Department of Agronomy
Mahatma Phule Krishi Vidyapeeth
Rahuri-413 722, Dist. Ahmednagar (MS)

Doctoral Programme in Agronomy

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	15
2.	Minor	08
3.	Supporting	05
4.	Seminar	02
5.	Research	45
	Total Credits	**75**
	Compulsory Non Credit Courses	06 *If these course completed in M. Sc Degree no need to take this courses for Ph D degree

Sr. No.	Course Number	Course Title	Credits
A) Major subjects (Min.15 credits)			
1.	AGRON 601	Current Trends in Agronomy	3+0=3
2.	AGRON 602	Crop Ecology	2+0=2
3.	AGRON 604	Advances in Crop Growth And Productivity	2+1=3
4.	AGRON 605	Irrigation Management	2+1=3
5.	AGRON 606	Advances in Weed Management	2+0=2
6.	AGRON 607	Integrated Farming Systems	2+0=2
7.	AGRON 608	Soil Conservation and Watershed Management	2+1=3
B) Minor Subjects (Min.08 credits)			
1.	Soil.601	Advances in Soil Physics	2+0=2
2.	PP.605	Climate Change and Crop Growth	2+0=2
3.	PP.607	Weed Physiology and Herbicide Action	1+1=2
4.	SST.601	Hybrid Seed Production	1+1=2
C) Supporting Subjects (Min. 05 credits)			
1	Soils.603	Physical Chemistry of Soils	2+0=2
2	Soils.602	Advances in Soil Fertility	2+0=2

3	Soils.606	Land Use Planning and Watershed Management	2+0=2
D) Seminar (02 credit)			
		Seminar-I	0+1=1
		Seminar-II	0+1=1
E) Doctoral Research (45 credits)			
		Doctoral Research	0+45=45
F) Non Credit Compulsory Courses			
1.	PGS 501	Library and Information Services	0+1=1
2.	PGS 504	Basic Concepts in Laboratory Techniques	0+1=1
3.	PGS 502	Technical Writing and Communication Skills	0+1=1
4.	PGS 503	Intellectual Property and its Management in Agriculture	1+0=1
5.	PGS 505	Agricultural Research Ethics and Rural Development Programmes	1+0=1
6.	PGS 506	Disaster Management	1+0=1

Course Contents

Major Subjects

COURSE NO - AGRON 601
COURSE TITLE: CURRENT TRENDS IN AGRONOMY
(3+0=3)

Theory

UNIT I
Agro-physiological basis of variation in yield, recent advances in soil-plant-water relationship.

UNIT II
Globalization of agriculture and WTO, precision agriculture, contract farming, organic farming, marketing and export potential of organic products, certification, labeling and accreditation procedures.

UNIT III
Crop residue management in multiple cropping systems; latest developments in plant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy.

UNIT IV
GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

UNIT V
Concepts of system agriculture; holistic approach of farming systems, dryland farming, sustainable agriculture and research methodology in Agronomy.

Suggested Readings:

Agarwal RL. 1995. Seed Technology. Oxford & IBH Publ.
Dahiya BS & Rai KN. 1997. Seed Technology. Kalyani Publ..
Govardhan V. 2000. Remote Sensing and Water Management in Command Areas: Agroecological Prospective. IBDC.
ICAR. 2006. Hand Book of Agriculture. ICAR Publ.
Narasaiah ML. 2004. World Trade Organization and Agriculture. Sonali Publ.
Palaniappan SP & Annadurai K. 2006. Organic Farming – Theory and Practice. Scientific Publ.
Sen S & Ghosh N. 1999. Seed Science and Technology. Kalyani Publ..
Tarafdar JC, Tripathi KP & Mahesh Kumar 2007. Organic Agriculture. Scientific Publ.

COURSE NO - AGRON 601
COURSE TITLE: CURRENT TRENDS IN AGRONOMY
(3+0=3)

Theory: Teaching Schedule

Sr. No.	Lecture No.	Topics to be Covered	Weightage (%)
1	1-3	Agro-physiological basis of variation in yield	7
2	4-6	Recent advances in soil plant-water relationship	6
3	7-9	Globalization of agriculture and WTO	4
4	10-12	Precision agriculture	6
5	13-15	Contract farming, organic farming	6
6	16-18	Marketing and export potential of organic products	5
7	19-21	Certification, labelling and accreditation procedures	5
8	22-24	Crop residue management in multiple cropping system	7
9	25-27	Latest developments in plant management, weed management, cropping systems, grassland management, agro-forestry, allelopathy	7
10	28-30	GIS, GPS and remote, sensing for crop management, global warming	7
11	31-33	GM crops, seed production technology	7
12	34-36	Seed certification, seed multiplication, hybrid seed production etc	6
13	37-39	Concepts of system agriculture	7
14	40-42	Holistic approach of farming systems	7
15	43-45	Dryland farming	7
16	46	Sustainable agriculture and research methodology in Agronomy	6
		Total	100

COURSE NO - AGRON 602
COURSE TITLE: CROP ECOLOGY
(2+0=2)

Theory

UNIT I
Concept of crop ecology, agricultural systems, ecology of cropping systems, principles of plant distribution and adaptation, crop and world food supply.

UNIT II
Ecosystem characteristics, types and functions, terrestrial ecology, flow of energy in ecosystem, ecosystem productivity, biomass, succession and climax concept.

UNIT III
Physiological response of crop plants to light, temperature, CO2, moisture and solar radiation; influence of climate on photosynthesis and productivity of crops; effect of global climate change on crop production.

UNIT IV
Exploitation of solar energy in crops; vertical distribution of temperature; efficiency in crop production.

UNIT V
Competition in crop plants; environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices, improvement of unproductive lands through crop selection and management.

Suggested Readings:

Ambasht RS. 1986. A Text Book of Plant Ecology. 9thEd. Students' Friends & Co.
Chadha KL & Swaminathan MS. 2006. Environment and Agriculture. Malhotra Publ. House.
Dwivedi P, Dwivedi SK & Kalita MC. 2007. Biodiversity and Environmental Biotechnology. Scientific Publ.
Hemantarajan A. 2007. Environmental Physiology. Scientific Publ.
Kumar HD. 1992. Modern Concepts of Ecology. 7th Ed. Vikas. Publ.
Lenka D. 1998. Climate, Weather and Crops in India. Kalyani Publ..
Misra KC. 1989. Manual of Plant Ecology. 3rd Ed. Oxford & IBH Publ..
Pandey SN & Sinha BK. 1995. Plant Physiology. Vikas Publ.
Sharma PD. 1998. Ecology and Environment. Rastogi Publ.
Singh J & Dhillon SS. 1984. Agricultural Geography. Tata McGraw Hill Publ.
Taiz L & Zeiger E. 1992. Plant Physiology. Benjamin/ Cummings Publ.

COURSE NO - AGRON 602
COURSE TITLE: CROP ECOLOGY
(2+0=2)

Theory: Teaching Schedule

Sr. No.	Lecture No.	Topics to be Covered	Weightage (%)
1	1-3	Concept of crop ecology, agricultural systems, ecology of cropping systems	8
2	4-6	Principles of plant distribution and adaptation, crop and world food supply.	12
3	7-9	Ecosystem characteristics, Types and functions, Terrestrial ecology	10
4	10-12	Flow of energy in ecosystem, ecosystem productivity, Biomass, succession and climax concept	12
5	13-16	Physiological response of crop plants to light, temperature, CO_2, moisture and solar radiation	12
6	17-20	Influence of climate on photosynthesis and productivity of crops	12
7	21-23	Exploitation of solar energy in crops, Vertical distribution of temperature	10
8	24-26	Efficiency in crop production, Competition in crop plants	8
9	27-29	Environmental pollution, ecological basis of environmental management and environment manipulation through agronomic practices	8
10	30-32	Improvement of unproductive lands through crop selection and management	8
		Total	100

COURSE NO - AGRON 604
COURSE TITLE: ADVANCES IN CROP GROWTH AND PRODUCTIVITY
(2+1=3)

Theory

UNIT I

Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; leaf area; interception of solar radiation and crop growth; photosynthesis: the photosynthetic apparatus, factors essential for photosynthesis; difference in photosynthetic rates among and within species; physiological limitations to crop yield; solar radiation concept and agro-techniques for harvesting solar radiation.

UNIT II

Growth analysis: concept, CGR, RGR, NAR, LAI, LAD, LAR; validity and Limitations in interpreting crop growth and development; growth curves: sigmoid, polynomial and asymptotic; root systems; root-shoot relationship; principles involved in inter and mixed cropping systems under rainfed and irrigated conditions; concept and differentiation of inter and mixed cropping; criteria in assessing the yield advantages.

UNIT III

Competitive relationship and competition functions; biological and agronomic basis of yield advantage under intercropping; physiological principles of dry land crop production, constraints and remedial measures; heat unit concept of crop maturity: concept and types of heat units.

UNIT IV

Concept of plant ideotypes: crop physiological and new ideotypes; characteristics of ideotype for wheat, rice, maize, etc.; concept and types of growth hormones; their role in field crop production; efficient use of resources.

Suggested Readings:

Chopra VL & Paroda RS. 1984. Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants. Oxford and IBH.
Delvin RM & Vitham FH. 1986. Plant Physiology. CBS Publ.
Evans LT. 1975. Crop Physiology. Cambridge Univ. Press.
Evans LT. 1996. Crop Evaluation, Adaptation and Yield. Cambridge Univ. Press.
Gupta US. (Ed.). 1995. Production and Improvement of Crops for Drylands. Oxford & IBH.
Gupta US. 1988. Progress in Crop Physiology. Oxford and IBH Publ..
Kramer PJ & Boyer JS. 1995. Water Relations of Plant and Soils. Academic Press Publ..
Mukherjee S & Ghosh AK. 1996. Plant Physiology. Tata McGraw Hill Publ..
Narwal SS, Politycka B & Goswami CL. 2007. Plant Physiology: Research Methods. Scientific Publishers.

COURSE NO - AGRON 604
COURSE TITLE: ADVANCES IN CROP GROWTH AND PRODUCTIVITY
(2+1=3)

Theory: Teaching Schedule

Sr. No.	Lecture No.	Topics to be Covered	Weightage (%)
1	1	Plant density and crop productivity	4
2	2	Plant and environmental factors	4
3	3-4	Yield. Plant distribution, strategies for maximizing solar energy utilization	5
4	5-6	Leaf area; interception of solar radiation and crop growth	5
5	7-8	Photosynthesis; the photosynthetic apparatus, factors essential for photosynthesis	5
6	9-10	Photosynthetic rates among and within species	4
7	11-12	Difference in physiological limitations to crop yield	4
8	13-14	Solar radiation concept and agro-techniques for harvesting solar radiation	5
9	15-16	Growth analysis; concept, CGR, RGR, NAR, LAI, LAD, LAR.	4
10	17	Validity and Limitations in interpreting crop growth and development	4
11	18	Growth curves; sigmoid, polynomial and asymptotic	4
12	19	Root systems; root-shoot relationship	4
13	20	Principles involved in inter and mixed cropping systems under rainfed and irrigated conditions	4
14	21	Concept and differentiation of inter and mixed cropping	4
15	22	Criteria in assessing the yield advantages	4
16	23	Competitive relationship	3
17	24	Competition functions	4
18	25	Biological and agronomic basis of yield advantage under intercropping	4
19	26	Agronomic basis of yield advantage under intercropping	3
20	27	Physiological principles of dry land crop production, constraints and remedial measures	4
21	28	Heat unit concept of crop maturity; concept and types of heat units	4
22	29	Concept of plant ideotypes; crop physiological and new ideotypes	3
23	30	Characteristics of ideotype for wheat, rice maize, etc	4
24	31	Concept and types of growth hormones; their role in field crop production	4
25	32	Efficient use of resources	3
		Total	**100**

Practical:

•	Field measurement of root-shoot relationship in crops at different growth stages
•	Estimation of growth evaluating parameters like CGR, RGR, NAR, LAI etc., at
	different stages of crop growth
•	Computation of harvest index of various crops
•	Assessment of crop yield on the basis of yield attributing characters
•	Construction of crop growth curves based on growth analysis data
•	Computation of competition functions, *viz.* LER, IER aggressively competition index
	etc. in intercropping.
•	Senescence and abscission indices
•	Analysis of productivity trend in un-irrigated areas
•	Analysis of productivity trend in irrigated areas

COURSE NO - AGRON 605
COURSE TITLE: IRRIGATION MANAGEMENT
(2+1=3)

Theory

UNIT I
Water resources of India, irrigation projects; irrigation needs, atmospheric, soil, agronomic, plant and water factors affecting irrigation need; water deficits and crop growth.

UNIT II
Soil-plant-water relationships, transpiration and evapotranspiration, significance of transpiration, energy utilization in transpiration, physiological processes and crop productivity.

UNIT III
Infiltration; water movement under saturated and unsaturated conditions; management practices for improving water use efficiency of crops.

UNIT IV
Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the design and operation of irrigation projects; characteristics of irrigation and farming systems affecting irrigation management.

UNIT V
Strategies of using limited water supply; factors affecting ET, control of ET by mulching and use of antitranspirant; fertilizer use in relation to irrigation; optimizing the use of given irrigation supplies.

UNIT VI

Land suitability for irrigation, land irrigability classification; integrated water management in command areas, institution of water management in commands, farmer's participation in command areas; irrigation legislation.

Suggested Readings:

FAO. 1984. Irrigation Practice and Water Management. Oxford & IBH.
Michael AM. 1978. Irrigation: Theory and Practice. Vikas Publ.
Mishra RR & Ahmad M. 1987. Manual on Irrigation and Agronomy. Oxford & IBH.
Panda SC. 2003. Principles and Practices of Water Management. Agrobios.
Reddy SR. 2000. Principles of Crop Production. Kalyani.
Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). Production and Improvement of Crops for Drylands. Oxford & IBH.
Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US. (Ed.). Production and Improvement of Crops for Drylands. Oxford & IBH.

COURSE NO - AGRON 605
COURSE TITLE: IRRIGATION MANAGEMENT
(2+1=3)

Theory: Teaching Schedule

Sr.No.	Lecture No.	Topics to be Covered	Weightage (%)
1	1	Water resources of India, irrigation projects; irrigation needs	4
2	2-3	Atmospheric, soil, agronomic, plant and water factors affecting irrigation need	5
3	4-5	Water deficits and crop growth	5
4	6-7	Soil-plant-water relationships	5
5	8	Transpiration and evapotranspiration	5
6	9	Significance of transpiration, energy utilization in transpiration	4
7	10	Physiological processes and crop productivity	5
8	11-12	Infiltration; water movement under saturated and unsaturated conditions	5
9	13-14	Management practices for improving water use efficiency of crops	4
10	15-16	Application of irrigation water, conveyance and distribution system, irrigation efficiency	5
11	17-18	Agronomic considerations in the design and operation of irrigation projects	5
12	19-20	Characteristics of irrigation and farming systems affecting irrigation management.	6
13	21-22	Strategies of using limited water supply	5
14	23-24	Factors affecting ET, control of ET by mulching and use of anti-transpirants	6
15	25-26	Fertilizer use in relation to irrigation	5
16	27	Optimizing the use of given irrigation supplies	5

17	28	Land suitability for irrigation, land irrigability	6
18	29-30	Integrated water management in command areas	5
19	31	Institution of water management in commands	5
20	32	Farmer's participation in command areas; irrigation legislation	5
		Total	**100**

Practicals

- Determination of water infiltration characteristics and water holding capacity of soil profiles
- Moisture extraction pattern of crops
- Consumptive use, water requirement of a given cropping pattern for optimum/variable productivity
- Crop planning at the farm and project level
- Agronomic evaluation of irrigation projects, case studies

COURSE NO - AGRON 606
COURSE TITLE: ADVANCES IN WEED MANAGEMENT
(2+0=2)

Theory

UNIT I
Crop-weed competition in different cropping situations; changes in weed flora, various causes and affects.

UNIT II
Physiological and biological aspects of herbicides, their absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

UNIT III
Climatic factors and phytotoxicity of herbicides; fate of herbicides in soil and factors affecting them, residue management of herbicides, adjuvants.

UNIT IV
Advances in herbicide application techniques; herbicide resistance; antidotes and crop Protection compatibility of herbicides of different groups; compatibility of herbicides with other pesticides.

UNIT V
Development of transgenic herbicide resistant crops; herbicide development, registration procedures.

UNIT VI
Relationship of herbicides with tillage, fertilizer and irrigation; bio-herbicides, allelochemical herbicide bioassays.

Suggested Readings:

Aldrich RJ & Kramer RJ. 1997. Principles in Weed Management. Panama Publ.
Ashton FM & Crafts AS. 1981. Mode of action of Herbicides. 2nd Ed. Wiley-Inter Science.
Gupta OP. 2000. Weed Management- Principles and Practices. Agrobios.
Mandal RC. 1990. Weed, Weedicides and Weed Control- Principles and Practices. Agro-Botanical Publ.
Rao VS. 2007. Principles of Weed Science. Oxford & IBH.
Ross MA & Carola Lembi A. 1999. Applied Weed Science. 2nd Prentice Hall.
Subramanian SAM & Kumar RJ. 1997. All about Weed Control. Kalyani.
Zimdahl RL. 1999. Fundamentals of Weed Science. 2nd Ed. Academic Press.

COURSE NO - AGRON 606
COURSE TITLE: ADVANCES IN WEED MANAGEMENT
(2+0=2)

Theory: Teaching Schedule

Sr. No	Lecture No.	Topics to be Covered	Weightage
1	1-2	Crop-weed competition in different cropping	7
2	3-4	Changes in weed flora, various causes and effects.	7
3	5-7	Physiological and biological aspects of herbicides, their absorption,translocation, metabolism and mode of action	8
4	8-10	Selectivity of herbicides and factors affecting them	7
5	11-12	Climatic factors and phytotoxicity of herbicides	7
6	13-14	Fate of herbicides in soil and factors affecting	7
7	15-16	Residue management of herbicides, adjuvants.	7
8	17-18	Advances in herbicide application techniques	7
9	19-20	Herbicide resistance; antidotes and crop protection ,compatibility of herbicides of different groups	8
10	21-22	Compatibility of herbicides with other pesticides	7
11	23-24	Development of transgenic herbicide resistant	7
12	25-27	Herbicide development, registration procedures	7
13	28-30	Relationship of herbicides with tillage, fertilizer and irrigation	7
14	31-32	Bioherbicides, allelochemical herbicide bioassays.	7
		Total	**100**

COURSE NO - AGRON 607
COURSE TITLE: INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE
(2+0=2)
Theory

UNIT I
Farming systems: definition and importance; classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises.

UNIT II
Concept of sustainability in farming systems; efficient farming systems; natural resources-identification and management.

UNIT III
Production potential of different components of farming systems; interaction and mechanism of different production factors; stability in different systems through research; eco-physiological approaches to intercropping.

UNIT IV
Simulation models for intercropping; soil nutrient in intercropping; preparation of different farming system models; evaluation of different farming systems.

UNIT V
New concepts and approaches of farming systems and cropping systems and organic farming; case studies on different farming systems.

Suggested Readings:

Ananthakrishnan TN. (Ed.) 1992. Emerging Trends in Biological Control of Phytophagous Insects. Oxford & IBH.

Balasubramanian P & Palaniappan SP. 2006. Principles and Practices of Agronomy. Agrobios.

Joshi M & Parbhakarasetty TK. 2005. Sustainability through Organic Farming. Kalyani.

Lampin N. 1990. Organic Farming. Farming Press Books.

Palaniappan SP & Anandurai K. 1999. Organic Farming- Theory and Practice. Scientific Publ.

Panda SC. 2004. Cropping systems and Farming Systems. Agribios.

Reddy MV. (Ed.) 1995. Soil Organisms and Litter Decomposition in the Tropics. Oxford & IBH.

Sharma AK. 2001. A Hand Book of Organic Farming. Agrobios.

Singh SP. (Ed.). 1994. Technology for Production of Natural Enemies. PDBC, Bangalore.

Trivedi RN. 1993. A Text Book of Environmental Sciences. Anmol Publ.

Veeresh GK, Srivashankar K & Suiglachar MA. 1997. Organic Farming and Sustainable Agriculture. Association for Promotion of Organic Farming, Bangalore.

Venkata Rao BV. 1995. Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective. Publ. 3. Parisaraprajna Parishtana, Bangalore.

COURSE NO - AGRON 607
COURSE TITLE: INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE
(2+0=2)

Theory: Teaching Schedule

Sr. No.	Lecture No.	Topics to be Covered	Weightage (%)
1	1-2	Farming systems; definition and importance	7
2	3-4	Classification of farming systems according to type of rotation, intensity of rotation, degree of commercialization, water supply, enterprises	8
3	5-6	Concept of sustainability in farming systems	7
4	7-9	Efficient farming systems; natural resources identification and management.	8
5	10-11	Production potential of different components of farming systems	7
6	12-13	Interaction and mechanism of different production factors	7
7	14v15	Stability in different systems through research	7
8	16-17	Eco-physiological approaches to intercropping	6
9	18-20	Simulation models for intercropping	7
10	21-22	Soil nutrient in intercropping	7
11	23-25	Preparation of different farming system models	7
12	26-27	Evaluation of different farming systems.	7
13	28-29	New concepts and approaches of farming systems and cropping systems and organic farming	8
14	30-32	Case studies on different farming systems	7
			100

Minor & Supporting Subjects

Course Title: ADVANCES IN SOIL PHYSICS
Course No. SOILS-601 2+1=3

Syllabus:

UNIT I
Soil water interactions, soil water potential, free energy and thermodynamics, basis of potential concept potential of soil water and entropy of the system.

UNIT II
Fundamentals of fluid flow, Poiseulles law, Laplace's equation, Darcy's law in saturated and unsaturated flows; development of differential equations in saturated and unsaturated water flow, capillary conductivity and diffusivity; limitations of Darcy's law; numerical solution for one dimensional water flow.

UNIT III
Theories of horizontal and vertical infiltration under different boundary conditions.

UNIT IV
Movement of salts in soils, models for miscible immiscible displacement, diffusion, mass flow and dispersion of solutes and their solutions through differential equations, break through curves.

UNIT V
Soil, air and aeration, mass flow and diffusion processes, thermal properties of soil, heat transfer in soils, differential equation of heat flow, measurement of thermal conductivity of soil.

UNIT VI
Soil crust and clod formation, structural management of puddle rice soils, soil conditioning – concept, soils conditioners types, characteristics, working principles, significance in agriculture.

UNIT VII
Solar and terrestrial radiation measurement, dissipation and distribution in soil crop systems, prediction of evapotranspiration using aerodynamic and canopy temperature based models, canopy temperature and leaf diffusion resistance in relation to plant water deficit; evaluation of soil and plant water status using infra-red thermometer.

Suggested Readings:

Baver L. D., Gardner W. H. And Gardner W. R. 1972. Soil Physics. John Wiley and Sons.

Hanks and Ascheroft. 1980. Applied Soil Physics. Springer Verlag.

Hillel D. 1980. Application of Soil Physics. Academic Press.

Hillel D. 1980. Environmental of Soil Physics. Academic Press.

Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi.

Kirkham D and Powers W. L. 1972. Advanced Soil Physics. Wiley Interscience.

Lal R. and Shukla M. K. 2004. Principles of Soil Physics. Marcel Dekker.

Oswal M. C. 1994. Soil Physics. Oxford and IBH.

SOILS 601 Advances in Soil Physics 2+1=3

Theory:

Unit No.	Lecture No.	Topics to be covered	Weightage in Marks
I	1& 2	Soil – water interaction, soil water potential.	5
	3 & 4	Free energy and thermodynamic basis of potential concepts.	5
	5	Chemical potential of soil water entropy of the system.	3
II	6	Fundamentals of fluid flow.	2
	7	Poiseuilles law, Laplace's equation.	3
	8 & 9	Darcy's law in saturated and unsaturated flows, development of differential equations in saturated and unsaturated water flow.	3
	10 & 11	Capillary conductivity and diffusivity; limitations of Darcy's law numerical solution for one dimensional water flow.	5
III	12 & 13	Theories of horizontal and vertical infiltration under different boundary conditions.	5
IV	14 & 15	Movement of salts in soils, models for miscible-immiscible displacement.	5
	16 & 17	Diffusion, mass flow and dispersion of solutes and there solutions through differential equations, break through curves.	5
V	18 & 19	Soil air and aeration, mass flow and diffusion processes	5
	20 & 21	Thermal properties of soil, heat transfer in soils, differential equation of heat flow.	5
	22	Measurement of thermal conductivity of soil.	3
VI	23	Soil crust and clod formation	3
	24	Structural management of puddle rice soils.	3
	25 & 26	Soil conditioning concept, soils conditioners- types, characteristics, working principles, significance in agricultures.	5
VII	27 & 28	Solar and terrestrial radiation measurement, dissipation and distribution in soil-crop systems.	4
	29- 30	Prediction of evapotranspiration using aerodynamic and canopy temperature-based models	4
	31-32	Canopy temperature and leaf diffusion resistance in relation to plant water deficit, evaluation of soil and plant water status using infra-red thermometer.	4
	33	Recent trends in advances in soil physics	3

Practical:

1	Measurement of soil water content by neutron probe.
2	Specific surface of soil by glycol method.
3	Soil moisture and tension relationships by sintered Glass Funnel method capillary and non-capillary porosity.
4	Determination of pore size distribution and specific water capacity of soil.
5	Determination of soil water diffusivity by Bruce and Klute method.
6	Measurement of soil strength by penetrometer.
7	Measurement of permeability of soil.
8	Measurement of soil temperature by soil thermometer and thermocouples.
9.	Determination of oxygen diffusion rates of soil.
10.	Measurement of crop canopy temperature by infra-red thermometer.
11.	Determination of saturated hydraulic conductivity of soil by augar hole method.
12.	Determination of leaf water potential by pressure chamber apparatus.
13.	Soil moisture and tension relationship with the use of pressure plate apparatus.

Course Title: PHYSICAL CHEMISTRY OF SOILS
Course No. SOILS-603 2+1=3

Syllabus:

UNIT I

Colloidal chemistry of inorganic and organic components of soils, their formation, clay organic interaction.

UNIT II

Predictive approaches for action exchange equilibria thermodynamics, empirical and diffuse double layer theory (DDL), relationships among different selectivity coefficients, structure and properties of diffuse double layer.

UNIT III

Thermodynamics of nutrient transformations in soils, cationic and anionic exchange and their models, molecular interaction.

UNIT IV

Adsorption / desorption isotherms Langmuir adsorption isotherm, Freundlich adsorption isotherm, normalized exchange isotherm, BET equation, selective and non selective adsorption of ions on inorganic surfaces and organic surfaces of soil materials (citation of utility in agricultural system)

UNIT V

Common solubility equilibrium – carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate; electrochemical properties of clays (citation of examples from agricultural use)

Suggested Readings:

Bear R. E. 1964. Chemistry of the Soil. Oxford and IBH.
Bolt G. H. and Bruggenwert MGM. 1978. Soil Chemistry. Elsevier.
Fried M. and Broeshart H. 1967. Soil Plant System in Relation to Inorganic Nutrition. Academic Press.
Greenland D. J. and Hayes. M.H.B. 1978. Chemistry of Soil Constituents. John Wiley and Sons.
Jurinak J. J. 1978. Chemistry of Aquatic Systems. Dept of Soil Science and Biometeorology, Utah State Univ.
McBride M. B. 1994. Environmental Chemistry of Soils. Oxford Univ. Press.
Sparks D. L. 1999. Soil Physical Chemistry 2nd Ed. CRC. Press.
Sposito G. 1981. The Thermodynamics of Soil Solutions. Oxford Univ. Press.
Sposito G. 1984. The Surface Chemistry of Soils. Oxford Univ. Press.
Sposito G. 1989. The Chemistry of Soils. Oxford Univ. Press.
Stevenson F. J. 1994. Humus Chemistry. 2nd John. Wiley.
Van Olphan H. 1977. Introduction of Clay Colloid Chemistry. John Wiley and Sons.

SOILS 603 Physical Chemistry of Soils 2+1=3

Theory:

Unit No.	Lecture No.	Topics to be covered	Weightage in Marks
I	1& 2	Colloidal chemistry of inorganic components of soils their formation.	5
	3	Clay organic interaction	5
	4 & 5	Colloidal chemistry of Organic components of soils their formation	6
II	6 & 7	Predictive approaches for cation exchange equilibria	6
	8 & 9	Thermodynamics, empirical and diffuse double layer theory (DDL)-	5
	10 & 11	Relationships among different selectivity coefficients; structure and properties of diffuse double layer.	6
III	12 & 13	Thermodynamics of nutrients transformation in soils;	5
	14 & 15	Cationic and anionic exchange and their models, molecular interaction.	6
IV	16	Adsorption / desorption isotherms definition importance.	5
	17	Langmuir adsorption isotherm.	5
	18	Freundlich adsorption isotherm.	5
	19, 20 & 21	Normalized exchange isotherm, BET equation; selective and non-selective adsorption of ions on inorganic surfaces and organic surfaces of soil	6

		materials (citation of utility in agriculture system).	
V	22, 23 & 24	Common solubility equilibria - carbonates, iron oxide and hydroxides, aluminum silicate, aluminum phosphate;	5
	25-26	Electrochemical properties of clays (citation of examples from agriculture use.)	5
	27-28	Recent trends in physical chemistry of soils	5

Course Title: ADVANCES IN SOIL FERTILITY

Course No. SOILS-602 2+0=2

Syllabus:

UNIT I

Modern concepts of nutrient availability, soil solution and plant growth nutrient response functions and availability indices.

UNIT II

Nutrient movement in soils, nutrient absorption by plants, mechanism approach to nutrient supply and uptake by plants, models transformation and movement of major micronutrients in soils.

UNIT III

Chemical equilibria (including solid solution equilibria) involving nutrient ions in soils, particularly in submerged soils.

UNIT IV

Modern concepts of fertilizer evaluation, nutrient use efficiency a nutrient budgeting.

UNIT V

Modern concepts in fertilizer application, soil fertility evolution techniques, role of soil tests in fertilizer use recommendations, site specific nutrient management for precision agriculture.

UNIT VI

Monitoring physical, chemical and biological changes in soils, permanent manurial trails and long term fertilizer experiments, soil productivity under long term intensive cropping direct, residual and cumulative effect and fertilizer use.

Suggested Readings:

Barber S. A. 1995. Soil Nutrient Bioavailability. John Wiley and Sons.

Barker, V. Allen and Pilbeam David J. 2007. Handbook of Plant Nutrition CRC / Taylor and Francis.

Brady N. C. and Weil R. R. 2002. The Nature and Properties of Soils. 13th Ed. Pearson Educ.

Cooke G. W. 1979. The Control of Soil Fertility. Crossby Lockwood and Sons.

Epstein E. 1987. Mineral Nutrition of Plants – Principles and Perspectives. International Potash Institute, Switzerland.

Kabata – Pendias Alina 2001. Trace Elements in Soils and Plants. CRC Taylor and Francis.

Kannaiyan S., Kumar K. and Govindarajan K. 2004. Biofertilizer Technology. Scientific Publ.

Mortvedt J. J., Sluman L. M. Cox F. R. And Welch R. M. (Eds.) 1991. Micronutrients in Agriculture. 2nd Ed. Soil Science Society of America, Madison.

Prasad R. and Powar J. F. 1997. Soil Fertility Management for Sustainable Agriculture. CRC Press.

Stevenson, F. J. and Cole M. A. 1999. Cycles of Soil. Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrient. John Wiley and Sons.

Stevenson F. J. (Ed.) 1982. Nitrogen in Agricultural Soils. Soil Science Society of America, Madison.

Tisdale S. L., Nelson W. L. Beaton J. D. and Havlin J. L. 1990. Soil Fertility and Fertilizers. 5th Ed. Macmillan Publ.

Wild A. (Ed.) Russell's Soil Conditions and Plant Growth. 11th Ed. Longman.

SOILS 602 Advances in Soil Fertility 2+1=3

Theory:

Unit No.	Lecture No.	Topics to be covered	Weightage in Marks
I	1	Modern concept of nutrient availability.	4
	2 & 3	Soil solution and plant growth nutrient response.	6
	4	Functions and availability indices.	4
II	5 & 6	Nutrient movement in soils, nutrient absorption by plants.	4
	7 & 8	Mechanisms approach to nutrient supply and uptake by plants; models	5
	9 & 10	Transformation and movements of major and smicronutrients in soil	6
III	11 & 12	Chemical equilibria (including solid-solution equilibria) involving nutrient ions in soil particularly submerged soils.	5
IV	13 & 14	Modern concept of fertilizer evaluation, nutrient use efficiency and nutrient budgeting	5
V	15 & 16	Modern concept in fertilizer application, methods.	5
	17 & 18	Soil fertility evolution techniques	6
	19	Role of soil test in fertilizer use recommendations	4
	20	Site specifica nutrient management for precision agriculture.	4
VI	21 & 22	Monitoring physical, chemical and biological changes in soils.	5
	23 & 24	Permanent manurail trails and long term fertilizer experiments	4
	25 & 26	Soil productivity and long-term intensive cropping, direct, residual and cumulative effect of fertilizer use.	5
	27 & 28	Integrated plant nutrient supply (IPNS) its importants in maintaining the soil fertility and crop productivity.	5
	29 & 30	Recent trends in advances in soil fertility	3

Practical:

1, 2 & 3	Laboratory and greenhouse experiments for evaluation of indices of nutrient availability and their critical values in soils and plants;
4	Determination of different pools of macro and micronutrients;
5	Quantity-intensity relations of P and K.
6	Soil fertility evolution studies by using Mitschalich pot culture methods

7	Soil fertility evolution studies by using Naubauer seedling methods
8	Soil fertility evolution studies by using Sunflower pot culture techquie for boron
9	Soil fertility evolution studies by using Mahlich tachiques for available K_2O
10	Soil fertility evolution studies by using The Mulder's Aspergllus niger test for copper and magnesium
11	Soil fertility evolution studies by using Tracer Technique – 'A' value
12	Soil fertility evolution studies by using DRIS technique

Course Title: LAND USE PLANNING AND WATERSHED MANAGEMENT

Course No. SOILS-606 2+0=2

Syllabus:

UNIT I

Concept and techniques of land use planning; factors governing present land use.

UNIT II

Land evaluation methods and soil site suitability evaluation for different crops, land capability classification and constraints in application

UNIT III

Agro ecological regions/sub regions of India and their characteristics in relation to crop production

UNIT IV

Water harvesting concept, significance, types, methodology, use of harvested water in agriculture to increase water productivity.

UNIT V

Watershed development / management concept, objectives, characterization, planning, execution, community participation and evaluation, rehabilitation of watershed; PRA; developing economically and ecologically sustainable agro forestry systems for watershed case studies.

Suggested Readings:

All India Soil and Land Use Survey Organization 1970. Soil Survey Manual. IARI, New Delhi.

FAO 1976. A Framework for Land Evaluation. Handbook 32. FAO.3

Sehgal J. L., Mandal, D. K., Mandal C. And Vadivelu S. 1990. Agro Ecological Regions of India. NBSS and LUP, Nagpur.

Soil Survey Staff 1998. Keys to Soil Taxonomy. 8th Ed. USDA and NRCS, Washington, DC.

USDA 1974. A Manual on Conservation of Soil and water Handbook of Professional Agricultural Workers. Oxford and IBH.

SOILS 606 **Land use Planning and Watershed Management** **2+0=2**

Theory:

Unit No.	Lecture No.	Topics to be covered	Weightage in Marks
I	1 & 2	Scope and importance of Land use planning and watershed management.	5
	3 & 4	Concept and techniques of land use planning.	5
	5	Factors governing present land use.	4
II	6	Land evolution methods.	4
	7 & 8	Soil-site suitability evolution for different crops.	5
	9 & 10	Land capability classification and constraints in application.	5
III	11, 12 & 13	Agro-ecological regions/sub-regions of India their characteristics in relation to crop production.	6
IV	14 & 15	Water harvesting- concept, significance.	4
	16 & 17	Types of water harvesting methodologies.	6
	18 & 19	Use of harvested water in agriculture for increases water productivity.	6
V	20, 21 & 22	Watershed development/management – concept, objectives, characterization.	6
	23, 24 & 25	Planning and execution of watershed development/management.	6
	26, 27 & 28	Community participation and evaluation; rehabilitation of watershed.	6
	29 & 30	Development of economically and ecologically sustainable agro-forestry system for watershed A case studies.	6
	31	Recent trends in Land use Planning and Watershed Management	6
	32	Visit to watershed projects	-

Seminar (02 credit)		
	Seminar-I	0+1=1
	Seminar-II	0+1=1
Doctoral Research (45 credits)		
	Doctoral Research	0+45=45
Non Credit Compulsory Courses		
PGS 501	Library and Information Services	0+1=1
PGS 504	Basic Concepts in Laboratory Techniques	0+1=1
PGS 502	Technical Writing and Communication Skills	0+1=1
PGS 503	Intellectual Property and its Management in Agriculture	1+0=1
PGS 505	Agricultural Research Ethics and Rural Development Programmes	1+0=1
PGS 506	Disaster Management	1+0=1