva and pupa with examples. ➤ Sensory and Sound producing organs: Location and functions: mechanoreceptors, audio receptors, chemoreceptors, thermo and humidity receptors, photoreceptors and organs of visions with examples. 	10
14-22	<ul style="list-style-type: none"> ➤ Structure and functions of digestive, nervous, circulatory, respiratory, excretory, secretory and reproductive system in insects. Types of reproduction in insects. Post embryonic development: eclosion. 	20
23-24	<p>Systematics:</p> <ul style="list-style-type: none"> ➤ Definitions: Taxonomy, Systematics, Binomial nomenclature, Order, Family, Genus, Species, Subspecies, Biotype. Binomial nomenclature: Definition and Rules. ➤ Classification of Class Insecta up to Orders. 	05
25-27	<ul style="list-style-type: none"> ➤ Study of important orders of insects: Important distinguishing/taxonomic characters of orders. Families of horticultural importance with examples. Orthoptera: Acrididae, Tettigonidae, Gryllidae, Gryllotalpidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae. 	10
28-29	<ul style="list-style-type: none"> ➤ Hemiptera: Pentatomidae, Coreidae, Cimicidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Aleurodidae, Pseudococcidae, Lophopidae, Lacciferidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papilionidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Saturniidae, Bombycidae. 	10

30-31	➤ Coleoptera: Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera: Tenthredinidae, Apidae, Braconidae, Trichogrammatidae, Ichneumonidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.	10
32	➤ Plant mites: Morphological/general features of phytophagous mites, important families with examples (Tetranychidae, Tarsonomidae, Tenuipalpidae and Eriophyidae).	05
	Total	100

Teaching Schedule: Practical -

Ex. No	Name of the experiment
1.	Methods of collection and preservation of insects including immature stages
2.	External features of typical insect (eg. Cockroach/ Grasshopper) structure of head, thorax and abdomen/General body organisation of insect
3.	Structure of antennae and its modifications along with examples. Structure of typical leg and modifications of legs.
4.	Study and Dissection of chewing and biting type of mouthparts.
5.	Study and Dissection of Chewing and lapping type of mouthparts.
6.	Study and Dissection of piercing and sucking type of mouthparts.
7.	Study and Dissection of sponging type of mouthparts.
8.	Study of insect wings: Structure, Wing Venation, types of wings and wing coupling apparatus along with examples.
9.	Types of larvae and pupae.
10.	Study and Dissection of digestive system of Cockroach / Grasshopper.
11.	Study and Dissection of male reproductive system of Cockroach / Grasshopper. Study and Dissection of female reproductive system of cockroach / Grasshopper.
12.	Study and Dissection of central nervous system of Cockroach / Grasshopper.
13.	Study of distinguishing/taxonomic characters of orders <i>viz.</i> , Odonata, Orthoptera, Dictyoptera. Families of Horticultural importance from these orders with examples.
14.	Study of distinguishing/taxonomic characters of orders <i>viz.</i> , Isoptera, Thysanoptera and Hemiptera. Families of Horticultural importance from these orders with examples.
15.	Study of distinguishing/taxonomic characters of orders <i>viz.</i> , Neuroptera, Lepidoptera and Hymenoptera. Families of Horticultural importance from these orders with examples..
16.	Study of distinguishing/taxonomic characters of orders <i>viz.</i> , Diptera and Coleoptera.

Families of Horticultural importance from these orders with examples..
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Textbooks:

- Richards O.W. and R.G. Davies – Imms' General Text Book of Entomology –Vol. I and II

Reference Books:

- Chapman, R. F. – The Insects : Structure and Functions
- David, B. V. and T. Kumarswami – Elements of Economic Entomology
- Marc J. Klowden- Physiological systems in Insects
- Pant N.C. and Swaraj Ghai – Insect Physiology and Anatomy
- Nayar, K. K.; Anathkrishanan T.N. and B.V.David – General and Applied Entomology
- Patton R.L.- Introductory Insects Physiology
- Wigglesworth – Principles of Insects Physiology
- Metcalf and Flint – Destructive and Useful Insects; their habits and control.
- Evan G.O -Principles of Acarology.
- Krantz G.W – A manual of Acarology.

e-reading: <http://ecourses.iasri.res.in/>

Course NO. H/ENTO-365

Course title : Nematode Pests of Horticultural Crops and their management

Credits : 1 + 1 = 2

Semester : VI

Theory:

History of development of Nematology-Definition, economic importance. General characteristics of plant parasitic nematodes. Nematode general morphology, taxonomy and biology. Classification of nematodes. Symptomatology. Control of important plant parasitic nematodes of Fruit crops: Pomegranate, Grapes, Fig, Citrus, Strawberry, Cashewnut, Vegetable crops: Tomato, Brinjal, Okra, Chilli and Cucurbits etc. Tuber and bulb crops: Potato, Sweet potato, Carrot, Radish and onion; Ornamental crops: Chrysanthemum, Rose, Tuberose, Gladiolus, Carnation and Gerbera; Spices: Turmeric, Ginger, Cardamom and Clove; Plantation Crops: Banana, Area nut and Coconut.

Practical:

Methods of sampling.Extraction of nematodes from soil and plant parts.Counting and estimation of plant parasitic nematodes. Nematode killing, fixing and preparation of temporary and permanent mounts. Nematicides and their use. Collection and preservation of 20 plant species/parts damaged by plant parasitic nematodes.

Lesson plan : Theory

Lecture No.	Topic	Weightage (%)
1	History of development of Nematology-Definition, economic importance.	10
2	General characteristics of plant parasitic nematodes.	5
3-4	Nematode general morphology and biology.	5
5-6	Classification of nematodes : (up to major order and families)	10
7	Classification based on habitats Symptomatology: Above and below ground	10
8-9	Control of important plant parasitic nematodes of fruit crops: Pomegranate, Grapes, Fig, Citrus, Strawberry, Cashew nut.	10
10	Vegetable crops: Tomato, Brinjal, Okra, Chilli and Cucurbits etc.	10
11	Tuber and bulb crops: Potato, Sweet potato, Carrot, Radish and Onion.	10
12	Ornamental crops : Chrysanthemum, Rose, Tuberose, Gladiolus, Carnation and Gerbera.	5
13	Spices : Turmeric, Ginger, Black pepper Cardamom and Clove	5
14	Plantation crops: Banana, Areca nut and Coconut.	10
15	Role of nematodes in plant disease complex.	5
16	Integrated nematode management.	5
	Total	100

Lesson plan : Practical

Sr. No.	Particulars
1.	Procedure for collection of soil and root samples
2.	Extraction of nematodes from soil samples
3.	Extraction of nematodes from plant material
4.	Counting and picking of nematodes

	Preparation of temporary and permanent mounts of nematodes
5.	Gross morphology of plant parasitic nematodes
6.	Taxonomic classification of plant parasitic nematodes of horticultural importance
7.	Below and above ground symptoms produced by nematodes with examples
8.	Interaction between plant parasitic nematodes with disease causing fungi, bacteria, viruses etc.
9	Important nematode pests of horticultural (fruit) crops- Root Knot Nematode <i>Meloidogyne</i> spp, Reni form Nematode- <i>Rotylenchulus Reniformis</i> , Root Lesion Nematode- <i>Pratylenchus</i> spp, Spiral Nematode- <i>Helicotylenchus</i> spp, Cyst Nematodes- <i>Heterodera</i> and <i>Globodera</i> , Dagger Nematode- <i>Xiphenema</i> spp, Citrus Nematode- <i>Tylenchulus semipenetrans</i> , Burrowing Nematode- <i>Radopholus similis</i> .
10	Important nematode pests of plantation crops- Root Knot Nematode <i>Meloidogyne</i> spp, Reni form Nematode- <i>Rotylenchulus Reniformis</i> , Root Lesion Nematode- <i>Pratylenchus</i> spp, Spiral Nematode- <i>Helicotylenchus</i> spp, Cyst Nematodes- <i>Heterodera</i> and <i>Globodera</i> , Dagger Nematode- <i>Xiphenema</i> spp, Citrus Nematode- <i>Tylenchulus semipenetrans</i> , Burrowing Nematode- <i>Radopholus similis</i> .
11	Important nematode pests of vegetable crops- Root Knot Nematode <i>Meloidogyne</i> spp, Reni form Nematode- <i>Rotylenchulus Reniformis</i> , Root Lesion Nematode- <i>Pratylenchus</i> spp, Spiral Nematode- <i>Helicotylenchus</i> spp, Cyst Nematodes- <i>Heterodera</i> and <i>Globodera</i> , Dagger Nematode- <i>Xiphenema</i> spp, Citrus Nematode- <i>Tylenchulus semipenetrans</i> , Burrowing Nematode- <i>Radopholus similis</i> .
12	Integrated nematode management methods – Cultural (Crop rotation, Fallowing, Soil amendments, Other land management techniques, Resistant varieties etc.),
13	Integrated nematode management methods –Physical (Soil solarization, Sterilization, Hot water treatment, Fumigation), Biological, Chemical, Legislative methods,
14	Nematicides and their use
15.	Collection and preservation of 20 plant species/parts damaged by Plant parasitic nematodes.
16	Collection and preservation of 20 plant species/parts damaged by Plant parasitic nematodes.

No.	Name of book	Name of the author and publication
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Text books:

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| 1. | A Textbook of Plant Nematology | Upadhyay K.D. and Dwivedi K. 1997, Amman Publishing House, Meerut. |
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References books:

- | | | |
|----|---|---|
| 1. | Plant nematode control | Whitehead A.G., CAB International Wallingford U.K. |
| 2. | Nematode pest management | Swarup G. Deogupta D.R. and Gill J.S. |
| 3. | An appraisal of Eco-Friendly Approaches | Nematological Society of India IARI, New Delhi |
| 4. | A Treatise on phytonematology | P. Parvatha Reddy Agri. Cole Publishing Academy New Delhi |
| 5. | Plant Nematology | P. Parvatha Reddy |

e-reading: <http://ecourses.iasri.res.in/>

Course No.: H/ENTO-243

Course Title: Insect Pests of Fruit, Plantation,
Medicinal and Aromatic Crops

Credits: (2+1) 3

Semester: IV

Syllabus (Theory):

General – economic classification of insects. Ecology and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops. Pest survey, surveillance & forecasting. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits, plantation, medicinal and aromatic crops like citrus, mango, grapevine, pomegranate, guava, fig, banana, papaya, custard apple, ber, sapota, jamun, aonla, jackfruit, coconut, areca nut, oil palm, cashew, cacao, tea, coffee, rubber, betelvine, apple, pear, peach, plum, almond, cinchona, senna, neem, hemp, belladonna, pyrethrum, isabgol, dhatu, wildbrinjal, sweetflag, safedmusli, shatavari, ashwangandha, sarpgandha, opium, tephrosia, mint, dioscoria, comphor, costus, crotalaria, jasmine, patchouli, vetiver, davana, kevara, citronella, geranium, lemongrass, palmarose, eucalyptus and sandalwood . 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 residual limits (MRLs).

Syllabus (Practical):

Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of important insect – pests affecting citrus, mango, grapevine pomegranate, guava, fig, banana, papaya, custard apple, ber, sapota, jamun, aonla, jackfruit, coconut, areca nut, oil palm, cashew, cacao, tea, coffee, rubber, betel vine, apple, pear, peach, plum, almond, cinchona, senna, neem, hemp, belladonna, pyrethrum, isabgol, dhatu, wild brinjal, sweet flag, safedmusli, shatavari, ashwangandha, sarpgandha, opium, tephrosia, mint, dioscoria, comphor, costus, crotalaria, jasmine, patchouli, vetiver, davana, kevara, citronella, geranium, lemongrass, palmarose, eucalyptus and sandalwood. Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of pests of stored fruits, plantation, medicinal and aromatic plants.

Teaching Schedule & Lesion Plan (Theory):

Lecture No.	Topic	Weightage (%)
1 & 2	General and economic classification of insects; definition of pest, ETL, EIL, pest management, category of pest, harmful and beneficial insects.	10
3.	Ecology, scope, importance, its types, components of environment and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops. Pest survey, surveillance, forecasting and its importance in IPM.	
Fruit crops: Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting		
4.	Citrus: Major pests; Fruit sucking moth, lemon butterfly, leaf Minor, citrus psylla, whitefly and black fly, bark eating caterpillar. Minor pests; Nematodes, mealy bug, aphid, scale.	

5.	Mango: Major pests; Hoppers/Jassids, fruit fly, stone weevil, stem borer, mealy bug, bark eating caterpillar, thrips, leaf gall, midge fly. Minor pests; Red ants, shoot borer, scale insects, slug caterpillar.	45	
6.	Grapevine: Major pests; Flea beetle, thrips, mealy bug, mites. Minor pests; Stem girdler, cockchafer beetle.		
7.	Pomegranate: Major pests; Fruit borer, mealy bug, thrips, scale insects, white fly, bark borer. Minor pests; Fruit sucking moth, mites, shot hole borer, aphid.		
8.	Guava: Major pests; Fruit fly, spiraling white fly, bark eating caterpillar, fruit borer. Minor pests; Scale insects, mealy bug. Fig: Major pests; Jassids, scale insects, mealy bug. Minor pests; Mite, stem borer.		
9.	Banana: Major pests; Root stock weevil, thrips, tinged bug, leaf eating caterpillar, pseudostem borer, aphid. Minor pests; Burrowing nematodes. Papaya: Mealy bug, white fly, green peach aphid, ash weevil. Custard apple: Mealy bug.		
10.	Ber: Major pests; Ber fruit borer, ber fruit fly. Minor pests; Hairy caterpillar, jassids.		
11.	Sapota: Major pests; Chiku moth, seed borer, bud borer, fruit fly, stem borer, hairy caterpillar. Minor pests; Mealy bug, green scale, leaf folder. Jamun: Ash weevil, fruit fly, sphinx moth, white fly, leaf eating caterpillar.		
12.	Aonla: Major pests; Shoot gall maker, bark borer, fruit borer. Minor pests; Mealy bug, aphids, leaf eating caterpillar. Jackfruit: Shoot and fruit borer, bud weevil/leaf eating weevil, leaf Webber, mealy bug, scale, spittle bug.		
Plantation crops: Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting			
13& 14	Cashew nut: Major pests; Stem and root borer, tea mosquito bug, apple and nut borer, thrips Minor pests; Leaf Minor, leaf and blossom Webber, leaf beetle/red beetle. Cacao: Stem borer, Mealy bug, black aphids, cow bug.		10
15.	Coconut and Oil Palm: Major pests; Rhinoceros beetle, red palm weevil, black headed caterpillar, eriophyide mite, rodent. Minor pests; Termite, scale insects, Mealy bug. Arecanut: Spindle bug, root grub, inflorescence caterpillar, mites		
16&17	Tea: Major pests; Tea mosquito bug, jassids, pink/orange mite, red spider mite, bunchy caterpillar, tea borer, hepialid borer. Minor pests; Shot hole borer, nematodes, thrips Coffee: Major pests; coffee berry borer, red borer, white borer. Minor pests; Root lesion nematode, cockchopper beetle, coffee scale,		

	snail.	
18.	Betelvine: Betelvine bugs, scale insects, white fly, Mealy bug, white grub. Rubber: Rubber bark eating caterpillar, scale insects, ash weevils, Mealy bug.	
19.	Study of pests of Temperate Fruit crops (Apple, Pear, Peach and Plum): Major pests; Peach leaf curl aphid, apple wooly aphids, san jose scale, apple codling moth, apple tent caterpillar. Minor pests; blossom thrips, plum weevil, plum fruit moth, mites. Almond: Almond weevil, almond moth, tent caterpillar, brown mite, tree borer, stink bug, leaf roller	05
Medicinal crops: Nature of damage & control measures of pests affecting		
20.	Cinchona: Scale insects, mirid bug. Senna: Leaf eating caterpillar, White butterfly, pod borer. Neem: Tea mosquito bug, thrips, semilooper. Hemp: Hemp flea, hemp borer, green fly, European corn borer. Belladonna: Leaf defoliator. Pyrethrum: Nematodes, thrips, aphids, red spider mites.	
21.	Isabgul: White grub, red cotton bug, cutworm. Dhatura: Thrips, leaf bug, white flies, aphid. Costus: Grasshopper, thorn bug, hairy caterpillar, ash weevil. Crotalaria: Sunnhemp moth, stem borer, top shoot borer, flea beetle. Wild brinjal: Brinjal shoot and fruit borer, brinjal stem borer. Sweet flag: Shoot and root Mealy bugs. Safedmusli: White grub, leaf eating caterpillar.	10
22.	Shatavari : Asparagus beetle. Ashwagandha/sarpagandha: Epilachna beetle, Mealy bugs, sphingid caterpillar. Opium: Root weevil, cutworm, capsule borer. Tephrosia: Mealy bug, seed borer, cutworm, tea mosquito bug. Mint: Leaf roller, hairy caterpillar, root borer. Dioscorea: Aphids, red spider mite, cutworm.	
Aromatic crops: Nature of damage & control measures of pests affecting		
23.	Camphor: Scale insects. Patchouli: Leaf Webber/leaf eating caterpillar, mirid bug, root knot nematode.	
24.	Jasmine: Leaf webworm, budworm, aphid, thrips, two spotted spider mite.	
25.	Vetiver: Stem borer, root infecting beetle, nematodes. Davana: Davana bug, semilooper. Kevara: Leaf hopper.	10
26.	Citronella: Shoot borer, grasshopper, armyworm, eriophyid mite. Geranium: Root knot nematodes, termite, cutworm. Lemon grass: Shoot borer, spittle bug. Palmarose: Thrips, white grub.	
27.	Eucalyptus: Termites shoot borer. Sandalwood: Leaf Webber, long horned grasshopper, leaf hopper, thrips, red borer.	

Stored pests: Distribution, host range, bio-ecology, injury		
28&29	Major pests: Indian meal moth, Fig and almond moth, rust red flour beetle, khapra beetle, raisin moth, dried fruit beetle. Minor pests: Saw toothed grain beetle, rice moth.	05
30.	Preventive and curative measures for pest management of stored fruits, plantation, medicinal and aromatic plants.	
Pesticides residues		
31&32	Definition of pesticides residues, acceptable daily intake, maximum residual limits, toxicity, its types, LC50, LD50, LT50, GAP, list of instrument for detection of pesticide residues and maximum residual limits of pesticides in export fruits, plantation, medicinal and aromatic commodities.	05
Total		100

Practical Schedule:

Ex. No.	Title of Exercise
1.	Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of pests of citrus
2.	Study of Pests of Mango
3.	Study of Pests of Grapevine
4.	Study of Pests of Pomegranate, Aonla Study of Pests of Guava, Fig and Jackfruit
5.	Study of Pests of Banana, Papaya and Custard apple
6.	Study of Pests of Ber , Sapota and Jamun
7.	Study of Pests of Cashew, Cacao, Tea and Coffee
8.	Study of Pests of Coconut, Areca nut and Oil Palm.
9.	Study of Pests of Temperate Fruit crops (Apple, Pear, Peach, Plum, almond)
10.	Study of Pests of Betel vine and Rubber
11.	Study of Pests of Cinchona, senna, neem, hemp & belladonna
12.	Study of Pests of Pyrethrum, Isabgoal, Dhatura, Costus & Crotalaria
13.	Study of Pests of Wild brinjal, Sweet flag, Safedmusli, Shatavari, Ashwagandha, Opium
14.	Study of Pests of Tephrosia, Mint, Dioscoria, Comphor, & Jasmine
15.	Study of Pests of Patchouli, Vetiver, Davana, Kevara & Citronella Study of Pests of Geranium, Lemongrass, Palmarose, Eucalyptus & Sandalwood
16.	Study of pests of stored fruits, plantation, medicinal and aromatic plants

Textbooks:

- David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book Department, Madras, 536p.
- Ramnivas Sharma : Identification and management of horticulture pest.

Reference Books:

- 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. V. Alford. Pest of fruit crops. A. M. Ranjith. Identification and management of Horticultural pest.
- Rachna and Bennakumari. Pest management and residual analysis in horticultural crop
- K. P. Srivastav and Y. S. Ahawat. Pest management in citrus.
- Fryer : Insect pest of fruit crops
- S. Atwal. Agricultural pests of south Asia and their management.
- Mark Vernon Slinger land and C. R. Crosby. Manual of fruit insects.
- Metcalf, R.Land Luckman,W.H.1982. Introduction to Insect pest management. WileyInterSciencePublishing,NewYork
- Butani, D.K.1984. Insects and Fruits. Periodical Expert Book Agency, NewDelhi
- *e-reading:* <http://ecourses.iasri.res.in/>

Course No: H/ENTO- 354

Course Title: Apiculture, Sericulture and Lac Culture

Credits: (1+1) 2

Semester: V

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, hardness 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 rain fed 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 moutages. 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 insects.

Teaching Schedule:

Lecture No.	Topic	Weightage (%)
1	Introduction to beneficial insects. Importance and History of apiculture.	20
2	Studies on different species of honey bees, morphology and anatomy.	
3	Studies on bee colony organization, life style and seasons management.	
4	Bee keeping equipments, types and social behavior of bee hives and their description.	10
5	Reproduction in bees and queen rearing. Bee pasturage, bee products and their uses. Economics of bee keeping.	
6	Bee enemies and diseases. Role of bees in pollinations.	
7	Importance, History and development of silkworms in India. Silk worms species and their hosts, systematic position, distribution, lifecycles in brief, Silk glands.	20
8-9	Mulberry silkworm- races. Moriculture-Mulberry varieties, package of practices.	
10	Rearing house and equipments, disinfection and hygiene.	
11	Grainage acid treatment, packing and transportation of eggs, Incubation, black boxing, hatching of eggs.	
12	Silkworm rearing young age (chawki) rearing and old age rearing of silkworms.	
13	Feeding, spacing, environmental conditions and sanitation. Cocoon characters: colour, shape, hardness and shell ratio.	40
14	Defective cocoons and stifling of cocoons. Uses of silk and by-products. Economics of silk cocoon production.	
15	Pests and diseases of silkworm and their management.	
16	Lac growing areas in India, Lac insects, biology. Lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac-insects.	10
	Total	100

Practical Lesson plan

Ex. No.	Practical
1.	Honey bee colony and different bee hives and apiculture equipment.
2.	Seasonal management of bee colony-Summer and winter.
3.	Study of production of honey, handling and bottling.
4.	Study of pests and diseases of honeybees.
5.	Establishment of mulberry garden.
6.	Study of cultivation of mulberry under irrigated and rainfed conditions.
7.	Maintenance of mulberry garden-pruning, fertilization, irrigation and leaf harvest.
8.	Pests, diseases and nutritional disorders of mulberry crop and their management.

9.	Study of different species of silkworms species and morphology and anatomy of mulberry silkworm- Silk gland
10.	Rearing equipments and rearing room.
11.	Rearing of silkworms-chalky larvae.
12.	Rearing of silkworms late age silkworm and mountages.
13.	Study of silkworm pests and their management.
14.	Lac insects-biology, behaviour
15.	Lac cultivation, food plants, pruning, inoculation, cropping.
16.	Kinds of lac and their enemies.

Suggested Reading:

Text books:

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

Reference books:

- 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)
- Y.A. Shinde and B.R. Patel. Sericulture in India
- Tribhuvan 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 SulochanaChetty, 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 Research in Tropical Sericulture, Mysore, 209.
- B.R. David and V.V.Ramamurthy. Elements of Economic Entomology, 7th Edition. Namrutha Publications, Chennai

e-reading: <http://ecourses.iasri.res.in/>

Course No. : H/ENTO 232

**Title: Insect Pests of Vegetable, Ornamental and
Spice Crops**

Credits : (2+1) 3

Semester-III

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, ornamental and spice crops. 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.

Teaching Schedule

Theory

Lecture No.	Topic	Weightage (%)
1	Economic importance of insects in vegetable, ornamental and spice crops - ecology and pest management with reference to these crops	10
2	Pest surveillance in important vegetable, ornamental and spice crops. Good agricultural practices in relation to pest management	
3	Pests of Okra : Shoot and fruit borer, Fruit borer, Leaf roller, Jassid, Aphid, Whitefly, Mite	10
4	Pests of Brinjal : Shoot and fruit borer, Whitefly, Aphid, Jassid, Hadda beetle, Leaf webber, Mite Pests of Tomato : Fruit borer, Leaf eating caterpillar, Serpentine leaf miner, Leaf miner, Whitefly, Aphid, Mealybug	
5	Pests of Bell pepper / Capsicum : Thrips, Tobacco leaf eating caterpillar, Cutworm, Fruit borer, Whitefly, Mite	
6 &7	Pests of Cruciferous and Root crops (Cabbage, Cauliflower, Brocoli, Knolkol, Raddish, Carrot) : Diamondback moth, Mustard sawfly, Aphid, Head borer, Cabbage butterfly, Leaf miner, Cluster caterpillar, Tobacco leaf eating caterpillar, Semilooper, Cabbage bug	10

8	Pests of Cucurbitaceous crops (Pumpkin, Ridge gourd, Bitter gourd, etc.) : Fruit fly, Pumpkin beetle, Blister beetle, Hadda beetle, Leaf miner, Aphid, Whitefly, Mite	15
9	Pests of Potato : Potato tuber moth, Cutworm, Aphid, Jassid, Leaf eating caterpillar, Epilachna beetle, Mite	
10	Pests of Sweet Potato and Yam Sweet Potato : Sweet potato leaf eating caterpillar, Sweet potato weevil Yam : Yam beetle, Mealybug, Scale insect, Sawfly	
11	Pests of Leafy vegetables (Amarathus, Coriender, Fenugreek, Spinach, Salad crops) : Cutworm, Leaf eating caterpillar, Aphid, Leafhopper, Mustard sawfly, Leaf miner, Pollu beetle	05
12	Pests of Peas & Beans : Pod borers, Aphid, Stem fly, Pulse beetle, Mite	
13	Pests of Roses : Aphid, Jassid, Thrips, Scale insect, Flower borer, Leaf eating caterpillar, Leaf cutting bees, Digger wasp, Termite, Mite	10
14	Pests of Chrysanthemum and Marigold : Aphid, Thrips, Whitefly, Jassid, Leaf miner, Lace bug, Bud borer, Leaf miner, Mite, Slug	
15	Pests of Jasmine and Tuberose : Budworm, Galleryworm, Tingid bug, Rose bud borer, Aphid, Thrips, Scale insect, Mite	05
16	Pests of Aster : Leafhopper, Black blister beetle, Leaf miner, Aphid, Mite	
17	Pests of Gladiolus : Seed corm maggot, Aphid, Thrips, Cutworm, Mite	
18	Pests of Gerbera : Whitefly, Leaf miner, Leaf eating caterpillar, Rose bud borer, Mite Pests of Carnation : Aphid, Thrips, Rose bud borer, Red spider mite	05
19	Pests of Lily, Anthurium and Orchids : Aphid, Thrips, Mite	
20	Pests of Black pepper : Pollu beetle, Mealy bug Pests of Clove : Stem borer, Scale	10
21	Pests of Cinnamon : Cinnamon butterfly, Leaf miner, Shoot and leaf webber, Chafer beetle	
22	Pests of Cardamom : Cardamom thrips, Shoot and capsule borer, Root grub, Capsule borer, Hairy caterpillar, Shoot fly	
23	Pests of Nutmeg and Mace : Scale	
24	Pests of Curry leaf (Psylla, Black fly, Lemon butterfly, Scale) Pests of Coriander, Cumin and Fennel (Aphid, Mite)	05
25	Pests of Turmeric and Ginger : Rhizome fly, Stem borer, Thrips, Scale insect, White grub	
26	Pests of Chilli : Thrips, Whitefly, Aphid, Fruit borer, Mite	
27	Pests of Onion and Garlic : Thrips, Cutworm, Onion fly, Earwig	
28	Integrated Pest Management in protected condition	15
29&30	Storage insect-pests of vegetable, ornamental and spice crops and their management	

31	Insect – pests of processed vegetable, ornamental and spice crops and their management	
32	Insecticidal residue problems in vegetables and ornamental crops : Definition of pesticide residue, acceptable daily intake, maximum residual limits, LD ₅₀ , LC ₅₀ , toxicity & its types, list of instrument for detection of pesticide residues and maximum residual limits of pesticides in vegetables, ornamental and spice crops	
	Total	100

Teaching Schedule Practical

Practical No.	Topic
1	Pests of Okra
2	Pests of Brinjal
3	Pests of Tomato, Bell pepper / Capsicum
4	Pests of Cruciferous and Roost crops
5	Pests of Cucurbitaceous crops
6	Pests of Potato, Sweet potato, Yam
7	Pests of Leafy vegetable, Pea, Beans
8	Pests of Rose, Chrysanthemum, Marigold
9	Pests of Jasmine, Tuberose, Aster
10	Pests of Gladiolus, Gerbera, Carnation, Lily, Anthurium & Orchids
11	Pests of Black pepper, Clove
12	Pests of Cinnamon, Cardamom, Nutmeg & Mace
13	Pests of Curry leaf, Coriander, Cumin & Fennel, Turmeric & Ginger
14	Pests of Chilli, Onion & Garlic
15	Integrated Pest Management in Polyhouse
16	Insect-pests of storage & processed vegetable, ornamental and spice crops and their management

Reference books

- Ayyar, T.V.R. 1963, Hand Book of Economics Entomology for South India. Govt. Press Madras.
- David, B.V. 2006. Elements of Economic Entomology. Popular Book Depot, Chennai.
- Butani, D.K. and M.G.Jotwani, 1984. Insects of Vegetables. Periodical Expert Book Agency, New Delhi.
- Srivastava, K.P. and D.K.Butani, 1998. Pest Management in Vegetables (Part I & II) Research Periodicals and Book Publishing House, India.

e-reading: <http://ecourses.iasri.res.in/>

DEPARTMENT OF NATURAL
RESOURCE MANAGEMENT

DEPARTMENT OF NATURAL RESOURCE MANAGEMENT

Course No. : H/SSAC-111

Course Title: Fundamentals of Soil Science

Credit: (1+1) 2

Semester: I

Theory –

Composition of earth's crust, Soil as a natural body- major components. Formation of Soil – soil forming factors and Pedogenic processes. Physical properties- Texture definition, methods of textural analysis, Stock's law, assumptions, limitations, textural classes, use of textural triangle. Absolute Specific gravity/particle density definition, apparent specific gravity/bulk density porosity, factors influencing BD. Relation between BD & Porosity Pore space: definition, factors affecting capillary & non- capillary porosity. Soil colour-definition, significance, Munsell soil colour chart. Factors influencing soil colour- parent material, soil moisture and organic matter. Soil structure: definition, classification, clay prism like structure, and Genesis. Factors influencing soil structure. Soil consistence, plasticity, Atterberg's limits. Soil air : composition, factors influencing , soil air, gaseous exchange/ renewal and effect on plant growth. Soil Temperature : Sources ,distribution of heat, factors influencing soil temperature and measurement of soil temperature and effect on plant growth. Soil chemical properties: Soil colloids: organic, humus, inorganic, secondary silicate clays and hydrous oxides. Ion exchange: cation and anion, importance of ion exchange. pH and nutrient availability, soil buffering capacity. Soil organic matter: sources, factors, decomposition and importance. Soil water, energy concepts, measurement of soil water, movement, pF scale. Soil biology :importance soil microbes, benefits and harmful effects. Soil taxonomy (soil orders), land capability classification, Soils of different ecosystems and their properties. Methods and objective of soil survey. Soil erosion, types and control measures. Aerial photography : Satellite image interpretation, Soil survey , types and importance ,Remote sensing application in soil and plant studies. Soil degradation, soil compaction, compression, Problematic Soils –Salt affected soil, Acid soil, Flooded and Coastal saline soil properties. Management of problematic soils. Soil environmental quality.

Teaching Schedule

Lecture No.	Topic	Weightage
1	Composition of earth's crust, Soil as a natural body- major components	5
2	Formation of Soil – soil forming factors and Pedogenic processes.	5
3	Physical properties- Texture definition, methods of textural analysis, Stock's law, assumptions, limitations, textural classes, use of textural triangle.	10
4	Absolute Specific gravity/particle density definition, apparent specific gravity/bulk density porosity, factors influencing BD. Relation between BD & Porosity Pore space: definition, factors affecting capillary & non- capillary porosity	7.5
5	Soil colour-definition, significance, Munsell soil colour chart. Factors influencing soil colour- parent material, soil moisture and organic matter.	5
6	Soil structure: definition, classification, clay prism like structure, and Genesis. Factors influencing soil structure. Soil consistence, plasticity, Atterberg's limits.	5
7	Soil air : composition, factors influencing , soil air, gaseous exchange/ renewal and effect on plant growth	5
8	Soil Temperature : Sources ,distribution of heat, factors influencing soil temperature and measurement of soil temperature and effect on plant growth	7.5
9	Soil chemical properties: Soil colloids: organic, humus, inorganic, secondary silicate clays and hydrous oxides	5
10	Ion exchange: cation and anion, importance of ion exchange.	5
11	pH and nutrient availability, soil buffering capacity.	5

12	Soil organic matter: sources, factors, decomposition and importance.	5
13	Soil water, energy concepts, measurement of soil water, movement, pF scale.	5
14	Soil biology :importance soil microbes, benefits and harmful effects	5
15	Soil taxonomy (soil orders), land capability classification, Soils of different ecosystems and their properties. Methods and objective of soil survey Soil erosion, types and control measures.	10
16	Aerial photography : Satellite image interpretation, Soil survey , types and importance ,Remote sensing application in soil and plant studies Soil degradation, soil compaction, compression, Problematic Soils –Salt affected soil, Acid soil, Flooded and Coastal saline soil properties. Management of problematic soils. Soil environmental quality.	10
	Total	100

Practicals-

Basic analytical concepts, techniques and calculation. Collection and preparation of soil samples for horticultural crops. Determination of moisture content in soil by gravimetric method. Determination of pH and EC of soil sample. Determination of calcium carbonate by Rapid Titration method. Determination of Organic carbon by Walkely and Black method. Determination of Bulk density and porosity of soil. Textural analysis of soil by Boucouyos hydrometer method. Determination of available nitrogen content in soil. Determination of available Phosphorus from soil. Determination of available Potassium from soil. Determination of available sulphur from soil. Determination of DTPA extractable micronutrient from soil. Description of soil profile in field. Determination of soil colour using Munsell colour chart, Estimation of water holding capacity , Field capacity, Permanent wilting point and Determination of soil water potential characteristic curve by tensiometer and pressure plate apparatus Visit to Soil and Water Clinic.

Practicals

Ex. No.	Title
1	Basic analytical concepts, techniques and calculation.
2	Collection and preparation of soil samples for horticultural crops
3	Determination of moisture content in soil by gravimetric method
4	Determination of pH and EC of soil sample
5	Determination of calcium carbonate by Rapid Titration method
6	Determination of Organic carbon by Walkely and Black method
7	Determination of Bulk density and porosity of soil
8	Textural analysis of soil by Boucouyos hydrometer method
9	Determination of available nitrogen content in soil
10	Determination of available Phosphorus from soil
11	Determination of available Potassium from soil

12	Determination of available sulphur from soil
13	Determination of DTPA extractable micronutrient from soil
14	Description of soil profile in field
15	Determination of soil colour using Munsell colour chart, Estimation of water holding capacity , Field capacity, Permanent wilting point and
16	Determination of soil water potential characteristic curve by tensiometer and pressure plate apparatus Visit to Soil and Water Clinic

Suggested Reading

1. Brady, N. C. 2016. The Nature and Properties of Soils. 15th edition Publisher: Pearson Education, ISBN: 978-0133254488.
2. Biswas, T.D.; Mukherjee, S.K.. 1995. Text Book of Soil Science 2nd sEd.Tata McGraw Hill Publisher, Delhi pp 433.
3. Das D. K. 2011. Introductory Soil Science, 3rd revised and Enlarged Ed, Kalyani Publisher, Ludhiana. pp. 645.
4. Jakson, M.L. 1973. Soil Chemical Analysis. Printice Hall, India, Pvt. Ltd. New Delhi. pp 498.

Course No. : H/SSAC – 122

Course Title: Soil Fertility and Nutrient Management

Credits: (1+1) 2

Semester: II

Theory:

Introduction to Soil fertility and soil productivity :factors Essential nutrient elements and functions, deficiency symptoms. Mechanism of Nutrient transport / uptake to plants and nutrient availability. Acid calcarious and salt affected soil characteristics and management, Role of micro organisms in organic matter decomposition and humus formation, importance of C:N ratio and pH in plant nutrition soil buffering capacity. Integrated plant nutrient management. Soil fertility evaluation methods: chemical, biological and by visual symptoms, critical levels of different nutrients and hidden hunger in soil. DRIS Approach, critical limit approach. Manures and fertilizer classification and manufacturing process. Properties and fate of major and micronutrient in soils. NPK fertilizers: composition and application methodology, luxury consumption, nutrient reactions, deficiency symptom by visual diagnosis. Secondary & Micronutrient fertilizers their types, composition, reaction in soil and effect on crop growth. Fertilizer control order. Plant nutrient toxicity symptoms and remedial measures. Soil test crop response and targeted yield concept. Biofertilizers: importance, types and use in horticultural crop. Nutrients use efficiency (NUE) and management. Effect of potential toxic elements in soil and plant.

Teaching Schedule

Sr. No.	Topic	Weight age
1, 2&3	Introduction to Soil fertility and soil productivity :factors Essential nutrient elements and functions, deficiency symptoms. Mechanism of Nutrient transport / uptake to plants and nutrient availability. Acid calcarious and salt affected soil characteristics and management	10
4&5	Role of micro organisms in organic matter decomposition and humus formation, importance of C:N ratio and pH in plant nutrition soil buffering capacity.	10
6	Integrated plant nutrient management	7.5
7&8	Soil fertility evaluation methods: chemical, biological and by visual symptoms, critical levels of different nutrients and hidden hunger in soil. DRIS Approach, critical limit approach,	10
9	Manures and fertilizer classification and manufacturing process. Properties and fate of major and micronutrient in soils	10
10&11	NPK fertilizers: composition and application methodology, luxury consumption, nutrient reactions, deficiency symptom by visual diagnosis	10
12	Secondary & Micronutrient fertilizers their types, composition, reaction in soil and effect on crop growth. Fertilizer control order	7.5

13	Plant nutrient toxicity symptoms and remedial measures.	7.5
14	Soil test crop response and targeted yield concept	7.5
15	Biofertilizers: importance, types and use in horticultural crop. Nutrients use efficiency (NUE) and management.	10
16	Effect of potential toxic elements in soil and plant	10
	Total	100

Practicals-

Determination of organic matter from compost / FYM /oil cake (Ignition method), Determination of soil available nitrogen (Subbiah and Asija,, 1956). Determination of available phosphorus in soil (Olsen et al, 1954) for alkaline soils. Determination of soil available potassium in soil. Determination of soil available sulphur in soil. Determination of exchangeable Calcium and Magnesium in soil. Determination of exchangeable Calcium and Magnesium by Versenate (EDTA) Method. Determination of soil Micronutrients. Determination of Lime requirement of Problem soils Determination of Lime requirement of acid soils (SMP buffer method) (for soils of pH less than 6) To estimate the Lime requirement of a soil (Hutchinson and MacLenan procedure) . Fertilizer Adulteration test / Identification of Adulteration in fertilizer / Detection of adulteration in fertilizers (Rapid test). Determination of total nitrogen from FYM / Compost / oilseed cake and C : N ratio (By Kjeldahl method) . Determination of total phosphorus and potassium from compost / FYM. Determination of (Amide nitrogen) from urea. Determination of ammonical nitrogen content of ammonium sulphate. Determination of water soluble phosphorus in superphosphate (Pumberton method) Use of soil testing kit and Use of leaf colour chart for nutrient deficiency diagnosis

Practicals

Exercise No	Title
1	Determination of organic matter from compost / FYM /oil cake (Ignition method)
2	Determination of soil available nitrogen (Subbiah and Asija,, 1956)
3	Determination of available phosphorus in soil (Olsen et al, 1954) for alkaline soils.
4	Determination of soil available potassium in soil
5	Determination of soil available sulphur in soil.
6	Determination of exchangeable Calcium and Magnesium in soil
7	Determination of exchangeable Calcium and Magnesium by Versenate (EDTA) Method.
8	Determination of soil Micronutrients
9	Determination of Lime requirement of Problem soils Determination of Lime requirement of acid soils (SMP buffer method) (for soils of pH less than 6) To estimate the Lime requirement of a soil (Hutchinson and MacLenan procedure)
10	Fertilizer Adulteration test / Identification of Adulteration in fertilizer / Detection of adulteration in fertilizers (Rapid test)
11	Determination of total nitrogen from FYM / Compost / oilseed cake and C : N ratio (By Kjeldahl method)
12	Determination of total phosphorus and potassium from compost / FYM.
13	Determination of (Amide nitrogen) from urea.
14	Determination of ammonical nitrogen content of ammonium sulphate. Determination of water soluble phosphorus in superphosphate (Pumberton method)

15	Determination of total potassium content of muriate of potash (by flame photometer). And zinc in zinc sulphate.
16	Use of soil testing kit and Use of leaf colour chart for nutrient deficiency diagnosis

Suggested Reading

1. Yawalkar K.S, Agarwal J. P. and Bokkde, 1992. Manures and Fertilizers. Agri. Horticultural Publishing House, Nagpur.
2. Tandan HLS, 1994. Fertilizers Guide. Fertilizers Development Consulation Organizations, New Delhi.
3. Mengel , et al., 2001. Principles of Plant Nutrition (5th Edition), Springer
4. Seethramaan, S. Biswas, B.C. Maheshwari, S. and Yadav, D.S. 1986 Hand Book on Fertilizers Technology. The Fertilizers Association of India, New Delhi

Course No:-H/EVS-121

Course Title:-Environmental Studies and Disaster Management

Credit hours: (2+1) 3

Semester:-II

Theory

Environmental studies:- Nature, Definition, scope and importance. Natural Resources:-Renewable and non-renewable resources, Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation. 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. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of non-conventional energy sources. 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. Study of Producers, Consumers and Decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids. Types of Ecosystem Introduction, characteristic features, structure and function of Forest, Grassland, Desert and Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) Biodiversity: - Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India, Value of biodiversity. 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, Endangered and endemic species of India., Conservation of biodiversity. Environmental Pollution:- Types of pollution, definition, cause, effects and control measures of Air, Water, Soil, Marine, Noise, Thermal pollutions and Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution. Carbon Credit: Concept, Exchange of carbon credits. Carbon Sequestration, Importance, Meaning and ways. Environmental ethics- issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Environment (Protection) Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act and Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. Human Population and the Environment: Population growth, variation among nations, population explosion. Environment and human health: Human Rights, Value Education. 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:-Concept, Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. 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; Police and other organizations

Lecture No.	Topic	Weightage (%)
1.	Environmental studies:- Nature, Definition, scope and importance	3
2	Natural Resources:-Renewable and non-renewable resources, Natural resources and associated problems.	16
3-6	a) Forest resources: Use and over-exploitation, deforestation. 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.	

	d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of non-conventional energy sources. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.	
7	Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.	
8	Ecosystems: -Concept of an ecosystem, Structure and function.	
9	Study of Producers, Consumers and Decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids.	14
10	Types of Ecosystem Introduction, characteristic features, structure and function of Forest, Grassland, Desert and Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	
11-12	Biodiversity: - Introduction, definition, genetic, species & ecosystem diversity and bio-geographical classification of India, Value of biodiversity.	
13-14	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 Endangered and endemic species of India., Conservation of biodiversity.	12
15-17	Environmental Pollution:- Types of pollution, definition, cause, effects and control measures of Air, Water, Soil, Marine, Noise, Thermal pollutions and Nuclear hazards.	14
18	Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.	
19-20	Carbon Credit: Concept, Exchange of carbon credits. Carbon Sequestration, Importance, Meaning and ways.	
21-22	Environmental ethics- issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products.	08
23-24	Environment (Protection) Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act and Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.	08
25	Human Population and the Environment: Population growth, variation among nations, population explosion. Environment and human health: Human Rights, Value Education.	04
26-27	Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves.	10
28	Climatic change: global warming, Sea level rise, ozone depletion.	
29-30	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.	08
31-32	Disaster Management:-Concept, Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. 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; Police and other organizations.	03
	Total Weightage (%)	100

Practical-

Study of collection, processing and storage of effluent samples. To estimate solids in water samples. To measure the dissolved O₂ content in pond water by Winkler's method. Estimation of respirable and non-respirable dust in the air by using a portable dust sampler. Determination of sound level by using a sound level meter. Study of community structure. Study of pond / River/ hill slopes ecosystem-abiotic and biotic components. Study of grass land and agro-ecosystem and measurement of their productivity. Crop adaptation to different ecosystems. A. Hydrophytes, B. Mesophytes, C. Xerophytes, D. Halophytes. Study and Visit of flora and Fauna. Visit to local polluted site - Urban / Rural/ Industrial: observations and remedial control measures. Collection, identification, herbarium, maintenance and study of plants grown in various ecosystems.

Exercise	Experiment Title
1	Study of collection, processing and storage of effluent samples.
2	To estimate solids in water samples.
3	To measure the dissolved O ₂ content in pond water by Winkler's method.
4	Estimation of respirable and non-respirable dust in the air by using a portable dust sampler.
5	Determination of sound level by using a sound level meter.
6	Study of community structure.
7	Study of pond / River/ hill slopes ecosystem-abiotic and biotic components.
8	Study of grass land and agro-ecosystem and measurement of their productivity.
9	Crop adaptation to different ecosystems. A. Hydrophytes
10	Crop adaptation to different ecosystems. B. Mesophytes
11	Crop adaptation to different ecosystems. C. Xerophytes
12	Crop adaptation to different ecosystems. D. Halophytes
13	Study and Visit of flora and Fauna.
14	Visit to local polluted site - Urban / Rural: observations and remedial control measures.
15	Visit to local polluted site - Industrial: observations and remedial control measures.
16	Collection, identification, herbarium, maintenance and study of plants grown in various ecosystems.

Text books:

- 1 Text book of Environmental Studies for undergraduate courses by Erach Bharucha University Grants Commission, New Delhi.
- 2 A text book on Ecology and Environmental Science by M.Prasanthrajan and P.P. Mahendran., Agrotch Publishing Academy, Udaipur-313002.

Reference Book:

- 3 Ecology and Environment by P.D. Sharma, Rastogi Publication. Meerut.
- 4 Environmental Sciences by S.S. Purohit, Q.J. Shammi and A.K. Agrawal, Student Edition, Jodhpur.
- 5 Disaster Management by Sarthak Singh. Oxford Book Company.
- 6 Disaster – Strengthening community Mitigation and Preparedness by Dr. B.K. Khanna and Nina Khanna. New India Publication Agency.
- 7 Laboratory Manual of Ecology and Environmental Studies by Amrit Kaur, Paragon International Publisher, New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

Course No. : H/SSAC-243

Course Title: Soil, Water and plant analysis

Credit: (1+1) 2

Semester: IV

Theroy: Importance and objectives of soil, water and plant analysis Principles of instrumentation in soil, water and plant analysis, Methods of soil, water and plant sampling and processing for analysis, Nutrient mobility, diffusion and mass flow, Renewal of gases in soil and their abundance, Principles and methods of measurement of oxygen diffusion rate and redox potential, Radio tracer technology application in plant nutrient studies and fertility evaluation, Soil micro-organisms and their importance, Saline and alkali appraisal and management, Acid soil appraisal and management, Waterlogged soil appraisal and management, Sandy soil 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 test for plant, Management of poor quality irrigation water in crop management Soil pollution and water pollution.

Teaching Schedule

Lecture No.	Topic	Weightage
1 & 2	Importance and objectives of soil, water and plant analysis Principles of instrumentation in soil, water and plant analysis	10
3	Methods of soil, water and plant sampling and processing for analysis	7.5
4	Nutrient mobility, diffusion and mass flow	7.5
5	Renewal of gases in soil and their abundance	5
6	Principles and methods of measurement of oxygen diffusion rate and redox potential	7.5
7 & 8	Radio tracer technology application in plant nutrient studies and fertility evaluation	10
9	Soil micro-organisms and their importance	5
10	Saline and alkali appraisal and management	5
11	Acid soil appraisal and management	5
12	Waterlogged soil appraisal and management	5
13	Sandy soil appraisal and management	5
14	Chemical and mineral composition of horticultural crops	7.5
15	Leaf analysis standards , index tissue, interpretation of leaf analysis values quality of irrigation water. Rapid tissue test for plant	10
16	Management of poor quality irrigation water in crop management Soil pollution and water pollution	10
	Total	100

Practicals:

Collection and preparation of soil, water and plant samples for analysis, Preparation of standard solutions, Determination of pH and EC of soil, Determination of SAR and ESP of soil, Estimation of moisture content in soils and plants, Determination of available nitrogen in soil, Determination of available phosphorus in soil, Determination of available potassium in soil, Determination of DTPA extractable micronutrients in soil, Determination of boron, Determination of pH and EC in irrigation water samples, Determination of Carbonates , bicarbonates sulphates and chlorides in irrigation water, Determination of calcium, magnesium , sodium , potassium and Boron in irrigation water, Determination of NPK calcium , magnesium and sulphur in plant sample, Determination of micronutrients in plant sample , Preparation of plant nutrient deficiency symptoms album.

Practicals

Exercise No.	Title
1	Collection and preparation of soil, water and plant samples for analysis
2	Preparation of standard solutions
3	Determination of pH and EC of soil
4	Determination of SAR and ESP of soil
5	Estimation of moisture content in soils and plants
6	Determination of available nitrogen in soil
7	Determination of available phosphorus in soil
8	Determination of available potassium in soil
8	Determination of DTPA extractable micronutrients in soil
10	Determination of boron
11	Determination of pH and EC in irrigation water samples
12	Determination of Carbonates , bicarbonates sulphates and chlorides in irrigation water
13	Determination of calcium, magnesium , sodium , potassium and Boron in irrigation water
14	Determination of NPK calcium , magnesium and sulphur in plant sample
15	Determination of micronutrients in plant sample
16	Preparation of plant nutrient deficiency symptoms album

Suggested Reading Books:

- 1 H.L.S. Tandon. 2013, Methods of analysis of soil, plant, water and fertilizers. FDCO, New Delhi.
- 2 Yawalkar, K.S. Agarwal, Pand Bokde., 1977 Methods and fertilizers. Agri-Horticultural Publishing House, Nagpur.
- 3 Sehgal J.A. 2005. Textbook of Pedology Concepts and Applications. Kalyani Publishers, New Delhi.

- 4 Jaiswal, P.C., 2006. Soil, Plant and Water Analysis (2nd Edition), Kalyani Publishers, Ludhiana.
- 5 Jackson M.L, 1967. Soil Chemical Analysis, Oxford and IBH Publishing Co., New Delhi.
- 6 P.K. Gupta., 2013, Soil, Plant, water and fertilizer analysis. Agrobios, India.
- 7 M. V. Durai., 2014, Hand book of Soil, plant, water, fertilizers and Manure analysis. New India Publishing Agency.

Course No. : H/ENGG-362

Course Title: Farm Machinery and Power

Engineering

Credits: 1+1=2

Semester : VI

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, fuel supply system for CI and SI engine, 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 plough and rotary plough/rotavator. Secondary tillage implements: construction and function of tiller/cultivator, harrows, ridgers and bund formers. Sowing and transplanting equipment: seed drills, potato planters, seedling transplanter, 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.

Practical:

Calculation on force, power and energy. IC engines – showing the components of dismantled engines and motors. Study of fuel supply system of CI & SI engine, Lubrication system, Cooling systems, Clutch System, Gear box and differential unit. Primary and secondary tillage implements, hitching, adjustments and operations. Spraying equipment, calibration and operation. Plant protection equipment, calculation of dilution ratio and operation. Study of Horticultural Tools and equipments. Study of power tiller.

Teaching Schedule:

Lecture	Topic / Topics Details	Weightage
1	Basic concepts of various forms of energy Human, Animal, Mechanical, electrical, Wind Power, Scope of Mechanization.	7
2-3	Principle of operation of I.C. engine- Basic principles of operation of compression, ignition and spark ignition engines, Two and Four stroke engine, Engine terminology and examples	13
4-5	I.C. Engine systems- Fuel supply system for CI and SI engine, Cooling and lubrication system.	12
6-7	Tractor Tractors, power tillers and their types, selection and uses, fixed and operating cost of tractors with examples	12
8	Tillage Tillage, objectives of tillage, classification & types of tillage, Tillage implements -types	7
9	Primary tillage implements- Construction and function of indigenous plough, M. B. plough and Disc plough with	6

	examples,	
10-11	Secondary tillage implements Construction and functions of Harrows, cultivators, ridgers and bund former & examples	12
12-13	Sowing and transplanting equipments-Sowing methods, seed drill, components of seed drill, seed metering mechanism, types of furrow openers, calibration of seed drill, examples	13
14	Planter Planter, and their functions ,classification of planters, potato planter,	6
15	Inter culturing equipments-Sweep, junior hoe, weeders, long handle weeders	6
16	Crop harvesting equipments potato diggers	6
	Total	100

Practical

Exercise No.	Name of the Exercise
1.	Engine terminology and numerical
2.	Study of components of internal combustion (I. C.) engine
3.	Study of two stroke cycle engine
4.	Study of four stroke cycle engine
5.	Study of fuel supply system of CI &SI engine
6.	Study of Lubrication system
7.	Study of Cooling systems
8.	Study of Clutch System of the tractor
9.	Study of Gear box and differential unit of the tractor
10.	Study of primary tillage implements: mould board plough, hitching, adjustment and operation
11.	Study of primary tillage implements: disc plough, hitching, adjustment and operation
12.	Study of secondary tillage hitching, adjustment and operation
13.	Study of inter-culturing tools and implements, hitching, adjustment and operation
14.	Study of sprayers and dusters, calibration and operation
15.	Study of Horticultural Tools and equipment's
16.	Study of power tiller

Text Books:

1. Principles of Agricultural Engineering Vol. 1. Reprint Edition: 2012. by T. P. Ojha, A. M. Michael, Jain Brothers, New Delhi

2. Elements of Agricultural Engineering by Jagadishwar Sahay. Forth Edition, 2010 Standard Distributor and Publishers, New Delhi
3. Agricultural Engineering by O P Singhal (2011) Aman Publishing House, Meerut
4. Elements of Farm Mechaneries by A C Srivastava, Oxford and IBH Publishing Co Pvt Ltd, New Delhi

Reference Books:

1. Farm Tractor -Repair and Maintenance by S.C. Jain and C.R. Rai.
2. Principles of Farm Machineies by R A Kepner, R Bainer, E C Barger (2000) CBS Publishers and Distributors, Delhi
3. Farm Engines and Tractors by H E Gulvin (2001) McGraw Hill, New York
4. Servicing and Maintenance of Farm Tractors (2005) E J Johnson and A H Hollenburg, McGraw Hill, New York
5. Tractor Implement System by Alcock and Ralph (1986) Athe AVI Publishing Co. Inc Springer, New York

e-reading: <http://ecourses.iasri.res.in/>

Course No. : H/ENGG-121

Course Title: Water Management in Horticultural Crops

Credits: 1+1=2

Semester :II

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 – kinds of water- 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. Study of fertilizer application system, Study of different types of filters, Study of acid treatment and chlorination treatment to avoid clogging in micro-irrigation system, Field evaluation of drip and micro-sprinkler irrigation system 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. Visit to Drip and sprinkler Irrigation Installation

LESSON-PLAN (Teaching- Schedule)

Lecture	Topic / Topics Details	Weightage
1	Water resources- Global water scenario, Hydrological cycle and Indian water Budget	6
2	Irrigated Area under principle crops	6
3	Function of water for plant growth- Soil moisture and plant growth	8
4	Effect of moisture stress on crop growth- soil moisture stress, moisture stress and plant response	6
5	Available and unavailable soil moisture – kinds of water, rooting characteristics, moisture extraction pattern	7
6	Water requirement of horticultural crops – net irrigation requirement, gross irrigation requirement	9
7 & 8	Lysimeter studies, Plant water potential-Consumptive use Use of pan evaporimeter-definition of evaporation, transpiration, Evapo-transpiration and potential evapotranspiration Pan evaporimeter	13
9	Factor for crop growth stages – critical stages of crop growth for irrigation. Irrigation scheduling – different approaches	6

10 & 11	Methods of Irrigation- Classification, border, check basin, Square and ring basin, Furrow irrigation methods	9
12	Sub-surface pressurized methods Sprinkler- definition, adoptability, limitations,	7
13 & 14	Components and types of Sprinkle irrigation system, fertilizer applicator	11
15 & 16	Drip Irrigation System- Definition, advantages, dis- advantages, components, fertilizer applicator, Layout	12
	Total	100

Practical:

Exercise Number	Title of the Exercise
1.	Study of Weirs, Notches
2.	Study of Parshall flume and orifices
3.	Numericals on Weirs, Notches, Parshall flume and orifices
4.	Collection of field data for designing micro-irrigation system for orchard and vegetable crops
5.	Study of different components of drip irrigation system
6.	Study of different components of Sprinkler irrigation system
7.	Study of fertilizer application system
8.	Study of different types of filters
9.	Study of acid treatment and chlorination treatment to avoid clogging in micro-irrigation system
10.	Field evaluation of drip and micro-sprinkler irrigation system
11.	Estimation of soil moisture constants
12.	Determination of Soil Moisture by Air Oven Method
13.	Estimation of irrigation efficiency of horticultural crops
14.	Estimation of water requirements of horticultural crops
15.	Study of Soil Moisture Conservation Practices
16.	Visit to Drip and sprinkler Irrigation Installation

Text Books:

1 R.K. Shivanappan Drip Irrigation Keerthi Publishing House Pvt. Ltd., 126-Sarojini Street, Ramnagar, coimtare-461009

2 A.M. Michael Irrigation Theory and Practice-Reprint-2002 Vikas Publishing House Pvt. Ltd. New Delhi-110007

3 A.M. Michael and T.P. Ojha Principles of Agricultural Engineering Vol-II, Third Edition 1999 Jain Brothers, Karol Bagh, New Delhi

4 Y P Rao and S. R. Bhakar Irrigatin Technology Theory & Practices 2008 AgroTech Publishing Academy, Udaipur

5 D. Lenka Irrigation and Drainage 2001 Kalyani Publishing, Ludhiana

Reference Book:

1 J.N. Luthin Drainage Engineering 1978 Wiley

2 Richey et al Agricultural Engineer's Handbook 1961 Tata McGraw-Hill Publishing Company Ltd, New York

3 S. K. Garg Hydrology and Water Resource Engineering Khanna Publications, New Delhi

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/AGRO-351

Course Title: Organic Farming

Credits:(1+1) 2

Semester: V

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.

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.

Lesson Plan

S.N.	Topic	Weightages
1-2	Introduction, concept, relevance in present context; Organic production requirements	11
3	Biological intensive nutrient management	13
4-6	organic manures-FYM, vermicomposting, green manuring	16
7-8	recycling of organic residues, biofertilizers	13
9-10	Soil improvement and amendments; Integrated weed, diseases and pest management;	14
11-13	use of biocontrol agents, biopesticides pheromones, trap crops, bird perches	17
14-16	Quality considerations, certification, labeling and accreditation processors, marketing, exports	16
	Total	100

Practical:

SN	Title of the Exercise
1	Preparation of FYM, compost and green manuring
2	Preparation of vermicompost
3	Raising of agronomic/vegetable crops organically
4	Calculation of nutrient requirement for organically raised crops using different sources.
5	Preparation of phosphor-compost by using minerals.
6	Use of phosphor- compost to organically grown, fruits and vegetable crops
7	Study of parameters and their characteristics and favorable conditions required for production of quality compost
8	Study of relative suitability of different organic materials for composting according to ease of decomposition.
9	Use of concentrated organic manures (oil cakes, slaughter house waste, fish meal and poultry manures etc.) in organically grown different horticultural crops.

10	Use of bio-stimulants in organically grown horticultural crops
11	Preparation of vermin-wash for vegetable seedlings
12	Pest management in organically raised crops
13	Disease management in organically grown vegetable crops
14	Use of bio fertilizer for seed treatment of vegetable crops
15	Nutritional management in organically grown orchards, pest management in organically grown floriculture Nutritional management in organically grown vegetable crops. Grading, packaging, post-harvest management and marketing of organically raised produce.
16	Visit to bio-control lab, bio fertilizer unit and vermicomposting unit.

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.*Trends in Organic Farming in India*. AgrosBios(INDIA), Jodhpur.
- Thampan,P.K.1995.*Organic Agriculture*. PeckaytreeCropsDevelopmentFoundation, Cochin,Kerala.
- Sathe,T. V. 2004.*Vermiculture and Organic Farming*. DaysPublishingHouse,NewDelhi.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/AGROMET-111

Course Title: Agro-meteorology and Climate Change

Credits: (1+1) 2

Semester: I

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, weather disasters and their management atmospheric pollution and role of meteorology. 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. Atmospheric chemistry. 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.

Practicals: Site selection for Agromet observatory; 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. Visit to Meteorological observatory, Visit to IMD meteorological observatory-Lay out plan of standard meteorological observatory. Recording of air and soil temperature. Measurement of radiation and components, Measurement of rainfall-different types of raingauges, Measurement of wind speed and direction and atmospheric humidity, Recording of evaporation. Synoptic charts and weather reports, symbols, *etc.*

Practical:

Experiment	Topic
1	Site selection for Agromet observatory
2	Measurement of temperature
3	Measurement of rainfall
4	Measurement of evaporation (atmospheric/ soil)
5	Measurement of atmospheric pressure
6 & 7	Measurement of sunshine duration and solar radiation
8	Measurement of wind direction and speed and relative humidity
9	Study of weather forecasting and synoptic charts.
10	Visit of Agrometeorological Observatory.
11	Visit to IMD meteorological observatory –Layout plan of standard meteorological observatory.
12	Recording of air and soil temperature.
13	Measurement of radiation and components,
14	Measurement of rainfall-different types of rain gauges
15	Measurement of wind speed and direction and atmospheric humidity, recording of evaporation
16	Synoptic charts and weather reports, symbols etc.

Suggested Reading:**Reference books:**

- 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. Introduction to Meteorology. Me. Graw Hill Book Co. Inc., New York
- Tailor, J. T. 1967. Agricultural Climatology. Pergman Press Ltd. Headington Hill Hall, Oxford, England
- Trewarthe, T. G. 1968. An Introduction to Climate. Me Graw Hill Book Co. Inc., New York
- Mavi, H. S. 1985. Introduction to Agrometeorology. Oxford & IBH Publishing Co. New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

DEPARTMENT OF BASIC
SCIENCES

DEPARTMENT OF BASIC SCIENCES

Course No. H/STAT-111

**Course Title: Elementary Statistics and
Computer Application**

**Credits: (2+1) 3
Theory**

Semester: I

Definitions of Statistics and its applications in Horticulture, limitations of statistics, variable, 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 (o give curve) average and measures of location, Arithmetic mean, median, mode, GM, HM, weighted average, quartile, deciles, percentiles, for raw and grouped data. Characteristics of ideal measure, merits and demerits of various measures (grouped and ungrouped data),

Dispersion- Range, mean deviation, quartile deviation, standard deviation and variance, and respective relative measures (grouped and ungrouped Data), Concept of measures of Skewness and Kurtosis.

Definitions of population, sample, parameter, statistic, need of sampling, sampling versus complete enumeration parameter Simple random sampling with and without replacement. Use of random number tables for selection of simple random sample.

Random experiment, events (simple, compound, equally likely, complementary, independent) Definitions of probability (mathematical, statistical, axiomatic), addition and multiplication theorem (without proof). Simple problems based on probability, Random variable, discrete and continuous random variable, probability mass and density function, definition and properties of Binomial, Poisson and Normal distributions.

Null and alternate hypothesis, types of errors, degrees of freedom, level of significance, critical region, steps in testing of hypothesis, one sample, two sample and paired 't' test. F test for equality of variance, Large sample tests for one sample mean, two sample means 'Z' tests, Chi-square test of goodness of fit of Mendalian ratios, Chi-square test of independence of attributes in 2×2 contingency table.

Test of significance- Definition of correlation, types, scatter diagram. Karl Pearson's coefficient of correlation and its test of significance. Spearman's rank correlation coefficient and its applications

Linear regression equations, definition & properties of regression coefficient, constant, fitting of regression lines with test of significance, comparison of regression and correlation coefficients.

Introduction to analysis of variance, Assumptions of ANOVA, Principles of designs of expt., layout and analysis of completely randomized design, Layout and analysis of randomized block design, Layout and analysis of latin square designs, Factorial experiments, basic concepts, layout and analysis of factorial experiments up to 3 factors symmetric

& asymmetric, introduction to split plot design, introduction to Strip plot design, Plot size, guard rows, long term experiments.

Introduction to computers and personal computers, basic concepts, operating system, DOS and Windows.

MS Word- Features of word processing, creating document and tables and printing of document.

MS Excel-Concept of electronic spreadsheet, creating, editing and saving of spreadsheet, inbuilt statistical functions and formula bar.

MS Power point-preparation, presentation of slides and slide show.

Introduction to programming languages, BASIC language, concepts, basic and programming techniques.

Visual basic-concepts, basic and programming techniques.

Introduction to internet.

Practical syllabus

Graphical presentation: Construction of frequency distribution table and its graphical presentation, histogram, frequency polygon, frequency curve, cumulative frequency curve (ogive curve), Bar chart, simple, multiple, component and percentage bar charts, pie chart.

Computations of arithmetic mean, mode, median, GM and HM, quartiles, deciles & percentiles (grouped and ungrouped data).

Computations of range, mean deviation, quartile deviation, standard deviation and variance and respective relative measures (grouped and ungrouped Data).

One sample, two Sample and paired t-test. Chi-Square test of Goodness of Fit. Chi-square test of independence of Attributes for 2x 2 contingency table.

Computations of Karl Pearsons coefficient of correlation with its test of significance, Spearman's rank correlation.

Fitting of linear regression equation with test of significance of regression coefficient.

Analysis of completely randomized design and randomized block design.

Operating System : Windows , Practical on Visual basic.

MS Office: Word, Excel, Powerpoint, Writing program in BASIC language,

Internet and multi media.

Teaching Schedule : Theory (2+1)

Lecture No.	Topic	Weightage (%)
1-2	Introduction and graphical presentation : Definitions of Statistics and its applications in Horticulture, limitations of statistics, variable, 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 (ogive curve)	03

3-4	Measures of central tendency: Arithmetic mean, mode, median, geometric mean, harmonic mean, weighted average quartiles, deciles, percentiles, characteristics of ideal measure, merits and demerits of various measures (Grouped and Ungrouped data)	04
5-6	Measures of Dispersion: Range, Mean deviation, quartile deviation, standard deviation, variance and respective relative measures (Grouped and Ungrouped data), Concept of measures of Skewness and Kurtosis.	04
7-8	Sampling: Definition of population, sample, parameter, statistic. Need of sampling and various sampling methods, sampling versus complete enumeration and introduction to simple random, stratified and multistage sampling methods. Simple random sampling with and without replacement. Use of random number tables for selection of simple random sample.	04
9	Probability: Random experiment, events (simple, compound, equally likely, complementary, independent) Definitions of probability (mathematical, statistical and axiomatic), addition and multiplication theorem (without proof). Simple problems based on probability.	07
10-11	Probability distribution: Random variable, discrete and continuous random variable, probability mass and density function, definition and properties of Binomial, Poisson and Normal distributions.	09
12	Tests of significance: Null and alternate hypothesis, types of errors, degrees of freedom, level of significance, critical region, steps in testing of hypothesis, one sample, two sample and paired 't' test.	04
13	Chi-Square test of goodness of fit of Mendalian ratios. Chi-square test of independence of Attributes for 2×2 contingency table.	04
14	Correlation: Definition of correlation, types, scatter diagram. Karl Pearson's coefficient of correlation and its test of significance. Spearman's rank correlation coefficient and its applications	04
15	Regression: Linear regression equations, definition & properties of regression coefficient, constant, fitting of regression lines, its test of significance, comparison of regression and correlation coefficients.	04
16	Experimental designs: Introduction to analysis of variance, assumptions of ANOVA, Principles of designs of expt., layout and analysis of completely randomized design.	05
17	Layout and analysis of randomized block design	04
18	Layout and analysis of latin square designs	04
19-20	Factorial experiments, basic concepts, layout and analysis of factorial experiments up to 3 factors symmetric & asymmetric	05
21	Introduction to split plot design	04
22	Introduction to Strip plot design	04
23	Plot size, guard rows, long term experiments.	04
24-25	Computer application: Introduction to computers and personal	03

	computers, basic concepts, operating system, DOS and Windows,	
26	MS Word- Features of word processing, creating document and tables and printing of document	03
27	MS Excel-Concept of electronic spreadsheet, creating, editing and saving of spreadsheet, inbuilt statistical functions and formula bar	03
28	MS Power point-preparation, presentation of slides and slide show.	03
29-30	Introduction to programming languages, BASIC language, concepts, basic and programming techniques,	03
31-32	Visual basic-concepts, basic and programming techniques and Introduction to internet, Introduction to multi-media and its application	08
	Total	100

Practical schedule

EX.No.	Name of Exercise
1	Graphical presentation: Construction of frequency distribution table and its graphical presentation, histogram, frequency polygon, frequency curve, cumulative frequency curve (ogive curve)
2	Bar chart, simple, multiple, component and percentage bar charts, pie chart
3	Measures of central tendency: Computations of arithmetic mean, mode, median,
4	Measures of central tendency: GM and HM, quartiles, deciles & percentiles (grouped and ungrouped data).
5	Measures of Dispersion: Computations of range, mean deviation, quartile deviation,
6	Measures of Dispersion: standard deviation and variance and respective relative measures (grouped and ungrouped Data).
7	Test of Significance: Problems on one sample, two Sample and paired t-test.
8	Chi-Square test of Goodness of Fit. Chi-square test of independence of Attributes for 2×2 contingency table.
9	Correlation: Computations of Karl Pearsons coefficient of correlation with its test of significance, Spearman's rank correlation
10	Regression: Fitting of linear regression equation with test of significance.
11	Design of Experiment: Analysis of completely randomized design and randomized block design.
11	Operating System : Windows
12	MS Office: Word, Excel, Powerpoint
13	Writing program in BASIC language

14	Writing program in BASIC language
15	Practical on Visual basic
16	Practical on multi-media and internet

Text books

1. A Text book of Agriculture Statistics by R. Rangaswami (2009)New Age International (P) Limited, Hyderabad
2. Statistics for Agriculture Sciences by Nageshwar Rao G.(2007)New Delhi : BS Publications

Reference books

1. Statistical methods for Agricultural workers by Panse V.G. Sukhatme P.V. (1985) Indian Council of Agricultural Research New Delhi.
2. Statistical Methods by Snedecor GW. & Cochran WG. (1989), Iowa State University Press.
3. Statistical Procedures for Agricultural Research by Gomez, K.A. and Gomez, A.A.(1984) John Wileyand Sons. New York.
4. Fundamentals of Applied statistics by V.K. Kapoor (2007). Sultan Chand and Sons, New Delhi- 110 002
5. Comdex Computer *Kit*. by Gupta, V.,(2002). Dream Tech Press, NewDelhi.
6. Working with Windows AhandsonTutorials by Parmar, A. Mathur, N. DeeptiP. U. and Prasanna, V. B., (2000). Tata McGrawHill Publishing Co., New Delhi.
7. Fundamentals of Information Technology by Bandari,V. B., (2012). Pearson Education, New Delhi.
8. Fundamentals of Computers. by ITL Education Solution Limited (2011). Pearson Education- New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/BIOCHEM-111
Credits: (1+1) 2

Course Title: Elementary Plant Biochemistry
Semester: I

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, colour 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, structure and function of nucleic acid replication, transcription and translation.

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 pigments extracted from flowers, Extraction of oil from oil seeds; Enzymes: Enzyme assay, Enzyme Immobilization.

TEACHING SCHEDULE (Theory)

BIOCHEM-111, Elementary Plant Biochemistry Credits: 2(1+1)

Lect. No.	Topic	Weightage (%)
1	History of Biochemistry and scope of Biochemistry in Agriculture. Important Biomolecules – Enlist the Biomolecules and mention their functions in brief.	5
2-4	Carbohydrates - Definition, classification and functions. Carbohydrate metabolism- Glycolysis and T.C.A. cycle	15
5-7	Lipids- Definition, classification and functions. Fatty acids- Definition and classification. Lipid metabolism - Beta oxidation of fatty acids, biosynthesis of lipid.	15
8-9	Proteins-Definition, classification, properties and functions. Amino acids- Definition, classification, properties.	15
10- 11	Vitamins-Definition, classification, co-enzyme derivatives of water soluble vitamins, sources, metabolic functions and deficiency disorders of vitamins.	10
12	Nucleic acids – Definition , types and their hydrolytic products, Watson and Crick double helical structure of DNA.	7
13	Enzymes-Definition, classification (IUB system), factors affecting enzyme activity.	8
14	Photosynthesis - Definition, Light and Dark reactions, factors	8

	affecting photosynthesis.	
15	Plant pigments - Definition, classification, properties and physiological functions. Sterols - Definition, classification, properties and physiological functions.	10
16	Essential oils - Definition, classification and physiological role, Methods of extraction of Essential oils.	7
	Total	100

TEACHING SCHEDULE (Practical)

BIOCHEM-111, Elementary Plant Biochemistry Credits: 2(1+1)

Practical No.	Name of the practical
1	Preparation of solution, pH & buffers
2	Qualitative tests for carbohydrates
3	Qualitative tests for amino acids
4	Estimation of reducing sugars by Nelson-Somogyi method from fruit juice
5	Determination of soluble protein by Lowry method
6	Determination of soluble protein
7	Estimation of free amino acids by Ninhydrin method
8	Estimation of total crude fat/oil by Soxhlet method
9	Determination of crude fiber from fruit seeds.
10	Determination of crude fiber
11	Determination of starch by anthrone method potato
12	Estimation of total chlorophyll from okra
13	Estimation of Ascorbic acid in sweet orange
14	Determination of acidity of lemon.
15	Paper chromatography/ TLC demonstration for separation of amino acids
16	Determination of amylase activity

Text Books:

- 1 Bhatia S. C., 1984, Biochemistry in Agricultural Sciences, Shree Publication House, New Delhi.
- 2 Purohit S.S. 2009, Biochemistry - Fundamentals and Applications, Agrobios, Jodhpur
- 3 Singh M. 2011, A Textbook of Biochemistry, Dominant Publishers & Distributors, New Delhi
- 4 Veerkumari L. 2007, Biochemistry, MIP Publishers, Chennai
- 5 Jain J. L. et al 2005, Fundamentals of Biochemistry, S. Chand & Company Ltd. , New Delhi
- 6 Rastogi S. C.. 2003 - *Biochemistry* Tata McGraw-Hill Education, New Delhi.
- 7 Rama Rao A. V. S. S., 2002 *A Textbook of Biochemistry*. Edition, 9, illustrated. Publisher, Sangam Books Limited, New Delhi.

Reference Books: (Theory)

- 1 Com EE & Stumpf PK. 2010. Outlines of Biochemistry. 5th Ed. John Wiley Publications.
- 2 Donald Voet and Judith G. Voet. 2011. Biochemistry, 4th Ed. John Wiley and Sons, Inc., NY, USA.
- 3 Goodwin, TW & Mercer EI. 1983. Introduction to Plant Biochemistry. 2nd Ed. Oxford, New York. Pergaman Press.
- 4 David L. Nelson and Michael M. Cox. 2012. Lehninger Principles of Biochemistry, 6th Ed. Macmillan Learning, NY, USA

- 5 Jeremy M. Berg, John L. Tymoczko, Lubert Stryer and Gregory J. Gatto, 2002. *Biochemistry*, 7th Ed. W.H. Freeman and Company, NY, USA

Reference Books: (Practical)

- 1 Jayaram. T. 1981. *Laboratory manual in biochemistry*, Wiley Eastern Ltd. New Delhi:
- 2 Plummer D. 1988. *An Introduction to Practical Biochemistry*. 3rd ed. Tata McGraw Hill, New Delhi.
- 3 *Practical biochemistry*: R. L. Nath. *A treatise on Analysis of Food, Fats and Oils*: A. R. Sen, N.K. Pramanik and S.K. Roy
- 4 Sadasivam S, Manickam A (1996) *Biochemical methods*. 2nd edition, New Age International (p) Ltd. Publisher, New Delhi.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/BIOT-231**Course Title: Elementary Plant Biotechnology****Credits: (1+1) 2****Semester: III****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. 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 Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoresis techniques. Green synthesis of nano particles and their size characterization.

Lesson plan - Theory

No.	Topic	Sub Topics	Marks
1.	History, scope and importance of Biotechnology in Crop Improvement	History of Plant Tissue Culture and Plant Genetic Engineering, scope and importance in Crop Improvement:	10
2.	Totipotency and Morphogenesis,	Definition, Importance of totipotency and morphogenesis.	8
3.	Nutritional requirements of in-vitro cultures.	General techniques of tissue and cell culture, Different composition of culture medium, components of tissue culture medium, importance of growth regulator in culture medium	8
4.	Techniques of In-vitro cultures	Types of culture, Micro-propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture Factors affecting above in-vitro culture; Factors affecting above in-vitro culture; Applications and	7

		Achievements;	
5.	Somaclonal variation,	Introduction, causes, procedure and application in crop improvement. Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications in crop improvement.	10
6.	somatic embryogenesis	Types, direct and indirect embryogenesis, factors influencing somatic embryogenesis and synthetic seed production technology	8
7.	Protoplast Culture,	Introduction, method of protoplast fusion, selection of somatic hybrids and application of somatic hybridization.	7
8.	Genetic engineering;	Concept, vector and its types Restriction enzymes, Recombinant DNA techniques – Gene cloning, Direct and indirect method of gene transfer – Transgenic plants and their applications.	6
9.	Blotting techniques –	Types, procedure, Application, advantages and disadvantages.	10
10.	DNA finger printing	Introduction, Methodology, DNA based markers – RFLP, AFLP, RAPD, SSR and DNA Probes –	10
11.	Mapping QTL –	Introduction, concept, types, Mapping QTL – Future prospects. MAS (Marker Assisted Selection), and its application in crop improvement.	8
12.	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.	8
Total			100

Lesson Plan- Practical

Ex. No.	Title
1.	General instruction and laboratory methods.
2.	Plant tissue culture laboratory organization.
3.	Plant tissue culture laboratory equipments and their uses.
4.	Dry, Heat and Wet Heat sterilization methods
5.	Chemical sterilization, Filtration and UV irradiation.
6.	Preparation of solutions
7.	Preparation of tissue culture media and their composition

8.	Establishment and maintenance of callus culture from different explants, sub culture of callus.
9.	Production of embryogenic callus
10.	Indirect organogenesis: Production of shoots and roots from callus
11.	Acclimatization and Hardening
12.	Micropropagation with shoot apex culture in different plants (Banana)
13.	Demonstration of Gene transfer techniques, direct methods and indirect methods;
14.	Demonstration of Confirmation of Genetic transformation;
15.	Demonstration of gel-electrophoresis techniques.
16.	Green synthesis of nano particles and their size characterization.

Suggested Reading:

Reference books:

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.

e-reading: <http://ecourses.iasri.res.in/>

Course No: H/BOT-111
Credits : 1+1=2

Course Title : Introductory Crop Physiology
Semester: I

Theory

Introduction to plant physiology. Water Relations in Plants: Role of water in plant metabolism, diffusion and osmosis. Water potential and its components, measurement of water potential in plants. Absorption of water, mechanism of absorption and absorption of water in plant. Ascent of sap and theories of ascent of sap. Transpiration Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Factors affecting transpiration, Osmotic pressure, guttation, stem bleeding. Drought: Different types of stresses; water, heat, cold and salinity tolerance; mechanism of tolerance. Drought: Different types of stresses; water, heat, cold and salinity tolerance; mechanism of tolerance. Plant Nutrition: criteria of essentiality, classification of mineral elements and its role in plant metabolism and absorption of mineral elements. Photosynthesis: definition, structure and function of chloroplast, Pigment involved in Photosynthesis, nature of light. Light reaction; photolysis, water emersion effect, cyclic and non-cyclic electron transfer.

TEACHING SCHEDULE (THEORY)

Lecture No	Topics	Weightage (%)
1	Introduction to plant physiology	5
2	Water Relations in Plants: Role of water in plant metabolism, diffusion and osmosis	5
3	Water potential and its components, measurement of water potential in plants	5
4	Absorption of water, mechanism of absorption and absorption of water in plant	5
5	Ascent of sap and theories of ascent of sap	10
6	Transpiration Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata.	10
7	Factors affecting transpiration, Osmotic pressure, guttation, stem bleeding.	5
8	Drought: Different types of stresses; water, heat, cold and salinity tolerance; mechanism of tolerance.	10
9	Plant Nutrition: criteria of essentiality, classification of mineral elements and its role in plant metabolism and absorption of mineral elements	5
10	Photosynthesis: definition, structure and function of chloroplast,	10

	Pigment involved in Photosynthesis, nature of light.	
11	Light reaction; photolysis, water emersion effect, cyclic and non-cyclic electron transfer	5
12	Dark reactions, CO ₂ fixation , C ₃ , C ₄ and CAM cycle, advantages of C ₄ pathway and factors affecting photosynthesis.	5
13	Photorespiration : mechanism and its implications	5
14	Biological nitrogen fixation- mechanism and nodulation and its importance	5
15	Secondary metabolites, types and its importance in plant defense.	5
16	Herbicide : physiology and mode of action and mechanism of herbicide resistance	5
Total		100

TEACHING SCHEDULE (PRACTICAL)

Lecture No	Topics
1	Study of osmosis
2	Study of water potential by different methods-I
3	Study of water potential by different methods-II
4	Study of root pressure
5	Study of Structure of stomata
6	Study of distribution of stomata
7	Study of opening and closing of stomata
8	Measurement of rate of transpiration different methods- photometer method
9	Measurement of rate of transpiration different methods- bell jar method
10	Study of transpiration pull by Darwings photometer
11	Study of importance of light in photosynthesis.
12	Study of importance of chlorophyll in photosynthesis.
13	Separation of chloroplast- a pigment in horticultural crops by solvent extraction method.
14	Measurement of Relative water content.
15	Study of plant movements- positive tropism, negative tropism
16	Study of plant movements- photo tropism,

Test books & Reference book:

SR	Name of Book	Author	Publisher
Text books			
1.	A Text Book Plant Physiology*	Dr. V. Verma	Emkay Publisher, Delhi-110 051
2.	A Text Book Plant Physiology* 2005	c. P. Malik & A. K. Srivastava	Kalyani publisher, Ludhiana
3.	Introductory Plant physiology* 2013	G. Roy Noggle & George friz	PHI learning pvt ltd, N. Delhi
4.	Plant Physiology*	S. N. Pandey & B. K. Sinha	Vikas Publishing House, New Delhi-110 014
5.	Experiment in Plant Physiology –A Lab. Manual * 1998	Dayanand Bajracharya	Narosa publishing house, panchshil park, N. Delhi
6.	Practical Plant Physiology*1967	Amar Singh	Kalyani Publisher, Ludhiana
7.	Plant Physiology*2005	C. P. Malik	Kalyani Publisher, Ludhiana
8.	Crop Physiology*	C. N. Chore, S. R. Ghadekar & R. K. Patil	Agromet Publisher, Nagpur-440 010
9.	Plant physiology*2010	Taiz & Zeiger, E	Sinaur asso.Inc,USA
Reference books:			
10.	Plant Physiology@	K. N. Dhumal, T. N. More and M. R. Munnali	Nirali prakashan, Pune
11.	Plant Physiology	Robert M. Devlin & Francis H. Witham	CBS Publisher & Distributors, Delhi-110 032
12.	Plant Physiology@	H. S. Shrivastava	Rustogi Publications, Meerut-250 002
13.	Plant physiology 2005@	S. Mukharji and A. K. Ghosh	New central book agency, Kolkatta
14.	Plant Physiology@1993	S. Chandra Datta	Wiley Eastern ltd, Daryaganj, N. Delhi
15.	Plant Physiology – fundamentals & applications @2005	Arvind kumar & S. S. Purohit	Agrobios (India), Jodhpur
16.	Modern Plant physiology 2007@	R. K. Sinha	Narosa publishing house, panchshil park, N. Delhi
17.	e-reading: http://ecourses.iasri.res.in/		

***Text book & practical book**

@Reference book

Course No. H/ECON-111

Course title: Economics and Marketing

Credits: (2+1) 3

Semester: I

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, Engil’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 or 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 – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agricultural produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management.

Practical

Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products. Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets.

LESSON PLAN

Lesson No.	UNIT- I	Weight ages
1 & 2	Economics:, Meaning -Definition : Adam smith, Marshall, Robbins Subject matter of Economics: Economic activities, (Wants, efforts , satisfaction), Traditional view & Modern view & approaches.	8
3 & 4	Basic Terms, Goods (Classification, types) utility – Meaning - forms of utility, value, wealth, and Price.	8
5 & 6	Consumption – Meaning, types of consumption, Engles law, Standard of living, factors affecting Standard. living, factors affecting consumption	4
7 & 8	Demand – Meaning, definition, kinds of demand, demand schedule, demand curve, Law of demand, exception to law of Demand, Extension and Contraction, increase decrease in demand.	5
9 & 10	Elasticity of demand – Meaning, types & methods of measurement	3

	of elasticity of demand (3 methods), factors affecting elasticity of demand	
11 & 12	Supply – Definition, Kinds of supply, Supply schedule, Law of Supply, Extension & Contraction of supply, Increase & decrease of supply, factors affecting supply.	5
13 & 14	Elasticity of supply – Meaning, elastic, inelastic supply, Measurement of elasticity of supply & its importance.	3
15	Production – Meaning, factors of production: Land, Labour, Capital & Management	3
16 & 17	National Income –Concepts of National Income: GNP, NNP,PI Methods of measurement of National Income its Importance.	8
18 & 19	Role of Horticulture in the National Income and GDP.	3
Lesson No.	UNIT- II	Weight ages
20 & 21	Market – Meaning, Definition, Marketing, meaning, definition, Role & scope of Marketing.	4
22 & 23, 24	Classification of Markets, Marketing functions and its Classification.	16
25 & 26	Marketing channels – Meaning, and types of marketing channels, price spread- meaning, marketing efficiency, constraints in marketing of Biotech Products.	16
27	Market intelligence- meaning and its importance	4
Lesson No.	UNIT- III	Weight ages
28	Project : Meaning, Definition, types of projects, project cycles	4
29 & 30	Basic guidelines for preparation of project proposals- Introduction, overview of project, project description, technical feasibility, commercial feasibility, cost estimates, finance (Requirement), financial feasibility, managerial aspects and project benefits. Bank norms, insurance – Definition, meaning, its importance	4
31 & 32	SWOT – Analysis- Horticultural projects, Crisis management- meaning, importance.	2
	Total	100

PRACTICAL EXCERISE

Ex No	Title of Exercise
1	Techno –economic parameters for preparation of Horticultural Projects
2	Preparation of Bankable proposal for Horticultural projects)
3	Preparation of Bankable proposal for Horticultural projects (Statements)

4	To study different- marketing channels for different Horticultural Products.
5	To study price spread and producer's share in consumer's rupee, marketing cost & margin for different Horticultural Products.
6	To study marketing cost & margin for different Horticultural Products.
7	To study the market structure
8	To study the market structure
9	Visit to various markets in the area
10	Visit to various markets in the area
11	Visit to different market institutions (NAFED, APMC)
12	Visit to different market institutions (Marketing Society)
13	To study SWC, CWC & STC institution (History, objectives, functions & reference)
14	To study price behavior of Horticultural Products
15	To study the Producer's Surplus for different Horticultural Products.
16	To study the Producer's Surplus for different Horticultural Products.

Suggested Reading

Reference books:

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

William 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.

Suggested Readings:

1. Elementary Economic Theory by K K Dewett and Varma
2. Modern Economic Theory by K K Dewett
3. Agricultural Economics by Reddy S S , Raghuram, P. Neel Kanta Shastri
4. Agricultural Finance and Management by S. Subba Reddy, P. Raghuram
5. Agricultural Marketing in India by S.S. Acharya, N.L. Agrawal
6. Agricultural Project Management by S D Barde, K G Karmakar

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/ECON-362**Course Title: Horti-Business Management****Credits: (2+0) 2****Semester: VI****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, economies 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. 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 of marketing. Financial management – financial statements and ratios, capital budgeting. Project management – project preparation evaluation measures.

LESSON PLAN

Lesson Plan- Theory:

Lecture No.	Details of Lecture	Weightages
1	Farm management - Definition, Nature, Characteristics of farm management, Farm management process, Scope i.e. farm management research, training and extension and Farm management decisions	5
2-4	Production function-Meaning, Types of production function (Continuous/Dis-continuous/ Short run/ Long run production function), Forms of production function (Graphic/Algebraic/Tabular). Factor-Product Relationships- Meaning, Types of factor product relationships (constant marginal rate of return/ Decreasing marginal rate of return/ Increasing marginal rate of return)	8
5	Technical Relationships : Relationship between Total, Average and Marginal Product, Three regions/stages of production function and its significance	4
6	Cost concept, Curves and Functions : Cost-meaning, categories of cost (fixed cost/variable cost/total cost), Relationship between total fixed cost, total variable cost and total cost, Relationship between average fixed cost, average variable cost, average total cost and marginal cost	5
7-10	Factor-Factor Relationship : Meaning, Iso-quant curve and its properties, Types of factor-factor relationship (Fix proportion combination of inputs /	6

	Constant rate of substitution/ Varying rates of substitution), Iso-cost line and its properties, Least-cost combination principle (Methods – Arithmetic/ Graphic/ Algebraic), Isocline, Expansion Path, Ridge line	
11-12	Product-Product Relationship: Meaning, Production possibility curve, Iso-revenue line and its characteristics, Basic relationship, Types of product-product relationship (Joint product enterprises, Complementary enterprises, Supplementary enterprises, Competitive enterprises).	6
13-14	Principles of farm management : <ol style="list-style-type: none"> 1. Laws of Returns or principle of variable proportions 2. Cost Principle 3. Principle of substitution between input 4. Equi-marginal principle or opportunity cost principle 5. Principle of substitution between product 6. Principle of comparative advantage 7. Principle underlying decision making involving time and uncertainty Economies of scale, Returns to scale	8
15	Time value of money : Compounding and Discounting	4
16	Cost of cultivation : Meaning, components, Standard cost concept- Cost A,B,C	4
17	Cost of production : Meaning, components, cost of production/quintal Break-even analysis : Meaning and measurement	4
18	Decision making under risk and uncertainty : Meaning and types	3
19-20	Farming System and Types : Specialized farming, Diversified farming, Mixed farming, Dry farming, Ranching Organization : Forms of business organization (Systems of farming) <ol style="list-style-type: none"> 1. Peasant farming 2. Co-operative farming 3. Capitalistic farming 4. Collective farming 5. State farming 	8
21-22	Planning : Meaning, Necessity of planning, Characteristics, Steps, Methods Types of plan – Simple farm plan and complete farm plan	4
23-24	Division of Labour Unity of command Scalar pattern, Job design, Span of control, Responsibility , Power, Authority and Accountability	2
25	Direction: Guiding, Leading, Motivating, Supervising Co-ordination: Meaning, Types, Methods of controlling Evaluation: Control systems and devices	2
26	Budgeting: Meaning, Types of farm budgeting- Partial or enterprise, total or complete budgeting	4

27-28	Record Keeping : Advantages of record keeping, Types of farm records- 1. Physical Farm Record- Production record, Labour record, Store register, feed record etc. 2. Financial Record- Farm inventory, farm financial accounts etc. 3. Supplementary Record- Sanction register, auction register etc.	6
29	Functional area of management: Operation management- Physical facilities, implementing the plan, scheduling the work, controlling production in term of quantity and quality	2
30	Material Management: Types of inventories, Inventory cost, Managing the inventory, Economic order quantity (EOQ)	2
31	Personnel Management: Recruitment, selection, Training, Job specification Marketing management Definition, Planning the marketing programme, Marketing mix, Four P's of marketing (Product/price/promotion/place)	6
32	Financial Management: Financial statement, Rations, Capital budgeting Project management Project definition, Aspects, Project cycle, Discounted and Undiscounted measures of project evaluation	7
	Total	100

Reference books:

- 1) Heady Earl O and Herald R. Jenson, 1954, *Farm Management Economics*. Prentice Hall, New Delhi
- 2) S.S. Johl, J.R. Kapur, 2006, *Fundamentals of Farm Business Management*. Kalyani Publishers, New Delhi
- 3) Karan Singh and Kahlon A S. *Economics of Farm Management in India*. Theory and Practice. New Delhi. Allied
- 4) L.M. Prasad. 2001. *Principles and Practices of Management*, 9th Ed. S. Chand & Sons, New Delhi.
- 5) Koontz Harold. *Principles of Management*. Tata McGraw-Hill Education Private Limited, New Delhi.
- 6) P.C. Thomas. *Managerial Economics*, 9th Ed. Kalyani Publishers.
- 7) K.K. Dewett and M.H. Navalur. *Modern Economic Theory*. S. Chand & Sons, New Delhi.
- 8) P. Subba Rao. *Human Resource Management*. Himalaya Publications.
- 9) S.P. Jain. *Financial Accounting*. Kalyani Publications, Ludhiana.
- 10) Shapiro E. *Macroeconomic analysis*. Galgotia Publications Delhi
- 11) Barry P J, Hopkins J A and Baker C B. *Financial Management in Agriculture*, 6th ed. Danville, IL Interstate Publishers.
- 12) Gittiner, J P., *Economic analysis of agricultural projects*. The John Hopkins University Press Baltimore, USA, 1982
- 13) Benjamin Mc Donald P 1985. *Investment Projects in Agriculture- Principles and Case studies*. Longman Group Limited. Essex. UK
- 14) Pandey U K 1990. *An Introduction to Agricultural Finance*. Kalyani Publishers New Delhi.

e-reading:<http://ecourses.iasri.res.in/>

Suggested Text Book for Reading:

Sr. No.	Name of Book	Author(s)	Publisher
1	Fundamental of farm Business Management	Johl S. S. and Kapur T. R.	Kalyani Publishers, New Delhi
2	Agricultural Economics	S. Subba Reddy <i>et al.</i>	Oxford & IBH, New Delhi.
3	Farm Management : An Economic Analyst	Dhondyal S. P.	Friends Publications, Merrut.
4	Economics of Farm management in India - Theory and Practices	Kahlon A. S. and Singh K.	Allied Publishers, New Delhi
5	Economics of Farm Production and Management	V.T.RAJU and D.V.S.RAO	Oxford & IBH, New Delhi.
6	Principles and Practices of Management	Rao, V.S.B, and P.S. Narayana	Konark Publishers Pvt. Ltd. New Delhi.
7	Principles and Practices of Management	Prasad, L.M	Sultan Chand and Sons Educational Publishers, New Delhi.
8	Agricultural Finance and Management	S. Subba Reddy and P. Raghuram	Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.

Course No. H/EXTN- 231
Credits :(1+1) 2

Course title: Fundamentals of Extension Education
Semester: III

Theory

- Education: Meaning, definition and types – Formal, informal and non formal education
- Extension Education- Meaning, definition, need, scope and process; history, objectives, philosophy, principles and approaches.
- Programmes of selected leading national and international horticultural institutes : Objectives and Salient achievements/ Major activities
 - Indian Institute of Horticultural Research
 - Indian Institute of Spices Research
 - Indian Institute of Vegetable Research
 - National Horticultural Board
 - Coconut Development Board
 - The Institute of Horticulture
 - The National Horticultural Forum
 - Central Institute of Subtropical Horticulture
- People's participation in Horticulture programmes : Meaning, importance and ways of participation
- Motivation : Meaning, definition, types, importance of motivation
- Rural Development: Meaning, definition, objectives and genesis.
- Transfer of technology programmes : Lab to Land programme (LLP), National Demonstration (ND), Front Line Demonstration (FLD), Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) of ICAR.
- Communication: Meaning and definition; elements, selected models and barriers to communication
- Extension Teaching Methods and Audio-Visual Aids : Meaning, definition, importance, classification, media mix strategies; Factors affecting selection and use of methods and aids
- Diffusion and adoption of innovation: Concept and meaning, Attributes of innovation, Innovation decision process, adopter categories.
- Teaching-Learning Process : Meaning and definition of teaching, learning, Learning experience and learning situation, elements of learning situation and its characteristics, Principles of learning and their implication for teaching
- Extension Programme Planning- Meaning, process, principles and steps in programme development
- Evaluation in Extension : Meaning, definition, types of evaluation, monitoring and evaluation
- Participatory Rural Appraisal (PRA) : Meaning, definition, scope and importance
- Extension administration and management: Meaning and concept, principles, functions and differences
- Capacity building of extension personnel and farmers : Meaning, Training and Education, Types of training, Training institutes in India, Concept of Human Resource Development
- Leader and Leadership: Meaning, definition, types of leaders, role of leaders in extension work.
- ICT in Extension education, ICT use in rural India.

Practical:

1. Visit to study structure, functions, linkages and extension programmes of voluntary organizations
2. Visit to study structure, functions, linkages and extension programmes of voluntary organizations Mahila Mandal
3. Visit to study structure, functions, linkages and extension programmes of voluntary organizations Village Panchayat
4. Visit to study structure, functions, linkages and extension programmes of voluntary organizations State Dept. of Horticulture
5. Visit to village to understand PRA techniques and their application in village development planning
6. Exercises on distortion of message
7. Script writing for farm broadcasts
8. Script writing for farm telecasts,
9. Planning, preparation and use of poster
10. Planning, preparation and use of chart
11. Planning, preparation and use of flash cards
12. Planning, preparation and use of OHP transparencies
13. Planning, preparation and use of power point slides.
14. Identification of local leaders to study their role in extension work.
15. Evaluation of some selected case studies of horticulture extension programmes.
16. Preparation of Village Agricultural production plan.

TEACHING SCHEDULE – Theory

Lecture	Topic	Weightage (%)
1	Education: Meaning, definition and types – Formal, informal and non formal education	5
2, 3	Extension Education- Meaning, definition, need, scope and process; history, objectives, philosophy, principles and approaches	5
4	Programmes of selected leading national and international horticultural institutes : Objectives and Salient achievements/ Major activities <ul style="list-style-type: none"> o Indian Institute of Horticultural Research o Indian Institute of Spices Research o Indian Institute of Vegetable Research o National Horticultural Board o Coconut Development Board o The Institute of Horticulture o The National Horticultural Forum o Central Institute of Subtropical Horticulture 	5
5	People's participation in Horticulture programmes : Meaning, importance and ways of participation	5
	Motivation : Meaning, definition, types, importance of motivation	5
6	Rural Development: Meaning, definition, objectives and genesis	5
7	Transfer of technology programmes : Lab to Land programme (LLP), National Demonstration (ND), Front Line Demonstration (FLD), Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) of ICAR	5
8	Communication: Meaning and definition; elements, selected models and barriers to communication	5
9	Extension Teaching Methods and Audio-Visual Aids : Meaning, definition, importance, classification, media mix strategies; Factors affecting selection and use of methods and aids	10
10	Diffusion and adoption of innovation: Concept and meaning, Attributes of innovation, Innovation decision process, adopter categories	5
11	Teaching-Learning Process : Meaning and definition of teaching, learning, Learning experience and learning situation, elements of learning situation and its characteristics, Principles of learning and their implication for teaching	10
12	Extension Programme Planning- Meaning, process, principles and steps in programme development	5
13	Evaluation in Extension : Meaning, definition, types of evaluation, monitoring and evaluation	5
14	Participatory Rural Appraisal (PRA) : Meaning, definition, scope and importance	5
	Extension administration and management: Meaning and concept, principles, functions and differences	5
15	Capacity building of extension personnel and farmers : Meaning, Training and Education, Types of training, Training institutes in India, Concept of Human Resource Development	5
16	Leader and Leadership: Meaning, definition, types of leaders, role of leaders in extension work	5
	ICT in Extension education, ICT use in rural India	5
	Total	100

TEACHING SCHEDULE –Practical

Practical	Topic
1	Visit to study structure, functions, linkages and extension programmes of voluntary organizations
2	Visit to study structure, functions, linkages and extension programmes of voluntary organizations Mahila Mandal
3	Visit to study structure, functions, linkages and extension programmes of voluntary organizations Village Panchayat
4	Visit to study structure, functions, linkages and extension programmes of voluntary organizations State Dept. of Horticulture
5	Visit to village to understand PRA techniques and their application in village development planning
6	Exercises on distortion of message
7	Script writing for farm broadcasts
8	Script writing for farm telecasts
9	Planning, preparation and use of poster
10	Planning, preparation and use of chart
11	Planning, preparation and use of flash cards
12	Planning, preparation and use of OHP transparencies
13	Planning, preparation and use of power point slides
14	Identification of local leaders to study their role in extension work
15	Evaluation of some selected case studies of horticulture extension programmes
16	Preparation of Village Agricultural production plan

Suggested Readings

Text books:

- Sandhu, A.S. (1993). Text book on Agricultural Communication : Process and Methods. Oxford and IBH Publishing Pvt. Ltd., New Delhi.

Reference books:

- Dahama, O.P. and Bhatnagar, O.P. (1980). Education and Communication for Development. Oxford and IBH Publication Co., New Delhi.
- Supe, S.V. (1997). An Introduction to Extension Education, Oxford and IBH Publication Co., New Delhi.
- Van den Ban, A.W. and Hawkins, H.S. (1996). Agricultural Extension. Blackwell Science, INC., Cambridge.
- Kelsey, L.D. and Hearne, G.C. (1963). Cooperative Extension Work, Comstar Publishing Associate, New York.
- Ray, G.L. (1991). Extension Communication and Management. Noya Prakash, Calcutta.
- Mosher, A.T. (1978). An Introduction to Agricultural Extension, ADC, New York.
- Singh, A.K., Lakhan Singh, R. and Roy Burman (2006). Dimensions of Agricultural Extension. Aman Publishing House, Meerut.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/EXTN-363

Course Title: Entrepreneurship Development and Business Management

Credits: (1+1) 2

Semester: VI

Theory

Entrepreneurship development

- Entrepreneur : Meaning, definitions, characteristics of entrepreneurship, Assessment of entrepreneurship skills, identifying potential entrepreneurs
- Entrepreneurship development – Concept of entrepreneurship, Process of entrepreneurship development,
- Achievement motivation and entrepreneurship development
- Generation, incubation and commercialization of business ideas and innovations
- SWOT analysis : Concept and technique
- Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs/SSIs)
- Supply chain management, Time management and Total quality management
- Market Survey : Meaning, objectives, methods of conducting survey
- Formulation of project, financial analysis of project
- Overview of horticulture industry characteristics of Indian horticultural processing and export industry.

Business Communication

- Communication – Meaning and process of communication
- Communication skills for entrepreneurship – Written communication, Verbal communication, Investigating and analyzing, Planning and Organizing, Negotiating and persuading, Cooperative (Team work), Leadership and Numeracy
- Developing different skills for entrepreneurship - Leadership Skills, Speaking Skills, Listening Skills, Organizational skill, Managerial skills, Problem solving skill,
- Writing Skill – Business letter, letters of enquiry, quotation, orders, and tenders, complaint letter
- Oral presentation skills – Preparation, presentation and evaluation
- Advertisements – Meaning, types, forms, functions

Practical

1. Assessing entrepreneur potential
2. Assessment of problem solving ability
3. Exercises in creativity
4. Conducting market survey to know the demands for different products
5. Preparing advertisements for popularization of products
6. News writing
7. Preparing project proposals
8. Individual and group presentations and evaluation of presentation and Telephonic conversation : Rate of speech, clarity of voice, speaking and listening politeness, telephonic etiquettes
9. Telephonic conversation
10. Conducting meeting – Purpose, procedure, participation, physical arrangements, recording and writing of minutes of meeting
11. Seminar and conferences : Use of body language
12. Conducting mock interviews – testing initiative, team spirit and leadership
13. Group discussion and debates on current topics
14. Visit to entrepreneurship institute/ case study of successful entrepreneurs
15. Presentations by the students

TEACHING SCHEDULE - Theory

Lecture	Topic	Weightage (%)
1	Entrepreneur : Meaning, definitions, characteristics of entrepreneurship	10
2	Assessment of entrepreneurship skills, identifying potential entrepreneurs	5
3	Entrepreneurship development – Concept of entrepreneurship, Process of entrepreneurship development	5
4	Achievement motivation and entrepreneurship development	5
5	Generation, incubation and commercialization of business ideas and innovations	5
6	SWOT analysis : Concept and technique	10
7	Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs/SSIs)	5
8	Supply chain management, Time management and Total quality management	5
9	Market Survey : Meaning, objectives, methods of conducting survey	10
10	Formulation of project, financial analysis of project	10
11	Communication – Meaning and process of communication	5
12	Communication skills for entrepreneurship – Written communication, Verbal communication, Investigating and analyzing, Planning and Organizing, Negotiating and persuading, Cooperative (Team work), Leadership and Numeracy	5
13	Developing different skills for entrepreneurship - Leadership Skills, Speaking Skills, Listening Skills, Organizational skill , Managerial skills, Problem solving skill	5
14	Writing Skill – Business letter, letters of enquiry, quotation, orders, and tenders, complaint letter	5
15	Oral presentation skills – Preparation, presentation and evaluation	5
16	Advertisements – Meaning, types, forms, functions	5
	Total	100

TEACHING SCHEDULE –Practical

Practical	Topic
1	Assessing entrepreneur potential
2	Assessment of problem solving ability
3	Exercises in creativity
4	Conducting market survey to know the demands for different products
5	Preparing advertisements for popularization of products and news writing
6	Preparing project proposals
7	Individual and group presentations and evaluation of presentation
8	Individual and group presentations and evaluation of presentation
9	Telephonic conversation : Rate of speech, clarity of voice, speaking and listening politeness, telephonic etiquettes
10	Conducting meeting – Purpose, procedure, participation, physical arrangements, recording and writing of minutes of meeting
11	Seminar and conferences : Use of body language
12	Conducting mock interviews – testing initiative, team spirit and leadership
13	Group discussion and debates on current topics
14	Visit to entrepreneurship institute/ case study of successful entrepreneurs
15	Presentations by the students
16	Presentations by the students

Suggested Readings:

Text books:

- Mondal Sagar and G.L.Ray (2009). Text Book of Entrepreneurship and Rural Development. Kalyani Publishers, Ludhiana. ISBN 978-81-272-5599-2

Reference books:

- Akhouri, M.M.P., Mishra, S.P. and Sengupta, Rita (1989). Trainers Manual on Developing Entrepreneurial Motivation, NIESBUD, New Delhi
- Betty, Gorddan B. (1979). Entrepreneurship, Playing to Win, Taraporewala, Mumbai
- Entrepreneurship Development Institute in India (1987). Developing New Entrepreneurs, EDII, Ahmedabad, NISIET, Library : 338.93/EDI/87/25104.
- Mancuso, Joseph (1974). The Entrepreneurs Handbook, Vol.I & II, Artech House Inc. USA.
- Patel, V.G. (1987). Entrepreneurship Development in India and its relevant Developing Countries, Entrepreneurship Development Institute of India, Ahmedabad, NISIET, Library : 338.93 (540)/PAT/87/25103.
- Singh, A.K., Lakhan Singh, R. and Roy Berman (2006). Dimensions of Agricultural Extension, Aman Publishing House, Meerut.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/HORT- 121

Course Title: Growth and Development of Horticultural Crops

Credits: (1+1) 2

Semester: II

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-climatic and non-climacteric fruits. Physiology of fruits under post-harvest storage.

Practical

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

Teaching Schedule:

Lecture No	Topics	Weightage (%)
1	Plant growth and development – definition, components of growth and phases of growth in Horticultural Crops	5
2	Different stages of growth and growth curve.	5
3	Growth analysis of Horticultural Crops, crop development and dynamics (case studies of annual/perennial Horticultural Crops)	5
4	Leaf area index (LAI), optimum LAI in Horticultural Crops and canopy development	5
5	Photosynthetic productivity – Photosynthetic efficiency of C ₃ and C ₄ plants.	5
6	Translocation of assimilates – theories of translocation of organic solute, source and sink relationship.	10
7-8	Plant bioregulators – Auxins, gibberellins, cytokinin, ethylene , inhibitors and retardants, basic functions & biosynthesis.	10
9	Role of bioregulators in growth and development.	5
10	Role of bioregulators in propagation and flowering, fruit setting. Fruit thinning, fruit development, fruit drop and fruit ripening.	10
11	Photoperiodism – long day, short day and day neutral plant and vernalization	5

	and its application in Horticultural Crops	
12	Physiology of flowering, factors affecting flowering.	5
13	Training and pruning, physiological basis of training and pruning.	5
14	Physiology of fruit growth and development, fruit setting, factors affecting fruit setting and development.	10
15	Physiology of ripening fruit, climacteric and non-climacteric fruit, Physiology of fruits under post-harvest storage.	5
16	Physiology of fruit growth and development, fruit setting, factors affecting fruit setting and development.	10
Total		100

Practical schedule:

Practical	Name/Title
1	Estimation of photosynthesis potential of hort. Crops by IRGA
2	Estimation of leaf area & leaf area index in hort. Crops
3	Studies on growth analysis- measurement of growth by using Arc indicator and auxanometer.
4	Measurement of growth by different growth analysis equations.
5	Determination of harvest index in different hort. Crops
6	Studies on preparation of hormonal solutions.
7	Identification and use of synthetic plant hormone and growth retardant, bioassay of plant hormone.
8	Studies on PGR in induction of rooting in cutting in hort. Crops.
9	Study of role of PGR in fruit ripening.
10	Study of role of PGR in control of flower drops.
11	Studies of important physiological disorder and their remedial measures in fruit & vegetables – I Macro elements
12	Studies of important physiological disorder and their remedial measures in fruit & vegetables –II- Microelements
13	Study of seed dormancy – causes and methods of breaking dormancy with chemicals & growth regulators,.
14	Study of seed viability testing
15	Study of germination – types of seed germination – factors affecting seed germination
16	Study of germination-methods of seed germination testing.

Text books:

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

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

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

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

Reference books:

Edward E. Durna. 2014. Principles Of Horticultural Physiology. CABI,

Lincoln Taiz and Eduards Zeiger (5th Edition). Plant physiology

Pandey and Sinha. 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

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/EXTN-352**Course Title: Communication Skills and Personality Development****Credits: (1+1) 2****Semester: V****Theory**

- Definition and Basics of Personality.
- Analyzing Strength and Weakness.
- Personality Development : Concept and Process
- Body Language – Meaning, Definition, Use of body language - Gesture, Posture, Eye contact, facial expression
- Preparation of Self -Introduction.
- Communication Skills: Listening, writing, speaking skills
- Communication Barriers; Overcoming these barriers.
- Building Self-Esteem and Self- Confidence.
- Attitudes: Meaning, Types - Assertive, Aggressive and Submissive; Positive, Negative, Neutral
- Introduction to Leadership; Leadership Styles; Group Dynamics.
- Team Building : Meaning, Steps
- Interpersonal Communication and Relationship; Use of verbal and non verbal communication
- Conflict Management: Introduction, Levels of Conflict and Managing Conflict.
- Time Management: Concept, Importance and Need, Steps towards better Time Management.
- Public Speaking: Introduction, Increasing Vocabulary, Voice Modulation, Social Graces
- Email and Telephone Etiquettes

Practicals

1. One-on-One Sessions for Individual Personality Traits
2. Role Play and Impromptu Conversation/Public Speaking Practice focusing on Body Language;
3. Vocabulary Practices: Developing a repertoire of words in various fields like Agriculture, Politics, Economics, Family, Personal Grooming etc.
4. Role Play for Self Introduction in the class;
5. Listening to recorded Short
6. Questionnaires for Building Self-Esteem and Self Confidence;
7. Case Studies based on Development of Attitudes;
8. Case Studies on Leadership Development;
9. Case Studies on Leadership Development;
10. Group Games, Ice breakers, Warm-ups and Energizers Team Building Activities
11. Practice of Non-Verbal Communication Skills: Dumb Charades and Dubsplash Practice;
12. Exercise on Mutually Acceptable Proximity; and Eye Contact;
13. Time Management Games to Practice and Experience the Importance of Planning / Delegating Work among them to properly manage time and complete the task in the shortest time possible;
14. Public Speaking Games: (Introducing a friend with his/her life style; Describing a funny image provided by the teacher; Continuing a Story starting with one student and others try to continue with it and try to complete it Take any object available and try to make a commercial for it;
15. Practice of Emails
16. Practice of Emails

TEACHING SCHEDULE - Theory

Lecture	Topic	Weightage (%)
1	Definition and Basics of Personality	5
2	Analyzing Strength and Weakness	5
3	Personality Development : Concept and Process	5
4	Body Language – Meaning, Definition, Use of body language - Gesture, Posture, Eye contact, facial expression	10
5	Preparation of Self -Introduction	5
6	Communication Skills: Listening, writing, speaking skills	10
7	Communication Barriers; Overcoming these barriers	5

8	Building Self-Esteem and Self- Confidence	5
9	Attitudes: Meaning, Types - Assertive, Aggressive and Submissive; Positive, Negative, Neutral	10
10	Introduction to Leadership; Leadership Styles; Group Dynamics	5
11	Team Building : Meaning, Steps	5
12	Interpersonal Communication and Relationship; Use of verbal and non verbal communication	10
13	Conflict Management: Introduction, Levels of Conflict and Managing Conflict	5
14	Time Management: Concept, Importance and Need, Steps towards better Time Management	5
15	Public Speaking: Introduction, Increasing Vocabulary, Voice Modulation, Social Graces	5
16	Email and Telephone Etiquettes	5
	Total	100

TEACHING SCHEDULE – Practical

Practical	Topic
1	One-on-One Sessions for Individual Personality Traits
2	Role Play and Impromptu Conversation/Public Speaking Practice focusing on Body Language
3	Vocabulary Practices: Developing a repertoire of words in various fields like Agriculture, Politics, Economics, Family, Personal Grooming etc
4	Role Play for Self Introduction in the class
5	Listening to recorded Shot
6	Questionnaires for Building Self-Esteem and Self Confidence
7	Case Studies based on Development of Attitudes
8	Case Studies on Leadership Development
9	Case Studies on Leadership Development
10	Group Games, Ice breakers, Warm-ups and Energizers Team Building Activities
11	Practice of Non-Verbal Communication Skills: Dumb Charades and Dubsplash Practice
12	Exercise on Mutually Acceptable Proximity; and Eye Contact
13	Time Management Games to Practice and Experience the Importance of Planning / Delegating Work among them to properly manage time and complete the task in the shortest time possible
14	Public Speaking Games: (Introducing a friend with his/her life style; Describing a funny image provided by the teacher; Continuing a Story starting with one student and others try to continue with it and try to complete it Take any object available and try to make a commercial for it
15	Practice of Emails
16	Presentations by the students

Text books:

Balasubramanian T. 1989. A Textbook of Phonetics for Indian Students. Orient Longman, New Delhi.

Reference books:

1. Balasubramanyam M. 1985. Business Communication. Vani Educational Books, New Delhi.
2. Naterop, Jean, B. and Rod Revell. 1997. Telephoning in English. Cambridge University Press, Cambridge.
3. Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.
4. Krishnaswamy, N and Sriraman, T. 1995. Current English for Colleges. Macmillan India Ltd. Madras.
5. Narayanaswamy V R. 1979. Strengthen your writing. Orient Longman, New Delhi.
6. Sharma R C and Krishna Mohan. 1978. Business Correspondence. Tata Mc Graw Hill publishing Company, New Delhi.
7. Carnegie, Dale. 2012. *How to Win Friends and Influence People in the Digital Age*. Simon & Schuster.

8. Covey Stephen R. 1989. *The Seven Habits of Highly Successful People*. Free Press.
 9. Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. *Human Communication: Motivation, Knowledge & Skills*. Wadsworth.
 10. Verma, KC. 2013. *The Art of Communication*. Kalpaz.
 11. Mamatha Bhatnagar and Nitin Bhatnagar. 2011. *Effective Communication and Soft Skills*. Person Education.
 12. Meenakshi Raman, Sangeeta Sharma. *Technical Communication Principles and Practice*
 13. Harold Wallace and Ann Masters. *Personality Development*. Cengage Publishers.
 14. Andrea J. Rutherford. *Basic Communication Skills for Technology*. Pearson Education.
 15. Carroll, B.J. 1986. *English for College*, Macmillan India Ltd. New Delhi
 16. Hahn, "The Internet complete reference", TMH
 17. Hornby, A.S. 1975. *Guide to patterns and usage in English*. Oxford University, New Delhi.
 18. Quirk, R and Green Baum, S 2002. *A University Grammar*
- e-reading:**<http://ecourses.iasri.res.in/>

Course No. H/MIBO-121

Course title: Introductory Microbiology

Credits: (1+1) 2

Semester: II

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-curve 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. 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 in large scale production and common microbial fermentations.

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 plants, turbid metric estimation of microbial growth, mushroom culture-Spawn production, Culture and production techniques, harvesting, packing and storage.

Theory : Teaching Schedule and weightages

Lecture No.	Topics	Weightages (Percent)
1	History and Scope of Microbiology	5
2	The discovery of micro-organism. Spontaneous generation conflict, germ theory of diseases	5
3	microbial effect on organic and inorganic matter.	5
4	Development of microbiology in India and composition of microbial world.	5
5	Microscopy and Specimen Preparation : The bright field microscope, fixation, dyes and	7
6	simple staining, differential staining.	8
7	Difference between prokaryotic and eukaryotic cells. Prokaryotic cell structure and functions.	8
8&9	Types of culture media and pre-curve techniques. Microbial growth in models of bacterial, yeast and mycelia growth curve.	10
10	Measurement of bacterial growth.	5
11	General properties of viruses and brief description of bacteriophages.	8

12	Antibiosis, symbiosis, intra-microbial and extra-microbial association.	8
13	Sterilization methods-Physical and chemical, Isolation of pure cultures and preservation of cultures	10
14&15	Beneficial microbes: Plant growth promoters and microbes used for Bio control.	8
16	Industrially important microorganisms in large scale production and common microbial fermentations	8
Total		100

Practical

Practical	Topics
1	Introduction and use of equipments used in microbiology laboratory.
2	Microscope and microscopy.
3	Structure, Morphology and methods of reproduction of bacteria.
4	Structure, morphology and methods of reproduction in fungi
5	Sterilization and methods of sterilization
6	Media used in culturing micro organisms and Preparation of Broth culture, agar slopes, streak plates and pour plants,
7	Preparation of Nutrient agar medium
8	Preparation of PDA.
9	Isolation of micro organisms by pore plate method
10	Isolation of micro organisms by dilution plate method
11	Stains and staining. Simple staining of bacteria
12	Gram staining of bacteria
13	Isolation of <i>Rhizobium</i> from root nodules.
14	Isolation of <i>Azotobacter</i> from soil.
15	Isolation of phosphate solubilizing micro organisms from soil
16	Maintenance and preservation of microbial cultures

Reference Books:

1. Microbiology –M.J.Pelzar , ECS. Chan and N.R.Krieg Fifth edition tata McGraw Hill Pub. Co.Ltd.
 2. Fundamentals of microbiology- Martin Frobisher 9 th edn W. B. Saunders Co. Ltd.
 3. Experiments in microbiology plant pathology and Bio Technology- K. R. Aneja 4th edn New Age international PVT LTD.
 4. Microbiology fundamentals and application- S.S. Purohit 7th edn
- e-reading:* <http://ecourses.iasri.res.in/>

Course No. H/IT-121**Course Title: Information and Communication Technology****Credits: (1+1) 2****Semester: II****Theroy**

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. Audio visual aids - definition, advantages, classification and choice of A.V aids; cone of experience and criteria for selection and evaluation of AV aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication.

Lesson/Course Plan-Theory

Lecture No.	Topic	Weightage (%)
1	IT and its importance, tools, services and their impact on society	8
2	Fundamentals of computer hardware and software.	8
3	Computer input and output devices;	8
4	Word and character representation	6
5	Features of machine language and their advantages and disadvantages;	4
6	Features of assembly language and their advantages and disadvantages	4
7	Features of high level language and their advantages and disadvantages	4
8	Principles of programming- algorithms and flowcharts	8
9	Operating systems (OS) - definition, basic concepts.	8
10	Types of OS i.e. Windows and Linux	8
11	Internet system such as Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP	8
12	Introduction to MS Office such as Word, Excel, Power Point	8
13	Audio visual aids - definition, advantages, classification and choice of A.V aids.	4
14	cone of experience and criteria for selection and evaluation of AV aids.	4
15	video conferencing	2
16	Communication process, Berlo' s model, feedback and barriers to communication.	8
	Total	100

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 fisheries data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

S.N.	Practical
1-2	Introduction of binary system
3-4	Analysis of Binary system using algorithms and flow chart
5-6	Introduction to MS Office
7-8	Introduction to internet and World Wide Web
9-10	Preparation of MS- Excel sheet using Fisheries data
11-12	Handling of Audio Visual equipments
13-14	Planning, Preparation and Presentation of Posters, Charts, Overhead transparencies and slides
15-16	Organisation of Audio Visual Programme.

Suggested Readings:

Reference books:

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.

e-reading: <http://ecourses.iasri.res.in/>

OTHER COURSES

OTHER COURSES

Course No. H/HORT-352

Course Title: Introductory Agro-forestry

Credit hours–(1+1) 2

Semester: V

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 agroforestry. Agroforestry projects – national, overseas, MPTS – their management practices, economics of cultivation – nursery and planting (*Acacia catechu*, *Dalbergia sissoo*, *Tectona*, *Populus*, *Morus*, *Grewia*, *Eucalyptus*, *Quercus* spp. and bamboo, tamarind, *Casurina equisittifolia*, neem etc.).

Practical- Identification and seeds and seedlings of multipurpose tree species. Nursery practices for (*Acacia catechu*, *Dalbergia sissoo*, *Tectona grandis*, *Morus alba*, *Grewia tiliaefolia*, *Eucalyptus* spp., and bamboo, *Tamarindus indica*, *Azadirachta indica* 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.

Lesson/Course plan-Theory

Lecture No.	Topic	Weightage (%)
1	Agroforestry– definition, objectives and potential.	8
2	Distinction between agroforestry and social forestry.	8
3-4	Status of Indian forests and role in Indian farming systems.	8
5	Agroforestry system, sub-system and practice: agri-silviculture, silvipastoral	8
6	Horti-silviculture, horti-silvipastoral	8
7	Shifting cultivation, taungya, home gardens, alley cropping, intercropping	8
8	Wind breaks, shelterbelts and energy plantations.	8
9-10	Planning for agroforestry – constraints, diagnosis and design methodology	8
11-12	Selection of tree crop species for agro-forestry.	8
13	Agroforestry projects – national, overseas	8
14-15	MPTS – their management practices, economics of cultivation – nursery and planting (<i>Acacia catechu</i> , <i>Dalbergia sissoo</i> , <i>Tectona grandis</i> , <i>Morus alba</i> , <i>Grewia tiliaefolia</i> , <i>Eucalyptus</i> spp. and bamboo, <i>Tamarindus indica</i> , <i>Azadirachta indica</i> , <i>Casurina equisittifolia</i> etc.).	15
16	Recommendations of Joint Agresco	5
	Total	100

Practical programme :

Practical No.	Topic
1	Identification of seeds and seedlings of multipurpose tree species.
2	Identification of seeds and seedlings of multipurpose tree species.
3	Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops
4	Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops
5	Visit to agro-forestry systems: silvipastoral, agro-silvipasture
6	Visit to agro-forestry systems: alley cropping, horti-silviculture
7	Visit to agro-forestry systems: fuel and fodder blocks
8	Visit to social forestry plantations–railway line plantations, canal plantations, roadside plantations
9	Visit to social forestry plantations – industrial plantations
10	Visit to social forestry plantations – shelterbelts
11	Rapid assessment of farmers needs for green manure, fodder, fuel wood in selected villages-I.
12	Rapid assessment of farmers needs for green manure, fodder, fuel wood in selected villages-II.
13	Economics and marketing of products raised in agro-forestry systems.
14	Nursery practices for <i>Acacia catechu</i> , <i>Dalbergia sissoo</i>
15	Nursery practices for <i>Tectona grandis</i> , <i>Eucalyptus</i> spp. <i>Morus alba</i> , <i>Grewia tiliaefolia</i>
16	Nursery practices for <i>Tamarindus indica</i> , <i>Azadirachta indic</i> , bamboo

Suggested Readings:**Text books:**

- Chundawat and S K Gautam.1996. *A text book of Agroforestry*. Oxford and IBH Publishing company Pvt.Ltd.

Reference Books:

- Chaturvedi,A.N.andKhanna,L.S.1982.*ForestlMenstruation*. Reprintedin2006.InternationalBookDistributors,Dehradun.
- Dadhwal et al., 2014. *Practical Manual on Agroforestry*. Jaya publishing house, Delhi.
- K. Patra, 2013. *Agroforestry – Principles and Practices*. New India publishing agency.
- L.K. Jha, 2015. *Advances in Agroforestry*. APH Publishing corporation, New Delhi.
- LedaSatish.2006. *BiodieselandJatrophaPlantations*. AGROBIOS,Jodhpur.
- Linford, Jenny, 2007. *A concise guide to Trees*. Parragon books service limited, Parragon.
- Luna,R.K.1989. *PlantationforestryinIndia*. InternationalBookDistributors,Dehradun.
- Negi, S.S., 2007. *Agroforestry Hand book*. International book distributor, New Delhi.
- Negi,S.S.2006. *ForestTreeSeed*. PrashantGahlotatValleyprintersandpublishers, Dehradun.
- P. Dwivedi, 1992. *Agroforestry – Principles and Practices*. Oxford and IBH Publishing company.
- 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.
- RamachandranNair,P.K.1993. *AnIntroductionto Agroforestry*. FirstreprintinIndia–2008. SpringerInternationalEdition

- Ramesh Umrani and C.K. Jain, 2010. *Agroforestry – Systems & Practices*. ABD Publishers, New Delhi.
 - Tejawani, K.G. 1994. *Agroforestry in India*. Oxford & IBH, Publishing Co. Pvt. Ltd., New Delhi.
- e-reading:* <http://ecourses.iasri.res.in/>

Course No. H/MAP -351**Course title- Medicinal and Aromatic Crops****Credit hours- (2+1) 3****Semester: V**

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. Storage techniques of essential oils. Medicinal Plants: *Withania*, periwinkle, Rauwolfia, Dioscorea, Isabgol, opium poppy *Ammi majus*, Belladonna, Cinchona, Pyrethrum Safed musli, Aloe vera, Paspimpali, Wild Brinjal, Arjun, Behada, Hirdaand other species relevant to local conditions. Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, menthe, Leman grass, Tikhadi, musk, occimum and other species relevant to the local conditions. Marketing.

Practical- Identification of Medicinal and Aromatic Plants 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.

Lesson/Course plan–Theory

Lecture No.	Topic	Weightage (%)
1-2	History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India.	8
3-6	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.	15
7-9	Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants.	8
10-11	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.	8
12-13	Therapeutic and pharmaceutical uses of important species. Storage techniques of essential oils. Medicinal plants and other species relevant to local conditions.	8
14-16	<i>Withania</i> , periwinkle, Safed musli, Arjun, Behada	8
17-19	Rauwolfia, dioscorea, Aloe vera	8
20-22	Isabgol, opium poppy, Paspimpali	8
23-25	<i>Ammi majus</i> , Belladonna, Wild Brinjal	8

26-28	Citronella grass, khus grass, Cinchona, Pyrethrum and Hirda	6
29-32	Aromatic plants flag (baje), lavender, geranium, patchouli, bursera, menthe, musk, occimum Leman grass, Tikhadi and other species relevant to the local conditions. Marketing.	15
Total		100

Practical programme:

Practical No.	Topic
1	Collection of medicinal and aromatic plants from their natural habitat.
2	Identification of Medicinal and Aromatic Plants.
3	Study of morphological description of medicinal and aromatic plants (Withania, periwinkle, Safed musli, Arjun, Behada, Rauwolfia, dioscorea, Aloe vera)
4	Study of morphological description of medicinal and aromatic plants (Isabgol, opium poppy, Paspimpali, Ammi majus, Belladonna, Wild Brinjal, Citronella grass, khus grass, Cinchona, Pyrethrum and Hirda)
5	Study of morphological description of medicinal and aromatic plants (flag (baje), lavender, geranium, patchouli, bursera, menthe, musk, occimum Leman grass, Tikhadi)
6	Nursery techniques in medicinal and aromatic plants.
7	Harvesting of medicinal and aromatic plants (Withania, periwinkle, Safed musli, Arjun, Behada, Rauwolfia, dioscorea, Aloe vera)
8	Harvesting of medicinal and aromatic plants ((Isabgol, opium poppy, Paspimpali, Ammi majus, Belladonna.)
9	Harvesting of medicinal and aromatic plants (Wild Brinjal, Citronella grass, khus grass, Cinchona, Pyrethrum and Hirda)
10	Harvesting of medicinal and aromatic plants (flag (baje), lavender, geranium, patchouli, bursera, menthe).
11	Harvesting of medicinal and aromatic plants (musk, occimum Leman grass, Tikhadi).
12	Curing and processing techniques of medicinal and aromatic plants.
13	Curing and processing techniques of medicinal and aromatic plants.
14	Curing and processing techniques of medicinal and aromatic plants.
15	Extraction of essential oils in medicinal and aromatic plants
16	Extraction of essential oils in medicinal and aromatic plants

Suggested Reading:**Reference Books:**

- Atal, E.K. and Kapur, B. 1982. Cultivation and Utilization of Medicinal and Aromatic plants. CSIR, New Delhi.
- Azhar Ali Farooqui and Sreeramu, B.S. 2001. Cultivation of medicinal and aromatic plants. United Press Limited.
- Chadha, K.L. ICAR, 2001. Hand Book of Horticulture. Directorate of Information and Publications of Agriculture, Pusa, New Delhi.
- Dastur, J.F. 1982. Medicinal plants of India Pakistan Taraprevala sons and co-private Ltd, Bombay.
- Jain, S.K. 1968. Medicinal Plants .National Book Trust New Delhi. Oxford & IBH, 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.

e-reading: <http://ecourses.iasri.res.in/>

Course No. H/AGRO-242**Course Title: Introduction to Major Field Crops****Credit hours - (1+1) 2****Semester: IV****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.

Theory		
Sr. No.	Topic	Weightages
1	Agronomy – Definition, scope and importance, it's relationship with other sciences, historical sketch of agronomy.	25
2	Agro-climatic zones of India and Maharashtra State. National and International Agricultural Research Organizations in India.	
3	Classification of Crops. Origin, geographic distribution, economic importance of <i>kharif</i> crops	
4	Selection of seed, different sowing methods.	
5	Tillage- objectives, classification and function of tillage.	
6	Cropping Scheme and Cropping System- different types of cropping system: intercropping, mixed cropping, intensive cropping, relay cropping, Alley cropping etc., definition and advantages with examples.	
7	Crop Rotation - objectives types and advantage.	
8	Classification of Manures and Fertilizers, Green Manuring.	
9-10	Cultivation of Cereals- Rice, Maize, Sorghum, Pearl millet and Minor millets	20
11-12	Cultivation of Pulses- Pigeon pea, Green gram, Black gram, Horse gram, Cowpea, Moth beans	20
13-14	Cultivation of Oilseeds – Ground nut, sunflower, Sesamum, Soyabean, Castor, Niger	15
15	Cultivation of Fibre crops – Cotton, Jute, Sunhemp, Dhaincha	15
16	Cultivation of Forage crops - Sorghum, Maize, Pearl millet, Cow pea, Napier, Rainfed and Irrigated Grasses	5
Practical		
Identification of crop plants, seeds and weeds. Preparation of cropping scheme. Application of herbicides in field crops.		
Practical :		
1	Identification of Field Crops and preparation of crop herbarium.	
2	Study of tillage implements and operations.	
3	Practice of field preparation, Seed bed preparation and sowing of <i>Kharif</i> crops.	

4	Rice nursery preparation, Practice of puddling and transplanting.
5	Study of seeding equipment's, Different methods of sowing.
6	Identification of manures, fertilizers and green manure crops.
7	Calculation of seed rate and fertilizers.
8	Effect of seed size on germination and seedling vigour of soybean / groundnut.
9	Effect of sowing depth on germination of different <i>Kharif</i> crops.
10	Study of inter-culture implements and practices, thinning and gap filling.
11	Identification of weeds in <i>Kharif</i> crops.
12	Practice of methods of fertilizer and Herbicide application.
13	Preparation of fertilizers mixture and spray solutions; Compost making.
14	Study of growth and yield contributing characters and yield estimation.
15	Participation in ongoing field operations. Study of crop varieties and important agronomic experiments.
16	Preparation of calendar of operations of different <i>Kharif</i> field crops.

Suggested Reading:

Reference books:

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.

e-reading: <http://ecourses.iasri.res.in/>

Course No. : H/AHDS-241
Credits :- (1+0)1

Title – Livestock Production & Management
Semester: IV

Theory

Importance of livestock in Horticulture Terminology used in livestock production and management Important breeds of cattle, buffalo, sheep, goat Feeding management and classification of feedstuffs. Principles of rationing Inter cropping of fodder crops under rainfed Horticulture Inter cropping of fodder crops under plantation crops Horti-pasture systems Horti silvi pasture systems Integrated farming systems Factors affecting quality and quantity of milk Methods of milking Clean and hygienic milk production

Lesson/ Theroy plan

Sr. No.	Topic to be covered	Contact hr.	Weightage %
1	Importance of livestock in Horticulture	1	9
2	Terminology used in livestock production and management	1	8
3	Important breeds of cattle	1	5
4	Important breeds of buffalo	1	5
5	Important breeds of sheep	1	5
6	Important breeds of goat	1	5
7	Feeding management and classification of feedstuffs.	1	9
8	Principles of rationing	1	8
9	Inter cropping of fodder crops under rainfed Horticulture	1	4
10	Inter cropping of fodder crops under plantation crops	1	4
11	Horti-pasture systems	1	8
12	Horti silvi pasture systems	1	7
13	Integrated farming systems	1	9
14	Factors affecting quality and quantity of milk	1	3.5
15	Methods of milking	1	3.5
16	Clean and hygienic milk production	1	7
Total			100

Suggested reading / references

Sr. No.	Name of Books	Author
Reference books:		
1	Farm Animal Management	NSR Shastri & C. K. Thomas
2	Sheep, Goat and Pig production and Management	Jagdish Prasad
3	Outline of Dairy Technology	Sukumar De
4	Crop Management and Integrated Farming	S. C. Panda
5	Fodder Production and Grassland Management for Veterinarians.	D. V. Reddy
6	Forage for Sustainable Livestock Production	N. Das, A. K. Misra, S. B. Maity
7	Livestock and poultry Production	Harban Singh and Moore, E. N. (1968)

8	Goat, Sheep and Pig Production and Management	Jagdish Prasad, (1996), Kalyani Publishers 1/1, Rajinder Nagar, Ludhiana
9	Text Book of Animal Husbandry	G. C. Banergee (1999), 9th ed Oxford and IBH Publishers, New Delhi.
10	Dairy Bovine Production	Thomas, C. K. and Sastri, N. S. R., Kalyani Publishers, 1/1, Rajinder Nagar, Ludhiana.
11	Text-Book of Buffalo Production	Ranjhan, S. K. and Pathak, N. N. (1979) Vikas, Publishing House Pvt. Ltd. 576, Masjid Road, Jangpura, New Delhi.

e-Books

Sr. No.	Name of Books	Author
1	Fertility Farming	Newman Turner
2	The farm as Ecosystem Tapping Natures Reservoir	Jemy Brunethi
3	Training Manual on Integrated Farming System	Sanjeev Kumar, Mrs Shivani, Bhagawati Prasad Bhatt and K. M. Singh

LESSION PLAN (Teaching Schedule)

Course No. : H/MATHS-111

Title :Mathematics (Deficiency Course)

Credits : (1 + 1) 2

Semester:I

Lecture No.	Topic	Topic/Topics to be covered in theory period	Book No.	Articles/Pag e No. (s)
1	Quadratic equation	Definition of quadratic equation factorization method, and Method of perfect square (Statement only) for solving quadratic equation. Nature of roots, sum and Product of roots	1	111,112,113, 114,115
2	Mensuration	Ordinates & common distance between them. Simpson's rule statement and its application for measuring areas of irregular field and other Illustrations.	6	98, 99, 100, 101, 102
3,4	Determinants	Definition of second order and third order determinants (Statements) minors, Expansion of determinant. Elementary Properties of determinant (Statement only)	1	486,487,488 489,490,491 492,493,494 495,
5	Circle	Definition of circle, radius, centre, Equation to circle, centre and radius form, General equation, its radius and centre (formulae only)	3	138, 140, 142 144
6,7	Function, Limit	Definition of function, Different types of functions, viz, Algebraic, Logarithmic, Trigonometric, Inverse, Exponential (Illustrations only), Definition of limits and continuity, theorems and standard limits (only statements),	4	1.51, 1.52, 1.53, 3.2, 3.21, 3.3, 3.53, 3.6
8,9	Theorems of differntiation, chain Rule, Differentiation of various types of function	Statements of Theorems of differentiations, Composite function, Chain Rule, Differentiation of algebraic function x, & n, and trigonometric function, Sinx and cosx, List of derivatives of logarithmic, exponential, other trigonometric, inverse trigonometric functions,	4	4,11, 4,12, 4,13, 4,21, 4,22, 4,31, 4,32, 4,33, 4,34

Book Recommended: 1. Higher Algebra - by Hall and Knight

2. Plane Trigonometry - 1 - by S.L. Loney

3. Coordinate Geometry - by S.L. Loney

4. Differential Calculus - Shanti Narayan

5. Integral Calculus - Shanti Narayan

6. Mensuration - I - by Pierpoint

e-reading: <http://ecourses.iasri.res.in/>

Deficiency course

Course No. BOT-111

Title -Introductory Biology

Credits : (1 + 1) 2

Semester:I

Theory

Diversity in living world, systematics- objectives of systematics, classification, taxonomy-taxonomic hierarchy and binomial nomenclature. Biological classification- Plant Kingdom viz., Monera, Protista, fungi, plantae and Animalia. Kingdom Plantae- Introduction and classification. Gymnosperms- Definition and classification. Angiosperms- Morphology and Reproduction of flowering plants. Cell- Plant and Animal cell, classification of cell, cell cycle and cell division. Biochemistry of cell-Introduction, chemical constituents of cell. Seed structure and composition- Introduction, major structure, different parts of seed, types of seed, structure of dicotyledonous (pea) and monocotyledonous seed (maize). Morphology of flowering plants- Introduction, parts of a typical flowering plants root, shoot and Inflorescences. Plant growth-Seed germination, characteristics of growth, phases of growth. Genetic basis of inheritance and Mendelian genetics. Photosynthesis- Definition and structure and function of chloroplast. Respiration-Definition and its mechanism. Biotechnology- Introduction, and its applications. Reproduction in plants-mode of reproduction.

Practical

Study of vegetative morphology of flowering plants. Study of Reproductive morphology of flowering plants. Preparation of stains and fixatives. Preparation of microscopic slides of Mitosis. Preparation of microscopic slides of Meiosis. Method of finding out the gametes and gametic recombination. Emasculation and dissection of flower.

Lecture No.	Topic	Weightage
1	Diversity in living world, systematics- objectives of systematics, classification, taxonomy- taxonomic hierarchy and binomial nomenclature.	08
2	Biological classification- Plant Kingdom viz., Monera, Protista, fungi, plantae and Animalia.	08
3	Kingdom Plantae- Introduction and classification.	05
4	Gymnosperms- Definition and classification	05
5	Angiosperms- Morphology and Reproduction of flowering plants.	08
6	Cell- Plant and Animal cell, classification of cell, cell cycle and cell division.	08
7	Biochemistry of cell-Introduction, chemical constituents of cell.	05
8	Seed structure and composition- Introduction, major structure, different parts of seed, types of seed, structure of dicotyledonous	08

	(pea)and monocotyledonous seed (maize)	
9	Morphology of flowering plants- Introduction, parts of a typical flowering plants root, shoot and Inflorescences.	10
10	Plant growth-Seed germination, characteristics of growth, phases of growth.	04
11	Genetic basis of inheritance and Mendelian genetics	05
12	DNA and RNA- as a genetic material.	04
13	Photosynthesis- Definition and structure and function of chloroplast.	05
14	Respiration-Definition and its mechanism.	08
15	Biotechnology- Introduction, and its applications.	05
16	Reproduction in plants-mode of reproduction.	04
	Total	100%

Exercise No.	Title of practical
1& 2	Study of vegetative morphology of flowering plants.
3 & 4	Study of Reproductive morphology of flowering plants.
5 & 6	Preparation of stains and fixatives.
7 & 8	Preparation of microscopic slides of Mitosis.
9 &10	Preparation of microscopic slides of Meiosis.
11 &12	Method of finding out the gametes and gametic recombination.
13&14	Emasculation and dissection of flowers/Hibiscus Sinensis.
15.	To demonstrate that the light is necessary for photosynthesis
16.	To demonstrate that oxygen is liberated in process of photosynthesis.

Suggested Reading:

1. Verma V. (2013) Botany. Ane's Student Edition, New Delhi, Ane Books Pvt. Ltd.
2. Dutta A. C. and Dutta T. C. (2014) Botany (For Degree Student) Oxford University Press, New Delhi.
3. Pandey S.N. and Sinha B. K. (1982). Plant Physiology. Vikas Publishing HousePvt. Ltd.
4. Singh B. D. (1990). Fundamentals of Genetics, Kalyani Publisher, Ludhiana.

Course No. H/PHYEDN-121
Credits: (0+1) 1

Title: Physical and Health Education
Semester II

Practical: -

Exercise No.	Topic	Weightages
1.	Introduction to physical education definition, objectives, scope, and importance; physical culture; Warming up - General Warming down - General	6
2.	Meaning and importance of Physical Fitness and Wellness; Physical fitness components -speed, strength, endurance, power, flexibility, agility, coordination and balance;	6
3.	Methods of Training; aerobic and anaerobic exercises;	6
4.	weight training, circuit training,	6
5.	Interval training, Fartlek training;	6
6.	Effects of Exercise on Muscular, Respiratory, Circulatory & Digestive systems	6
7.	Need and requirement of first aid.	6
8.	Yoga; Introduction to - Asanas,	7
9.	Yoga Introduction to Asanas	7
10.	Yoga Introduction to Pranayam	7
11.	Suryanamaskar	6
12.	Skill of Volleyball, Rules & Regulation	6
13.	Advance Skill of Volleyball, Specific Warming up	6
14.	Meditation	6
15.	Skill of Athletics, Short Distance running	7
16.	skill of Athletics Throwing events	6
	Total	100

Practical:

Introduction to physical education definition, objectives, scope, and importance; physical culture; Warming up - General Warming down – General, Meaning and importance of Physical Fitness and Wellness; Physical fitness components -speed, strength, endurance, power, flexibility, agility, coordination and balance; Methods of Training; aerobic and anaerobic exercises; weight training, circuit training, Interval training, Fartlek training; Effects of Exercise on Muscular, Respiratory, Circulatory & Digestive systems, Need and requirement of first aid., **Yoga; Introduction to - Asanas,(Practical NO.8& 9)** Ashtang Yoga Steps & meaning, (Yam,Niyam,Asan,Pranayam,Pratyahar, Dharana, Dhayhan Samadhi) Padmasan, Pavanmuktasan, pashchimottanasan, Dhanurasan, halasan, matsyasam, shalabhasan, bhujangasan, Matsyendrasan, Vakrasan, Uttanasan, Makavasan, Gomukhasan, Garudasan, Vrukshasan, Santulasan, Paadhastasan, Trikonasan, Vajrasan, Ushtrasan,

Chakrasan, Sarvangasan, Shavasana. **Yoga Introduction to Pranayam (Practical No.10)**
Suryabhadran, (Anulom vilom) Ujjayec, Shitkari, Shitali, Bhastrika, (Kapal bhati) Bhramari,
Omkar. Suryanamaskar, Skill of Volleyball, Rules & Regulation, Advance Skill of
Volleyball, Specific Warming up, Meditation, Skill of Athletics, Short Distance running, skill
of Athletics Throwing events.

Reference Books:

1. O.P. Aneja. Encyclopaedia of Physical education, sports and exercise science (4 volumes).
2. Anil Sharma. Encyclopaedia of Health and Physical Education (7 Volumes).
3. N V Chaudhery, R Jain. Encyclopedia of Yoga Health and Physical Education (7 Volumes).
4. Pintu Modak, O P Sharma, Deepak Jain. Encyclopaedia of Sports and Games with latest rules and regulations (8 volumes).
5. Edwin F Bryant. Yoga sutra of Patanjali.
6. Physical Education And Recreational Activities, Deepak Jain Year of Pub.: 2011
7. Dimensions Of Physical Education, Anil Sharma Year of Pub.: 2011
8. Physical Fitness, Vijaya Lakshmi Year of Pub.: 2005
9. Research Process In Physical Education And Sports: An Introduction by K. G. Jadhav / Sachin B. Pagare / Sinku Kumar Singh Year of Pub.: 2011
10. Sports Training And Biomechanics In Physical Education, Sinku Kumar Singh Year of Pub.: 2011
11. Test, Measurement and Evaluation in Physical Education, P. L. Karad Year of Pub.: 2011
12. Foundations of Physical Education, Exercise Science, and Sport, Deborah A. Wuest, Charles A. Bucher

Marking System for All Agriculture Disciplines. - (Total 100 Marks)

1. Manual	-	20 Marks
2. Asanas	-	20 Marks
3. Physical Fitness Test	-	20 Marks
4. Games Skills	-	20 Marks
5. Presence	-	20 Marks

Course No. H/NSS/NCC-111

Course Title: National Service Scheme/
National Cadetcorps

Credits: (0+1) 1

Semester I

Practical-

Exercise No.	Topic	Weightages
1.	<u>Introduction and basic components of NSS: Orientation: history, objectives, principles, symbol, badge; regular programmes under NSS, organizational structure of NSS,</u>	7
2.	<u>Code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health</u>	7
3.	<u>NSS programmes and activities</u> Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey,	7
4.	Analysing guiding financial patterns of scheme, youth programme/ schemes of GOI,	7
5.	Coordination with different agencies and maintenance of diary	6
6.	<u>Understanding youth</u> Definition, profile, categories, issues and challenges of youth;	6
7.	Opportunities for youth who is agent of the social change	6
8.	<u>Community mobilisation</u> Mapping of community stakeholders, designing the message as per problems and their culture;	6
9.	Identifying methods of mobilisation involving youth-adult partnership	6
10.	<u>Social harmony and national integration</u> Indian history and culture,	6
11.	Role of youth in nation building, conflict resolution and peace-building	6
12.	<u>Volunteerism and shramdan</u> Indian tradition of volunteerism, its need, importance, motivation and constraints;	6
13.	Shramdan as part of volunteerism	6
14.	<u>Citizenship, constitution and human rights</u> Basic features of constitution of India, fundamental rights and duties,	6
15.	Human rights, consumer awareness and rights and rights to information	6
16.	<u>Family and society</u> Concept of family, community (PRIs and other community based organisations) and society	6
	Total	100

National Cadet corps (NC)

Practical NCC: Introduction to NCC, defense services, system of NCC training, 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.

Reference books :-

1. National Service Scheme: A Report, by Khwaja Ghulam Saiyidain. Published by Ministry of Education, Govt. of India, 1961.
2. Training and consultancy needs in national service scheme, by N. F. Kaikobad, Krishan K. Kapil. Published by Tata Institute of Social Sciences, 1971.
3. National Service Scheme: guide-lines to project-masters, by Andhra University, Dept. of Sociology & Social Work. Published by Dept. of Sociology & Social Work, Andhra University, 1971.
4. National Service Scheme in Gujarat: An Evaluation Report for the Year 1986-87, by Tata Institute of Social Sciences Training Orientation & Research Centre (NSS), India, India. Dept. of Youth Affairs and Sports. Published by The Centre, 1987.
5. National Service Scheme in Maharashtra: An Evaluation Report for the Year 1986-87, by Tata Institute of Social Sciences Training Orientation & Research Centre (NSS), India, India Dept. of Youth Affairs and Sports. Published by The Centre, 1988.
6. National Service Scheme in India: A Case Study of Karnataka, by M. B. Dilshad. Published by Trust Publications, 2001.

Course No. H/DEG-111

Course Title: Democracy, Elections and Good Governance

Credits: (1+0) 1

Semester I

Syllabus

Theory

Unit No. 1

Democracy – Introduction meaning, classification, Principles of Democracy, Dimensions of democracy, Democracy and Diversity Decentralization : concept, features, Fundamental Rights in the Indian Constitution, Outcomes of Democracy and Challenges of Democracy

Unit No. 2

Independent Election Commission in India powers of election commission in India, Elections to local self Government Bodies, National level, State level, Institutions at the local level Municipal Cooperation, Municipal Council Nagar Panchayat, Zilla Parishad, Panchayat Samiti, Gram Panchayat : powers duties, Constitutional Provision of 73 & 74 constitutional Amendment Act and Important features of 73 & 74 Constitutional Amendment Act

Unit No. 3

Good Governance : Concept, meaning, Government & Good Governance, , Good Governance and India, Nature of G.G. in India, Attributes of Poor Governance and Steps taken for Good Governance in India.

Teaching Schedule (Theory)

Lecture	Topic	Weightage (%)
1	Democracy – Introduction meaning, classification	4
2	Principles of Democracy, Dimensions of democracy	6
3	Democracy and Diversity Decentralization : concept, features,	6
4	Fundamental Rights in the Indian Constitution	10
5	Outcomes of Democracy, Challenges of Democracy	5
6	Independent Election Commission in India powers of election commission in India	8
7	Elections to local self-Government Bodies, National level, State level	8
8	Institutions at the local level Municipal Cooperation, Municipal Council Nagar Panchayat	8
9 & 10	Zilla Parishad, Panchayat Samiti, Gram Panchayat : powers duties	10

11	Constitutional Provision of 73 & 74 constitutional Amendment Act	5
Lecture	Topic	Weightage (%)
12	Important features of 73 & 74 Constitutional Amendment Act	5
13	Good Governance : Concept, meaning	5
14	Government & Good Governance, , Good Governance and India, Nature of G.G. in India	5
15	Attributes of Poor Governance	5
16	Steps taken for Good Governance in India	10
	Total	100

Suggested Readings:

- 1) Development and Democracy in India by Shailendra D Dharma, Publication : Publisher: Lynne Rienner, Boulder. Year: 2002
- 2) The Constitution of India, by P. M. Bakshi. Publication: Universal Law Publishing. Edn.: 14th, Year :2017

**Rural Horticulture Work
Experience and Experiential
Learning Programme**

Placement in Industry

Nursery Production & Management

Sr.No.	Course No	Course Title	Credits
1	IND (H)-472	Nursery Production	0 + 5 = 5
2	IND (H)-473	Economics of Horticultural crops.	0 + 1 = 1
3	IND (H)-474	Extension education & Rural Sociology	0 + 1 = 1
4	IND (H)-475	Integrated Pest and disease Management.	0 + 2 = 2
5	IND (H)-476	Soil test & Integrated Nutrient Management	0 + 1 = 1
		Total	0 + 10 = 10

Sr. No.	Particulars	Department	Weightage (%)
1.	Survey of Agro Based Industries in the region	Horticulture, Agril. Economics, Extension Education	4
2.	Selection of Agro Based Industry	Horticulture, Agril. Economics, Extension Education	4
3.	Features and general information of selected Agro Based Industry	Horticulture, Agril. Economics	3
4.	Documentations Required and procedure for establishment of selected Agro Based Industry/Unit	Horticulture	4
5.	Management system and Process in selected Agro Based Industry/Unit	Horticulture, Agril. Economics and other related fields	5
6.	Identification of critical management areas in selected Agro Based Industry/Unit	Horticulture, Agril. Economics and other related fields	5
7.	Human Resource Planning: Forecasting Inventorying, Anticipating Planning, Job analysis.	Horticulture, Agril.	5

	Human Resource Acquisition: Recruitment, Selection, Placement, Induction, Socialization. Human Resource Development: Training, Career Management, Monitoring and Performance coaching, Team building, Compensation Strategy and Award management, industrial relation	Economics, Extension Education, Agril. Entomology, Agril. Chemistry and Soil Science, Agril. Botany and other related fields	
8.	Resource use management in Agro Based Industry/Unit. Raw materials, capital, man power, machinery and equipment, energy, site.	Horticulture and other related fields	5
9.	Process flow-chart, Technical Aspects	Horticulture, Agril. Engineering	5
10.	Inventory management in selected Agro Based Industry/Unit. Raw materials, work in process, finished product. Inventory account and control.	Horticulture, Agril. Engineering	5
11.	Total quality management in selected Agro Based Industry/Unit. Operation management, Quality improvement, Quality assurance, Quality policy	Horticulture, Agril. Engineering	5
12.	Marketing management in selected Agro Based Industry. Marketing function management: Assembling, Transportation, packaging, storage, sale promotion, distribution. Marketing mix strategy: Product strategy, pricing strategy, distribution strategy, communication strategy.	Horticulture, Agril. Economics, Extension Education,	15
13.	Supply chain management in selected agro based industry: procurement, management, distribution management	Horticulture, Agril. Economics,	5
14.	Estimation of Cost of Production of selected agro based industry: Total Variable Cost: Raw Material Cost, Fuel Cost, Labour Cost, Transportation Cost, Packing cost, other (Light bill, stationary etc.). Total fixed cost: Land rent, Depreciation, Interest on fixed capital, Total cost= Total Variable Cost+ Total fixed cost B:C ratio, liquidity ratio, turnover ratio, profitability ratio	Horticulture, Agril. Economics,	10
15.	Financial Management of selected agro based industry Sources of funds, allocation of funds, financial feasibility, Break-Even Analysis	Horticulture, Agril. Economics,	10
16.	SWOT Analysis of selected Agro Based Industry/Unit- Strength, Weakness, Opportunities	Horticulture, Agril.	5

	and Threats	Economics, Extension Education and other related fields	
17.	Summary and Conclusion	Horticulture and other related fields	5
	Total		100

STUDENTS READY PROGRAMME

Experiential Learning Modules in Horticulture for B.Sc. (Hort.)

1. Objectives

- To develop skill in producing quality planting material of fruit and ornamentals crops
- Commercial production of vegetables
- Demand base large-scale production of cut flowers, cut greens and vegetables
- To acquire skills in Post-harvest management and value addition of fruits and vegetables
- To develop competence, capability, capacity building, acquiring skills, expertise and built up confidence among the students to start their own enterprise and turn job creators instead of job seekers.

2. Justification

The term READY refers to “Rural Entrepreneurship Awareness Development Yojana” has been proposed by V Dean’s Committee to reorient the agricultural graduates for ensuring and assuring employability and develop entrepreneurs for emerging knowledge in the field of horticulture. Horticulture has become a key driver for economic development in many states of the country but one of the constraints is availability of planting material, poor yields and low productivity, wider year to year fluctuations and poor quality of produce. The use of low grade and poor quality planting materials is one of the major causes for low productivity. This warrants proper planning to increase production and productivity for which trained skilled human resources development in the field of horticulture are the prime needs of the hour. Through experiential learning programme on commercial horticulture to develop competence, capability, capacity building, acquiring skills, expertise and built up confidence among the students to start their own enterprise and turn job creators instead of job seekers. The students will produce quality planting material of fruits, vegetables, ornamentals, cut flowers and processed products of fruits and vegetables.

3. Activity components

- a. Survey and risk assessment
- b. Sourcing for inputs
- c. Production plan
- d. Production and quality control
- e. Saleable produce
- f. Packaging & marketing
- g. Financial accounting
- h. Profits

4. Project development

- i) Demand assessment :To be obtained from concerned state Horticulture/ Agriculture departments, market need assessment, hostel mess in nearby area, consumers, housing societies,
- ii) Sourcing of Inputs :Planting material of fruits, vegetables and flowers, manures, agrochemicals, fertilizers, raw material, etc.
- iii) Type of products : Nursery plants, vegetables, flowers.
- iv) Action plan :Production of nursery plants, vegetables, flowers.
- v) Funding agencies :ICAR/SAU
- vi) Marketing :Housing societies, hotels, local market, college counter, college mess, sale units etc.
- vii) Financial accounting :

5. Faculty responsibilities

- Orientation – introduction, objectives
- Procurement of inputs
- Monitoring, assessment and evaluation
- Arrangement of guest lectures and expert entrepreneurs
- Supervision of production and marketing

6. Evaluation of Experiential Learning Programme

Sl.No.	Parameters	Max. Marks
1.	Project Planning and Writing	10
2.	Presentation	10
3.	Regularity	10
4.	Monthly Assessment	10
5.	Output delivery	10
6.	Technical Skill Development	10
7.	Entrepreneurship Skills	10
8.	Business networking skills	10
9.	Report writing skills	10
10.	Final Presentation	10
	Total	100

OR

Sr. No.	Parameters	Max. Marks
1	Attendance	10
2	Daily diary	10

Syllabus

1. Course No. HORT EL-481/1

Title: Nursery Management of Horticultural Crops

Credits: 0+10=10

Sr. No.	Topics	Discipline
1	Importance and scope present status of Horticulture nurseries – in Maharashtra and India.	Horticulture
2	Nursery Act- Legislation/rules, regulation, producer of obtaining license.	Horticulture
3	Planning and layout of nursery	Horticulture
4	Maintenance of mother orchards.	Horticulture
5	Procurement/preparation of scion material of commercially important varieties Horticulture crops.	Horticulture
6	Selection and raising of roots stocks	Horticulture
7	Commercial production of rooted cutting, grafts, layers, seed, bulbs corns, etc. of Horticultural crops.	Horticulture
8	Selection and preparation of scion material of commercially important Horticultural crops	Horticulture
9	Selection and raising of rootstock for different Horticultural Crops.	Horticulture
10	Raising seedlings: vegetable, flower, fruit and ornamental plants.	Horticulture
11	Propagation by cutting of fruits, flowers and ornamental plants	Horticulture
12	Propagation by grafting, layering and budding viz. fruit and flower crops.	Horticulture
13	After care nursery plants, viz; watering, nutrient management, use of plant growth regulators and protection against adverse climate.	Horticulture
14	Disease management	Pathology
15	Pest management	Entomology
16	Estimation of cost of production of nursery plants. Entrepreneurship development in nursery, marketing of nursery plants	Economics
17	Visit to different plant nursery unit/Industry.	Horticulture
18	Report writing.	Horticulture
Note-Quantity of the planting materials to be prepared on commercial basis		

2. Course No. HORT EL-481/2

Title: Vegetable Production

Credits: 0+10=10

Sr. No.	Topics	Discipline
	Production technology of vegetables a. Fruit vegetables: Chilli, brinjal, okra, capsicum etc b. Cole crops: Cabbage ,cauliflower etc c. Cucurbits: Cucumber, bottle gourd, bitter gourd, ridge gourd, water melon, musk melon etc d. Bulb and root crops: Onion, carrot, radish etc e. Peas and beans: cluster bean, french bean, garden pea, cowpea etc f. Leafy vegetables: Fenugreek, palak, shepu, coriander, amaranthus etc	Horticulture
1	Nursery bed preparation and seed treatment, sowing and after care	Horticulture
2	Preparation of main field and layout	Horticulture
3	Seedling treatment and transplanting	Horticulture
4	Weed management and mulching	Horticulture
5	After care, irrigation and nutrition management	Horticulture
6	Intercultural operations	Horticulture
7	Special horticultural practices	Horticulture
8	Application of bio-regulators	Horticulture
9	Disease management	Pathology
10	Pest management	Entomology
11	Harvesting, grading, packing, transport and marketing	Horticulture
12	Survey of domestic and market channels for vegetables	Economics
13	Estimation of cost of production and marketing of vegetables	Economics
14	Visit to commercial vegetable farms	Horticulture
Note: Area for each crop should be 5 R as group activity of five students		

3. Course No. HORT EL-482

Title: Protected Cultivation of high value horticultural crops

Credits: 0+10=10

Sr. No.	Topics	Discipline
1	Important, scope and constraints for protected cultivation	Horticulture
2	Site of selection and preparation of site for green house erection	Agril. Engg.
3	Different types of green-houses/shadenet houses and cladding materials	Agril. Engg.
4	Climatic control devices	Horticulture
5	Preparation of media, sterilization and bed preparation	Horticulture
7	Irrigation and fertigation	Agril. Engg.
8	Production technology of vegetables - Capsicum Cucumber, gourds, melons and tomato	Horticulture
9	Production technology of cut flower crops- Rose, Carnation, Chrysanthemum, Orchids and Gerbera	Horticulture
10	Disease management	Pathology
11	Pest management	Entomology
12	Harvesting, pre-cooling, grading, packing, transport and marketing of vegetables and flowers	Horticulture
13	Market study, economics of production, cost benefit ratio of above mentioned vegetables and flowers	Economics
14	Visit to commercial green house/shade net projects	Horticulture
15	Govt. /NHB scheme, finance and insurance for protected cultivation.	Horticulture
Note: Area for each crop should be 5 R as group activity of Five students		

4. Course No. HORT EL-483

Title: Processing of fruits and Vegetables for value addition

Credits: 0+10=10

Sr. No.	Topics	Discipline
1	Current status and importance of post-harvest technology and value addition of fruits and vegetables	Horticulture
2	Site selection and layout for post harvest unit.	Horticulture
3	Sorting, grading and packaging house for fruit/vegetables.	Horticulture
4	Identification and use of tools and equipments for post harvest handling and processing	Horticulture
5	Quality standards and procurement of fruits and vegetables packaging of fruits and vegetables	Horticulture
6	Minimal processing	Horticulture
7	Processing of aonla- candy, supari and powder	Horticulture
8	Processing of banana	Horticulture
9	Processing of dried flakes and powder	Horticulture
10	Drying of flowers	Horticulture
11	Flower bouquets and garlands	Horticulture
12	Quality evaluation and spoilage of processed products	Biochemistry and microbiology
13	Working out economics of preparation of products	Economics
14	Marketing of minimally processed and processed products	Economics
15	Visit to commercial processing units.	Horticulture
16	Govt. /NHB scheme, finance and insurance for processing units.	Horticulture
17	Project report	Horticulture
Note-Quantity of the products to be prepared on commercial basis		

5. Course No. HORT EL-484

Title: Floriculture and Landscape architecture

Credits: 0+10=10

Sr. No.	Topics	Discipline
1	Current status, importance, constraints/ problems of floriculture and landscape architecture	Horticulture
2	Production technology of major flower crops	Horticulture
	Marigold	
	Aster	
	Tuberose	
	Gladiolus	
	Chrysanthemum	
	Gaillardia	
3	Special horticulture practices	Horticulture
4	Harvesting, grading, packing and marketing of flowers	
5	Working out economics of production of major flower crops	Economics
6	Production technology of ornamental plants, climbers, creepers, shrubs, trees, annuals, bulbs, cacti, succulents, palms and bonsai	Horticulture
7	Identification of climbers, shrubs, annuals, trees, bulbous plants, cacti, succulents and palms	Horticulture
8	Training and pruning of climbers, shrubs, trees, staking, pinching and bending, etc.	Horticulture
9	Preparation of bonsai, and flower arrangement	Horticulture
10	Principles of garden design, type of garden, lawn making and its management,	Horticulture
11	Garden features and adornments	Horticulture
12	Utility of trees, shrubs, palms, cycads, climbers in garden and placement in landscape design	Horticulture
13	Layout plans of gardens for different places,	Horticulture
14	Indoor gardening, planning and ecotourism	Horticulture
15	Selection of ornamental plants	Horticulture
16	Landscaping of road side, road divider, railway lines, private buildings, hostels	Horticulture
17	Garden tools and implements, garden features	Horticulture
18	Nursery techniques for different species used for landscaping	Horticulture
19	Visit to public parks, garden and nurseries	Horticulture
20	Pest management	Entomology
21	Disease management	Pathology

