SHRI GURU RAM RAI UNIVERSITY

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]

M.Sc. (Ag.) Soil Science

School of Agricultural Sciences
(w.e.f. 2021-2022)

CATION

Programme Outcome (PO) of M.Sc. Agriculture

Programme outcome (PO)

Students post graduating with M.Sc. Agriculture degree will be able to acquire:

PO 1:	Quality education in Agriculture with special reference to Agronomy, Soil Science, Horticulture, Entomology, Plant Pathology, Seed Science & Technology and crop improvement to the solution of Agriculture related issues.
PO 2:	Understand and analyze the current events and issues that are occurring in agriculture and how they affect futuristic agriculture.
PO 3:	Skills to select and apply natural resources, modern techniques and IT tools for weather forecasting, soil analysis, pest management and quality seed production of food crops.
PO 4:	Research oriented innovative ideas should be recognized and examine the relationship between inputs and outputs in their agricultural field to make profitable decisions.
P O 5:	Research based knowledge of the environment and recognizes the importance of crop biodiversity in the field to preserve agro-ecosystem
P O 6:	Able to recognize and examine the relationship between employer and students which enhance career opportunities in different sectors
P O 7:	Demonstrate the impact of globalization and diversification of agriculture. extension programmes to disseminate modern technologies for farmer's welfare
PO 8:	To engage in critical thinking by analyzing situations and constructing viable solutions with ability to work effectively with each.
PO 9:	The Skills to recognize and evaluate the relationships between input and outputs, cost: benefit ratio in their agricultural field to make effective decision .The programme will enhance job opportunities and entrepreneurship development
PO 10:	Self critical opinion to solve the on farm problems on sustainable basis. The students will generate a culture of lifelong learning in an inclined environment to get personal achievement and professional ethics

M.Sc. (Ag.) Soil Science

Programme Specific Outcome (PSO)

PSO1	Memorize soil genesis, soil classification, soil survey and interpretation of soil survey report in land use planning
PSO2	Develop skill on analytical techniques for soil, water and plant samples.
PSO3	Acquire knowledge on soil physics, soil chemistry, soil fertility, nutrient management and fertilizer technology for sustainable agriculture.
PSO4	Provide consultancy for problems related to soil, water and nutrient management, project formulation and entrepreneurship development in Soil Science.

School of Agricultural Sciences

'ACADEMIC RULES AND REGULATIONS'

(Effective from 2021-22)

01. Regulations

The Regulations provided herein shall apply to M.Sc. Agriculture Degree Programme offered by the Shri Guru Ram Rai University**.**

02. Short Title and Commencement

These regulations shall be called "M.Sc. Agriculture Degree Programme Academic Rules and Regulations 2021". They shall come into force from the academic year 2021-22.

03. Definitions & Abbreviations

3.1 'University' means the Shri Guru Ram Rai University, Pathribagh, Dehradun, Uttarakhand.

3.2 'Curriculum' is a group of courses and other specified requirements for the fulfillment of the Degree Programme.

3.3 'Curricula and syllabi' It includes a list of approved courses for the Degree Programme wherein each course is identified by course code, outline of syllabus, credit assigned and semester wise distribution.

3.4 'Semester' means a period consisting of 90 working days inclusive of the mid-semester and practical examinations but excluding the study holidays and final theory examinations in each semester. The broad schedule of two semesters is:

a. Odd semesters (I & III): July to December
b. Even semesters (II & IV): January to June

3.5 'Academic Year' means a period consisting of two consecutive semesters including the inter-semester break as announced by the University. The first year of study shall be the first and second semesters following student's admission. The second year of study shall be the third and fourth semesters.

3.6 'Course' is a teaching unit of a discipline to be covered within a semester as detailed in the Curricula and Syllabi issued by the University.

3.7 Core Course: Core course means the list of courses specified by the University in the curricula and syllabi to be registered compulsorily by the students of M.Sc. Agriculture Degree Programme.

3.8 Elective Course: Elective course means the list of courses specified by the University in the curricula and syllabi to be registered optionally by the students of M.Sc. Agriculture Degree Programme.

3.9 Course Code: Each course shall bear a distinguishing code (as mentioned in the evaluation scheme) that identifies the discipline from which it is being offered.

3.10 "A credit' in theory means one hour of class room lecture and a credit in practical means two and half hour of laboratory or field work per week.
Explanation :
A 1+1 course (2 credits) means 1 hour theory and two and half hour practical per week.
A 0+1 course (1 credit) means two and half hour practical per week.

A 1+0 course (1 credit) means 1 hour theory per week.

3.11 'C' is abbreviated for Core course

'E' for Elective course

'L' for Lecture

'T' for Tutorial

'P' for Practical or Lab work or Field work

04. Eligibility for admission to M.Sc. Agriculture Degree Programme:

Any candidate who has passed the B. Sc. Agriculture/ B.Sc. (Hons.) Agriculture /B.Sc. Horticulture/ B.Sc.(Hons.) Horticulture degree programme from a recognized college/Institute/University with not less than 45 %-marks in aggregate is eligible for admission.

05. Admission Procedure: As per the University Norms.

06. System of Education

6.1 The system of education for M.Sc. Agriculture Degree programme is Semester System with duration of two academic years (4 Semesters). The maximum duration permissible for a student shall be 06 consecutive semesters (3 years). If a student at any stage of his/her course is found unable to complete it within the said time, he/she shall not be allowed to continue the studies further.

6.2 The date of commencement and closure of semesters as well as inter-semester break and schedule of final theory examinations shall be announced by the University.

6.3 Credits are assigned to each course in M.Sc. Agriculture on the basis of the number of theory classes or lectures and Practical classes or laboratory work or field work as well as other form of learning required to complete course content in a scheduled period as decided by the University.

6.4 Core courses prescribed are mandatory for all the students registered in M.Sc. Agriculture Degree programme.

6.5 There shall be one compulsory elective course in Semester-III.

6.6 Master's Thesis shall be offered in fourth semester.

6.7 An academic calendar shall be prepared by the University for every semester indicating the date of commencement and closure of semesters, date of mid semester examinations, final practical and theory examinations, inter semester break and holidays.

6.8 Summary of Credits in M.Sc. (Ag.) Soil Science (All Semesters)

Semester	Core course	Basic Supporting	Elective course	Total credits
I	**10**	**4**	**3**	**17**
II	**6**	**-**	**6**	**12**
III	**6**	**-**	**-**	**6**
IV	**20**	**-**	**-**	**20**
Grand Total				**55**

6.9 A student must successfully complete a total of 54 credits which include 41 credits for core courses, 09 for Elective and 04 for Basic supporting course as per the Curriculum requirement of M.Sc. Agriculture Degree programme.

6.10 A course shall be offered only once in an academic year during the semester as listed in the course curricula and syllabi.

07. The Medium of Instruction: The medium of instruction will be in English.

08. Reservation: The reservation will be as per the State Government rules / University Norms and Policies.

09. Total Seats: The total seats in M.Sc. Agriculture degree programme will be as per the provision of the University.

10. Fee structure: As decided by the University.

11. Attendance: As per University Norms.

12. Examination and Evaluation: As per University Norms with following guidelines

12.1 The medium of Examination: The medium of Examination will be English.

12.2 Duration of examinations: The examinations shall be conducted according to the description given below:

Examination	**Courses with theory and practical**	**Courses with only theory**	**Courses with only practical**
Mid-semester Examination (Internal)	1.0 hour	1.0 hour	--
Final Theory Examination	2.5 hours	2.5 hours	--
Final Practical Examination	3.0 hours	--	3.0 hours

12.3 Distribution of marks in External and Internal Exams:

(a) Courses with Theory and Practical both (Maximum Marks 100):
- External Theory Examination (50% or 50 marks) in each paper
- Internal Mid-term Examinations (30% or 30 marks) in each paper
- Internal Practical Examination (20% or 20 marks) in each paper

(b) Courses with only Theory (Maximum Marks 100):
- External Theory Examination (50% or 50 marks) in each paper
- Internal Mid-term Exams (40% or 40 marks) + Assignment (10% or 10 marks) in each paper

(c) Courses with only Practical (Maximum Marks 100):
- Internal Practical Examination (100% or 100 marks) in each paper

12.4 Assessment Norms: As per University Norms

12.5 Question paper pattern:

Paper to be set by external: HOD shall ensure the coverage of syllabus. If needed moderation question paper can be done.

Evaluation is to be done **i**nternally by the faculty other than the Course Instructor. Syllabus of the concerned course shall be sent to the external examiner, who shall prepare the question papers. For practical, it is recommended that examination shall be conducted by course instructor(s) and one teacher nominated by HOD.

(a) External theory Examinations for courses with theory and practical:

The question paper pattern for External theory Examination (Maximum Marks: 50) for courses with theory and practical is given below:

SECTION	Type of question	Number of questions	Number of questions to be answered	Mark per question	Total Marks
A	Objectives	10	10	01	10
B	Short answer type	06	04	05	20
C	Long answers type	03	02	10	20
				Total	**50**

(b) External theory Examinations for courses with theory only:

The question paper pattern for External theory Examinations (Maximum marks: 50) for courses with only theory shall be as per given in section 12.5 (a).

(c) Mid-term Exam:

Courses with theory and practical both shall contain two Mid-term Exams of 15 marks each. Courses with only theory shall contain two mid-term Exams of 20 marks each plus an assignment of 10 marks. Question paper for Mid-term Exams can be designed by Examiner as per the requirement of course content including objective and short answer type questions.

(d) Practical Exam:

Courses with theory and practical shall contain one practical Exam of 20 marks.

(e) Practical Examinations for courses with practical only:

Courses with practical only shall contain one practical Exam of 100 marks including Field work/Viva (50 marks) + Lab record (15 marks) + Assignment (15 marks) + Presentation (20 marks).

(f) Master's Thesis evaluation: Evaluation of "Master's Thesis (MSHT-402)" will be as Satisfactory/Unsatisfactory and will not be used for calculation of GPA/CGPA/OGPA.

13. Submission of Master's Thesis: As per University Norms.

14. Promotion of students to next semester: Cases of students' promotion to next semester such as Back papers, Carry over system, Ex – Studentship, Special examination, Grace marks, Candidate leaving the semester will be as per the University Norms and policies.

15. Approval of Final Results, Award of Degree and Issue of Provisional Certificates and Transcripts or Mark sheet: As per University Norms

16. Removal of Difficulties:

16.1 If any difficulty arises in giving effect to the Provisions of these regulations, the University may issue necessary orders which appear to be necessary or expedient for removing the difficulty.

16.2 Every order issued by the University under this provision shall be laid before the Academic Council of the University immediately after the issuance.

16.3 Not-withstanding anything contained in the rules and regulations, the Board of Studies or Academic Council shall make changes whenever necessary.

DEPARTMENT OF SOIL SCIENCE

S.G.R.R. University, Dehradun, Uttarakhand, India-248 001

Course Curriculum for M. Sc.(Ag.)Soil Science, 2021-22

Course offered

Core Courses

Course No.	Course Title	Credits
MSSC-101	Soil fertility and fertilizer use	**4 (3-0-1)**
MSSC-102	Soil chemistry	**3 (2-0-1)**
MSSC-103	Soil biology and biochemistry	**3(2-0-1)**
MSSC-201	Soil physics	**3 (2-0-1)**
MSSC-202	Soil mineralogy, genesis, classification and soil survey	**3 (2-0-1)**
MSSC-301	Management of problem soils and waters	**3 (2-0-1)**
MSSC-302	Analytical techniques and instrumental methods in soil	**2 (0-0-2)**
MSSS-303	Master's Seminar	**1 (0-0-1)**
MSST-401	Master's Thesis	**20 (0-0-20)**
Basic Supporting course		
MSSB-104	Experimental Statistics	**4 (3-0-1)**
	Total	**46 (16-0-30)**

Elective Courses

Course No.	Course Title	Credits
MSSE-105	Soil, water and air pollution	**3(2-0-1)**
MSSE-106	Soil Erosion and Conservation	**3(2-0-1)**
MSSE-203	Land degradation and restoration	**1 (1-0-0)**
MSSE-204	Land Use Planning and Watershed Management	**3(3-0-0)**
MSSE-205	Remote sensing and GIS technique for soil and crop studies	**3(2-0-1)**
	Total	**13* (11-0-4)**

*****Students have to opt three courses (i.e. 9 credit hours as7-0-2 or 6-0-3) in degree course programme.

SEMESTER WISE DISTRIBUTION OF COURSES

M.Sc. (Ag.) Soil Science

SEMESTERWISEDISTRIBUTIONOF COURSES

Semester-I

S.No.	Course Code	Course Title	Credit distribution			MM
			T	P	Total	
1.	MSSC-101	Soil fertility and fertilizer use	**3**	**1**	**4**	**100**
2.	MSSC-102	Soil chemistry	**2**	**1**	**3**	**100**
3.	MSSC-103	Soil biology and biochemistry	**2**	**1**	**3**	**100**
Basic supporting						
1.	MSSB-104	Experimental Statistics	**3**	**1**	**4**	**100**
Elective course (Students have to select any one)						
1.	MSSE-105	Soil, water and air pollution	**2**	**1**	**3**	**100**
2.	MSSE-106	Soil Erosion and Conservation	**2**	**1**	**3**	**100**
		Total	**17 (12+5)**			**500**

Semester-II

S.No.	Course Code	Course Title	Credit distribution			MM
			T	P	Total	
1.	MSSC-201	Soil physics	**2**	**1**	**3**	**100**
2.	MSSC-202	Soil mineralogy, genesis, classification and soil survey	**2**	**1**	**3**	**100**
Elective course (Students have to select any two)						
1.	MSSE-203	Land degradation and restoration	**1**	**0**	**1**	**100**
2.	MSSE-204	Land Use Planning and Watershed Management	**3**	**0**	**3**	**100**
3.	MSSE-205	Remote sensing and GIS technique for soil and crop studies	**2**	**1**	**3**	**100**
		Total			**12**	**400**

Semester-III

S.No.	CourseCode	CourseTitle	Credit distribution			MM
			T	P	Total	
1.	MSSC-301	Management of problem soils and waters	**2**	**1**	**3**	**100**
2.	MSSC-302	Analytical techniques and instrumental methods in soil and plant analysis	**0**	**2**	**2**	**100**
3.	MSSS-303	Master's Seminar	**0**	**1**	**1**	**100**
		Total	**6 (2+4)**			**300**

Semester-IV

S.No.	CourseCode	CourseTitle	Credit distribution			MM
			T	P	Total	
1.	MSST-401	Master's Thesis	**0**	**20**	**20**	**Satisfactory**
		Total			**20 (0+20)**	

Summary of Credits in M.Sc.(Ag.) Soil Science (All Semesters)

Semester	Core course	Basic Supporting	Elective course	Total credits
I	10	4	3	**17**
II	6	-	6	**12**
III	6	-	-	**06**
IV	20	-	-	**20**
			Grand Total	**53**

SYLLABUS

M.Sc. (Ag.) SOIL SCIENCE

Semester – I

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSC-101	Credit	04
Year/Sem	1/I	L-T-P	3-0-1
Course Name	Soil Fertility and Fertilizer Use		

Course Objectives:

1. To impart knowledge about soil fertility and its control.
2. To understand the role of fertilizers and manures in supplying nutrients to plants so as to achieve high fertilizer use efficiency.

UNIT I (Total Topics - 8 and Hrs -8)

Soil fertility and soil productivity; nutrient sources – fertilizers and manures; essential plant nutrients - functions and deficiency symptoms, soil and fertilizer nitrogen – sources, forms, immobilization and mineralization, nitrification, denitrification

UNIT II (Total Topics - 6 and Hrs -6)

Biological nitrogen fixation -types, mechanism, microorganisms and factors affecting; nitrogenous fertilizers and their fate in soils; management of fertilizer nitrogen in lowland and upland conditions for high fertilizer use efficiency.

UNIT- III (Total Topics - 5 and Hrs -5)

Soil and fertilizer phosphorus - forms, immobilization, mineralization, reactions in acid and alkali soils; factors affecting phosphorus availability in soils; phosphatic fertilizers - behavior in soils and management under field conditions.

UNIT-IV (Total Topics - 8 and Hrs -8)

Potassium - forms, equilibrium in soils and its agricultural significance; mechanism of potassium fixation; management of potassium fertilizers under field conditions, sulphur - source, forms, fertilizers and their behavior in soils; calcium and magnesium– factors affecting their availability in soils; management of sulphur, calcium and magnesium fertilizers.

UNIT-V (Total Topics - 4 and Hrs -4)

Micronutrients – critical limits in soils and plants; factors affecting their availability and correction of their deficiencies in plants; role of chelates in nutrient availability.

UNIT-VI (Total Topics - 5 and Hrs -5)

Common soil test methods for fertilizer recommendations; quantity– intensity relationships; soil test crop response correlations and response functions, fertilizer use efficiency; blanket fertilizer recommendations – usefulness and limitations.

UNIT-VII (Total Topics - 6 and Hrs -6)

Site- specific nutrient management; plant need based nutrient management; integrated nutrient management, soil fertility evaluation - biological methods, soil, plant and tissue tests; soil quality in relation to sustainable agriculture.

Practical (Experiments- 10 and Hrs -20)

- Determination of total nitrogen in soil
- Determination of total phosphorus in soil
- Determination of total potassium in soil
- Determination of total sulphur in soil

- Determination of available nitrogen in soil
- Determination of available phosphorus in soil
- Determination of available potassium in soil
- Determination of available sulphur in soil
- Availability indices of micronutrient in soil particularly multi nutrient extractant
- Determination of total nutrient content in plant samples

Course Outcomes (COs):

CO1: Define Soil fertility and soil productivity
CO2: Categorize Biological nitrogen fixation
CO3: Choose Common soil test methods for fertilizer recommendations
CO4: Explain Site-specific nutrient management.
CO5: Assess soil test crop response correlations and response functions
CO6: Plan site specific nutrient management

Suggested readings:

• Brady NC and Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
• Kabata-Pendias A and Pendias H. 1992. *Trace Elements in Soils and Plants*. CRC Press.
• Kannaiyan S, Kumar K and Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ.
• Leigh J G. 2002. *Nitrogen Fixation at the Millennium*. Elsevier.
• Mengel K and Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.
• Mortvedt JJ, Shuman LM, Cox FR and Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.
• Pierzinsky GM, Sims TJ and Vance JF. 2002. *Soils and Environmental Quality*. 2nd Ed. CRC Press.
• Stevenson FJ and Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.
• Tisdale SL, Nelson SL, Beaton JD and Havlin JL. 1999. *Soil Fertility and Fertilizers.* 5th Ed. Prentice Hall of India.
• Troeh FR and Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	1	1	1	1	1	2	1	2	1	1	1	1	1	1
CO-2	2	1	2	2	1	1	1	1	1	1	1	2	1	1
CO-3	1	2	1	1	1	1	1	1	2	1	2	1	1	1
CO-4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-5	2	1	1	1	1	2	1	1	1	1	2	1	1	1
CO-6	1	2	1	1	1	1	1	2	1	1	1	2	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSC-102	Credit	03
Year/Sem	1/I	L-T-P	2-0-1
Course Name	Soil Chemistry		

Course Objectives:

To introduce the classical concepts of soil chemistry.

To familiarize students with modern developments in chemistry of soils in relation to using soils as a medium for plant growth.

To understand the physical and chemical properties of soil and to examine the soil quality and health in relation to plant growth.

UNIT I (Total Topics - 3 and Hrs -3)

Chemical (elemental) composition of the earth's crust and soils, Elements of equilibrium thermodynamics, chemical equilibria, electrochemistry and chemical kinetics.

UNIT II (Total Topics - 4 and Hrs -4)

Soil colloids: inorganic and organic colloids - origin of charge, concept of point of zero- charge (PZC) and its dependence on variable-charge soil components, surface charge characteristics of soils.

UNIT- III (Total Topics - 5 and Hrs -5)

Diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation and peptization of soil colloids; electrometric properties of soil colloids; sorption properties of soil colloids.

UNIT-IV (Total Topics - 2 and Hrs -2)

Soil organic matter - fractionation of soil organic matter and different fractions, clay-organic interactions.

UNIT-V (Total Topics - 6 and Hrs -6)

Ion exchange processes in soil; cation exchange- theories based on law of mass action (Kerr- Vanselow, Gapon equations, hysteresis, Jenny's concept), adsorption isotherms, donnan- membrane equilibrium concept, clay-membrane electrodes and ionic activity measurement,; anion and ligand exchange – innersphere and outer-sphere surface complex formation.

UNIT-VI (Total Topics - 3 and Hrs -3)

Fixation of oxyanions, hysteresis in sorption-desorption of oxy-anions and anions, shift of PZC on ligand exchange, AEC, CEC; experimental methods to study ion exchange phenomena.

UNIT-VII (Total Topics - 5 and Hrs -5)

Practical implications in plant nutrition, Potassium, phosphate and ammonium fixation in soils covering specific and non-specific sorption; precipitation-dissolution equilibria; step and constant-rate K; management aspects.

UNIT-VIII (Total Topics - 4 and Hrs -4)

Chemistry of acid soils; active and potential acidity; lime potential,; sub-soil acidity, Chemistry of salt-affected soils and amendments, Chemistry and electrochemistry of submerged soils.

Practical (Experiments- 4 and Hrs -8)

- Determination of CEC and AEC of soils.
- Analysis of equilibrium soil solution for pH, EC, Eh by the use of Eh-pH, meter and conductivity meter.
- Adsorption-desorption of phosphate/sulphate by soil using simple, adsorption isotherm.
- Determination of titratable acidity of an acid soil by $BaCl_2$-TEA method.

Course Outcomes (COs):

CO1: Define different aspects of soil chemistry
CO2: Summarize Soil colloids: inorganic and organic colloids
CO3: Analysis of equilibrium soil solution for various parameters
CO4: Experience on the knowledge of chemical behaviour of soil and their utility inresearch for solving field problem.
CO5: Assess experimental methods to study ion exchange phenomena
CO6: Design diffuse double layer theories of soil colloids

Suggested readings:

- Bear RE. 1964. *Chemistry of the Soil.* Oxford and IBH.
- Bolt GH and Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.
- Greenland DJ and Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.
- Greenland DJ and Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.
- McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford University Press.
- Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford University Press.
- Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford University Press.
- Sposito G. 1989. *The Chemistry of Soils*. Oxford University Press.
- Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.
- Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	2	3	2	1	1	1	1`	1	1	1	2	1	1	1
CO-2	1	3	2	2	1	1	1	1	1	1	2	1	1	1
CO-3	2	2	1	1	2	2	1	1	2	3	1	1	1	1
CO-4	1	2	1	1	1	1	3	1	1	1	1	1	1	1
CO-5	1	1	2	1	1	1	2	1	1	2	1	1	1	1
CO-6	2	1	2	1	1	1	1	1	1	2	1	1	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSC-103	Credit	03
Year/Sem	1/II	L-T-P	2-0-1
Course Name	Soil Biology and Bio Chemistry		

Course Objectives:

1. To teach students the basics of soil biology and biochemistry.
2. To know the biogeochemical cycles, plant growth promoting rhizobacteria, microbial interactions in soil and other soil activities.
3. Analyzing biological parameter for deciding soil health.
4. Experience on the knowledge of soil biology and biochemistry and their utility in research for solving field problem.

UNIT I (Total Topics - 3 and Hrs -3)

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

UNIT II (Total Topics - 4 and Hrs -4)

Microbiology and biochemistry of root-soil interface; phyllosphere; rhizoshpere, soil, enzymes, origin, activities and importance; soil characteristics influencing growth and activity of microflora.

UNIT- III (Total Topics - 7 and Hrs -7)

Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil; biochemical composition and biodegradation of soil organic matter and crop residues.

UNIT-IV (Total Topics - 8 and Hrs -8)

Humus formation; cycles of important organic nutrients, biodegradation of organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

UNIT-V (Total Topics - 3 and Hrs -3)

Preparation and preservation of farmyard manure, animal manures, rural and urban composts and vermicompost.

UNIT-VI (Total Topics - 5 and Hrs -5)

Biofertilizers – definition, classification, specifications, method of production and role in crop production, BIS standards for biofertilizer for quality control.

Practical (Experiments- 9 and Hrs -18)

- Determination of soil microbial population (bacteria, fungi, actinomycetes and blue green algae)

- Study of rhizosphere effect
- Estimation of soil microbial biomass
- Study of organic matter decomposition in soil
- Estimation of dehydrogenase activity in soil
- Study of methods of estimation of biological nitrogen fixation
- Study of mineralization process during organic matter decomposition
- Determination of p-solubilization efficiency of p-solubilizing microorganism
- Fractionation of organic matter & functional groups

Course Outcomes (COs):

CO1: Experience on the knowledge of soil microbes
CO2:Summarize Microbiology and biochemistry of root
CO3:Categorize biofertilizers and estimate soil microbial biomass
CO4:Utility of soil microbes in research for solving field problem.
CO5: Assess BIS standards biofertilizer for quality control
CO6: Design preparation and preservation of organic manures

Suggested readings:

• Paul EA and Clark FE. *Soil Microbiology and Biochemistry.*
• Lynch JM. *Soil Biotechnology*
• Willey JM, Linda M. Sherwood and Woolverton CJ. *Prescott's Microbiology.*
• SubbaRao NS. *Advances In Agricultural Microbiology.*

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	2	1	2	1	1	2	1	1	1	1	2	1	1	1
CO-2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-3	1	1	1	1	2	1	1	1	2	1	1	1	1	1
CO-4	1	2	1	2	1	1	2	1	1	1	2	1	1	1
CO-5	1	2	1	1	1	1	1	1	1	1	1	1	1	1
C0-6	2	1	1	2	1	1	1	1	1	1	2	1	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSB-104	Credit	04
Year/Sem	1/I	L-T-P	3-0-1
Course Name	Experimental Statistics		

Course Objectives:

1. To educate basics terms used in collection, classification, presentation and analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
2. To develop understanding of use of various formulas, principles and methods of statistical calculations used in agriculture.
3. To develop skills in methods of collection of any type of data, classification of data, presentation of data, analysis of data, descriptive statistics, parametric and non-parametric tests, etc.
4. To analyze results of statistical calculations and their validation.

UNIT I (Total Topics - 7 and Hrs -7)

Processing of data: Classification and tabulation of statistical data by categories and measurements, graphical and diagrammatic representation-histogram. Frequency polygon, frequency curve and cumulative frequency curves.

UNIT II (Total Topics - 8 and Hrs -8)

Measure of location and dispersion: Mean, median, mode, partition values (quartiles, deciles and percentiles). Range, quartile deviation, mean deviation about mean and median, standard deviation coefficient of variation, moment kurtosis.

UNIT- III (Total Topics – 8 and Hrs -8)

Probability & distribution: Random experiment, sample space (discrete case only), events mathematical and statistical definition of probability, random variable (discrete and continuous), bermoulli trials, binomial distn. Posson distn. Poision distn as a limiting case of the bionominal distn, normal sistn, properties of the above distributions and fitting with available date, Test for their goodness of fit.

UNIT-IV (Total Topics - 7 and Hrs -7)

Correlation and regression : Bivariate dats, bivariate frequency distn, correlation coefficient, rank correlation, Regression lines, regression coefficients and their relation with correlation coefficient, Multiple regression, multiple and partial correlation coefficients.

UNIT-V (Total Topics - 8 and Hrs -8)

Estimation: Concept of population and sample; parameters and statistics: criteria for a good estimator unbiasedness, consistency of population mean and its confidence internal in the normal case. Testing of hypothesis: Null and alternative hypotheses, two type of errors, level of significance, power of the test, one tailed and two tailed tests.

UNIT-VI (Total Topics - 8 and Hrs -8)

Tests of significance: (a) large sample tests for mean & equality of means of two populations (2 tests). Student's statistic and its use of testing the mean equality of means of two populations (with independent and paired observations) correlation coefficient and regression coefficients. (b) Chi-Square statistics and its use as a test of goodness of fit, independence of attributes (contingency table) with Yates correction, and testing for the variance of a population. (c) Fishers statistic and its use in testing the equality of two variances and homogeneity of means (analysis of variance).

UNIT-VII (Total Topics - 5and Hrs -5)

Analysis of variance and covariance (ANOVA and ANCOVA): Analysis of variance and covariance with one way and two-way classifications (one observation per cell). Bartlettin test for testing the homogeneity of variances.

UNIT-VIII(Total Topics - 5and Hrs -5)

Design of experiments: Need: uniformity trials, Principles of experimental design replication, randomization and local control, (a) Completely Randomized Design, Randomized Block Design and Latin Square Designs and their analysis, missing plot technique in RBD. (b) Simple factorial experiments of the type 22, 33, 24, 32, confounding in factorial experiments. (c) Split-plot experiments.

Practical (Experiments- 7 and Hrs -14)

- Presentation of data-tabulation, histograms and frequency polygons
- Calculation of mean, mode, standard deviation, skewness and kurtosis
- Calculation of expected frequencies in binomial, posson and normal distributions testing the observed results against expected frequencies
- Tests of significance as prescribed in theory
- Regression and correlation coefficients and their significance
- Analysis of variance for different designs prescribed
- Analysis of covariance

Course Outcomes (COs):

CO1: Define the basic concept of statistics, t-test, f-test, hypothesis, sampling etc.
CO2: Understand the role of statistics in research experiments.
CO3: Choose and prepare experimental designs.
CO4: Analyze the results of statistical calculations and their validation
CO5: Able to collect and analyse the experimental data
CO6: Design to make stastical calculations their validation

Suggested readings:

- Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi
- NageswaraRao, G. 2007. Statistics for Agricultural Sciences. B.S. Publications, Hyderabad.
- Panse, V. G. and Sukhatme, P. V. 1961. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research.
- Rangaswamy, R. 1995. A Text Book of Agricultural Statistics. New Age International Publishing Limited, Hyderabad.
- S.R.S. Chandel. 2007. A Handbook of Agricultural Statistics. AnchalPrakashanMadir, Kanpur-208005.
- Snedecor, G. W. and Cochran, W.G. 1989. Statistical Methods 8th Edition. Iowa State University Press.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	2	1	1	1	1	1	1	2	1	1	1	1	1	1
CO-2	1	1	1	2	1	2	1	1	1	1	1	2	1	3
CO-3	2	2	2	1	1	1	1	2	2	3	2	1	1	1
CO-4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-5	1	2	1	1	1	1	1	1	1	2	1	1	1	1
CO-6	1	1	1	2	1	1	1	1	1	1	1	1	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSE-105	Credit	03
Year/Sem	1/I	L-T-P	2-0-1
Course Name	Soil, Water and Air Pollution		

Course Objectives:

1. To make the student views towards problems of soil, water and air pollution.
2. To define the problems associated with use of soils for crop production.
3. To understand the development and evaluation of management plans with multiple objectives and constraints

UNIT I (Total Topics - 6 and Hrs -6)

Soil, water and air pollution problems associated with agriculture, nature and extent, nature and sources of pollutants– agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.

UNIT II (Total Topics - 8 and Hrs -8)

Air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings, sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings.

UNIT- III (Total Topics – 8 and Hrs -8)

soil as sink for waste disposal, pesticides – their classification, behavior in soil and effect on soil microorganisms, toxic elements – their sources, behavior in soils, effect on nutrients availability, effect on plant and human health.

UNIT-IV (Total Topics - 8 and Hrs -8)

Pollution of water resources due to leaching of nutrients and pesticides from soil; emission of greenhouse gases – carbon dioxide, methane and nitrous oxide, remediation/amelioration of contaminated soil and water; soil as a sink for waste disposal, soil and water quality standards.

Practical (Experiments- 7 and Hrs -14)

- Sampling of sewage waters, sewage sludge, solid/liquid industrial wastes, polluted soils and plants.
- Estimation of dissolved and suspended solids.
- Estimation of chemical oxygen demand (COD), biological demand (BOD).
- Determination of Nitrate and ammonical nitrogen and phosphorus, heavy metal content in effluents.
- Estimation of heavy metals in contaminated soils and plants.
- Analysis of soil and plant samples for pesticides residues.
- Visit to various industrial sites to study the impact of pollutants on soil and plants.

Course Outcomes (COs):

CO1: Understanding Soil, water and air pollution problems associated with agriculture.
CO2: Analyzing different parameter for deciding level of pollution in soil and water.
CO3: Effects of pollution on nutrients availability, plant and human health.
CO4: Management of soil and water pollution.
CO5: Assess to emission of green house gases
CO6: Design soil as a sink for waste disposal

Suggested readings:

- Lal R, Kimble J, Levine E and Stewart BA. 1995. *Soil Management and Greenhouse Effect.* CRC Press.

• Middlebrooks EJ. 1979. *Industrial Pollution Control*. Vol. I. *Agro-Industries*. John WileyInterscience.
• Ross SM. *Toxic Metals in Soil Plant Systems*. John Wiley & Sons.
• Vesilund PA and Pierce 1983. *Environmental Pollution and Control*. Ann Arbor SciencePubl.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	1	1	1	1	1	2	1	1	1	1	2	1	1	1
CO-2	2	2	1	2	1	1	1	1	1	1	2	1	1	1
CO-3	1	1	1	2	1	2	1	1	2	3	1	1	1	1
CO-4	1	2	2	1	2	1	3	1	1	1	1	1	1	1
CO-5	1	1	1	2	1	1	2	1	1	1	1	1	1	1
CO-6	1	1	2	1	1	1	1	1	1	2	1	1	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSE-106	Credit	03
Year/Sem	1/I	L-T-P	2-0-1
Course Name	Soil Erosion and Conservation		

Course Objectives:

1. To enable students to understand various types of soil erosion.
2. Measures to be taken for controlling soil erosion to conserve soil and water.

UNIT I (Total Topics - 4 and Hrs -4)

History, distribution, identification and description of soil erosion problems in India. Forms of soil erosion; effects of soil erosion and factors affecting soil erosion.

UNIT II (Total Topics - 8 and Hrs -8)

Types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as EI_{30} index and kinetic energy; factors affecting water erosion; empirical and quantitative estimation of water erosion; methods of measurement and prediction of runoff; soil losses in relation to soil properties and precipitation.

UNIT- III (Total Topics - 2 and Hrs -2)

Wind erosion- types, mechanism and factors affecting wind erosion; extent of problem in the country.

UNIT-IV (Total Topics - 5 and Hrs -5)

Principles of erosion control; erosion control measures – agronomical and engineering; erosion control structures - their design and layout.

UNIT-V (Total Topics - 4 and Hrs -4)

Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands.

UNIT-VI (Total Topics - 7 and Hrs -7)

Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical (Experiments- 4 and Hrs -8)

- Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, percolation ratio, raindrop erodibility index
- Computation of kinetic energy of falling rain drops
- Computation of rainfall erosivity index (EI30) using rain gauge data
- Visits to a watersheds.

Course Outcomes (COs):

CO1:Experience on the knowledge of soil conservation.
CO2: Evaluation of mechanisms of soil erosion.
CO3: Understanding concept and approach of watershed management
CO4: Utility of soil conservation in research for solving fieldproblem.
CO5: Classify soil erosion
CO6: Plan to use of remote sensing in assessment and planning of watersheds

Suggested readings:

• Biswas TD and Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and*

Environment. Bull. Indian Society of Soil Science No. 17.
• Doran JW and Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society ofAmerica, Spl Publ. No. 49, Madison, USA.
• Gurmal Singh, Venkataramanan C, Sastry G and Joshi BP. 1990. *Manual of Soil and WaterConservation Practices*. Oxford & IBH.
• Hudson N. 1995. *Soil Conservation*. Iowa State University Press.
• Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
• Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	2	1	1	1	2	2	1	1	1	1	2	1	1	1
CO-2	1	1	1	1	1	2	1	1	1	1	2	1	1	1
CO-3	1	2	1	2	1	1	1	1	2	3	1	1	1	1
CO-4	1	1	2	2	1	1	3	1	1	1	1	1	1	1
CO-5	1	1	1	1	2	1	2	1	1	1	1	1	1	1
CO-6	2	1	1	1	1	1	2	1	1	1	1	1	1	1

Semester – II

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSC-201	Credit	03
Year/Sem	1/II	L-T-P	2-0-1
Course Name	Soil Physics		

Course Objectives:

1. To impart basic knowledge about soil physical properties and processes in relation to plant growth.
2. Measurement of soil-moisture potential
3. Measurement of soil aeration; aeration requirement for plant growth
4. Management of soil air, water and temperature.

UNIT I (Total Topics - 2 and Hrs -2)

Scope of soil physics and its relation with other branches of soil science; soil as a three phase system.

UNIT II (Total Topics - 5 and Hrs -5)

Soil texture, textural classes, mechanical analysis, specific surface, soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - basic concepts.

UNIT- III (Total Topics - 4 and Hrs -4)

Soil structure - genesis, types, characterization and management soil structure; soil aggregation, aggregate stability; soil tilth, characteristics of good soil tilth.

UNIT-IV (Total Topics - 5 and Hrs -5)

Soil crusting - mechanism, factors affecting and evaluation; soil conditioners; puddling, its effect on soil physical properties; clod formation.

UNIT-V (Total Topics - 5 and Hrs -5)

Soil water: content and potential, soil water retention, soil-water constants, measurement of soil water content, energy state of soil water, soil water potential, soil-moisture characteristic curve; hysteresis.

UNIT-VI (Total Topics - 7 and Hrs -7)

Measurement of soil-moisture potential, water flow in saturated and unsaturated soils, Poiseuille's law, Darcy's law; hydraulic conductivity, permeability and fluidity, hydraulic diffusivity; measurement of hydraulic conductivity in saturated and unsaturated soils.

UNIT-VII (Total Topics - 3 and Hrs -3)

Infiltration; internal drainage and redistribution; evaporation; hydrologic cycle, field water balance; soil-plant-atmosphere continuum.

UNIT-VIII (Total Topics - 4 and Hrs -4)

Composition of soil air; renewal of soil air - convective flow and diffusion; measurement of soil aeration; aeration requirement for plant growth; soil air management.

UNIT-IX (Total Topics - 5 and Hrs -5)

Modes of energy transfer in soils; energy balance; thermal properties of soil; measurement of soil temperature; soil temperature in relation to plant growth; soil temperature management.

Practical (Experiments- 11 and Hrs -22)

- Mechanical analysis by pipette and international methods.
- Determination of bulk density of soil by core sampler method.
- Measurement of Atterberg limits, aggregate analysis - dry and wet.
- Measurement of soil-water content by different methods.
- Measurement of soil-water potential by using tensiometer and gypsum blocks.

- Determination of soil-moisture characteristics curve and computation of pore-size distribution.
- Determination of hydraulic conductivity under saturated and unsaturated conditions. Determination of infiltration rate of soil.
- Determination of aeration porosity and oxygen diffusion rate.
- Soil temperature measurements.
- Estimation of water balance components in bare and cropped fields.

Course Outcomes (COs):

CO1: Experience on the knowledge of soil physical properties and processes in relationto plant growth.
CO2: Define soil physics and its scope.
CO3: Analizing soil-moisture characteristics curve
CO4: Explain soil-plant-atmosphere continuum.
CO5: Classify soil texture, structure and soil water
CO6: Design soil- plant- atmosphere continum

Suggested readings:

• Baver LD, Gardner WH and Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.
• Ghildyal BP and Tripathi RP. 2001. *Soil Physics*. New Age International.
• Hanks JR and Ashcroft GL. 1980. *Applied Soil Physics*. Springer Verlag.
• Hillel D. 1972. *Optimizing the Soil Physical Environment toward Greater Crop Yields*. Academic Press.
• Hillel D. 1980. *Applications of Soil Physics*. Academic Press.
• Hillel D. 1980. *Fundamentals of Soil Physics*. Academic Press.
• Hillel D. 1998. *Environmental Soil Physi*cs. Academic Press.
• Hillel D. 2003. *Introduction to Environmental Soil Physics*. Academic Press.
• Indian Society of Soil Science. 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
• Kirkham D and Powers WL. 1972. *Advanced Soil Physics*. Wiley-Interscience.
• Kohnke H. 1968. *Soil Physics*. McGraw Hill.
• Lal R and Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
• Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	1	1	1	2	2	2	1	1	1	1	2	1	1	1
CO-2	1	2	1	1	1	2	1	1	1	3	2	1	1	1
CO-3	1	1	1	2	1	1	1	1	2	1	1	1	1	1
CO-4	2	1	2	2	1	1	2	1	1	1	1	1	1	1
CO-5	1	1	2	1	1	1	1	2	1	1	1	1	1	1
CO-6	1	1	1	1	1	3	1	1	1	1	1	1	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSC -202	Credit	03
Year/Sem	1/II	L-T-P	2-0-1
Course Name	Soil Mineralogy, Genesis, Classification and soil survey		

Course Objectives:

To acquaint students with basic structure of alumino-silicate minerals.
Knowledge of genesisof clay minerals.
To make understanding soil genesis interms of factors and processes of soil formation.
To enable students conduct soil survey and interpret soil survey reports in termsof land use planning.

UNIT I (Total Topics - 3 and Hrs -3)

Fundamentals of crystallography, isomorphism and polymorphism, Structural chemistry, Classification of minerals.

UNIT II (Total Topics - 5 and Hrs -5)

Chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; amorphous soil constituents and other non- crystalline silicate minerals.

UNIT- III (Total Topics - 8 and Hrs -8)

Clay minerals in Indian soils,Soil morphology and micromorphology, Factors of soil formation, soil forming processes, weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

UNIT-IV (Total Topics - 8 and Hrs -8)

Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness.

UNIT-V (Total Topics - 7 and Hrs -7)

Soil survey and its types; soil survey techniques - conventional and modern; soil series – characterization and procedure for establishing soil series; benchmark soils and soil correlations; soil survey interpretations; soil mapping, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.

UNIT-VI (Total Topics - 3 and Hrs -3)

Landform – soil relationship; major soil groups of India with special reference to respective states.

UNIT-VI (Total Topics - 6 and Hrs -6)

Land capability classification and land irrigability classification; land evaluation and land use type (LUT) – concept and application; approaches for managing soils and landscapes in the framework of agro-ecosystem.

Practical (Experiments- 7 and Hrs -14)

- Identification of rocks and minerals.
- Morphological properties of soil profile in different landforms.
- Classification of soils using soil taxonomy.
- Grouping soils using available data base in terms of soil quality.

- Aerial photo and satellite data interpretation for soil and land use/
- Cartographic techniques for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales,
- Land use planning exercises using conventional and RS tools.

Course Outcomes (COs):

CO1:Identifying different rocks and minerals.
CO2:Summarize the chemical composition and properties of clay minerals
CO3:Express weathering sequences of minerals with special reference to Indian soils
CO4:Correlate soil mineralogy and soil maps in relation to soil Taxonomy.
CO5:Use land capability classification and land irrigability classification
CO6: Design land evaluation and land use type(LUT)

Suggested readings:

- Brady NC and Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu. Buol EW, Hole ED, MacCracken RJ and Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.
- Dixon JB and Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.
- Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.
- Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
- Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi
- Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.
- USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.
- Wade FA and Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford &IBH.
- Wilding LP and Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*.Elsevier.
- Wilding NE and Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	1	1	1	2	2	2	1	1	2	1	2	1	1	1
CO-2	1	1	2	2	1	1	1	1	1	1	1	1	1	1
CO-3	2	1	1	1	1	1	1	1	1	2	1	1	1	1
CO-4	1	1	1	1	1	2	2	1	1	1	2	1	1	1
CO-5	1	2	1	1	1	1	1	1	1	1	1	1	1	1
CO-6	3	1	1	1	1	2	1	1	1	1	1	1	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSE-203	Credit	01
Year/Sem	1/I	L-T-P	1-0-0
Course Name	Land degradation and restoration		

Course Objectives:

To impart knowledge related to various factors and processes of land degradation and their restoration techniques.

Unit I (Total Topics - 3 and Hrs -3)

Type, factors and processes of soil/land degradation and its impact on soil productivity including soil fauna, biodegradation and environment.

Unit II (Total Topics - 4 and Hrs -4)

Land restoration and conservation techniques-erosion control, reclamation of salt affected soils; Mine land reclamation, afforestation, organic products.

Unit III (Total Topics - 8 and Hrs -8)

Extent, diagnosis and mapping of land degradation by conventional and modern RS-GIS tools; monitoring land degradation by fast assessment, modern tools, land use policy, incentives and participatory approach for reversing land degradation; global issues for twenty first century.

Course Outcomes (COs):

CO1: Understanding processes of land degradation and their restoration.
CO2: Knowledge about land conservation techniques.
CO3: Understanding land use policy and approaches for reversing land degradation.
CO4:Experience on restoration of degraded soil for optimization of crop yield.
CO5: Use land use policy, incentives and participatory approach for reversing land degradation
CO6: Design global issues for twenty first century

Suggested readings:

- Biswas TD and Narayanasamy G. (Eds.). 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Soc. Soil Sci. 17, New Delhi.
- Doran JW and Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Madison.
- Greenland DJ and Szabolcs I. 1994. *Soil Resilience and Sustainable Land Use*. CABI.
- Lal R, Blum WEH, Vailentine C and Stewart BA. 1997. *Methods for Assessment of Soil Degradation.* CRC Press.
- Sehgal J and Abrol IP. 1994. *Soil Degradation in India - Status and Impact*. Oxford & IBH.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	1	3	1	1	1	2	1	1	1	1	2	1	1	1
CO-2	2	2	1	2	1	1	1	1	1	1	2	1	1	1
CO-3	1	2	2	1	2	2	1	1	2	3	1	1	1	1
CO-4	1	2	1	1	1	1	3	1	1	1	1	1	1	1
CO-5	1	1	1	2	1	1	1	1	2	1	1	1	1	1
CO-6	2	1	1	1	2	1	2	1	2	1	2	1	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSE-204	Credit	03
Year/Sem	1/II	L-T-P	3-0-0
Course Name	Land Use Planning and Watershed Management		

Course Objectives:

1. To teach the better utilization of land for agricultural purposes.
2. To know the better management of run-off or surplus/ excessive rain-water
3. Knowledge of catchment area foragricultural purposes in a watershed.

UNIT I (Total Topics - 7 and Hrs -7)

Concept and techniques of land use planning; factors governing present land use , land evaluation methods and soil -site suitability evaluation for different crops.

UNIT II (Total Topics - 7 and Hrs -7)

Land capability classification and constraints in application, agro- ecological regions/sub- regions of India and their characteristics in relation to crop production.

UNIT- III (Total Topics - 7 and Hrs -7)

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

UNIT-IV (Total Topics - 9 and Hrs -9)

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.

Course Outcomes (COs):

CO1: Planning for land use in proper way for higher crop productivity.
CO2:Memorize Concept and techniques of land use planning
CO3:Express Land capability classification.
CO4:Develop economically and ecologically sustainable agro-forestry systems for watershed
CO5: Categorize types of Water harvesting in agriculture.
CO6: Use water harvested water in agriculture to increase water productivity

Suggested readings:

Boul SW, Hole ED, MacCraken RJ and Southard RJ. 1997. *Soil Genesis and Classification.*4th Ed. Panima Publ.
• Brewer R. 1976. *Fabric and Mineral Analysis of Soils.* John Wiley & Sons.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	1	1	1	2	1	1	1	1	1	1	2	1	1	1
CO-2	1	2	1	1	1	1	1	1	1	1	1	1	1	1
CO-3	2	1	2	1	1	2	1	1	2	1	1	1	1	1
CO-4	1	1	1	1	2	1	2	1	1	1	2	1	1	1
CO-5	1	1	2	1	1	1	1	1	1	1	2	1	1	1
CO-6	1	1	1	1	1	1	2	1	1	1	1	3	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSE-205	Credit	03
Year/Sem	1/II	L-T-P	2-0-1
Course Name	Remote Sensing and GIS Techniques for Soil and Crop studies		

Course Objectives:

To impart knowledge about the basic concepts of remote sensing.
To know aerial photographs and imageries, and their interpretation;
To get knowledge about application of remote sensing in general and with special reference to soil, plants and yield forecasting.
To impart knowledge about geo-statistical techniques with special reference to krigging, and GIS and applications in agriculture.

Unit I (Total Topics - 7 and Hrs -7)

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter, basic concepts and principles; hardware and software requirements; common terminologies of geographic information system (GIS)

Unit II (Total Topics - 6 and Hrs -6)

Sensor systems-camera, microwave radio meters and scanners; fundamentals of aerial photographs and multispectral imaging, hyperspectral imaging, thermal imaging; image processing and interpretations.

Unit III (Total Topics - 7 and Hrs -7)

Application of remote sensing techniques-landuse soil surveys, crop stress and yield forecasting, prioritization in watershed and drought management, waste land identification and management.

Unit IV (Total Topics - 5 and Hrs -5)

Significance and sources of the spatial and temporal variability in soils; variability in relation to size of sampling; classical and geo-statistical techniques of evolution of soil variability.

Unit V (Total Topics - 5 and Hrs -5)

Applications of GIS for water resources, agriculture, precision farming, disaster management, e-governance, Agricultural Research Information System (ARIS).

Practical (Experiments- 6 and Hrs -12)

- Familiarization with different remote sensing equipments and data products
- Interpretation of aerial photo graphs and satellite data for mapping of land resources
- Analysis of variability of different soil properties with classical and geo statistical Techniques
- Creation of data files in a database programme
- Use of GIS for soil spatial simulation and analysis
- To enable the students to conduct soil survey and interpret soil survey reports in terms of land use planning.

Course Outcomes (COs):

CO1: Understanding basic concepts and principles of remote sensing
CO2: Application of remote sensing techniques-landuse soil surveys and sustainable agriculture.
CO3: Analyzing use of GIS for soil spatial simulation
CO4: Experience on the knowledge of remote sensing and their utility in research for solving field problem.
CO5: Categorize waste land and their management
CO6: Create data files in a database programme

Suggested readings:

- Brady NC and Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.
- Elangovan K. 2006. *GIS Fundamentals, Applications and Implementations*. New India Publ. Agency.
- Lillesand TM and Kiefer RW. 1994. *Remote Sensing and Image Interpretation*. 3rd Ed. Wiley.
- Nielsen DR and Wendroth O. 2003. *Spatial and Temporal Statis*tics. Catena Verloggmbh.
- Star J and Esles J. 1990. *Geographic Information System: An Introduction*. Prentice Hall.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	1	1	1	2	2	1	1	1	1	1	2	1	1	1
CO-2	2	1	2	1	1	1	1	1	1	1	1	1	1	1
CO-3	1	1	1	1	1	1	2	1	1	1	1	1	1	1
CO-4	1	1	1	1	1	2	1	1	1	1	2	1	1	1
CO-5	1	1	1	1	1	1	1	1	1	1	2	1	3	1
CO-6	1	1	1	1	1	1	2	1	1	1	1	1	1	1

Semester – III

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSC-301	Credit	03
Year/Sem	2/III	L-T-P	2-0-1
Course Name	Management of Problems Soils and Water		

Course Objectives:

To educate students about basic concepts of problem soils and brackish water, and their management. Attention will be on management of problem soils and safe use of brackish water in relation to crop production.

UNIT I (Total Topics - 7 and Hrs -7)

Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils. Origin and basic concept of problematic soils, and factors responsible, morphological features of saline, sodic and saline-sodic soils.

UNIT II (Total Topics - 8 and Hrs -8)

Characterization of salt-affected soils - soluble salts, ESP, pH; physical, chemical and microbiological properties, management of salt-affected soils; salt tolerance of crops - mechanism and ratings; monitoring of soil salinity in the field; management principles for sandy, clayey, red lateritic and dry land soils.

UNIT- III (Total Topics - 6 and Hrs -6)

Acid soils - nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid soils; biological sickness of soils and its management.

UNIT-IV (Total Topics - 5 and Hrs -5)

Quality of irrigation water; management of brackish water for irrigation; salt balance under irrigation; characterization of brackish waters, area and extent.

UNIT-V (Total Topics - 4 and Hrs -4)

Relationship in water use and quality, agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical (Experiments- 10 and Hrs -20)

- Determination of Carbonate and Bicarbonate in soil and water
- Determination of Sulphate in soil and water
- Determination of Chloride in soil and water
- Determination of Total soluble salts
- Determination of pH and EC of Saturation extract
- Determination of CEC and Ex. Cations
- Determination of ESP and SAR
- Determination of RSC
- Determination of Lime requirement of soils
- Determination of Gypsum requirement of soils

Course Outcomes (COs):

CO1: Experience on solving field problem of problem soil and waters.
CO2: Outline and memorize origin and basic concept of problematic soils, and factors responsible
CO3: Classify salt-affected soils and their management.
CO4: Explain water quality, agronomic practices in relation to problematic soils.
CO5: Use of agronomic practices in relation to problematic soils
CO6: Design biological sickness of soils and its management

Suggested readings:

- Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.
- Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State University
- USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	1	1	1	1	2	1	1	1	1	1	2	1	1	1
CO-2	1	2	1	2	1	1	1	1	1	1	1	1	1	1
CO-3	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-4	1	1	2	1	1	2	1	1	1	1	1	1	1	1
CO-5	1	1	1	1	1	1	1	1	1	1	2	1	1	2
CO-6	1	1	1	1	1	1	1	1	1	1	1	2	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSC-302	Credit	03
Year/Sem	2/III	L-T-P	0-0-2
Course Name	Analytical Techniques and instrumental methods in soil and plant Analysis		

Course Objectives:

To familiarize the students with commonly used instruments – their working.

Preparations of common analytical reagents for qualitative and quantitative analysis of both soil as well as plant samples.

Practical (Total Exercise - 12 and Hrs -24)

- Preparation of solutions for standard curves, indicators and standard solutions for acid-base, oxidation reduction and complexometric titration.
- Soil, water and plant sampling techniques, their processing and handling.
- Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium;

- Estimation of phosphorus, ammonium and potassium fixation capacities of soils.
- Principles of visible, ultra violet and infrared spectrophotometery, atomic absorption, flame-photometry
- Principles of inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery
- Identification of minerals by X-ray by different methods, CHNS analyzer
- Electrochemical titration of clays; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.
- Wet digestion/fusion/extraction of soil with aquaregia with soil for elemental analysis; triacid/di-acid digestion of plant samples
- Determination of available and total nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe, Mn, B, Mo) in soils;
- Determination of total nutrients (N, P, K, S, Ca, Mg, Zn, Cu, Fe, Mn, B, Mo) in plants
- Drawing normalized exchange isotherms; measurement of redox potential.

Course Outcomes (COs):

CO1: Development of confidence for setting soil testing laboratory.
CO2: Experience of analytical techniques, soil, water and plant sampling techniques, their processing and handling.
CO3: Preparation of solutions for standard curves, analytical reagents.
CO4: Correlate analysis of soil and plant samples for macro-micro nutrients.
CO5: Use of soil, water and plant sampling techniques
CO6: Design identification of minerals by X-ray by different methods

Suggested readings:

• Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes& Sons.
• Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.
• Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.
• Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.
• Page AL, Miller RH and Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.
• Piper CE. *Soil and Plant Analysis*. Hans Publ.
• Singh D, Chhonkar PK and Pandey RN. 1999. *Soil Plant Water Analysis - A Methods Manual*. IARI, New Delhi.
• Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.
• Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.
• Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS Longman.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	1	1	1	1	2	1	1	1	1	1	1	1	1	1
CO-2	1	1	1	1	1	1	2	1	1	1	1	1	1	1
CO-3	1	2	1	2	1	1	1	1	1	1	2	1	1	1
CO-4	2	1	2	1	1	2	1	1	1	1	1	1	1	1
CO-5	1	1	1	1	1	1	1	1	1	1	2	1	1	1
CO-6	2	1	1	1	1	1	1	1	1	1	1	2	1	1

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSSS-303	Credit	1(0+1)
Year/Sem	2/III	L-T-P	0-0-1
Course Name	Master's Seminar		

Course Objectives:

1. To acquaint with scientific terms, concepts and content preparation, etc.
2. To develop the ability to make power point and presentation.
3. To develop the ideas for using photographs and sketches in power point to give valuable information.

To develop the skills of preparation of research proposal or synopsis, report, manuscripts/article and publications and use of computer programs etc.

UNIT (Hrs) - NA

Practical (Hrs-30)

- A power point presentation on any topic chosen from the courses studied to be prepared and

delivered to the group of faculty members/staff and students of department.

- Essential components of Presentation are: Organization of topic, Presentation of data.
- Oral presentation, Delivery, language, explanation of figures, Ability to grasp and understand the subject, Depth of understanding the topic.

Course Outcomes (COs):

CO1. Acquaint with scientific terms, concepts and content preparation, etc.
CO2. Outline and summarize presentation.
CO3. Present and implement photographs and sketches in power point to give valuable information.
CO4. Correlate research proposal or synopsis, report, manuscripts/article and publications
CO5: Ability to grasp and understand the subject
CO6: Assess the depth of understand the topic

Suggested readings:

- Grover, S. and Ameen, S. 2018. A Primer of Research, Publication and Presentation. Jaypee Publisher, New Delhi.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	2	1	2	1	1	1	1	1	1	1	1	1	1	1
CO-2	1	2	1	1	1`	2	1	1	1	1	1	1	1	1
CO-3	1	1	2	1	1	1	1	1	1	1	1	1	1	1
CO-4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-5	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-6	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Semester – IV

Programme Name	M.Sc. (Ag.) Soil Science	Programme Code	MSC-SOIL-1098
Course Code	MSST-401	Credit	20 (0+20)

Year/Sem	2nd/IV	L-T-P	0-0-20
Course Name	Master's Thesis		

Course Objectives:

1. Aim of introducing thesis in M.Sc. (Ag.) Soil Science is to give the students preliminary exposure for conducting the research and presenting its findings systematically and scientifically in a manuscript shape.
2. To fulfill this goal, a specific topic for thesis research shall be assigned to M.Sc. student by the teacher(s)/supervisor(s) of the department, in the first semester.
3. The student will carry out the research for thesis under the respective supervisor(s) and finally present it in a book shape called thesis

UNIT (Hrs) - NA

Practical (Hrs-40)

- Synopsis, Research Work & Thesis work provides the students an excellent opportunity to develop analytical research and entrepreneurial skills, and knowledge through meaningful hands on experience, confidence in their ability to design and investigate the things.

Course Outcomes (COs):

CO1. Remember scientific terms of research designing, citation and bibliography.
CO2. Summarize ethical dimensions of research work and knowledge to obtain appropriate approval.
CO3. Correlate scientific measurements, statistical calculations and analysis of data.
CO4. Explain research works, collection, classification, presentation and analysis of data.
CO5: Justify confidence in their ability to design and investigate the thing
CO6: Design thesis in a book shape

Suggested readings:

- Kumar, R. 2014. Research Methodology: A Step-by-Step Guide for Beginners. 4th Edition. SAGE Publications Ltd.
- Parikh, M.N, Gogtay, N. 2009. ABC of Research Methodology and Applied Biostatistics. Jaypee Publishers, New Delhi.

Articulated Attainment

COs / POs/PSOs	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PSO -1	PSO -2	PSO -3	PSO -4
CO-1	2	1	2	1	1	1	1	1	1	1	2	2	1	1
CO-2	1	2	1	1	1	2	1	1	1	1	1	1	1	1
CO-3	1	1	2	1	1	1	1	1	1	1	2	1	1	2
CO-4	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-5	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-6	1	1	1	1	1	1	1	1	2	1	1	1	1	1