



स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड - ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

स्वामी रामानंद तीर्थ
मराठवाडा विद्यापीठ, नांदेड

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'B++' grade

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण-२०२० नुसार पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६-२७ पासून लागू करण्याबाबत.

परिपत्रक

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, दिनांक २२ एप्रिल २०२६ रोजी संपन्न झालेल्या मा.विद्यापरिषद बैठकीतील विषय क्र.०८/६४-२०२६ च्या ठरावानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील राष्ट्रीय शैक्षणिक धोरण-२०२० नुसार पदवी तृतीय वर्षाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६-२७ पासून लागू करण्यास मा.विद्यापरिषदेने मान्यता प्रदान केली आहे. त्यानुसार विज्ञान व तंत्रज्ञान विद्याशाखेतील बी.एस्सी. तृतीय वर्षाचे खालील विषयाचे अभ्यासक्रम (Syllabus) शैक्षणिक वर्ष २०२६-२७ पासून लागू करण्यात येत आहे.

01	B.Sc. III Year Botany	10	B.Sc. III Year Biochemistry
02	B.Sc. III Year Chemistry	11	B.Sc. III Year Agriculture Microbiology
03	B.Sc. III Year Mathematics	12	B.Sc. III Year Electronics
04	B.Sc. III Year Zoology	13	B.Sc. III Year Seed Technology
05	B.Sc. III Year Microbiology	14	B.Sc. III Year Horticulture
06	B.Sc. III Year Geology	15	B.Sc. III Year Analytical Chemistry
07	B.Sc. III Year Environment & Earth Science	16	B.Sc. III Year Agrochemical & Fertilizers
08	B.Sc. III Year Statistics	17	B.Sc. III Year Industrial Chemistry
09	B.Sc. III Year Dairy Science	18	B.Sc. III Year Industrial Microbiology

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या www.srtmun.ac.in या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

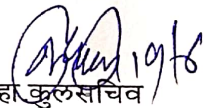
'ज्ञानतीर्थ' परिसर,

विष्णुपुरी, नांदेड - ४३१ ६०६.

जा.क्र.:शे-१ / परिपत्रक / पदवी / बीएस्सी / २०२६-२७ / 60

दिनांक : १९.०६.२०२६




सहा कुलसचिव

शैक्षणिक (१-अभ्यासमंडळे) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :-

- १) मा. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
- २) मा. प्र.कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ
- ३) मा. अधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
- ४) मा. संचालक, परीक्षा व मुल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
- ५) मा. प्राचार्य, सर्व संबंधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.



**SWAMI RAMANAND TEERTHMARATHWADA
UNIVERSITY, NANDED - 431 606 (MS)**



**UNDERGRADUATE PROGRAMME OF
SCIENCE & TECHNOLOGY**

**B.Sc. Third Year
SEED TECHNOLOGY
(For Affiliated Colleges)**

**Effective from Academic year 2026 – 2027
(As per NEP-2020)**

**Framed by
BOARD OF STUDIES IN BOTANY
S.R.T.M. University, Nanded - 431 606**

From the Desk of the Dean, Faculty of Science and Technology

Swami Ramanand Teerth Marathwada University, Nanded, enduring to its vision statement “*Enlightened Student: A Source of Immense Power*”, is trying hard consistently to enrich the quality of science education in its jurisdiction by implementing several quality initiatives. Revision and updating curriculum to meet the standard of the courses at national and international level, implementing innovative methods of teaching-learning, improvisation in the examination and evaluation processes are some of the important measures that enabled the University to achieve *the 3Es, the equity, the efficiency* and *the excellence* in higher education of this region. To overcome the difficulty of comparing the performances of the graduating students and also to provide mobility to them to join other institutions the University has adopted the cumulative grade point average (CGPA) system in the year 2014-2015. Further, following the suggestions by the UGC and looking at the better employability, entrepreneurship possibilities and to enhance the latent skills of the stakeholders the University has adopted the Choice Based Credit System (CBCS) in the year 2018-2019 at graduate and post-graduate level. This provided flexibility to the students to choose courses of their own interests. To encourage the students to opt the world-class courses offered on the online platforms like, NPTEL, SWAYM, and other MOOCS platforms the University has implemented the credit transfer policy approved by its Academic Council and also has made a provision of reimbursing registration fees of the successful students completing such courses.

SRTM University has been producing a good number of high calibre graduates; however, it is necessary to ensure that our aspiring students are able to pursue the right education. Like the engineering students, the youngsters pursuing science education need to be equipped and trained as per the requirements of the R&D institutes and industries. This would become possible only when the students undergo studies with an updated and evolving curriculum to match global scenario.

Higher education is a dynamic process and in the present era the stakeholders need to be educated and trained in view of the self-employment and self-sustaining skills like start-ups. Revision of the curriculum alone is not the measure for bringing reforms in the higher education, but invite several other initiatives. Establishing industry-institute linkages and initiating internship, on job training for the graduates in reputed industries are some of the important steps that the University would like to take in the coming time. As a result, revision of the curriculum was the need of the hour and such an opportunity was provided by the New Education Policy 2020. National Education Policy 2020 (NEP 2020) aims at equipping students with knowledge, skills, values, leadership qualities and initiates them for lifelong

learning. As a result the students will acquire expertise in specialized areas of interest, kindle their intellectual curiosity and scientific temper, and create imaginative individuals.

The curriculum given in this document has been developed following the guidelines of NEP-2020 and is crucial as well as challenging due to the reason that it is a transition from general science based to the discipline-specific-based curriculum. All the recommendations of the *Sukanu Samiti* given in the **NEP Curriculum Framework-2023** have been followed, keeping the disciplinary approach with rigor and depth, appropriate to the comprehension level of learners. All the Board of Studies (BoS) under the Faculty of Science and Technology of this university have put in their tremendous efforts in making this curriculum of international standard. They have taken care of maintaining logical sequencing of the subject matter with proper placement of concepts with their linkages for better understanding of the students. We take this opportunity to congratulate the Chairman(s) and all the members of various Boards of Studies for their immense contributions in preparing the revised curriculum for the benefits of the stakeholders in line with the guidelines of the **Government of Maharashtra regarding NEP-2020**. We also acknowledge the suggestions and contributions of the academic and industry experts of various disciplines.

We are sure that the adoption of the revised curriculum will be advantageous for the students to enhance their skills and employability. Introduction of the mandatory *On Job Training, Internship program* for science background students is praise worthy and certainly help the students to imbibe firsthand work experience, team work management. These initiatives will also help the students to inculcate the workmanship spirit and explore the possibilities of setting up of their own enterprises.

Dr. M. K. Patil
Dean

Faculty of Science and Technology
Swami Ramanand Teerth Marathwada University, Nanded

From Desk of Chairman, Board of Studies of the Subject Botany

PREAMBLE

The B.Sc. Seed Technology semester pattern course is running in different affiliated colleges of the S.R.T.M.U. Nanded. The program is designed to encourage and support the growing demands and challenging trends in the academic environment. Our training focuses on holistic development of students to face the competitive world. The course content has been designed on NEP-2020 pattern. The program consists of Major (C), Minor (M), Generic Electives (GE), Vocational and Skill Enhancement Course (VSEC). The course content of each theory paper is divided into four units by giving appropriate titles and subtitles. For each unit, total number of periods required, weightage of maximum marks and credits are mentioned. A list of practical exercises for laboratory course work based on theory papers to be completed in the academic year is also given. A list of selected reading material and a common skeleton question paper for all the theory papers of semester-I &II are also provided at the end of the syllabus.

The programme also inculcates various attributes at the Honours level. These attributes encompass values related to emotional stability, social justice, creative and critical thinking, well-being and various skills required for employability, thus preparing students for continuous learning and sustainability. The new curriculum based on learning outcomes of BSc (Honours) Seed Technology offers knowledge of areas including Seed Biology, Genetics and Plant Breeding, Plant Biotechnology, Seed Physiology, Seed Pathology, Seed Nematology, Seed Health management etc. The courses define clearly the objectives and the learning outcomes, enabling students to choose the elective subjects broadening their skills in the field of Seed Technology. The course also offers skills to pursue research and teaching in the field of Seed Technology and thus would produce best minds to meet the demands of society. This curriculum framework for the bachelor-level program in Seed Technology is developed keeping in view of the student-centric learning pedagogy, which is entirely outcome-oriented and curiosity-driven. To avoid a rote-learning approach and foster imagination, the curriculum is more leaned towards self-discovery of concepts. The curriculum framework focuses on the pragmatist approach whereby practical application of theoretical concepts is taught with substantial coverage of practical and field works. The addition of Generic Electives, Vocational and Skill Enhancement Courses aims to develop skills in plant sciences and practical experience in the students.

OBJECTIVES OF THE B. Sc. SEED TECHNOLOGY PROGRAMME:

The Objectives of this program are:

1. Understand the scope and importance of discipline.
2. Instil a love and curiosity for nature through living plants.
3. To make students open-minded and curious, we try our best to nurture and develop scientific Attitude.
4. We make students fit for society by enabling them to work hard.
5. Make the students exposed to the diverse life forms.
6. Make them skilled in practical work, experiments, laboratory equipment and to interpret correctly on biological materials and data.
7. Develop interest in Biological research.
8. Encourage students to research related topics.
9. Develop a thirst for protecting natural resources and the environment.
10. Develop the ability to use the knowledge acquired in various spheres of life to make our country self-reliant
11. Appreciate and apply ethical principles to biological science research and practice.

PROGRAM SPECIFIC OUTCOMES (PSO) OF B.Sc. SEED TECHNOLOGY:

By the end of the program the students will be able to:

- PO1:** Skill development for the proper description using seed technological terms, identification, testing, classification and evaluation of seeds, planting materials and associated microorganisms.
- PO2:** Acquisition of knowledge on seed structure, development, life cycle and physiological processes that exist among crop plants through model seed systems and experimental studies.
- PO3:** Understanding of various interactions that exist among seeds, plants and microorganisms; to develop curiosity about seed ecology, storage behavior and field dynamics.
- PO4:** Understanding of the major elements of variation that exist in seeds through comparative morphological, anatomical and genetic studies.
- PO5:** Ability to explain seed diversity, improvement and evolution based on empirical evidences from seed physiology, biochemistry, molecular biology, genetics and crop life history.
- PO6:** Skill development for seed sampling, collection, processing, preservation and recording of data after observation and analysis – from field level evaluation to laboratory and molecular techniques.

- PO7:** Making aware of scientific and technological advancements in seed technology – including Information and Communication Technology, Biotechnology, Molecular Breeding and Seed Testing techniques for advanced learning and research.
- PO8:** Internalization of concepts of seed conservation, genetic resource management and sustainable agriculture through scientific inquiry and innovation.
- PO9:** To enable the graduates to prepare for national and international level competitive examinations like UGC-CSIR, UPSC, ICAR, etc.
- PO10:** To enable the students to adopt effective teaching pedagogy as agriculture/biology educators, including use of modern digital tools and seed technology modules.
- PO11:** The graduates should be knowledgeable and competent to address global challenges like food security, climate change, sustainable development goals (SDGs) and green agricultural technologies.
- PO12:** The graduate should demonstrate proficiency in hands-on experimental techniques in seed technology such as seed testing, hybrid seed production, seed health analysis and quality evaluation during research and professional career.
- PO13:** The program enables the students to successfully face NET, SET, ICAR-JRF, MPSC, UPSC and other competitive examinations.

Dr. Saheb Laxmanrao Shinde
Chairman,
Board of Studies in Botany
Swami Ramanand Teerth Marathwada University, Nanded



Details of the Board of Studies Members in the subject Botany under the faculty of Science & Technology of S.R.T.M. University, Nanded

Sr No	Name of the Member	Designation	Address	Contact No.
1.	Dr. Saheb Laxmanrao Shinde	Chairman	Yeshwant Mahavidyalaya, Nanded	7588151967
2	Dr. Babasaheb Shivmurti Surwase	Member	School of Life Sciences, S.R.T.M.U. Nanded	9075829767
3	Dr Vijay Tulshiram Gorgile	Member	Shahir Annabhau Sathe Mahavidyalaya, Mkhed	9421762073
4	Dr. Sudhakar V. Chate	Member	Shivaji College, Udgir	8421241300
5	Dr. Suresh Manoharrao Telang	Member	Yeshwant Mahavidyalaya, Nanded	9822174684
6	Dr. R. M. Kadam	Member	M. G. M. Ahmedpur, Tq. Ahmedpur, Dist. Latur.	9422657976
7	Dr. Sopan Dnyanoba Dhavale	Member	Shahir Annabhau Sathe Mahavidyalaya, Mukhed,	9423614703
8	Dr. Sanjay Marotrao Dalvi	Member	Shri Guru Buddhiswami Mahavidyalaya, Purna (Jn),	9921101210
9.	Dr. Prashant A. Gawande	Professor from other University	Sant Gadge Baba Amravati University, Amravati.	9403622568
10	Dr. Ambadas Sheshrao Kadam	Experts	DSM College Parbhani.	8329151172
11	Dr. Kanhaiya Ranganathrao Kadam	Experts	K.K. Herbal Industries, Gut No. 252, Naleshwar Road, Limbgaon, Nanded.	9420261080
12	Bindu Maurya	Experts	07, Mangal Pravesh building Polt. C-16 Sector-3 Airoli, Navi Mumbai.	9987591561
13	Shri Bhanudas Balajirao Pendkar	Experts	K-Ferts Lab, W-4, MIDC Industrial Area, Nanded. Invitee Member	8888896710



Swami Ramanand Teerth Marathwada University, Nanded

Faculty of Science and Technology

Credit Framework for B.Sc.III Year

Multidisciplinary Degree Program with Multiple Entry and Exit

Subject: SEED TECHNOLOGY (Major)

Year & Level	Semester	Major (From the same Faculty)		Minor 1 (From the same Faculty)	Minor 2 (From the same Faculty)	Generic Elective (GE) (select from Basket 3 of Faculties other than Science and Technology)	Vocational & Skill Enhancement Course	Ability Enhancement Course (AEC) (Basket 4) Value Education Courses (VEC) / Indian Knowledge System (IKS) (Basket 5)	FieldProject/ Case Study/ OJT/	Credits	Total Credits
1	2	3		4	5	6	7	8	9	10	11
3 (5.5)	V	SSTLCT 1301 (3cr) SSTLCT 1302 (3cr) SSTLIKS 1303 (2cr) SSTLCP 1301 (2cr) SSTLCP 1302 (2cr) 12 Credits	Major Elective SSTLET 1301 (2cr) SSTLEP 1301 (2cr) 04 Credits	--	--	--	SSTLVC1301 02 Credits	--	FP/CS SSTLFP1301 Or SSTLCS1301 04 Credits	22	132
	VI	SSTLCT1351 (3cr) SSTLCT1352 (3cr) SSTLCT 1353 (2cr) SSTLCP1351 (2cr) SSTLCP1352 (2cr) 12 Credits	Major Elective SSTLET 1351 (2cr) SSTLEP 1351 (2cr) 04 Credits	--	--	--	SSTLVC1351 02 Credits	--	OJT SSTLOJ1351 04 Credits	22	
	Cum. Cr.	56		16	08	08	08+4=12	22	08+2=10	44	
<p>Exit option: UG Diploma in Major <u>Seed Technology</u> and Minor <u>Seed Technology</u> on completion of 88 credits and additional 4 credits NSQF / internship in <u>Seed Technology</u></p>											



B. Sc. Third Year Semester V (Level 5.5)

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SSTLCT 1301	Seed Developmental Biology	03	--	12	03	--
	SSTLCT 1302	Advances in Seed Science Research	03	--		03	--
	SSTLIKS 1303	Indigenous Seed Technology (IKS)	02	--		02	--
	SSTLCP 1301	Practical Based on SSTLCT 1301	-	02		--	04
	SSTLCP 1302	Practical Based on SSTLCT 1302		02		--	04
Elective	SSTLET 1301	Seed Pathology	02	--	04	02	--
	SSTLEP 1301	Practical Based on SSTLET 1301	-	02		--	04
Vocational Course	SSTLVC1301	Seed Quality Enhancement	--	02	02	--	04
Field Project/ Case Study/ OJT	SSTLFP1301 Or SSTLCS1301	Field Project/ Case Study	--	04	04	--	08
Total Credits 22			10	12	22	10	24



B. Sc. Third Year Semester V (Level 5.5)

Examination Scheme

[40% Continuous Assessment (CA) and 60% End Semester Assessment (ESA)]

(For illustration we have considered a paper of 02 credits, 50 marks, need to be modified depending on credits assigned to individual paper)

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA	CA (8)	ESA (9)	
			Test I (4)	Test II (5)	Average of T1 & T2 (6)	Total (7)			
Major	SSTLCT 1301	Seed Developmental Biology	15	15	30	45	--	--	75
	SSTLCT 1302	Advances in Seed Science Research	15	15	30	45	--	--	75
	SSTLIKS 1303	Indigenous Seed Technology (IKS)	10	10	20	30	--	--	50
	SSTLCP 1301	Practical Based on SSTLCT 1301	--	--	--	--	20	30	50
	SSTLCP 1302	Practical Based on SSTLCT 1302	--	--	--	--	20	30	50
Elective	SSTLET 1301	Seed Pathology	10	10	20	30	--	--	50
	SSTLEP 1301	Practical Based on SSTLET 1301	--	--	--	--	20	30	50
Vocational Course	SSTLVC1301	Seed Quality Enhancement	--	--	--	--	20	30	50
Field Project/ Case Study/ OJT	SSTLFP1301 Or SSTLCS1301	Field Project/ Case Study	--	--	--	--	40	60	100



B. Sc. Third Year Semester VI (Level 5.5)

Teaching Scheme

	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SSTLCT 1351	Hybrid Seed Production	03	--	12	03	--
	SSTLCT 1352	Post Harvest Handling and Storage of Seeds	03	--		03	--
	SSTLCT 1353	Seed Legislation and Certification	02	--		02	--
	SSTLCP 1351	Practical Based on SSTLCT 1351	-	02		--	04
	SSTLCP 1352	Practical Based on SSTLCT 1352		02		--	04
Elective	SSTLET 1351	Seed Nematology	02	--	04	02	--
	SSTLEP 1351	Practical Based on SSTLET 1351	-	02		--	04
Vocational Course	SSTLVC1351	Testing for Genuineness and Purity of Cultivars	--	02	02	--	04
Field Project/ Case Study/ OJT	SSTLOJ1351	OJT	--	04	04	--	08
Total Credits 22			10	12	22	10	24



B. Sc. Third Year Semester VI (Level 5.5)

Examination Scheme

[40% Continuous Assessment (CA) and 60% End Semester Assessment (ESA)]

(For illustration we have considered a paper of 02 credits, 50 marks, need to be modified depending on credits assigned to individual paper)

Subject (1)	Course Code (2)	Course Name (3)	Theory				Practical		Total Col (6+7) / Col (8+9) (10)
			Continuous Assessment (CA)			ESA	CA (8)	ESA (9)	
			Test I (4)	Test II (5)	Average of T1 & T2 (6)	Total (7)			
Major	SSTLCT 1351	Hybrid Seed Production	15	15	30	45	--	--	75
	SSTLCT 1352	Post Harvest Handling and Storage of Seeds	15	15	30	45	--	--	75
	SSTLCT1353	Seed Legislation and Certification	10	10	20	30	--	--	50
	SSTLCP 1351	Practical Based on SSTLCT 1351	--	--	--	--	20	30	50
	SSTLCP 1352	Practical Based on SSTLCT 1352	--	--	--	--	20	30	50
Elective	SSTLET 1351	Seed Nematology	10	10	20	30	--	--	75
	SSTLEP 1351	Practical Based on SSTLET 1351	--	--	--	--	20	30	50
Vocational Course	SSTLVC1351	Testing for Genuineness and Purity of Cultivars	--	--	--	--	20	30	50
Field Project/ Case Study/ OJT	SSTLOJ1351	OJT	--	--	--	--	40	60	100

Syllabus for B. Sc. Seed Technology
Third Year
Semester – V
As Per National Education Policy- 2020

To be implemented from
Academic Year 2026-2027

National Education Policy 2020
B.Sc. Seed Technology, III Year (Semester - V)
Major Core Theory Course
Course Code – SSTLCT1301

Title of the Course: SEED DEVELOPMENTAL BIOLOGY

[No. of Credits: 3 Credit]

[Total:45 Hours]

Course pre-requisite:

- Basic knowledge of plant morphology and plant reproduction.
- Understanding of seed structure and germination processes.
- Introductory knowledge of plant physiology and genetics.

Learning Objectives:

- To impart knowledge about floral biology and reproductive development in crop plants.
- To explain the processes of fertilization, embryogenesis and seed formation.
- To understand physiological and biochemical changes during seed development and maturation.

Learning Outcomes:

- Students will understand reproductive development and seed formation in flowering plants.
- Students will explain embryo development and seed maturation processes.
- Students will relate seed developmental processes with seed production and crop improvement.

Curriculum Details: SSTLCT 1301- Seed Developmental Biology

Module No.	Unit No.	Topics	Hrs. Required to cover the contents
1.0		FLORAL BIOLOGY AND REPRODUCTIVE DEVELOPMENT	12
	1.1	Structure and organization of flower and reproductive organs in economically important crop plants	
	1.2	Process of microsporogenesis and detailed development of pollen grains (male gametophyte)	
	1.3	Process of megasporogenesis and development of embryo sac (female gametophyte)	
	1.4	Pollination mechanisms, types and their significance in successful seed formation	
2.0		FERTILIZATION AND SEED FORMATION	11
	2.1	Pollen germination, pollen tube growth and guidance towards ovule	
	2.2	Double fertilization process and its significance in flowering plants	
	2.3	Development of zygote, endosperm and early stages of seed formation	
	2.4	Environmental and physiological factors affecting fertilization and seed set in crops	
3.0		EMBRYOGENESIS AND SEED STRUCTURE	10
	3.1	Embryogenesis in dicot plants with reference to developmental stages	
	3.2	Embryogenesis in monocot plants and comparative study with dicots	

	3.3	Development of seed coat, endosperm and other storage tissues	
	3.4	Structure, types and functional significance of mature seeds	
4.0		SEED MATURATION AND PHYSIOLOGY	
	4.1	Seed maturation process and accumulation of food reserves in developing seeds	12
	4.2	Physiological and environmental factors regulating seed dormancy and its significance	
	4.3	Physiology and biochemical aspects of seed germination and seedling growth	
	4.4	Importance of seed developmental biology in agriculture, crop production and seed technology	
		Total	45

Text Books and Reference Books:

1. Agarwal, R. L. (1996). Seed Technology. New Delhi, India: Oxford & IBH Publishing Co. Pvt. Ltd.
2. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology (4th edition). New York, USA: Springer Science & Business Media.
3. Bhojwani, S. S. and Bhatnagar, S. P. (2011). Embryology of Angiosperms (5th edition). New Delhi, India: Vikas Publishing House Pvt. Ltd.
4. Bewley, J. D. and Black, M. (1994). Seeds: Physiology of Development and Germination (2nd edition). New York, USA: Plenum Press.
5. Basra, A. S. (2006). Handbook of Seed Science and Technology. New York, USA: Food Products Press.
6. Desai, B. B. (2004). Seeds Handbook: Processing and Storage. New York, USA: Marcel Dekker Inc.
7. Buchanan, B., Gruissem, W. and Jones, R. (2015). Biochemistry and Molecular Biology of Plants. Rockville, USA: American Society of Plant Biologists.
8. Acquaah, G. (2012). Principles of Plant Genetics and Breeding (2nd edition). Oxford, UK: Wiley-Blackwell.
9. Singh, B. D. (2005). Plant Breeding: Principles and Methods. New Delhi, India: Kalyani Publishers.
10. Baskin, C. C. and Baskin, J. M. (2014). Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination (2nd edition). San Diego, USA: Academic Press.

National Education Policy 2020
B.Sc. Seed Technology, III Year (Semester - V)
Major Core Practical Course
Course Code – SSTLCP 1301

Title of the Course: Practical Based on SSTLCT 1301

[No. of Credits: 2 Credit]

[Total:60 Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of plant morphology, reproductive biology, seed structure and germination along with required credits in their Academic Bank of Credits.

Course objectives:

- To acquire laboratory skills in studying floral biology, pollination and seed developmental processes.
- To get practical knowledge of microsporogenesis, megasporogenesis, fertilization and embryogenesis in crop plants.
- To understand seed structure, maturation, dormancy and germination through experimental observations.

Course outcomes:

- Students will understand how to perform practicals related to seed developmental biology including floral and embryological studies.
- They will practically understand processes like fertilization, embryo development, seed formation and maturation.
- Students will gain knowledge about seed dormancy, germination and structural variations in monocot and dicot seeds.

Curriculum details: SSTLCP 1301: Practical Based on SSTLCT 1301

Sr. No	Practical Exercises	Hrs. Required to cover the contents
1.	To study the floral structure of monocot and dicot plants	4
2.	To study anther structure and stages of microsporogenesis	4
3.	To observe pollen grains and study pollen morphology	4
4.	To perform pollen germination test using suitable medium.	4
5.	To study ovule structure and stages of megasporogenesis.	4
6.	To observe stages of embryo development (embryogenesis) using slides/models.	4
7.	To study structure of monocot and dicot seeds.	4
8.	To study internal structure of seeds through sectioning.	4
9.	To identify storage tissues (endosperm/cotyledons) in different seeds	4
10.	To determine seed germination percentage by standard method	4
11.	To study seed dormancy in different crop seeds.	4
12.	To determine seedling vigour index	4
13.	To study abnormal seedlings and their classification.	4

14	To determine seed moisture content by oven dry method	4
15	Visit to seed testing laboratory / research station and submission of report	4
	Total	60

Text Books and Reference Books:

11. Agarwal, P. K. (1994). Principles of Seed Technology. ICAR, New Delhi.
12. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology (4th edition). Springer, New York.
13. Desai, B. B. (2004). Seeds Handbook: Processing and Storage. Marcel Dekker, New York.
14. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press, New York.
15. Bewley, J. D. and Black, M. (1994). Seeds: Physiology of Development and Germination (2nd edition). Plenum Press, New York.
16. Bhojwani, S. S. and Bhatnagar, S. P. (2011). Embryology of Angiosperms (5th edition). Vikas Publishing House, New Delhi.
17. Buchanan, B., Gruissem, W. and Jones, R. (2015). Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists, USA.
18. Baskin, C. C. and Baskin, J. M. (2014). Seeds: Ecology, Biogeography and Evolution of Dormancy and Germination (2nd edition). Academic Press, USA.

National Education Policy 2020
B.Sc. Seed Technology, III Year (Semester - V)
Major Core Theory Course
Course Code – SSTLCT1302

Title of the Course: ADVANCES IN SEED SCIENCE RESEARCH

[No. of Credits: 3 Credit]

[Total:45 Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- Students should have basic knowledge of seed biology, seed physiology, seed production and seed testing.

Course objectives:

- To introduce recent advances and research trends in seed science and technology.
- To understand molecular, physiological and biochemical aspects of seed science.
- To impart knowledge on modern seed enhancement and diagnostic techniques.

Course outcomes:

- Students will understand modern concepts and research approaches in seed science.
- Students will explain advanced techniques like molecular markers, seed priming and diagnostics.
- Students will apply improved seed technologies for enhancing seed quality and productivity.

Curriculum Details: SSTLCT 1302 - Advances in Seed Science Research

Module No.	Unit No.	Topics	Hrs. Required to cover the contents
1.0		ADVANCED SEED BIOLOGY AND PHYSIOLOGY	
	1.1	Seed Ontogeny and Mechanisms of Desiccation Tolerance	12
	1.2	Molecular basis of seed dormancy and germination	
	1.3	Seed ageing, longevity and deterioration processes	
	1.4	Biochemical and membrane changes during seed storage	
2.0		MOLECULAR APPROACHES IN SEED SCIENCE	
	2.1	Molecular markers (RAPD, SSR, SNP) in seed research	11
	2.2	DNA fingerprinting for varietal identification and genetic purity	
	2.3	Role of genomics and proteomics in seed science	
	2.4	Genetically modified seeds and biosafety issues	
3.0		EMERGING AREAS IN SEED SCIENCE RESEARCH	
	3.1	Climate-resilient and stress-tolerant seeds	10
	3.2	Seed banks and conservation of genetic resources	
	3.3	Organic and biofortified seeds	
	3.4	Artificial intelligence and future trends in seed technology	

4.0		SEED POLICY, IPR AND CERTIFICATION SYSTEMS	
	4.1	Indian Seed Act and seed policy framework	12
	4.2	PPV&FR Act and intellectual property rights in seeds	
	4.3	OECD seed certification system (overview)	
	4.4	N-DUS testing for plant variety protection	
		Total	45

Text Books and Reference Books:

1. Agarwal, R. L. (1996). Seed Technology. Oxford & IBH Publishing Co. Pvt. Ltd.
2. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology (4th Ed.). Springer.
3. Bewley, J. D. and Black, M. (1994). Seeds: Physiology of Development and Germination. Plenum Press.
4. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press.
5. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker Inc.
6. Baskin, C. C. and Baskin, J. M. (2014). Seeds: Ecology, Biogeography and Evolution. Academic Press.
7. Buchanan, B., Gruissem, W. and Jones, R. (2015). Biochemistry and Molecular Biology of Plants.
8. Acquaah, G. (2012). Principles of Plant Genetics and Breeding. Wiley-Blackwell.

National Education Policy 2020
B.Sc. Seed Technology, III Year (Semester - V)
Major Core Practical Course
Course Code – SSTLCP 1302

Title of the Course: Practical Based on SSTLCT 1302

[No. of Credits: 2 Credit]

[Total:60 Hours]

Coursepre-requisite:

- Students should have basic practical knowledge of seed testing, seed physiology and laboratory techniques.
- Students should have basic knowledge of laboratory instruments and safety procedures used in seed testing laboratories.
- Students should be familiar with basic biochemical and molecular techniques such as solution preparation, staining methods and handling of laboratory equipment.

Course objectives:

- To provide practical exposure to modern seed science techniques.
- To develop skills in seed quality enhancement and diagnostic methods.
- To understand application of research tools in seed science.

Course outcomes:

- Students will perform advanced seed testing and enhancement techniques.
- Students will understand molecular and biochemical methods (demonstration-based).
- Students will develop research skills in seed science.

Curriculum details: SSTLCP 1302: Practical Based on SSTLCT 1302

Sr. No	Practical Exercises	Hrs. Required to cover the contents
1.	To study and characterize seed priming techniques (hydro-priming and osmopriming) and their effect on seed performance	4
2.	To demonstrate and evaluate seed coating and pelleting technologies for seed quality enhancement	4
3.	To assess seed ageing and deterioration using accelerated ageing test	4
4.	To determine seed viability using tetrazolium chloride (TZ) test	4
5.	To determine and compare seed vigour using standard vigour testing methods	4
6.	To detect and identify seed-borne pathogens using blotter and incubation techniques	4
7.	To demonstrate ELISA and PCR techniques used in seed health testing	4
8.	To isolate and extract genomic DNA from seeds (demonstration)	4
9.	To study and demonstrate synthetic seed production	4
10.	To apply seed fortification and biofertilizer coating techniques	4
11.	To analyze seed quality using digital imaging techniques	4
12.	To study applications of nanotechnology in seed science	4
13.	To analyze genetically modified (GM) seeds and biosafety aspects (case study)	4
14.	To visit a seed testing laboratory or seed industry and submit a report	4
15.	To present a seminar on recent advances in seed science and technology	4
Total		60

Text Books and Reference Books:

9. Agarwal, P. K. (1994). Principles of Seed Technology. ICAR, New Delhi.
10. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology (4th edition). Springer, New York.
11. Bewley, J. D. and Black, M. (1994). Seeds: Physiology of Development and Germination (2nd edition). Plenum Press, New York.
12. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press, New York.
13. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker Inc., New York.
14. ISTA (International Seed Testing Association) (2019). International Rules for Seed Testing. ISTA, Switzerland.
15. Hampton, J. G. and TeKrony, D. M. (1995). Handbook of Vigour Test Methods. ISTA, Zurich.
16. Rao, N. K., Hanson, J., Dulloo, M. E., Ghosh, K., Nowell, D. and Larinde, M. (2006). Manual of Seed Handling in Genebanks. Bioversity International, Rome.
17. Delouche, J. C. and Baskin, C. C. (1973). Accelerated Ageing Techniques for Predicting Seed Storage Potential. Seed Science and Technology Journal.
18. McDonald, M. B. (1999). Seed Deterioration: Physiology, Repair and Assessment. Seed Science Research Journal.

National Education Policy 2020
B.Sc. Seed Technology, III Year (Semester - V)
Major Core Theory Course
Course Code – SSTLIKS 1303

Title of the Course: INDIGENOUS SEED TECHNOLOGY (IKS)

[No. of Credits: 2 Credit]

[Total:30Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of agriculture, seed science, traditional farming practices and biodiversity along with required credits in their Academic Bank of Credits.

Course objectives:

- To impart knowledge about traditional seed systems and indigenous agricultural practices in India.
- To understand seed selection, storage, conservation and exchange practices followed by farming communities.
- To develop awareness about the relevance of IKS in modern seed technology and sustainable agriculture.

Course outcomes:

- Students will understand indigenous seed systems and their role in conservation of biodiversity.
- Students will explain traditional seed storage, treatment and preservation techniques.
- Students will relate indigenous knowledge with modern seed technology for sustainable farming.

Curriculum Details: SSTLIKS 1303 - Indigenous Seed Technology (IKS)

Module No.	Unit No.	Topics	Hrs. Required to cover the contents
1.0		INDIAN TRADITIONAL KNOWLEDGE IN SEED AND AGRICULTURE	08
	1.1	Concept, definition and scope of Indigenous Knowledge Systems (IKS) with special reference to seed technology	
	1.2	Traditional agricultural knowledge in India and role of farmers in seed conservation and crop diversity	
	1.3	Indigenous seed diversity and importance of landraces in Indian agriculture	
	1.4	Ancient agricultural practices related to seed selection and crop cultivation (Vrikshayurveda, Krishi traditions)	
2.0		INDIGENOUS SEED SYSTEMS	07
	2.1	Indigenous seed systems: concept, importance and traditional practices	
	2.2	Seed selection methods used by farmers for maintaining genetic purity	
	2.3	Seed exchange systems and farmer-to-farmer seed networks	
	2.4	Socio-cultural and economic importance of traditional seeds in rural communities	
3.0		TRADITIONAL SEED STORAGE AND CONSERVATION	07
	3.1	Indigenous methods of seed storage and traditional storage structures	

	3.2	Use of natural materials such as neem, ash and plant extracts for seed protection	
	3.3	Seed conservation practices and maintenance of seed viability in traditional systems	
	3.4	Role of community seed banks and conservation of indigenous germplasm	
4.0		IKS IN SEED HEALTH AND SUSTAINABLE AGRICULTURE	
	4.1	Traditional seed treatment practices for pest and disease management	08
	4.2	Role of organic and natural farming in seed production	
	4.3	Integration of indigenous knowledge with modern seed technology	
	4.4	Importance of IKS in sustainable agriculture, climate resilience and food security	
		Total	30

Text Books and Reference Books:

1. Nene, Y. L. (2007). *Indian Agricultural Heritage*. Asian Agri-History Foundation, Secunderabad.
2. Randhawa, M. S. (1980). *A History of Agriculture in India*. ICAR, New Delhi.
3. Dharampal (1983). *Indian Science and Technology in the Eighteenth Century*. Academy of Gandhian Studies, Hyderabad.
4. Cotton, C. M. (1996). *Ethnobotany: Principles and Applications*. John Wiley & Sons, UK.
5. Jain, S. K. (1991). *Dictionary of Indian Folk Medicine and Ethnobotany*. Deep Publications, New Delhi.
6. Posey, D. A. (1999). *Cultural and Spiritual Values of Biodiversity*. UNEP and Intermediate Technology Publications.
7. Gadgil, M. and Guha, R. (1992). *This Fissured Land: An Ecological History of India*. Oxford University Press.
8. Shiva, V. (2005). *Earth Democracy: Justice, Sustainability and Peace*. South End Press.
9. ICAR (2010). *Indigenous Technical Knowledge in Agriculture*. ICAR Publications, New Delhi.
10. Sivarajan, V. V. and Balachandran, I. (1994). *Ayurvedic Drugs and Their Plant Sources*. Oxford & IBH Publishing Co., New Delhi.
11. Kumar, D. and Singh, N. B. (2001). *Plant Resources and Traditional Knowledge*. Scientific Publishers, Jodhpur.
12. Prakash, N. (2007). *Traditional Knowledge Systems in Agriculture*. Pointer Publishers, Jaipur.
13. Singh, J. S., Singh, S. P. and Gupta, S. R. (2006). *Ecology, Environment and Resource Conservation*. Anamaya Publishers, New Delhi.
14. Swaminathan, M. S. (2006). *An Evergreen Revolution*. Academic Foundation, New Delhi.
15. Altieri, M. A. (1995). *Agroecology: The Science of Sustainable Agriculture*. Westview Press, USA.
16. Pretty, J. (2002). *Agri-Culture: Reconnecting People, Land and Nature*. Earthscan Publications, UK.
17. FAO (2004). *Seed Quality Control and Seed Storage*. Food and Agriculture Organization, Rome.
18. Brush, S. B. (2004). *Farmers' Bounty: Locating Crop Diversity in the Contemporary World*. Yale University Press.
19. Upadhyaya, H. D. and Gowda, C. L. L. (2009). *Managing and Enhancing Plant Genetic Resources*. ICAR, New Delhi.

National Education Policy 2020
B.Sc. Seed Technology, III Year (Semester -V)
Major Elective Theory Course
Course Code – SSTLET1301
Title of the Course: SEED PATHOLOGY

[No. of Credits: 2 Credit]

[Total:30Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of plant pathology, microbiology, seed biology and crop production along with required credits in their Academic Bank of Credits.

Course objectives:

- To impart knowledge about seed-borne pathogens and their transmission.
- To understand detection methods and management of seed-borne diseases.
- To develop understanding of seed health testing and disease-free seed production.

Course outcomes:

- Students will understand different seed-borne pathogens and their impact on crop production.
- Students will explain methods for detection and identification of seed-borne diseases.
- Students will apply management practices for production of healthy and disease-free seeds.

Curriculum Details: SSTLET 1301 Seed Pathology

Module No.	Unit No.	Topics	Hrs. Required to cover the contents
1.0	INTRODUCTION TO SEED PATHOLOGY		07
	1.1	Concept, scope and importance of seed pathology in agriculture	
	1.2	Types of seed-borne pathogens (fungi, bacteria, viruses)	
	1.3	Seed infection, contamination and transmission mechanisms	
	1.4	Economic importance of seed-borne diseases in crop plants	
2.0	SEED BORNE DISEASES AND DETECTION METHODS		07
	2.1	Important seed-borne fungal, bacterial and viral diseases of crops	
	2.2	Symptoms and diagnosis of seed-borne diseases	
	2.3	Detection methods: blotter method, agar plate method and grow-out test	
	2.4	Advanced detection techniques and seed health testing procedures	
3.0	SEED HEALTH AND PATHOGEN MANAGEMENT		08
	3.1	Concept of seed health and its importance in agriculture	
	3.2	Methods of seed treatment (physical, chemical and biological)	

	3.3	Use of fungicides, bactericides and bio-control agents	
	3.4	Integrated disease management in seed production systems	
4.0	SEED CERTIFICATION AND DISEASE CONTROL		
	4.1	Seed certification standards for seed health	08
	4.2	Role of seed testing laboratories in disease detection	
	4.3	Quarantine measures and seed health regulations	
	4.4	Recent advances in seed pathology and disease control	
	Total		30

Text Books and Reference Books:

1. Agrios, G. N. (2005). Plant Pathology (5th edition). Elsevier Academic Press, USA.
2. Neergaard, P. (1977). Seed Pathology. Macmillan Press, London.
3. Agarwal, R. L. (1996). Seed Technology. Oxford & IBH Publishing Co., New Delhi.
4. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology (4th edition). Springer, New York.
5. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker, New York.
6. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press, New York.
7. Mathur, S. B. and Kongsdal, O. (2003). Common Laboratory Seed Health Testing Methods for Detecting Fungi. ISTA, Switzerland.
8. Agarwal, V. K. and Sinclair, J. B. (1997). Principles of Seed Pathology. CRC Press, USA.
9. Buchanan, B., Gruissem, W. and Jones, R. (2015). Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists, USA.
10. Singh, R. S. (2005). Plant Diseases. Oxford & IBH Publishing Co., New Delhi.

National Education Policy 2020

B.Sc. Seed Technology, III Year (Semester -V)

Major Elective Practical Course

Course Code – SSTLEP 1301

Title of the Course: Practical Based on SSTLET 1301

[No. of Credits: 2 Credits]

[Total:60Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of plant pathology, microbiology and laboratory techniques along with required credits in their Academic Bank of Credits.

Course objectives:

- To acquire practical skills in detection of seed-borne pathogens.
- To understand seed health testing methods and disease diagnosis.

- To develop skills in seed treatment and disease management.

Course outcomes:

- Students will identify seed-borne pathogens using laboratory techniques.
- They will perform seed health testing and disease detection methods.
- Students will gain knowledge about seed treatment and disease management practices.

Curriculum details: SSTLEP 1301: Practical Based on SSTLET 1301

Sr. No	Practical Exercises	Hrs. Required to cover the contents
1.	Study of seed-borne fungal pathogens under microscope.	4
2.	Detection of seed-borne fungi using blotter method.	4
3.	Detection of seed-borne fungi using agar plate method.	4
4.	Identification of seed-borne bacterial diseases.	4
5.	Study of seed-borne viral diseases (symptoms and transmission).	4
6.	Seed health testing procedures in laboratory.	4
7.	Grow-out test for detection of seed-borne diseases.	4
8.	Study of disease symptoms in infected seedlings.	4
9.	Seed treatment with fungicides and chemicals.	4
10.	Biological seed treatment using bio-agents.	4
11.	Study of seed storage diseases.	4
12.	Observation of infected seeds and pathogen structures.	4
13.	Visit to seed testing laboratory.	4
14.	Visit to plant pathology laboratory.	4
15.	Preparation of report on seed health testing.	4
	Total	60

Text Books and Reference Books:

11. Neergaard, P. (1977). Seed Pathology. Macmillan Press, London.
12. Mathur, S. B. and Kongsdal, O. (2003). Seed Health Testing Methods. ISTA, Switzerland.
13. Agarwal, V. K. and Sinclair, J. B. (1997). Principles of Seed Pathology. CRC Press, USA.
14. Agrios, G. N. (2005). Plant Pathology. Elsevier Academic Press, USA.
15. Singh, R. S. (2005). Plant Diseases. Oxford & IBH Publishing Co., New Delhi.
16. Agarwal, R. L. (1996). Seed Technology. Oxford & IBH Publishing Co., New Delhi.
17. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker, New York.
18. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology. Springer, New York.

National Education Policy 2020
B.Sc. Seed Technology, III Year (Semester -V)
VSC Course

Course Code – SSTLVC 1301

Title of the Course: SEED QUALITY ENHANCEMENT

[No. of Credits: 2 Credit]

[Total:60 Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of seed testing, germination and seed physiology along with required credits in their Academic Bank of Credits.

Course objectives:

- To provide practical exposure to seed enhancement techniques.
- To develop skills in seed priming, coating and treatment methods.
- To understand evaluation of seed quality parameters.

Course outcomes:

- Students will perform seed enhancement treatments and evaluate their effects.
- They will analyze seed vigour and germination improvements.
- Students will understand application of advanced seed technologies.

Curriculum details: SSTLVC 1301: Seed Quality Enhancement

Sr. No	Practical Exercises	Hrs. Required to cover the contents
1.	Determination of seed quality parameters such as germination percentage and vigour index.	4
2.	Study of seed priming techniques (hydro-priming, osmo-priming) and their effects on germination.	4
3.	Seed hardening treatment and evaluation of stress tolerance in seedlings.	4
4.	Seed fortification with nutrients and assessment of seed performance.	4
5.	Preparation and application of seed coating and pelleting materials.	4
6.	Film coating of seeds using polymers and evaluation of seed quality.	4
7.	Study of effect of plant growth regulators on seed germination and seedling growth.	4
8.	Use of biofertilizers in seed treatment and evaluation of seedling vigour.	4
9.	Study of biocontrol agents in seed treatment for disease management.	4
10.	Determination of seed moisture content before and after treatments.	4
11.	Evaluation of seed deterioration and ageing under storage conditions.	4
12.	Comparative study of treated and untreated seeds.	4
13.	Visit to seed processing or seed enhancement unit.	4
14.	Demonstration of advanced seed enhancement technologies.	4
15.	Preparation of report on seed enhancement techniques.	4
	Total	60

Text Books and Reference Books:

1. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology (4th edition). Springer, New York.
2. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press, New York.
3. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker, New York.
4. Agarwal, R. L. (1996). Seed Technology. Oxford & IBH Publishing Co., New Delhi.
5. Bewley, J. D. and Black, M. (1994). Seeds: Physiology of Development and Germination (2nd edition). Plenum Press, New York.
6. Bradford, K. J. and Nonogaki, H. (2007). Seed Development, Dormancy and Germination. Blackwell Publishing, UK.
7. Khan, A. A. (1977). The Physiology and Biochemistry of Seed Dormancy and Germination. Elsevier, Amsterdam.
8. Justice, O. L. and Bass, L. N. (1978). Principles and Practices of Seed Storage. USDA, USA.
9. Heydecker, W. (1973). Seed Ecology. Butterworths, London.
10. Delouche, J. C. (1980). Environmental Effects on Seed Development and Germination. Mississippi State University, USA.
11. Powell, A. A. and Matthews, S. (2005). Seed Vigour and Its Assessment. Blackwell Publishing, UK.
12. McDonald, M. B. (1999). Seed Deterioration: Physiology, Repair and Assessment. Seed Science Research, UK.
13. Taylor, A. G. (2004). Seed Treatments: Chemical, Biological and Physical. CAB International, UK.
14. Halmer, P. (2008). Seed Technology and Seed Enhancement. CABI Publishing, UK.
15. FAO (2011). Guide to Seed Quality Management and Enhancement. Food and Agriculture Organization, Rome.

Semester – VI
B.Sc. III Year
Seed Technology
As Per National Education Policy- 2020

National Education Policy 2020
B.Sc. Seed Technology, III Year (Semester - VI)
Major Core Theory Course
Course Code – SSTLCT1351

Title of the Course: HYBRID SEED PRODUCTION

[No. of Credits: 3 Credit]

[Total:45 Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of plant breeding, genetics, pollination mechanisms and seed production along with required credits in their Academic Bank of Credits.

Course objectives:

- To impart knowledge about principles and techniques of hybrid seed production.
- To understand the concept of heterosis and its application in crop improvement.
- To develop understanding of pollination control, male sterility systems and maintenance of parental lines.

Course outcomes:

- Students will understand the principles and importance of hybrid seed production.
- Students will explain mechanisms of heterosis and hybrid vigor in crop plants.
- Students will apply hybrid seed production techniques in different crop groups.

Curriculum Details: SSTLCT 1351- Hybrid Seed Production

Module No.	Unit No.	Topics	Hrs. Required to cover the contents
1.0		CONCEPT OF HYBRID SEED PRODUCTION	
	1.1	Concept, definition and importance of hybrid seed production in agriculture	12
	1.2	Heterosis and hybrid vigor and their significance in crop improvement	
	1.3	Genetic basis and theories explaining heterosis in plants	
	1.4	Advantages and limitations of hybrid seed production in different crops	
2.0		METHODS AND SYSTEMS OF HYBRID SEED PRODUCTION	
	2.1	Methods of hybrid seed production in self and cross pollinated crops	12
	2.2	Male sterility systems (genetic, cytoplasmic and cytoplasmic-genetic)	
	2.3	Self incompatibility systems and their role in hybrid seed production	
	2.4	Maintenance of parental lines and hybrid seed production systems	
3.0		HYBRID SEED PRODUCTION IN CROPS	
	3.1	Hybrid seed production in cereals (rice, maize, wheat)	11
	3.2	Hybrid seed production in oilseed crops (sunflower, mustard)	
	3.3	Hybrid seed production in vegetable crops	
	3.4	Field management practices for hybrid seed production	

4.0		HARVESTING, PROCESSING AND QUALITY CONTROL	
	4.1	Harvesting and post-harvest handling of hybrid seeds	10
	4.2	Seed processing techniques for hybrid seeds	
	4.3	Seed certification standards and quality control measures	
	4.4	Recent advances in hybrid seed production technology	
		Total	45

Text Books and Reference Books:

1. Singh, B. D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
2. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology (4th edition). Springer, New York.
3. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker, New York.
4. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press, New York.
5. Acquaah, G. (2012). Principles of Plant Genetics and Breeding. Wiley-Blackwell, UK.
6. Agarwal, R. L. (1996). Seed Technology. Oxford & IBH Publishing Co., New Delhi.
7. Allard, R. W. (1999). Principles of Plant Breeding (2nd edition). John Wiley & Sons, USA.
8. Buchanan, B., Gruissem, W. and Jones, R. (2015). Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists, USA.
9. Kelly, A. F. (1988). Seed Production of Agricultural Crops. Longman Group, UK.
10. Singhal, N. C. (2003). Hybrid Seed Production in Field Crops. Kalyani Publishers, New Delhi.

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B.Sc. Seed Technology, III Year (Semester - V)

Major Core Practical Course

Course Code – SSTLCP 1351

Title of the Course: Practical Based on SSTLCT 1351

[No. of Credits: 2 Credit]

[Total:60 Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of plant breeding, floral biology and pollination mechanisms along with required credits in their Academic Bank of Credits.

Course objectives:

- To acquire practical skills in hybridization and pollination techniques.
- To understand maintenance of parental lines and hybrid seed production methods.
- To develop skills in field inspection, seed processing and quality evaluation.

Course outcomes:

- Students will perform hybridization techniques and pollination control methods.
- They will understand male sterility systems and hybrid seed production practices.
- Students will gain knowledge about seed processing, testing and evaluation of hybrid seeds.

Curriculum details: SSTLCP 1351: Practical Based on SSTLCT 1351

Sr. No	Practical Exercises	Hrs. Required to cover the contents
1.	Study of floral biology of selected crop plants	04
2.	Emasculation and artificial pollination techniques.	04
3.	Hybridization in crop plants under field/lab conditions	04
4.	Study of male sterility systems in crop plants.	04
5.	Study of self incompatibility systems.	04
6.	Maintenance of parental lines in hybrid seed production.	04
7.	Hybrid seed production in cereal crops (demonstration).	04
8.	Hybrid seed production in oilseed crops (demonstration).	04
9.	Hybrid seed production in vegetable crops (demonstration).	04
10.	Demonstration of isolation distance in hybrid seed production plots.	04
11.	Field inspection of hybrid seed production plots.	04
12.	Harvesting of hybrid seed crops.	04
13.	Seed processing techniques of hybrid seeds.	04
14.	Seed germination and purity analysis of hybrid seeds	04
15.	Visit to hybrid seed production farm / seed industry and submission of report.	04
	Total	60

Text Books and Reference Books:

11. Singh, B. D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
12. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology. Springer, New York.
13. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker, New York.
14. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press, New York.
15. Acquaah, G. (2012). Principles of Plant Genetics and Breeding. Wiley-Blackwell, UK.
16. Agarwal, P. K. (1994). Principles of Seed Technology. ICAR, New Delhi.
17. Kelly, A. F. (1988). Seed Production of Agricultural Crops. Longman Group, UK.

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B.Sc. Seed Technology, III Year (Semester - VI)

Major Core Theory Course
Course Code – SSTLCT1352

Title of the Course: POST HARVEST HANDLING AND STORAGE OF SEEDS

[No. of Credits: 3 Credit]

[Total:45 Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of seed biology, seed production, seed physiology and seed quality parameters along with required credits in their Academic Bank of Credits.

Course objectives:

- To impart knowledge about post-harvest handling and processing of seeds.
- To understand principles and methods of seed storage and factors affecting seed longevity.
- To develop understanding of safe storage practices and seed quality maintenance.

Course outcomes:

- Students will understand post-harvest handling techniques and seed processing methods.
- Students will explain principles of seed storage and factors affecting seed deterioration.
- Students will apply storage techniques for maintaining seed quality and viability.

Curriculum Details: SSTLCT 1352 - Post Harvest Handling and Storage Of Seeds

Module No.	Unit No.	Topics	Hrs. Required to cover the contents
1.0		POST HARVEST HANDLING AND PROCESSING	
	1.1	Harvesting and threshing of seed crops and their importance in seed quality	12
	1.2	Seed drying methods and drying equipment used in seed processing	
	1.3	Seed cleaning and grading techniques for quality improvement	
	1.4	Seed processing operations and machinery involved in seed industry	
2.0		PRINCIPLES OF SEED STORAGE	
	2.1	Principles and importance of seed storage in maintaining viability	11
	2.2	Factors affecting seed storage such as moisture, temperature and relative humidity	
	2.3	Seed moisture and temperature management during storage	
	2.4	Seed deterioration and ageing processes during storage	
3.0		STORAGE STRUCTURES AND PROTECTION	
	3.1	Types of seed storage structures and their characteristics	10
	3.2	Packaging materials and their role in seed storage	
	3.3	Controlled storage conditions and their applications	
	3.4	Management of seed pests and diseases during storage	

4.0		STORAGE MANAGEMENT AND ADVANCES	
	4.1	Seed storage management practices in seed industry	12
	4.2	Seed inventory management and record keeping	
	4.3	Safe storage practices and quality assurance measures	
	4.4	Recent advances in seed storage technology	
		Total	45

Text Books and Reference Books:

1. Agarwal, R. L. (1996). Seed Technology. Oxford & IBH Publishing Co., New Delhi.
2. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology (4th edition). Springer, New York.
3. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker, New York.
4. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press, New York.
5. Kelly, A. F. (1988). Seed Production of Agricultural Crops. Longman Group, UK.
6. Singhal, N. C. (2003). Hybrid Seed Production in Field Crops. Kalyani Publishers, New Delhi.
7. Bewley, J. D. and Black, M. (1994). Seeds: Physiology of Development and Germination. Plenum Press, New York.
8. Buchanan, B., Gruissem, W. and Jones, R. (2015). Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists, USA.
9. Desai, B. B. (2004). Seeds Handbook: Processing and Storage. Marcel Dekker, New York.
10. Agarwal, P. K. (1994). Principles of Seed Technology. ICAR, New Delhi.

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B.Sc. Seed Technology, III Year (Semester - VI)

Major Core Practical Course

Course Code – SSTLCP 1352

Title of the Course: Practical Based on SSTLCT 1352

[No. of Credits: 2 Credit]

[Total:60 Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of seed biology, seed moisture, germination and seed quality parameters along with required credits in their Academic Bank of Credits.

Course objectives:

- To acquire practical skills in seed processing, drying and storage techniques.
- To understand seed moisture determination, storage structures and quality maintenance.

- To develop skills in handling and management of seeds during storage.

Course outcomes:

- Students will perform seed drying, cleaning and grading operations.
- They will understand seed storage techniques and management practices.
- Students will gain knowledge about maintaining seed quality during storage.

Curriculum details: SSTLCP 1352: Practical Based on SSTLCT 1352

Sr. No	Practical Exercises	Hrs. Required to cover the contents
1.	Study of seed harvesting and threshing methods in different crops	4
2.	Study of seed drying techniques and drying equipment.	4
3.	Operation of seed cleaner and grader	4
4.	Seed grading and separation methods	4
5.	Determination of seed moisture content by oven dry method.	4
6.	Study of different seed storage structures.	4
7.	Study of seed packaging materials.	4
8.	Effect of storage conditions on seed germination.	4
9.	Study of seed deterioration during storage.	4
10.	Management of seed pests and diseases during storage.	4
11.	Demonstration of controlled storage conditions.	4
12.	Study of seed inventory management.	4
13.	Visit to seed processing plant.	4
14.	Visit to seed storage warehouse.	4
15.	Preparation of seed storage management report.	4
	Total	60

Text Books and Reference Books:

11. Agarwal, P. K. (1994). Principles of Seed Technology. ICAR, New Delhi.
12. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker, New York.
13. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology. Springer, New York.
14. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press, New York.
15. Kelly, A. F. (1988). Seed Production of Agricultural Crops. Longman Group, UK.
16. Singhal, N. C. (2003). Hybrid Seed Production in Field Crops. Kalyani Publishers, New Delhi.
17. Bewley, J. D. and Black, M. (1994). Seeds: Physiology of Development and Germination. Plenum Press, New York.

B.Sc. Seed Technology, III Year (Semester - VI)**Major Core Theory Course****Course Code – SSTLCT1353****Title of the Course: SEED LEGISLATION AND CERTIFICATION****[No. of Credits: 2 Credit]****[Total:30 Hours]**

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of seed biology, seed production, seed quality parameters and seed testing procedures along with required credits in their Academic Bank of Credits.

Course objectives:

- To impart knowledge about seed laws, seed legislation and regulatory framework in India.
- To understand procedures and standards of seed certification.
- To develop understanding of seed quality control, labeling and legal aspects of seed marketing.

Course outcomes:

- Students will understand seed laws governing seed production and marketing.
- Students will explain seed certification procedures and quality assurance mechanisms.
- Students will apply certification standards and legal regulations in seed technology.

Curriculum Details: SSTLCT1353 - Seed Legislation and Certification

Module No.	Unit No.	Topics	Hrs. Required to cover the contents
1.0		SEED LEGISLATION IN INDIA	
	1.1	History and development of seed legislation in India and its significance	08
	1.2	Seed Act, 1966 and its amendments	
	1.3	Seed Rules and Seed Control Order and their provisions	
	1.4	International seed regulations and ISTA standards	
2.0		SEED CERTIFICATION SYSTEM	
	2.1	Concept, objectives and importance of seed certification	07
	2.2	Classes of seeds: breeder, foundation and certified seeds	
	2.3	Seed certification agencies and their functions	
	2.4	Field inspection procedures and certification standards	
3.0		SEED QUALITY CONTROL AND REGULATIONS	
	3.1	Seed sampling and testing procedures for certification	07
	3.2	Seed labeling, packaging and regulatory requirements	
	3.3	Seed marketing and distribution regulations	
	3.4	Seed law enforcement and penalties for violations	

4.0		ORGANIZATION AND ADVANCES IN SEED LEGISLATION	
	4.1	Organization and structure of seed certification agencies	08
	4.2	Role of national and state seed corporations in seed certification	
	4.3	Seed quality control laboratories and testing systems	
	4.4	Recent developments and advances in seed legislation and certification	
		Total	30

Text Books and Reference Books:

1. Agarwal, R. L. (1996). Seed Technology. Oxford & IBH Publishing Co., New Delhi.
2. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology (4th edition). Springer, New York.
3. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker, New York.
4. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press, New York.
5. Kelly, A. F. (1988). Seed Production of Agricultural Crops. Longman Group, UK.
6. Singhal, N. C. (2003). Hybrid Seed Production in Field Crops. Kalyani Publishers, New Delhi.
7. Acquaah, G. (2012). Principles of Plant Genetics and Breeding. Wiley-Blackwell, UK.
8. Singh, B. D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
9. PPV & FR Authority (2001). Guidelines for the Conduct of DUS Testing. Government of India.
10. Desai, B. B. (2004). Seeds Handbook: Processing and Storage. Marcel Dekker, New York.

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B.Sc. Seed Technology, III Year (Semester -VI)
 Major Elective Theory Course
 Course Code – **SSTLET 1351**
 Title of the Course: **SEED NEMATOLOGY**

[No. of Credits: 2 Credit]

[Total:30Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of plant pathology, seed biology, microorganisms and crop production along with required credits in their Academic Bank of Credits.

Course objectives:

- To impart knowledge about nematodes associated with seeds and their economic importance.
- To understand identification, life cycle and mode of infection of plant parasitic nematodes.
- To develop understanding of nematode management and seed health protection.

Course outcomes:

- Students will understand seed-borne and soil-borne nematodes affecting crops.
- Students will explain life cycle, symptoms and transmission of nematodes through seeds.
- Students will apply management practices for nematode control in seed production systems.

Curriculum Details: SSTLET 1351 - Seed Nematology

Module No.	Unit No.	Topics	Hrs. Required to cover the contents
1.0		INTRODUCTION TO SEED NEMATOLOGY	
	1.1	Introduction, scope and economic importance of nematodes in agriculture	8
	1.2	General morphology and classification of plant parasitic nematodes	
	1.3	Types of nematodes associated with seeds and planting materials	
	1.4	Nature of damage and symptoms caused by nematodes in crops	
2.0		LIFE CYCLE AND HOST PARASITE RELATIONSHIP	
	2.1	Life cycle and development of plant parasitic nematodes	8
	2.2	Host-parasite relationship and mode of infection	
	2.3	Seed-borne transmission of nematodes in crop plants	
	2.4	Factors influencing nematode infestation and spread	
3.0		IMPORTANT SEED BORNE NEMATODES	
	3.1	Ear cockle nematode of wheat and its management	7
	3.2	Root knot nematodes and their impact on crop production	
	3.3	Cyst nematodes and lesion nematodes in seeds	
	3.4	Symptoms, diagnosis and identification of nematode damage	

4.0		MANAGEMENT OF SEED NEMATODES	
	4.1	Cultural, mechanical and physical methods of nematode control	7
	4.2	Chemical methods and nematicides in seed treatment	
	4.3	Biological control of nematodes using bio-agents	
	4.4	Integrated nematode management in seed production systems	
		Total	30

Text Books and Reference Books:

1. Agrios, G. N. (2005). Plant Pathology (5th edition). Elsevier Academic Press, USA.
2. Nickle, W. R. (1991). Manual of Agricultural Nematology. CRC Press, USA.
3. Southey, J. F. (1986). Laboratory Methods for Work with Plant and Soil Nematodes. HMSO, London.
4. Perry, R. N. and Moens, M. (2006). Plant Nematology. CABI Publishing, UK.
5. Bridge, J. and Starr, J. L. (2007). Plant Nematodes of Agricultural Importance. Academic Press, USA.
6. Sikora, R. A., Coyne, D., Hallmann, J. and Timper, P. (2018). Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CABI Publishing, UK.
7. Agarwal, R. L. (1996). Seed Technology. Oxford & IBH Publishing Co., New Delhi.
8. Copeland, L. O. and McDonald, M. B. (2001). Principles of Seed Science and Technology. Springer, New York.
9. Desai, B. B. (2004). Seeds Handbook. Marcel Dekker, New York.
10. Basra, A. S. (2006). Handbook of Seed Science and Technology. Food Products Press, New York.

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B.Sc. Seed Technology, III Year (Semester -VI)

Major Elective Practical Course

Course Code – SSTLEP 1351

Title of the Course: Practical Based on SSTLET 1351

[No. of Credits: 2 Credit]

[Total:60 Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of plant pathology, microscopy and laboratory techniques along with required credits in their Academic Bank of Credits.

Course objectives:

- To acquire practical skills in identification and extraction of nematodes.

- To understand symptoms and diagnosis of nematode infection in seeds and plants.
- To develop skills in nematode management and seed treatment techniques.

Course outcomes:

- Students will identify different types of nematodes under microscope.
- They will perform extraction and observation techniques for nematodes.
- Students will gain knowledge about nematode management and control methods.

Curriculum details: SSTLEP 1351: Practical Based on SSTLET 1351

Sr. No	Practical Exercises	Hrs. Required to cover the contents
1.	Study of morphology of plant parasitic nematodes under microscope.	4
2.	Extraction of nematodes from soil and seed samples.	4
3.	Identification of different nematode species.	4
4.	Study of life stages of nematodes.	4
5.	Observation of nematode infected plant roots and seeds.	4
6.	Study of symptoms caused by nematodes in crops.	4
7.	Preparation of temporary slides of nematodes.	4
8.	Demonstration of nematode counting techniques	4
9.	Study of ear cockle disease of wheat	4
10.	Study of root knot nematode symptoms.	4
11.	Demonstration of chemical control methods.	4
12.	Demonstration of biological control methods.	4
13.	Seed treatment methods for nematode control.	4
14.	Visit to plant pathology / nematology laboratory.	4
15.	Preparation of practical report on nematode management.	4
	Total	60

Text Books and Reference Books:

11. Southey, J. F. (1986). Laboratory Methods for Work with Plant and Soil Nematodes. HMSO, London.
12. Nickle, W. R. (1991). Manual of Agricultural Nematology. CRC Press, USA.
13. Perry, R. N. and Moens, M. (2006). Plant Nematology. CABI Publishing, UK.
14. Agrios, G. N. (2005). Plant Pathology. Elsevier Academic Press, USA.
15. Bridge, J. and Starr, J. L. (2007). Plant Nematodes of Agricultural Importance. Academic Press, USA.
16. Sikora, R. A. et al. (2018). Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CABI Publishing, UK.
17. Agarwal, R. L. (1996). Seed Technology. Oxford & IBH Publishing Co., New Delhi.

National Education Policy 2020
B.Sc. Seed Technology, III Year (Semester -VI)
VSC Course

Course Code – SSTLVC 1351

Title of the Course: TESTING FOR GENUINENESS AND PURITY OF CULTIVARS

[No. of Credits: 2 Credits]

[Total:60 Hours]

Course pre-requisite:

- The course is offered for students who have completed second year undergraduate programme with Seed Technology as a major subject.
- The students should have basic knowledge of crop morphology, plant breeding and seed testing techniques along with required credits in their Academic Bank of Credits.

Course objectives:

- To provide practical exposure to genetic purity testing methods.
- To develop skills in morphological, biochemical and molecular identification techniques.

Course outcomes:

- Students will identify varietal differences using morphological characters.
- They will perform grow out tests and analyze genetic purity.
- Students will prepare reports and interpret data related to seed purity testing.

Curriculum details: SSTLVC 1351: Testing For Genuineness and Purity Of Cultivars

Sr. No	Practical Exercises	Hrs. Required to cover the contents
1.	Study of morphological descriptors and identification of diagnostic characters in different crop varieties.	04
2.	Identification and comparison of varietal differences in seeds based on external morphology and seed traits.	04
3.	Conduct of Grow Out Test (GOT) for evaluation of genetic purity under field conditions.	04
4.	Recording of observations and scoring of morphological traits during grow out test.	04
5.	Calculation of genetic purity percentage based on grow out test data.	04
6.	Performance of biochemical tests for varietal identification using seed proteins and enzymes.	04
7.	Demonstration of electrophoresis technique for separation of seed proteins in cultivar identification.	04
8.	Study of seed sampling techniques and preparation of representative samples for genetic purity testing.	04
9.	Comparative evaluation of two or more cultivars based on distinct morphological and agronomic characters.	04
10.	Preparation and maintenance of grow out test observation sheets and field records.	04
11.	Analysis and interpretation of data obtained from grow out test experiments.	04
12.	Preparation of detailed report on genetic purity testing and varietal identification.	04
13.	Visit to seed testing laboratory to study procedures of genetic purity analysis.	04
14.	Visit to seed certification agency to understand field inspection and certification procedures	04
15.	Seminar presentation on methods and importance of genetic purity testing in seed technology.	04
Total		60

Text Books and Reference Books:

1. Singh, B. D. (2005). *Plant Breeding: Principles and Methods*. Kalyani Publishers, New Delhi.
2. Copeland, L. O. and McDonald, M. B. (2001). *Principles of Seed Science and Technology* (4th edition). Springer, New York.
3. Desai, B. B. (2004). *Seeds Handbook*. Marcel Dekker, New York.
4. Basra, A. S. (2006). *Handbook of Seed Science and Technology*. Food Products Press, New York.
5. Agarwal, R. L. (1996). *Seed Technology*. Oxford & IBH Publishing Co., New Delhi.
6. Acquaah, G. (2012). *Principles of Plant Genetics and Breeding*. Wiley-Blackwell, UK.
7. Allard, R. W. (1999). *Principles of Plant Breeding* (2nd edition). John Wiley & Sons, USA.
8. PPV & FR Authority (2001). *Guidelines for the Conduct of DUS Testing*. Government of India.
9. ISTA (2015). *International Rules for Seed Testing*. International Seed Testing Association.
10. UPOV (2002). *Guidelines for the Conduct of Tests for Distinctness, Uniformity and Stability (DUS)*. Geneva, Switzerland.
11. Buchanan, B., Gruissem, W. and Jones, R. (2015). *Biochemistry and Molecular Biology of Plants*. American Society of Plant Biologists, USA.
12. Sharma, J. R. (2006). *Statistical and Biometrical Techniques in Plant Breeding*. New Age International Publishers, New Delhi.
13. Singh, P. (2010). *Essential of Plant Breeding*. Kalyani Publishers, New Delhi.
14. FAO (2011). *Seed Quality Control and Certification*. Food and Agriculture Organization, Rome.
15. Louwaars, N. P. (2007). *Seeds of Confusion: The Impact of Policies on Seed Systems*. Wageningen International, Netherlands.

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