Curriculum Book

and

Assessment and Evaluation Scheme

based on

Outcome Based Education (OBE)

and

Choice-Based Credit System (CBCS)

In

M Sc (Agri) in Genetics & Plant Breeding

2 Year Degree Program

Revised as on 01 August 2023
Applicable w.e.f. Academic Session 2023-24

AKS University

Satna 485001, Madhya Pradesh, India

Faculty of Agriculture Science and Technology

Department of Genetics & Plant Breeding

Head of Department
Department of Genetics And Plant Breeding
AKS University
Sherganj, Satna (M.P.)

DEAN
Agriculture Science & Technology
University, Satna (M.P.)

Professor B.A. Chopade
Vice - Chancellor
AKS University
Satna, 485001 (M.P.)

A K S University
Faculty of Agriculture Science and Technology
Department of Genetics and Plant Breeding
Curriculum & Syllabus of M.Sc. (Ag) in Genetics and Plant Breeding (GPB) program
(Revised as on 01 August 2023)

CONTENTS

Sl. No	Item	Page No
1	Forwarding	**ii**
2	Vice Chancellor Massage	**iii**
3	Preface	**iv**
4	Introduction	**1**
5	Vision & Mission of the Department of Genetics & Plant Breeding	**1**
6	Program Educational Objectives (POE)	**2**
7	Program Outcome (POs)	**2**
9	Component of Curriculum	**3**
10	General Course Structure and & Theme	**3**
11	General Course Structure and Credit Distribution	**5**
12	Category-wise Courses	**6**
13	Semester wise Brief of total Cerits and Teaching Hours	**8**
14	Semester wise Curriculum Structure	**9**
15	Detailed Syllabus Semester-I	**11**
16	Detailed Syllabus Semester-II	**104**
17	Detailed Syllabus Semester-III	**188**
18	Detailed Syllabus Semester-IV	**241**

***

AKS University

Faculty of Agriculture Science and Technology
Department of Genetics and Plant Breeding
Curriculum of M. Sc. (Ag) in Genetics and Plant Breeding (GPB) Program
(Revised as on 01 August 2023)

Forwarding

I am thrilled to observe the updated curriculum of the Genetics and Plant Breeding (GPB) Department for M. Sc. (Ag) in Genetics and Plant Breeding (GPB) Program, which seamlessly integrates the most recent genetically plant advancements and adheres to the guidelines set forth by National Core Group and BSMA Committees appointed by ICAR. The revised curriculum also thoughtfully incorporates the directives of NEP-2020 and the Sustainable Development Goals.

The alignment of course outcomes (COs), Programme Outcome (POs) and Programme specific outcomes (PSOs) has been intricately executed, aligning perfectly with the requisites of NEP-2020 and NAAC standards. I hold the belief that this revised syllabus will significantly enhance the skills and employability of our students.

With immense satisfaction, I hereby present the revised curriculum for the M. Sc. (Ag) in Genetics and Plant Breeding (GPB) program for implementation in the upcoming session.

Er. Anant Soni

Pro Chancellor & Chairman

01 August 2023

AKSUniversity, Satna

AKS University
Faculty of Agriculture Science and Technology
Department of Genetics and Plant Breeding
Curriculum of M. Sc. (Ag) in Genetics and Plant Breeding (GPB) Program
(Revised as on 01 August 2023)

From the Desk of the Vice-Chancellor

AKS University is currently undergoing a process to revamp its curriculum into an outcome-based approach, with the aim of enhancing the teaching and learning process. The foundation of quality of quality education lies in the implementation of a curriculum that aligns with both societal and industrial needs, focusing on relevant outcomes. This entails dedicated and inspired faculty members, as well as impactful industry internships.Hence, it is of utmost importance to begin this endeavor by crafting an outcome-based curriculum in collaboration with academia and industry experts. This curriculum design should be informed by the latest technological advancements, market demands, the guidelines outlined in the National Education Policy (NEP) of 2020, National Core Group and BSMA Committees appointed by ICAR, and sustainable goals. I'm delighted to learn that the revised curriculum has been meticulously crafted by the Genetics and Plant Breeding Department, in consultation with an array of experts from the Seed industry, research institutes, and academia. This curriculum effectively integrates the principles outlined in the NEP-2020 guidelines, National Core Group and BSMA Committees appointed by ICAR, as well as sustainable goals. It also adeptly incorporates the latest advancements in development of new varieties and seed production technology. To enhance students' skills, the curriculum integrates Hands on Training, industrial visits, and Training experiences, research and progress. This well-rounded approach ensures that students receive a comprehensive education, fostering their skill development and preparing them for success in the seed industry. I am confident that the updated curriculum for **Genetics and Plant Breeding** will not only enhance students' technical skills but also contribute significantly to their employability. During the process of revising the curriculum, I am pleased to observe that the **Genetics and Plant Breeding** department has diligently adhered to the guidelines provided by the National Core Group and BSMA Committees appointed by ICAR. Additionally, they have maintained a total credit requirement of 75 for **M. Sc. (Ag) in Genetics and Plant Breeding (GPB)** program. It's worth noting that curriculum revision is an ongoing and dynamic process, designed to address the continuous evolution of technological advancements and both local and global concerns. This ensures that the curriculum remains responsive and attuned to the changing landscape of education and industry.

AKS University warmly invites input and suggestions from government agriculture departments farmers, entrepreneurs, industry experts and technocrats and Alumni students to enhance the curriculum and make it more student-centered. Your valuable insights will greatly contribute to shaping an education that best serves the needs and aspirations of our students.

Professor B. A. Chopade

Vice Chancellor

AKS University, Satna

01 August

AKS University
Faculty of Agriculture Science and Technology
Department of Genetics and Plant Breeding
Curriculum of M. Sc. (Ag) in Genetics and Plant Breeding (GPB) Program
(Revised as on 01 August 2023)

Preface

As part of our commitment to ongoing enhancement, the Department of **Genetics and Plant Breeding** consistently reviews and updates its **M. Sc. (Ag) in Genetics and Plant Breeding (GPB)** program curriculum as per recommendation and need of ICAR. Through this process, we ensure that the curriculum remains aligned with the latest technological advancements, as well as local and global industrial and social demands.

During this procedure, the existing curriculum for the **M. Sc. (Ag) in Genetics and Plant Breeding (GPB)** Program undergoes evaluation by a panel of technocrats, industry specialists, and academics. Following meticulous scrutiny, the revised curriculum has been formulated and is set to be implemented starting from August 01, 2023. This implementation is contingent upon the endorsement of the curriculum by the University's Board of Studies and Governing Body.

This curriculum closely adheres to the National Core Group and BSMA Committees appointed by ICAR, syllabus distributed in August 2021. It seamlessly integrates the guidelines set forth by the Ministry of Higher Education, Government of India, through NEP2020, as well as the principles of Sustainable Development Goals. In order to foster the holistic skill development of students, a range of practical activities, including Hands-On Training, Industrial Visits, Project planning and execution, Report Writing, Seminars, and Industrial Training, have been incorporated.

For each course, a thorough mapping of Course Outcomes, Program Outcomes, and Programme Specific Outcomes has been undertaken. As the course syllabus is being meticulously developed, various elements such as session outcomes, laboratory instruction, classroom instruction, self-learning activities, assignments, and mini projects are meticulously outlined.

We hold the belief that this dynamic curriculum will undoubtedly enhance independent thinking, skills, and overall employability of the students.

Dr.S. S. Tomar

DEAN (FAST)

AKS University Satna

01August2023

AKS University
Faculty of Agriculture Science &Technology
Department of Genetics & Plant Breeding
Curriculum of M. Sc. (Ag) in Genetics and Plant Breeding (GPB) Program
(Revised as on 01 August 2023)

Introduction:

Plant breeding is the science of changing the traits of plants in order to produce desired characteristics. It has been used to improve the quality of nutrition in products for humans and animals. Plant breeding can be accomplished through many different techniques ranging from simply selecting plants with desirable characteristics for propagation, to methods that make use of knowledge of genetics and chromosomes, to more complex molecular techniques (see cultigens and cultivar). Genes in plant are what determine what type of qualitative or quantitative traits it will have. Plant breeders strive to create a specific outcome of plants and potentially new plant varieties.

Plant breeding has been practiced for thousands of years, since near the beginning of human civilizations. It is practiced worldwide by individuals such as gardeners and farmers and by professional plant breeders employed by organizations such as government institutions, universities, crop-specific industry associations or research centers.

International development agencies believe that breeding new crops is important for ensuring food security by developing new varieties that are higher yielding, disease resistant, drought tolerant regionally adapted different environments and growing conditions.

Vision:

To impart quality education in field the of Genetics & Plant Breeding to UG and PG students and to develop high yielding crop Varieties with biotic, abiotic stress resistance, climate resilient and high quality.

Mission:

M 01: To impart quality teaching in Genetics and Plant Breeding related subjects in UG and PG levels.
M 02: To guide quality research to M.Sc. and Ph.D. students in the field of Genetics & Plant breeding which will inculcate competence for higher education and societal needs?
M 03: To impart capacity building to the students and farmers through trainings and guidance.
M 04: To collect, evaluate, maintain and characterize the genetic resources of field crops.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO 01: To create human resources that is knowledgeable about the most recent crop breeding practices and methodologies.
PEO 02: To prepare the students with scientific knowledge about crop quality improvement using conventional and modern biotechnological tools viz, Marker Assisted Selection, Tissue culture and Transgenic approaches.
POE 03: To aware the students about recent technologies of crop improvement and inspire the students for higher education and research at an advanced level in the field of genetics & plant breeding.
PEO 04: To provide postgraduate students of genetics & plant breeding with the scientific training necessary to alter the genetic make-up of plants for improved resistance to biotic and abiotic challenges, while both preserving the genetic pool and discovering new genetic resources.

Program Outcomes (POs)

M. Sc. (Ag) in Genetics and Plant Breeding (GPB) Post Graduate will able to perform:

PO 1: To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.

PO 2: The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques**.**

PO-3: To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.

PO-4: Disseminate comprehensive practical understanding of crop hybridization, in- bred line development, and germplasm screening.

Program Specific Outcomes (PSOs)

On completion of M. Sc. (Ag) in Genetics and Plant Breeding (GPB) program, the students will achieve the following program specific outcomes:

PSO 1: This program will provide opportunities for students to understand the major constraints of crop production and their solutions.

PSO 2: The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.

PSO-3: To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture

PSO-4: To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to contemporary agriculture.

Consistency/Mapping of PEOs with Mission of the Department

PEO	M1	M2	M3	M4
PEO-1	3	3	2	2
PEO-2	2	3	1	3
PEO-3	2	3	3	3
PEO-4	3	3	3	2

1*: Slight (Low), 2: Moderate (Medium), 3: Substantial (High) "-": No correlation*

Components of the Curriculum
M.Sc. (Ag.) in Genetics and Plant Breeding
(Two Year Master Degree Programme)
Requirement of Credit Hours for Award of the Degree

S. No	Nature of Courses	Credit Hours
1	Major courses	21
2	Minor Courses	11
3	Supporting Courses	7
4	Common Courses	5
5	Master Seminar	1
6	Master Research	30
	Total	75

Major Subject: The subject (Department / Discipline) in which a student takes admission.
Minor Subject: The Subject closely related to a student's major subject**.**
Supporting Subject: The Subject not related to the major subject. It could be any subject considered relevant for students research work or necessary for building hisoverall competence**.**
Common Courses: The following courses (one credit each) will be offered to all students undergoing Master's degree programme:

1. Library and Information Services
2. Tehnical Writing and Communications Skills
3. Inellectual Property and its management in Agriculture
4. Basc Concepts in Laboratory Techniques
5. Agricultural Research, Research Ethics and Rural Development Programmes

GENERAL COURSE STRUCTURE & THEME

1. Definition of Credit

1Hr.Tutorial (T) per week	1 Credit
2Hours Practical (P) per week	1 Credit

2. Range of Credits:

In the light of the fact that a typical Model Two-year Post Graduate degree program in Agricultural has about 75 credits, the total number of credits proposed for the Two-year M.Sc. (Ag.) in Genetics & Plant Breeding is kept as PG Restructuring committee for ICAR 169 considering NEP-20 and NAAC guidelines.

3. Structure of PG Program in Genetics & Plant Breeding:

The structure of PG program in Genetics & Plant Breeding shall have essentially the following categories of courses with the breakup of credits as given:

(Program curriculum grouping based on course components)

Sl No	Course Component	% of total number of credits of the Program	Total number of Credits
1	Basic Sciences (BSC)	14.20	24
2	Genetics & Plant Breeding (GPB)	14.70	21
3	Humanities and Social Sciences (HMSC)	7.10	12
4	Program Core (PCC)	39.05	66
5	Program Electives (PEC)	5.33	9
6	Open Electives (OEC)	5.33	9
7	Project(s)(PRC)/On job Plant Training (OJT)	10.06	17
9	Seminar (PSC)	1.78	3
10	Indian Knowledge System	1.18	2
11	Sustainable Development Goal	1.18	2
	Total	100.00	**72**

General Course Structure and Credit Distribution
Curriculum of M.Sc. (Ag.) in Genetics & Plant Breeding

Semester-I		**Semester-II**	
Course Title	Credit	Course Title	Credit
1. Principles of Plant Breeding	2:0:1 =3	1. Principles of Cytogenetics	2:0:1 =3
2. Fundamentals of Quantitative Genetics	2:0:1 =3	2. Molecular Breeding and Bioinformatics	2:0:1=3
3. Seed Production and Certification	1:0:1 =2	3. MUTAGENESIS AND MUTATION BREEDING	2:0:1=3
4. Crop Breeding I (Kharif Crops)	2:0:1 =3	4. CROP BREEDING-II (RABI CROPS)	2:0:1 =3
5. Statistical Methods for Applied Science	3:0:1 =4	5. Experimental Design	2:0:1 =3
6. Library and Information Services	0:0:1 =1	6. Intellectual Property and Its Management in Agriculture	1:0:0 =1
7. Technical Writing and Communication Skills	0:0:1 =1	7. Basic Concepts in Laboratory Techniques	0:0:1 =1
Total Credit	**17**	**Total Credit**	**17**
Semester-III		**Semester- IV**	
Course Title	Credit	Course Title	Credit
1. Breeding for Quality and Special Traits	2:0:1 =3	1. Thesis/Research	0:0:20 =20
2. Breeding for Stress Resistance and Climate Change	2:0:1 =3		
3. Agricultural Research, Research Ethics and Rural Development Programs	1:0:0 =1		
4. Seminar	0:0:1 =1		
5. Thesis/Research	0:0:10 =10		
Total Credit	**18**	**Total Credit**	**20**

Category-wise Courses

COMMON COURSE

(2compulsory + 2 others)

(i) Common Course: 5, Credits: 5

Sl.	Code No.	Subject	Semester	Credits
1	PGS 501	Library and Information Services	1	0:0:1 =1
2	PGS 502	Technical Writing and Communication Skills	1	0:0:1 =1
3	PGS 503	Intellectual Property and Its Management in Agriculture	2	1:0:0 =1
4	PGS 504	Basic Concepts in Laboratory Techniques	2	0:0:1 =1
5	PGS 505	Agricultural Research, Research Ethics and Rural Development Programs	3	1:0:0 =1
			Total Credits:	**05**

Basic Supporting Courses (BSC) (TOTAL 2)

Sl.	Code No.	Subject	Semester	Credits
1	STAT-502	Statistical Methods for Applied Science	1	3:0:1 =4
2	STAT-511	Experimental Design	2	2:0:1 =3
			Total Credits:	**07**

PROFESSIONAL MAJOR CORE COURSES [PMCC] (Total 7)

Sl.	Code No.	Subject	Semester	Credits
1	GPB 501*	Principles of Genetics	1	2:0:1 =3
2	GPB 502*	Principles of Plant Breeding	1	2:0:1 =3
3	GPB503*	Fundamentals of Quantitative Genetics	1	2:0:1 =3
4	GPB 505	Principles of Cytogenetics	2	2:0:1 =3
5	GPB 506	Molecular Breeding and Bioinformatics	2	2:0:1 =3
6	GPB 507	Breeding for Quality and Special Traits	3	2:0:1 =3
7	GPB 516	Breeding for Stress Resistance and Climate Change	3	2:0:1 =3
			Total Credits:	**21**

PROFESSIONAL MINOR CORE COURSES [PMCC] (Total 4)

Sl.	Code No.	Subject	Semester	Credits
1	GPB 510	Seed Production and Certification	1	1:0:1 =2
2	GPB 510	Crop Breeding-I (Kharif Crops)	1	2:0:1 =3
3	GPB 508	Mutagenesis and Mutation Breeding	2	2:0:1 =3
4	GPB 512	Crop Breeding-II (Rabi Crops)	2	2:0:1 =3
			Total Credits:	**11**

MASTER RESEARCH / SEMINAR

Sl.	Code No.	Subject	Semester	Credits
1	GPB 591	Seminar	3	0:0:1 =1
2	GPB 599	Thesis/Research	3	0:0:10 =10
3	GPB 599	Thesis/Research	4	0:0:20 =20
			Total Credits:	**31**

Induction Program

Induction program for student has to be offered right at the start of the first year. It is mandatory. AKS University has design an induction program for 1st year student, details are below:

Physical activity

1. Creative Arts
2. Universal Human Values
3. Literary
4. Proficiency Modules
5. Lectures by Eminent People
6. Visits to local Areas
7. Familiarization to Dept./Branch & Innovations

Evaluation Scheme:

For Theory Courses:

1. The weight age of Internal assessment is 50% and
2. End Semester Exam is 50%

The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass

For Practical Courses:

1. The weight age of Internal assessment is 50% and
2. End Semester Examis50%

The student has to obtain at least 40% marks individually both in internal assessment and end semester exams to pass.

Evaluation is based on work done, quality of report, performance in viva-voce, presentation etc.

Semester wise Course Structure
Semester wise Brief of total Cerits and Teaching Hours

Semester	L	T	P	Total Hour	Total Credit
Semester-I	7	0	10	38	17
Semester-II	6	0	11	23	17
Semester-III	3	0	15	31	18
Semester-IV	0	0	20	40	20
Total	16	0	56	132	72

Program: M.Sc. (Ag.) in Genetics and Plant Breeding
2 years Curriculum Structure
Total Credit (2 year Course) 75
Semester wise Curriculum Structure
(L= Lecture, T= Tutorial, P= Practical & H = Hours per week)

SEMESTER-I

S.N.	Category	Code	Course Title	L	T	P	Total H	Credits
1	**Major Courses**	GPB 501*	Principles of Genetics	2	-	1	4	3
2	**Major Courses**	GPB 502*	Principles of Plant Breeding	2	-	1	4	3
3	**Major Courses**	GPB503*	Fundamentals of Quantitative Genetics	2	-	1	4	3
4	**Minor Courses**	GPB510	Seed Production and Certification	1	-	1	3	2
5	**Minor Courses**	GPB510	Crop Breeding-I (Kharif Crops)	2	-	1	4	3
6	**Supporting Courses**	STAT 502	Statistical Methods for Applied Sciences	3	-	1	5	4
7	**Common Courses**	PGS 501	Library and Information Services	-	-	1	2	1
8	**Common Courses**	PGS 502	Technical Writing and Communications Skills	-	-	1	2	1
Total				**12**	**-**	**7**	**28**	**20**

SEMESTER-II

S.N.	Category	Code	Course Title	L	T	P	Total H	Credits
1	**Major Courses**	GPB 505	Principles of Cytogenetics	2	-	1	4	3
2	**Major Courses**	GPB 506	Molecular Breeding and Bioinformatics	2	-	1	4	3
3	**Minor Courses**	GPB 508	Mutagenesis and Mutation Breeding	2	-	1	4	3
4	**Minor Courses**	GPB 512	Crop Breeding-II (Rabi Crops)	2	-	1	4	3
5	**Supporting Courses**	STAT 511	Experimental Design	2	-	1	4	3
6	**Common Courses**	PGS 503	Intellectual Property and its Management in Agriculture	1	-	-	1	1
7	**Common Courses**	PGS 504	Basic Concepts in Laboratory Techniques	-	-	1	2	1
Total				**11**	**-**	**6**	**23**	**17**

SEMESTER-III

S.N.	Category	Code	Course Title	L	T	P	Total H	Credits
1	**Major Courses**	GPB 507	Breeding for Quality and Special Traits	2	-	1	4	3
2	**Major Courses**	GPB 516	Breeding for Stress Resistance and Climate Change	2	-	1	4	3
3	**Major Courses**	GPB 591	Master Seminar	-	1	-	1	1
4	**Major Courses**	GPB 599	Master Research	-	-	10	20	10
5	**Common Courses**	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	1	-	-	1	1
Total				**5**	**1**	**12**	**29**	**17**

SEMESTER-IV

S.N.	Category	Code	Course Title	L	T	P	Total H	Credits
1	**Major Courses**	GPB 599	Master Research	-	-	20	1000	20
Total				**-**	**-**	**20**	**1000**	**20**

Detailed Syllabus
M.Sc. Ag. in Genetics & Plant breeding
Semester- I

Course Code: **GPB 501***

Course Title: **Principle of Genetics**

Pre- requisite: Student should have basic knowledge of principles of heredity, Mendelian population, Organization of DNA and RNA and Protein biosynthesis.

Rationale: Genes are the backbone of all crop improvement activities. Their chemical structure and physical inheritance are pivotal for any breeding program. Therefore, it has to be the core course for master's degree in Genetics and Plant Breeding. This course is aimed at understanding the basic concepts of inheritance of genetic traits, helping students to develop their analytical, quantitative and problem-solving skills from classical to molecular genetics.

Course Outcomes:

GPB501.1: To understand basic principles of heredity and variation.

GPB501.2: Students will have the ability to apply the knowledge gained about Mendelian population, Random mating population and Hardy-Weinberg equilibrium.

GPB501.3: Student will be able to understand genetic material, Gene isolation, synthesis and cloning

GPB501.4: Understanding on genomics and proteomics, mutation and gene expression

GPB501.5: Idea on DNA extraction and PCR amplification

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
Program Core (PCC)	GPB 501*	Principle of Genetics	2	2	0	0	2+2 = 4	(2+1) = 3

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+ CAT+AT)		
PCC	GPB 501*	Principle of Genetics	15	30	0	0	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB 501.1: To understand basic principles of heredity and variation.

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	**8**
SW	**2**
SL	**1**
Total	**17**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1. Understand Beginning of genetics, early concepts of inheritance, **SO1.2.** Understand Mendel's laws and discussion on Mendel's paper. **SO1.3.** Understand Chromosomal theory of inheritance. **SO1.4.** Understand Multiple alleles, Gene interactions, Sex determination, differentiation and sex-linkage. **SO1.5.** Understand Sex-influenced and sex-limited traits; Linkage-detection, estimation. **SO1.6.** Understand recombination and genetic mapping in eukaryotes, Somatic cell genetics and extra chromosomal inheritance.	1. To study Laboratory exercises in probability 2. To study chi-square. 3. To study about demonstration of genetic principles using laboratory organisms. 4. To study about Chromosome mapping using three-point test cross	**Unit-1. Beginning of genetics, Mendel's laws, Chromosomal theory, Sex determination, Recombination and genetic mapping in eukaryotes.** 1.1. Beginning of genetics, early concepts of inheritance. 1.2. Mendel's laws and discussion on Mendel's paper. 1.3. Chromosomal theory of inheritance. 1.4. Multiple alleles, Gene interactions, Sex determination, differentiation and sex-linkage. 1.5. Sex-influenced and sex-limited traits; Linkage-detection, estimation. 1.6. Recombination and genetic mapping in eukaryotes, Somatic cell genetics and extra chromosomal inheritance.	1. Mendel's laws of inheritance. 2. Sex determination ex-influenced and sex-limited traits

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Concepts of inheritance, sex determination, and somatic cell genetics and extra chromosomal inheritance.

b. Mini Project:

i. Monohybrid and Dihybrid Test cross with suitable example.

c. Other Activities (Specify): Note on the gene interaction its types and different Sex determination mechanisms in different living organism.

GPB 501.2: Students will have the ability to apply the knowledge gained about Mendelian population, Random mating population and Hardy-Weinberg equilibrium.

Approximate Hours

Item	Approximate Hours
CI	**4**
LI	**0**
SW	**2**
SL	**1**
Total	**7**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Understand the Mendelian population **SO2.2.** Understand the Random mating population **SO2.3.** Understand the Frequencies of genes and genotypes **SO2.4.** Understand the Causes of change: Hardy-Weinberg equilibrium.		**Unit-2. Mendelian and Random mating population.** 2.1. Mendelian population, 2.2. Random mating population, 2.3. Frequencies of genes and genotypes, 2.4. Causes of change: Hardy-Weinberg equilibrium.	**1.** Frequencies of genes and genotypes, **2.** Hardy-Weinberg Law.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

1. Frequencies of genes and genotypes.

b. Mini Project:

1. Causes of change: Hardy-Weinberg equilibrium.

c. Other Activities (Specify):

GPB501.3: Student will be able to understand genetic material, Gene isolation, synthesis and cloning

Item	Approximate Hours
CI	**8**
LI	**4**
SW	**2**
SL	**1**
Total	**15**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO 3.1. Understand the Nature, structure and replication of the genetic material **SO 3.2.** Organization of DNA in chromosomes, Genetic code **SO 3.3.** Understand the Protein biosynthesis, Genetic fine structure analysis, **SO 3.4.** Understand the Allelic complementation, Split genes, overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters **SO 3.5.** Understand the Regulation of gene activity in prokaryotes and eukaryotes equilibrium. **SO 3.6.** Understand the Molecular mechanisms of mutation, repair and suppression. **SO 3.7.** Understand the Bacterial plasmids, insertion (IS) and transposable (Tn) elements **SO 3.8.** Understand the Molecular chaperones and gene expression, RNA editing.	1. To study Tetrad analysis 2. To study Induction and detection of mutations through genetic tests	**Unit 3 Structure, replication and Organization of DNA, Protein biosynthesis and Regulation of gene.** **3.1.** Nature, structure and replication of the genetic material. **3.2.** Organization of DNA in chromosomes, Genetic code. **3.3.** Protein biosynthesis, Genetic fine structure analysis **3.**4. Allelic complementation, Split genes, overlapping genes, Pseudogenes, Oncogenes, Gene families and clusters. **3.5.** Regulation of gene activity in prokaryotes and eukaryotes. **3.6.** Molecular mechanisms of mutation, repair and suppression **3.7.** Bacterial plasmids, insertion (IS) and transposable (Tn) elements. **3.8.** Molecular chaperones and gene expression, RNA editing.	1. Genetic code and Protein biosynthesis, 2. Molecular mechanisms of mutation

SW-3 Suggested Sessional Work (SW):

a. Assignments:
Organization of DNA in chromosomes, Genetic code and Protein biosynthesis.

b. Mini Project:
a. DNA and RNA model.

c. Other Activities (Specify):

GPB501.4: Understanding on genomics and proteomics, mutation and gene expression

Item	Approximate Hours
CI	**6**
LI	**8**
SW	**2**
SL	**1**
Total	**17**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1. Understand the Gene isolation, cDNA libraries and PCR based cloning. **SO4.2.** Understand the Gene isolation, synthesis and cloning. **SO4.3.** Understand the Genomic and cDNA libraries. **SO4.4.** Understand the PCR based cloning, positional cloning. **SO4.5.** Understand the Nucleic acid hybridization and immunochemical detection; DNA sequencing. **SO4.6.** Micro-RNAs (miRNAs).	1. To study DNA extraction and 2. To study gene amplification by PCR technique. 3. To study amplification by Electrophoresis. 4. To study basic principles and running of amplified DNA	**Unit 4. Gene isolation, cDNA libraries and PCR based cloning.** 4.1. Gene isolation, synthesis and cloning. 4.2. Genomic and cDNA libraries, 4.3. PCR based cloning, positional cloning. 4.4. Nucleic acid hybridization and immunochemical detection; DNA sequencing. 4.5. DNA restriction and modification, Anti-sense RNA and ribozymes. 4.6. Micro-RNAs (miRNAs).	**3.** cDNA libraries and PCR based cloning. **4.** DNA restriction and modification Anti-sense RNA and ribozymes

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Nucleic acid hybridization and immunochemical detection.

b. Mini Project:

i. PCR based cloning, positional cloning.

c. Other Activities (Specify):

GPB501.5: Idea on DNA extraction and PCR amplification

Item	Approximate Hours
CI	**6**
LI	**10**
SW	**2**
SL	**1**
Total	**19**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Understand the Genomics and proteomics; metagenomics. **SO5.2.** Transgenic bacteria and bioethics. **SO5.3.** Understand the Gene silencing. **SO5.4.** Understand the genetics of mitochondria and chloroplasts. **SO5.5.** Understand the Concepts of Eugenics. **SO5.6.** Understand the Epigenetics, Genetic disorders.	1. To study Extraction of proteins and isozymes 2. To study Use of Agrobacterium mediated method 3. To study Use of Biolistic gun method. 4. To study Detection of transgenes in the exposed plant material. 5. Visit to transgenic glasshouse and learning the practical considerations	**Unit-5. Genomics, Transgenic bacteria, Gene silencing, and Concepts of Eugenics.** 5.1. Genomics and proteomics; metagenomics. 5.2. Transgenic bacteria and bioethics. 5.3. Gene silencing. 5.4. Genetics of mitochondria and chloroplasts. 5.5. Concepts of Eugenics. 5.6. Epigenetics, Genetic disorders.	1. Transgenic bacteria and bioethics. 2. Genetics of mitochondria and chloroplasts.

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Genomics and proteomics; metagenomics.

b. Mini Project:

ii. Concepts of Eugenics. Epigenetics, Genetic disorders.

c. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
GPB501.1: To understand basic principles of heredity and variation.	**14**	**2**	**1**	**17**
GPB501.2: Students will have the ability to apply the knowledge gained about Mendelian population, Random mating population and Hardy-Weinberg equilibrium.	**4**	**2**	**1**	**7**
GPB501.3: Student will be able to understand genetic material, Gene isolation, synthesis and cloning	**12**	**2**	**1**	**15**
GPB501.4: Understanding on genomics and proteomics, mutation and gene expression.	**14**	**2**	**1**	**17**
GPB501.5: Idea on DNA extraction and PCR amplification.	**16**	**2**	**1**	**19**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	**Beginning of genetics, Mendel's laws, Chromosomal theory, Sex determination, Recombination and genetic mapping in eukaryotes.**	**3**	**4**	**3**	**10**
CO 2	**Mendelian and Random mating population.**	**2**	**4**	**4**	**10**
CO 3	**Structure, replication and Organization of DNA, Protein biosynthesis and Regulation of gene.**	**4**	**3**	**3**	**10**
CO 4	**Gene isolation, cDNA libraries and PCR based cloning.**	**3**	**2**	**5**	**10**
CO 5	**Genomics, Transgenic bacteria, Gene silencing, and Concepts of Eugenics.**	**5**	**3**	**2**	**10**
Total		**17**	**16**	**17**	**50**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Principle of Genetics will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Group Discussion
3. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
4. Brainstorming
5. Power point presentation
6. Chalk and Board

7. Smart board
8. Assignments, quiz
9. Group tasks, student's presentations

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Genetics: "Analysis of Genes and Genomes"	Daniel L.H. and Maryellen R.	Laxmi Publications	2011
2	Principles of Genetics.	Gardner EJ and Snustad DP.	John Wiley and Sons. 8th ed.	2006
3	Concepts of Genetics.	Klug WS and Cummings MR.	Peterson Edu. Pearson Education India; Tenth edition	2003
4	Genes XII.	Lewin B.	Jones and Bartlett Publ. (International Edition) Paperback,	2008, 2018
5	Genetics.	Russell PJ.	The Benzamin/ Cummings Publ. Co	1998
6	Genetics.	Singh BD.	Kalyani Publishers (2nd Revised Edition)	2009
7	Genetics.	Snustad DP and Simmons MJ.	4th Ed. John Wiley and Sons. 6th Edition International Student Version edition	2006
8	Genetics.	Stansfield WD.	Schaum Outline Series Mc Graw Hill	1991
9	Genetics (III Ed).	Strickberger MW.	Prentice Hall, New Delhi, India; 3rd ed.,	2005, 2015
10	Principles of Genetics.	Tamarin RH.	Wm. C. Brown Publs., McGraw Hill Education; 7 edition	1999
11	Practical Manual on Basic and Applied Genetics.	Uppal S, Yadav R, Singh S and Saharan RP.	Dept. of Genetics, CCS HAU Hisar.	2005

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
4. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
5. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
6. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
7. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
8. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
9. Mr. Ankit Kumar Bhagat, Teaching Associate, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology, AKS University

Cos, POs and PSOs Mapping
Course Code: GPB 501
Course Title: - Principle of Genetics

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their sol	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								contemporary agriculture.					utions.			to contemporary agriculture.		
GPB501.1: To understand basic principles of heredity and variation.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB501.2: Students will have the ability to apply the knowledge gained about Mendelian population, Random mating population and Hardy-Weinberg equili	1	2	1	2	2	1	1	2	3	2	3	2	1	1	1	1	1	1

brium.																		
GPB501.3: Student will be able to understand genetic material, Gene isolation, synthesis and cloning	1	2	3	2	2	1	1	2	2	3	2	1	1	1	1	1	1	1
GPB501.4: Understanding on genomics and proteomics, mutation and gene expression..	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1
GPB501.5: Idea on DNA extraction and PCR amplification.	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Principle of Genetics

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB501.1:** To understand basic principles of heredity and variation.	**SO1.1 SO1.2 SO1.3**		Unit-1. Beginning of genetics, Mendel's laws, Chromosomal theory, Sex determination, Recombination and genetic mapping in eukaryotes**.**1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB501.2:** Students will have the ability to apply the knowledge gained about Mendelian population, Random mating population and Hardy-Weinberg equilibrium.	**SO2.1 SO2.2 SO2.3 SO2.4 SO2.5**	To study Extraction of proteins and isozymes	Mendelian and Random mating population 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB501.3:** Student will be able to understand genetic material, Gene isolation, synthesis and cloning	**SO3.1 SO3.2 SO3.3**	To study Use of Agrobacterium mediated method	Structure, replication and Organization of DNA, Protein biosynthesis and Regulation of gene.3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB501.4:** Understanding on genomics and proteomics, mutation and gene expression.	**SO4.1 SO4.2**	To study Use of Biolistic gun method.	Gene isolation, cDNA libraries and PCR based cloning 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB501.5:** Idea on DNA extraction and PCR amplification.	**SO5.1 SO5.2**		Genomics, Transgenic bacteria, Gene silencing, and Concepts of Eugenics**.** 5.1, 5.2	As mentioned in page number ……

Semester- I

Course Code: **GPB 502***

Course Title: **Principles of Plant Breeding**

Pre- requisite: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling. The course will also acquaint the student with importance of floral biology, mutation breeding and participatory plant breeding, etc.

Rationale: Development of plant variety is the ultimate aim of any plant breeding program. A post graduate in the subject of agriculture must know what are the different selection methods, techniques and related crop improvement strategies. Further, knowledge of genetic resources, evolution and their role in development of noble varieties is the need of the hour.

Course Outcomes:

GPB502.1: The knowledge of this course will enable the student to know Patterns of Evolution, Centre of Origin, and Agro-biodiversity with their significance.

GPB502.2: The knowledge of this course will enable the student to know Genetic basis of breeding, variability, its components and combining ability.

GPB502.3: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in self-pollinated crops.

GPB502.4: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in cross-pollinated crops.

GPB502.5: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in asexually/ clonally propagated crops

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
Program Core (PCC)	GPB 502*	Principles of Plant Breeding	2	2	0	0	4	(2+1) = 3

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks	Class Test 2 (2 best out of 3) 10 marks each	Seminar one	Class Activity any one	Class Attendance (AT)	Total Marks (CA+CT+SA+		

			each (CA)	**(CT)**		**(CAT)**		**CAT+AT)**	(ESA)	
PCC	GPB 502*	Principles of Plant Breeding	15	30	0	0	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB502.1: The knowledge of this course will enable the student to know Patterns of Evolution, Centre of Origin, and Agro-biodiversity with their significance.

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	**0**
SW	**2**
SL	**1**
Total	**9**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1. Students are able to explain the Early Plant Breeding. **SO1.2.** Students are able to explain the Accomplishments through plant breeding. **SO1.3.** Students are able to understand the Objectives of plant breeding. **SO1.4.** Students are able to explain the Patterns of Evolution in Crop Plants and Centre of Origin. **SO1.5.** Students are able to understand the Agro-biodiversity and its significance. **SO1.6.** Students are able to explain the Pre-breeding and plant introduction and role of plant genetic resources in plant breeding.		**Unit-1. Plant Breeding, introduction, objective, history and Agro-biodiversity of crop plants.** 1. Early Plant Breeding. 2. Accomplishments through plant breeding. 3. Objectives of plant breeding. 4. Patterns of Evolution in Crop Plants and Centre of Origin. 5. Agro-biodiversity and its significance. 6. Pre-breeding and plant introduction.	**1.** Plant breeding objectives for different self and cross pollinated crops**.**

SW-1 Suggested Sessional Work (SW):

d. Assignments:

ii. Important landmarks in plant breeding.

e. Mini Project:

ii. Plant genetic resources, types and their role in crop improvement.

f. Other Activities (Specify):

GPB502.2: The knowledge of this course will enable the student to know Genetic basis of breeding, variability, its components and combining ability.

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	**12**
SW	**2**
SL	**1**
Total	**21**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Students are able to understand genetic basis of breeding: self and cross pollinated crops including mating systems and response to selection. **SO2.2.** Students are able to evaluate nature of variability, components of variation. **SO2.3.** Students are able to evaluate heritability and genetic advance. **SO2.4.** Students are able to evaluate genotype environment interaction. **SO2.5.** Students are able to understand and evaluate general and specific combining ability. **SO2.6.** Students are able to explain types of gene actions and implications in plant breeding.	1. Floral biology in self pollinated species. 2. Floral biology in cross pollinated species. 3. Selfing and crossing techniques. 4. Analysis of variance (ANOVA). 5. Estimation of heritability. 6. Estimation of genetic advance	**Unit-2. Genetic basis of breeding and gene actions.** 1. Genetic basis of breeding: self and cross pollinated crops including mating systems and response to selection. 2. Nature of variability, components of variation. 3. Heritability and genetic advance. 4. Genotype environment interaction. 5. General and specific combining ability. 6. Types of gene actions and implications in plant breeding.	**5.** To estimate genetic variability and its components.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

2. Combining ability, its types and role in crop improvments.

b. Mini Project:

2. Evaluate the nature of variability, components of variation, heritability and genetic advance.

ci. Other Activities (Specify):

GPB502.3: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in self-pollinated crops.

Item	Approximate Hours
CI	**6**
LI	**10**
SW	**2**
SL	**1**
Total	**19**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1. Students are able to understand the process of pure line theory, pure line **SO3.2.** Students are able to understand the process of mass selection methods. **SO3.3.** Students are able to understand the process of pedigree method and bulk method. **SO3.4.** Students are able to understand the process of backcross, single seed descent and multiline breeding. **SO3.5.** Students are able to understand the process of population breeding in self-pollinated crops with special reference to diallel selective mating. **SO3.6.** Students are able to understand the process of transgressive breeding.	1. Selection methods in segregating populations and evaluation of breeding material by pedigree methods. 2. Selection methods in segregating populations and evaluation of breeding material by mass pedigree methods. 3. Selection methods in segregating populations and evaluation of breeding material by bulk methods. 4. Selection methods in segregating populations and evaluation of breeding material by single seed decent methods. 5. Selection methods in segregating populations and evaluation of breeding material by back cross methods.	**Unit 3 Plant breeding methods used for self pollinated crops.** 1. Pure line theory, pure line and 2. Mass selection methods. 3. Pedigree method and bulk method. 4. Backcross, single seed descent and multiline breeding. 5. Population breeding in self-pollinated crops with special reference to diallel selective mating. 6. Transgressive breeding.	3. Explain different types of mating design used in self and cross pollinated crops.

SW-3 Suggested sessional work (sw):

d. Assignments:

i. Handling of segregating generations by different methods.

e. Mini project:

ii. Process of different selection methods.

f. Other activities (specify):

GPB502.4: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in cross-pollinated crops.

Item	Approximate Hours
CI	**6**
LI	**0**
SW	**2**
SL	**1**
Total	**9**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1. Students are able to understand the process of population breeding: mass selection and ear-to-row methods. **SO4.2.** Students are able to understand the process of S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter-population improvement and development of synthetics and composites. **SO4.3.** Students are able to understand the process of hybrid breeding: genetical and physiological basis of heterosis and inbreeding, production of inbreeds. **SO4.4.** Students are able to understand the process of breeding approaches for improvement of inbreeds, predicting hybrid performance. **SO4.5.** Students are able to understand the process of seed production of hybrid and their parent varieties/ inbreeds. **SO4.6.** Students are able to understand the process of self-incompatibility, male sterility and apomixes in crop plants and their commercial exploitation.		**Unit 4. Breeding methods in cross pollinated crops.** 1. Population breeding: mass selection and ear-to-row methods. 2. S1 and S2 progeny testing, progeny selection schemes, recurrent selection schemes for intra and inter-population improvement and development of synthetics and composites. 3. Hybrid breeding: genetical and physiological basis of heterosis and inbreeding, production of inbreeds. 4. Breeding approaches for improvement of inbreeds, predicting hybrid performance. 5. Seed production of hybrid and their parent varieties/ inbreeds. 6. Self-incompatibility, male sterility and apomixes in crop plants and their commercial exploitation.	**1.** Hybrid breeding: heterosis and inbreeding, production and uses of inbreeds.

SW-4 Suggested Sessional Work (SW):

d. Assignments:

ii. Improvement of plant population through population breeding methods.

e. Mini Project:

j. Process of seed production of hybrid and their parent varieties/ inbreeds.

f. Other Activities (Specify):

GPB502.5: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in asexually/ clonally propagated crops.

Item	Approximate Hours
CI	**6**
LI	**8**
SW	**2**
SL	**1**
Total	**17**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Students are able to understand the process of Breeding methods in asexually/ clonally propagated crops, clonal selection. **SO5.2.** Students are able to understand the process of Special breeding techniques: Mutation breeding, breeding for abiotic and biotic stresses. **SO5.3.** Students are able to understand the Concept of plant ideotype and its role in crop improvement, concept of MAS. **SO5.4.** Students are able to explain the Concept of polyploidy and wide hybridization and doubled haploidy. **SO5.5.** Students are able to understand the process of Cultivar development: testing, release and notification, maintenance breeding. **SO5.6.** Students are able to understand the Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.	1. Maintenance of experimental records. 2. Study of agents employed for the induction of various ploidy levels in different crops. 3. Learning techniques in hybrid seed production using male-sterility in field crops 4. Prediction of performance of double cross hybrid.	**Unit-5. Breeding methods in asexually/ clonally propagated crops and Special breeding techniques.** 1. Breeding methods in asexually/ clonally propagated crops, clonal selection. 2. Special breeding techniques: Mutation breeding, breeding for abiotic and biotic stresses. 3. Concept of plant ideotype and its role in crop improvement, concept of MAS. 4. Concept of polyploidy and wide hybridization and doubled haploidy. 5. Cultivar development: testing, release and notification, maintenance breeding. 6. Participatory Plant Breeding, Plant breeders' rights and regulations for plant variety protection and farmers rights.	3. Intellectual property rights, PBR, PPV&FRA, and FR.

SW-5 Suggested Sessional Work (SW):

a. Assignments:

ii. Concept of polyploidy, production, doubling, and uses of haploids.

b. Mini Project:

iii. Concepts of mutation breeding, classification, production, identification, and uses of mutants.

d. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
GPB502.1: The knowledge of this course will enable the student to know Patterns of Evolution, Centre of Origin, and Agro-biodiversity with their significance.	**6**	**2**	**1**	**9**
GPB502.2: The knowledge of this course will enable the student to know Genetic basis of breeding, variability, its components and combining ability.	**18**	**2**	**1**	**21**
GPB502.3: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in self-pollinated crops.	**16**	**2**	**1**	**19**
GPB502.4: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in cross-pollinated crops.	**6**	**2**	**1**	**9**
GPB502.5: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in asexually/ clonally propagated crops	**14**	**2**	**1**	**17**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	**Plant Breeding, introduction, objective, history and Agro-biodiversity of crop plants.**	**3**	**4**	**2**	**9**
CO 2	**Genetic basis of breeding and gene actions.**	**5**	**3**	**3**	**11**
CO 3	**Plant breeding methods used for self pollinated crops.**	**4**	**3**	**3**	**10**
CO 4	**Breeding methods in cross pollinated crops.**	**2**	**3**	**4**	**9**
CO 5	**Breeding methods in asexually/ clonally propagated crops and Special breeding techniques.**	**3**	**4**	**4**	**11**
Total		**17**	**17**	**16**	**50**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Principle of Genetics will be held with written examination of 50 marks.

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

10. Improved Lecture
11. Group Discussion
12. Demonstration

13. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
14. Brainstorming
15. Power point presentation
16. Chalk and Board
17. Smart board
18. Assignments, quiz
19. Group tasks, student's presentations

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Principles of Plant Breeding	Allard R.W.	John Wiley & Sons	1981
2	Plant Breeding	Chopra V.L.	Oxford & IBH	2004
3	Plant Breeding and– Mendelian to Molecular Approach	Jain H.K. and Kharakwal M.C.	Narosa Publications, New Delhi	2004
4	Principles and Practice of Plant Breeding	Sharma J.R.	Tata McGraw-Hill	2001
5	Plant Breeding	Singh B.D.	Kalyani Publishers, New Delhi	2006
6	Principles of Plant Genetics and Breeding	George Acquaah	John Wiley & Sons	2012
7	Principles and Procedures of Plant Breeding	G. S. Chahal, S. S. Gosal	Alpha Science	2002
8	Handbook of Genetics and Plant Breeding	Rajendra Kumar Yadav	Bhavya Books	2021
9	Plant Breeding in 21st Century	B.D. Singh, N.S. Shekhawat	Scientific Publishers	2019

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
4. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
5. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
6. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
7. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
8. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
9. Mr. Ankit Kumar Bhagat, Teaching Associate, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology, AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 502
Course Title: - Principles of Plant Breeding

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Dissemiate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their sol	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								contemporary agriculture.					utions.			to contemporary agriculture.		
GPB502.1: The knowledge of this course will enable the student to know Patterns of Evolution, Centre of Origin, and Agro-biodiversity with their significance.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB502.2: The knowledge of this course will enable the student to know Genetic	1	2	1	2	2	1	1	2	3	2	3	2	1	1	1	1	1	1

basis of breeding, variability, its components and combining ability.																		
GPB502.3: The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in self-pollinated crops.	1	2	3	2	2	1	1	2	2	3	2	1	1	1	1	1	1	1
GPB502.4: The	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1

knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in cross-pollinated crops.																		
GPB502.5: The knowledge of this course will enable the student to know breeding methods, different hybrid	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

ization technique for genomic reshuffling in asexually/ clonally propagated crops																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Principle of Genetics

POs & PSOs No.	**COs No.& Titles**	**SOs No.**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB502.1:** The knowledge of this course will enable the student to know Patterns of Evolution, Centre of Origin, and Agro-biodiversity with their significance.	**SO1.1 SO1.2 SO1.3**		Unit-1. Plant Breeding, introduction, objective, history and Agro-biodiversity of crop plants.1.1, 1.2, 1.3	As mentioned in page number ……

PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB502.2:** The knowledge of this course will enable the student to know Genetic basis of breeding, variability, its components and combining ability.	**SO2.1** **SO2.2** **SO2.3** **SO2.4** **SO2.5**	To study Extraction of proteins and isozymes	Genetic basis of breeding and gene actions. 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB502.3:** The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in self-pollinated crops.	**SO3.1** **SO3.2** **SO3.3**	To study Use of Agrobacterium mediated method	Plant breeding methods used for self pollinated crops. .3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB502.4:** The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in cross-pollinated crops.	**SO4.1** **SO4.2**	To study Use of Biolistic gun method.	Breeding methods in cross pollinated crops. 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB502.5:** The knowledge of this course will enable the student to know breeding methods, different hybridization techniques for genomic reshuffling in asexually/ clonally propagated crops	**SO5.1** **SO5.2**		Breeding methods in asexually/ clonally propagated crops and Special breeding techniques. 5.1, 5.2	As mentioned in page number ……

Semester- I

Course Code: **GPB 503***

Course Title: **Fundamentals of Quantitative Genetics***

Pre- requisite: Student should have fundamental knowledge of Genetics and Statistical Methods

Rationale: Yield and quality characters are controlled by many genes and show the quantitative inheritance. If one has to go for improvement even for the components characters the knowledge of this course is very essential.

Course Outcomes:

GPB 503.1: Students will get knowledge Introduction and historical background of quantitative genetics.

GPB 503.2: Students will have the ability to apply the knowledge gained about designs for plant breeding experiments.

GPB 503.3: Student will be equipped with the knowledge of association analysis.

GPB 503.4: Student will be able to explain various mating designs.

GPB 503.5: Students will get knowledge on QTL mapping.

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**	**Scheme of studies (Hours/Week)**					**Total Credits (C)**
			CI	**LI**	**SW**	**SL**	**Total Study Hours CI+LI+SW+SL**	
	GPB 503*	**Fundamentals of Quantitative Genetics***	2	2	1	1	6	2+1=3

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies), **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Cous e Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessme nt (ESA)	Total Marks (PRA+ESA)
			Class/H ome Assignm ent 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Semina r one (SA)	Class Activity any one (CAT)	Class Attendan ce (AT)	Total Marks (CA+CT+ SA+CAT +AT)		
	GP	**Fundament**	15	30	0	0	5	50	50	100

	B 503 *	**als of Quantitative Genetics***								

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB 503.1: Students will get knowledge Introduction and historical background of quantitative genetics.

Approximate Hours

Item	Approximate Hours
CI	**8**
LI	**0**
SW	**1**
SL	**1**
Total	**10**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1. Student will be able to understand cell cycle. **SO1.2.** Students are able to explain architecture of chromosome in prokaryotes and eukaryotes. **SO1.3.** To know Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere **SO1.4.** Understand artificial chromosome construction and its uses **SO1.5.** Understand Special types of chromosomes and variation in chromosome structure. **SO1.6.** To know evolutionary significance; Introduction to techniques for karyotyping **SO1.7.** Understand Chromosome banding and painting -In situ		**Unit-1. Introduction and historical background of quantitative genetics** 1. Introduction background of quantitative genetics 2. Historical background of quantitative genetics 3. Multiple factor hypothesis 4 Qualitative and quantitative characters 1.5. Analysis of continuous variation mean, range, SD, CV; Components of variation 6. Components of variation- Phenotypic, Genotypic, Nature of gene action- additive, dominance and epistatic, linkage effect 7. Principles of analysis of variance and linear model, Expected variance components, Random and fixed effect model. 8. Comparison of means and variances for significance	1. Qualitative and quantitative characters

hybridization and various applications.			

SW-1 Suggested Sessional Work (SW):

g. Assignments:
Multiple factor hypothesis

h. Mini Project:

i. Other Activities (Specify):

GPB 503.2: Students will have the ability to apply the knowledge gained about designs for plant breeding experiments.

Approximate Hours

Item	Approximate Hours
CI	**5**
LI	**2**
SW	**0**
SL	**1**
Total	**8**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Understand Structural variations of chromosomes and their implications. **SO2.2.** Students are able to explain Numerical variations of chromosomes and their implications **SO2.3.** Symbols and terminologies for chromosome numbers **SO2.4.** To know euploidy, haploids, diploids and polyploids **SO2.5.** Student will be able to understand utilization of aneuploids in gene location. **SO2.6.** Knowledge about Variation in chromosome behaviour, somatic segregation and chimeras **SO2.7.** Students are able to explain Endomitosis and somatic reduction; Evolutionary significance of chromosomal aberrations, balanced lethal **SO2.8.** Chromosome complexes; Inter-varietal chromosome substitutions.	1. Analysis and interpretation of variability parameters;	**Unit-2. Designs for plant breeding experiments** 1. Designs for plant breeding experiments- principles 2. Designs for plant breeding experiments- applications 3. Variability parameters, 4. Concept of selection, simultaneous selection modes and selection of parents. 5. MANOVA	Variability parameters

SW-2 Suggested Sessional Work (SW):

c. Assignments:

d. Mini Project:

Other Activities (Specify):

GPB 503.3: Student will be equipped with the knowledge of association analysis.

Item	Approximate Hours
CI	**6**
LI	**14**
SW	**1**
SL	**1**
Total	**18**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO 3.1. Understand fertilization barriers in crop plants at pre-and post fertilization levels; In-vitro techniques to overcome the fertilization barriers in crops; Polyploidy **SO3.2.** Understand Genetic consequences of polyploidization and role of polyploids in crop breeding **SO3.3.** To know autopolyploid and allopolyploids. **SO 3.**4. Knowledge about Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer. **SO3.5.** Student will be able to understand Alien addition and substitution lines, creation and utilization. **SO3.6.** Students are able to explain apomixis, evolutionary and genetic problems in crops with apomixes.	1. Analysis and interpretation of Index score. 2. Analysis and interpretation of Metroglyph. 3. Clustering and interpretation of D2 analysis. 4. Genotypic and phenotypic correlation analysis and interpretation 5. Path coefficient analysis and interpretation. 6. Estimation of different types of heterosis, and interpretation. 7. Estimation of inbreeding depression and interpretation	**Unit 3 Association analysis** **1.** Association analysis- Genotypic and phenotypic correlation **2.** Path analysis 3. Discriminate function **4** principal component analysis **5.** Genetic divergence analysis Metroglyph and D2. 6. Generation mean analysis, Parent progeny regression analysis.	1. Metroglyph and D2.

SW-3 Suggested Sessional Work (SW):

g. Assignments:

Principal component analysis

h. Mini Project:

i. Other Activities (Specify):

GPB 503.4: Student will be able to explain various mating designs.

Item	Approximate Hours
CI	**6**
LI	**10**
SW	**1**
SL	**1**
Total	**18**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1. Understand Reversion of autopolyploid to diploids. **SO4.2** Student will be able to understand genome mapping in polyploids. **SO4.3.** Knowledge about Interspecific hybridization and allopolyploids. **SO.4.4.** Students are able to explain Synthesis of new crops (wheat, Triticale, Brassica, and cotton). **SO.4.5.** Understand hybrids between species with same chromosome number, alien translocations. **SO4.6.** To know Gene transfer using amphidiploids bridge species.	1.A, B and C Scaling test. 2. L × T analysis and interpretation. 3. Diallel analysis. 4. G × E interaction. 5. Stability analysis	**Unit 4. Mating designs** 1.Mating designs-classification 2. Diallel and partial diallel 3. L × T, NCDs, and TTC. 4. Concept of combining ability 4. Gene action, G × E interaction-Adaptability 5. Stability; Methods and models for stability analysis 6. Basic models- principles and interpretation, Bi-plot analysis.	**1.** Gene action.

SW-4 Suggested Sessional Work (SW):

g. Assignments:
Stability; Methods and models

h. Mini Project:

i. Other Activities (Specify):

GPB 503.5: Students will get knowledge on QTL mapping.

Item	Approximate Hours
CI	**5**
LI	**4**
SW	**1**
SL	**1**
Total	**11**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Understand Chromosome manipulations in wide hybridization. **SO5.2** Knowledge about Production and use of haploids and dihaploids in genetics and breeding.	1. QTL analysis. 2. Use of computer packages.	**Unit-5**: **QTL mapping** 1. QTL mapping, Strategies for QTL mapping- Desired population and statistical methods 2. QTL mapping in genetic analysis 3. Marker assisted selection. 4. Factors influencing the MAS.	1. Marker assisted selection

SO5.3 Students are able to explain Production and use of doubled haploids in genetics and breeding.		5. Simultaneous selection based on marker and phenotype.	

SW-5 Suggested Sessional Work (SW):

a. Assignments:

QTL mapping in genetic analysis

b. Mini Project:

Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
GPB503.1: Students will get knowledge Introduction and historical background of quantitative genetics.	**8**	1	1	**10**
GPB 503.2: Students will have the ability to apply the knowledge gained about designs for plant breeding experiments.	**7**	0	1	**8**
GPB 503.3: Student will be equipped with the knowledge of association analysis.	**20**	1	1	**22**
GPB 503.4: Student will be able to explain various mating designs.	**16**	1	1	**18**
GPB 503.5: Students will get knowledge on QTL mapping.	**9**	1	1	**11**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	Introduction and historical background of quantitative genetics.	3	5	2	10
CO 2	Designs for plant breeding experiments	2	5	3	10
CO 3	Association analysis	2	6	2	10
CO 4	Mating designs	4	4	2	10
CO 5	QTL mapping	4	4	2	10
Total Marks		15	26	9	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Fundamentals of Quantitative Genetics** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks.

Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion

5. Demonstration
6. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
7. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Principles of Plant Breeding	Allard RW.	John Wiley & Sons	1981
2	Plant Breeding	Chopra VL.	Oxford & IBH	2004.
3	Plant Breeding and–Mendelian to Molecular Approach,	1.Jain HK and Kharakwal MC.	Narosa Publications, New Delhi	2004
4	Principles and Practice of Plant Breeding.	Sharma JR.	Tata McGraw-Hill	2001

Curriculum Development Team:

a. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
b. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
c. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
d. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
e. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
f. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
g. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
h. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
i. Mr. Ankit Kumar Bhagat, Teaching Associate, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology, AKS University.

Cos, POs and PSOs Mapping

Course Code: GPB 503
Course Title: - Principles of Quantitative Genetics

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to contempor	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to contem	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								y agri cult ure.								por ary agri cult ure.		
GPB503.1: Students will get knowledge Introduction and historical background of quantitative genetics.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB 503.2: Students will have the ability to apply the knowledge gained about designs for plant breeding experiments.	1	2	1	2	2	1	1	2	3	2	3	2	1	1	1	1	1	1
GPB 503.3: Student will be equip	1	2	3	2	2	1	1	2	2	3	2	1	1	1	1	1	1	1

ped with the knowledge of association analysis.																		
GPB 503.4: Student will be able to explain various mating designs.	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1
GPB503.5: Students will get knowledge on QTL mapping.	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Principle Quantitative Genetics

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB503.1:**Students will get knowledge Introduction and historical background of quantitative genetics.	**SO1.1 SO1.2 SO1.3**	Analysis and interpretation of Index score.	Unit-1. Introduction and historical background of quantitative genetics .1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 503.2:** Students will have the ability to apply the knowledge gained about designs for plant breeding experiments.	**SO2.1 SO2.2 SO2.3 SO2.4 SO2.5**	Analysis and interpretation of Metroglyph.	Designs for plant breeding experiments 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 503.3:** Student will be equipped with the knowledge of association analysis.	**SO3.1 SO3.2 SO3.3**	Clustering and interpretation of D2 analysis.	Association analysis- Genotypic and phenotypic correlation.3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 503.4:** Student will be able to explain various mating designs.	**SO4.1 SO4.2**	Genotypic and phenotypic correlation analysis and interpretation	Mating designs- classification 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB503.5:** Students will get knowledge on QTL mapping.	**SO5.1 SO5.2**	Path coefficient analysis and interpretation.	QTL mapping, Strategies for QTL mapping- Desired population and statistical methods 5.1, 5.2	As mentioned in page number ……

Semester- I

Course Code: **GPB 510**

Course Title: **Seed Production and Certification**

Pre- requisite: Student should have basic knowledge of principles of Seed production, Nucleus seed production and its maintenance, Hybrid seed production, Organic seed production and certification.

Rationale: The students studying seed technology should possess foundational understanding about seed production and seed certification. This course is aimed at understanding to produce genetically pure and good quality seed.

Course Outcomes:

GPB510.1: Student will be able to understand seed quality concept and Genetic purity in seed production.

GPB510.2: Students will have the ability to apply the knowledge gained about nucleus seed production and its maintenance.

GPB510.3: To understand principles of seed production in different crops.

GPB510.4: Student will be able to understand hybrid seed production of crop plants.

GPB510.5: Students will get knowledge on seed certification and minimum Seed Certification Standards (MSCS) for different crops.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
	GPB 510	Seed Production and Certification	1	2	0	0	3	(1+1) = 2

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+ CAT+AT)		
	GPB 510	Seed Production and Certification	15	30	0	0	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB510.1: Student will be able to understand seed quality concept and Genetic purity in seed production.

Approximate Hours

Item	Approximate Hours
CI	**3**
LI	**2**
SW	**2**
SL	**1**
Total	**8**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1. Understand Beginning of genetics, early concepts of inheritance, **SO1.2.** Understand Generation system of seed multiplication **SO1.3.** Understand Various factors influencing seed production.	1. Planning for seed production: cost benefit ratio, seed multiplication ratio and seed replacement rate.	**Unit-1. Seed and Seed quality** 1.1. Importance of seed as basic input in agriculture; Seed quality concept and importance. 1.2. Generation system of seed multiplication -Varietal replacement rate, Seed multiplication ratios, Seed replacement rate, Seed renewal period and seed demand and supply 1.3. Various factors influencing seed production –Physical and Genetic purity in seed production; Factors responsible for varietal and genetic deterioration.	1 Seed quality concept. 2. seed demand and supply

SW-1 Suggested Sessional Work (SW):

j. Assignments:

Generation system of seed multiplication.

k. Mini Project:

Various factors influencing seed production

l. Other Activities (Specify):

Importance of seed as basic input in agriculture

GPB510.2: Students will have the ability to apply the knowledge gained about nucleus seed production and its maintenance

Approximate Hours

Item	Approximate Hours
CI	**3**
LI	**4**
SW	**2**
SL	**1**
Total	**10**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Nucleus seed production and its maintenance. **SO2.2.** Understand Principles of seed production in self- and cross-pollinated crops. **SO2.3.** Understand Organic seed production and certification	1. Visits to seed production plots. 2.visit to seed industries;	**Unit-2. Nucleus seed production and its maintenance** 2.1. Nucleus seed production and its maintenance - Maintenance of parental lines of hybrids, Production of breeder, foundation and certified seed and their quality maintenance 2.2. Principles of seed production in self- and cross-pollinated crops; Hybrid seed production - system and techniques involved in Seed village concept;, 2.3. Organic seed production and certification.	**6.** Nucleus seed production and its maintenance, **7.** Principles of seed production in self- and cross-pollinated crops

SW-2 Suggested Sessional Work (SW):

e. Assignments:

Maintenance of parental lines of hybrids.

f. Mini Project:

Principles of seed production in self- and cross-pollinated crops.

cii. Other Activities (Specify):

GPB510.3: To understand principles of seed production in different crops.

Item	Approximate Hours
CI	**3**
LI	**8**
SW	**2**
SL	**1**
Total	**14**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1. Understand Principles of seed production in field crops **SO3.2.** Understand Floral	1. Pollen collection and storage methods, pollen viability	**Unit 3 Principles of seed production.** **3.1.** Principles of seed production in field crops	4. Principles of seed production in field crops.

structure, pollination mechanism and seed production techniques in self- and cross-pollinated cereals. **SO3.3.** Understand Floral structure, pollination mechanism and seed production techniques in self- and cross-pollinated millets.	and stigma receptivity. 2.Pre-harvest sanitation, 3. Maturity symptoms. 4. harvesting techniques.	**3.2.** Floral structure, pollination mechanism and seed production techniques in self- and cross-pollinated cereals. **3.**3. Floral structure, pollination mechanism and seed production techniques in self- and cross-pollinated millets.	5. Floral structure of self pollinated crops

SW-3 Suggested Sessional Work (SW):

j. Assignments:

Seed production techniques in self- and cross-pollinated cereals

k. Mini Project:

Floral structure and pollination mechanism cross-pollinated cereals

l. Other Activities (Specify):

GPB510.4: Student will be able to understand hybrid seed production of crop plants.

Item	Approximate Hours
CI	**3**
LI	**8**
SW	**2**
SL	**1**
Total	**14**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1. Understand Floral structure, pollination mechanism and methods and techniques of seed production in major pulses and oilseed crops **SO4.2.** Varietal and hybrid seed production techniques in Pigeon pea, Mustard, Castor and Sunflower. Floral structure, pollination mechanism and methods and techniques of seed production in major commercial fibres. **SO4.3.** Hybrid-seed production techniques in major vegetatively propagated crops.	1. Planting design for variety- hybrid seed production techniques. 2. planting ratio of male and female lines, synchronization of parental lines and methods to achieve synchrony 3. Identification of rogues and pollen shedders, supplementary pollination, detasseling, 4. Hand emasculation and pollination.	**Unit 4. Varietal and hybrid seed production techniques.** 4.1. Floral structure, pollination mechanism and methods and techniques of seed production in major pulses and oilseed crops. 4.2. Varietal and hybrid seed production techniques in Pigeon pea, Mustard, Castor and Sunflower. Floral structure, pollination mechanism and methods and techniques of seed production in major commercial fibres. 4.3.Hybrid-seed production techniques in major vegetatively propagated crops.	1. Floral structure and pollination mechanism in major pulses.

SW-4 Suggested Sessional Work (SW):

j. Assignments:
Hybrid seed production techniques in Pigeon pea,

k. Mini Project:
Hybrid-seed production techniques in major vegetatively propagated crops.

l. Other Activities (Specify):

GPB510.5: Students will get knowledge on seed certification and minimum Seed Certification Standards (MSCS) for different crops.

Item	Approximate Hours
CI	**3**
LI	**8**
SW	**2**
SL	**1**
Total	**14**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Understand Seed certification - history, concept, objectives Central seed certification board Seed certification agency/ organization and staff requirement **SO5.2.** Legal status - Phases of seed certification, formulation, revision and publication of seed certification standards; Minimum Seed Certification Standards (MSCS) for different crops. **SO5.3.** General and specific crop standards, Field and seed standards; Planning and management of seed certification programs; Eligibility of a variety for certification, area assessment, cropping history of the seed field.	1. General procedure of seed certification, 2. Identification of weed and other crop seeds as per specific crops. 3. To study about field inspection at different stages of a crop. 4. Specifications for tags and labels to be used for certification purpose.	**Unit-5. Seed certification.** 5.1 Seed certification - history, concept, objectives Central seed certification board Seed certification agency/ organization and staff requirement 5.2 Legal status - Phases of seed certification, formulation, revision and publication of seed certification standards; Minimum Seed Certification Standards (MSCS) for different crops. 5.3 General and specific crop standards, Field and seed standards; Planning and management of seed certification programs; Eligibility of a variety for certification, area assessment, cropping history of the seed field.	4. Seed certification - history, concept, objectives Central seed certification board Seed certification agency/ organization. 5. Minimum Seed Certification Standards (MSCS) for different crops.

SW-5 Suggested Sessional Work (SW):

c. Assignments:
Phases of seed certification, formulation, revision and publication of seed certification standards;

d. Mini Project:

General and specific crop standards, Field and seed standards; Planning and management of seed certification programs

Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
GPB510.1: Student will be able to understand seed quality concept and Genetic purity in seed production.	**5**	**2**	**1**	**8**
GPB510.2: Students will have the ability to apply the knowledge gained about nucleus seed production and its maintenance	**7**	**2**	**1**	**10**
GPB510.3: To understand principles of seed production in different crops	**11**	**2**	**1**	**14**
GPB510.4: Student will be able to understand hybrid seed production of crop plants.	**11**	**2**	**1**	**14**
GPB510.5: Students will get knowledge on seed certification and minimum Seed Certification Standards (MSCS) for different crops.	**11**	**2**	**1**	**14**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	**Unit Titles**	**Marks Distribution**			**Total Marks**
		R	**U**	**A**	
CO 1	Seed and Seed quality.	**5**	**3**	**2**	**10**
CO 2	Nucleus seed production and its maintenance.	**4**	**3**	**3**	**10**
CO 3	Principles of seed production.	**5**	**4**	**3**	**12**
CO 4	Varietal and hybrid seed production techniques.	**4**	**3**	**2**	**9**
CO 5	Seed certification.	**5**	**3**	**1**	**9**
Total		**23**	**16**	**11**	**50**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Seed Production and Certification** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

8. Improved Lecture
9. Tutorial
10. Case Method
11. Group Discussion

12. Role Play
13. Demonstration
14. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
15. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Seed Technology	Agarwal, R.L.	Oxford & IBH Publishing Co. Delhi	1991
2	Seed Technology	Agarwal, P.K.	ICAR, New Delhi	1999
3	Seed Science and Technology	Subir Sen and Nabinanda Ghosh.	Kalyani Publishers. New Delhi	1999
4	Beej Pradyogiki	Maloo,S.R., Intodia, S.K. and Pratap Singh.	Agrotech Publishing Academy.	2008
5	Seed Technology.	A.K. Joshi and B.D. Singh.	Kalyani Publishers, New Delhi.	2005
6	Seed Technology In The Tropics	Mackay D B	Scientific Publishers	2013
7	Seed Science and Technology	K. Vanangamudi	New India Publishing Agency	2014
8	Field Inspection Manual and Minimum Seed Certification Standards	Anonymous	NSC Publication, New Delhi	1965

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
4. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
5. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
6. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
7. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
8. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
9. Mr. Ankit Kumar Bhagat, Teaching Associate, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology, AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 510
Course Title: - Seed Production and Certification

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to contemp	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to con	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								orary agriculture.					.			temporary agriculture.		
GPB510.1: Student will be able to understand seed quality concept and Genetic purity in seed production.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB510.2: Students will have the ability to apply the knowledge gained about nucleus seed production and its maintenance.	1	2	1	2	2	1	1	2	3	2	3	2	1	1	1	1	1	1
GPB510.3:	1	2	3	2	2	1	1	2	2	3	2	1	1	1	1	1	1	1

To understand principles of seed production in different crops.																		
GPB5 10.4: Student will be able to understand hybrid seed production of crop plants.	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1
GPB5 10.5: Students will get knowledge on seed certification and minimum Seed Certification Standards (MSCS) for different	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

crops.																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Seed Production and Certification

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB510.1**: Student will be able to understand seed quality concept and Genetic purity in seed production.	**SO1.1 SO1.2 SO1.3**	General procedure of seed certification,	Unit-1. Importance of seed as basic input in agriculture; Seed quality concept and importance.1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB510.2**: Students will have the ability to apply the knowledge gained about nucleus seed production and its maintenance.	**SO2.1 SO2.2 SO2.3 SO2.4 SO2.5**	Identification of weed and other crop seeds as per specific crops.	Nucleus seed production and its maintenance 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB510.3**: To understand principles of seed production in different crops.	**SO3.1 SO3.2 SO3.3**	To study about field inspection at different stages of a crop.	Principles of seed production. 3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB510.4**: Student will be able to understand hybrid seed production of crop plants.	**SO4.1 SO4.2**	Specifications for tags and labels to be used for certification purpose.	Varietal and hybrid seed production techniques 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB510.5**:Students will get knowledge on seed certification and minimum Seed Certification Standards (MSCS) for different crops.	**SO5.1 SO5.2**	Path coefficient analysis and interpretation.	Seed certification - history, concept, objectives Central seed certification board Seed certification agency/ organization and staff requirement 5.1, 5.2	As mentioned in page number ……

Semester- I

Course Code: GPB 511

Course Title: Crop Breeding I (Kharif Crops)

Pre- requisite: To provide insight into recent advances in improvement of kharif cereals, legumes, oilseeds, fiber, sugarcane and vegetative propagated crops using conventional and modern biotechnological approaches.

Rationale: After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of important kharif field crops.

Course Outcomes:

GPB511.1. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Rice, Maize, and Small millets.

GPB511.2. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Pigeon pea, Groundnut, and Other pulses.

GPB511.3. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Soybean, Castor and Sesame.

GPB511.4. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Cotton, and Jute.

GPB511.5. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Sugarcane, Forage crops, and Seed spices.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
	GPB 511	Crop Breeding I (Kharif Crops)	2	2	0	0	4	(1+2) = 3

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+ CAT+AT)		
	GPB	Crop	15	30	0	0	5	50	50	100

	511	**Breeding I (Kharif Crops)**								

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB511.1. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Rice, Maize, and Small millets.

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	**2**
SW	**2**
SL	**1**
Total	**11**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1. Students able to explain the Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship of rice. **SO1.2.** Students able to explain the Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Aerobic rice, its implications and drought resistance breeding of rice. **SO1.3.** Students able to explain the Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship of Maize. **SO1.4.** Students able to explain the Breeding objectives: yield, quality	1. Floral biology, emasculation, pollination techniques in rice and maize.	**Unit-1 Important botanical status and reproductive structures of crops and genetics of rice, maize, and small millets.** 1. **Rice:** Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship. 2. **Rice:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Aerobic rice, its implications and drought resistance breeding. 3. **Maize:** Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship.	1. **Genetics of rice, maize, and small millets.**

characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, releasedvarieties, examples of MAS used for improvement- QPM and Bt maize – strategies and implications of Maize. **SO1.5.** Students able to explain the Evolution and distribution of species and forms - wild relatives and germplasm of Small millets. **SO1.6.** Students able to explain the Small millets: Cytogenetics and genome relationship - breeding objectives yield, quality characters, biotic and abiotic stress resistance, etc of Small millets.		4. **Maize:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc.; Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, releasedvarieties, examples of MAS used for improvement- QPM and Bt maize – strategies and implications. 5. **Small millets:** Evolution and distribution of species and forms - wild relatives and germplasm. 6. **Small millets:** Cytogenetics and genome relationship - breeding objectives yield, quality characters, biotic and abiotic stress resistance, etc.	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Floral biology, emasculation and hybridization techniques in rice and maize.

b. Mini Project:

iii. Centers of origin, distribution of species wild relatives of rice and maize.

c. Other Activities (Specify):

GPB511.2. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Pigeon pea, Groundnut, and Other pulses.

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	**4**
SW	**2**
SL	**1**
Total	**13**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Students are able to understand the evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship. Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc of	1. Floral biology, emasculation, pollination techniques in pigeon	**Unit-2. - Important botanical status and reproductive structures of crops and genetics of Pigeon pea, Groundnut and Other pulses.** **1. Pigeon pea:** evolution, mode of reproduction, chromosome number;	**8.** Learn about qualitative and quantitative characters different pulse crops.

pigeon pea. **SO2.2.** Students are able to understand the Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at National and International institutes of pigeon pea. **SO2.3.** Students are able to understand the Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc of groundnut. **SO2.4.** Students are able to understand the Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement groundnut. **SO2.5.** Students are able to understand the Urdbean, mungbean, cowpea,: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc of other pulses. **SO2.6.** Students are able to understand the Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them of other pulses.	pea and soybean. 2. Attempting crosses between black gram and green gram.	Genetics – cytogenetics and genome relationship. Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. 2. **Pigeon pea:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement - Hybrid technology; maintenance of male sterile, fertile and restorer lines, progress made at National and International institutes. **3. Groundnut:** Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. **4. Groundnut:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. **5. Other pulses:** Urdbean, mungbean, cowpea,: Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship, breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. **6. Other pulses:** Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.	

SW-2 Suggested Sessional Work (SW):

1. Assignments:

3. Plant genetic resources, its utilization and conservation in different pulse crops**.**

1. Mini Project:

3. Study of genetics, handling of germplasm of different pulse crops.

ciii. Other Activities (Specify):

GPB511.3. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Soybean, Castor and Sesame.

Item	Approximate Hours
CI	**6**
LI	**8**
SW	**2**
SL	**1**
Total	**17**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1. Students are able to understand the origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship soybean. **SO3.2.** Students are able to understand the breeding objectives: yield, quality characters, biotic and abiotic stress resistance etc. soybean. **SO3.3.** Students are able to understand the breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement of Soybean. **SO3.4.** Students are able to understand the origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship of castor and sesame. **SO3.5.** Students are able to understand the Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of Castor and Sesame. **SO3.6.** Students are able to understand the breeding approaches, introgression of alien	1. Floral biology, emasculation, pollination techniques in sesame and cotton. 2. Study of range of variation for yield and yield components. 3. Study of segregating populations in cereal, pulses and oilseed crops. 4. Learning on the crosses between different species.	**Unit 3 Important botanical status and reproductive structures of crops and genetics of soybean, castor and sesame.** 1. **Soybean:** Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship. 2. **Soybean:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. 3. **Soybean:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. 4. **Castor and Sesame:** Origin, evolution mode of reproduction, chromosome number; Genetics –cytogenetics and genome relationship 5. **Castor and Sesame:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. 6. **Castor and Sesame:** Breeding approaches, introgression of alien gene(s) (if required), released varieties, examples of MAS used for improvement;	**1**. Concepts of breeding in soybean, castor and sesame.

gene(s) (if required), released varieties, examples of MAS used for improvement; Hybrid breeding in castor – opportunities, constraints and achievements of castor and sesame.		Hybrid breeding in castor – opportunities, constraints and achievements	

SW-3 Suggested Sessional Work (SW):

a) Assignments:

i. Important concepts of genetics and breeding soybean, castor and sesame.

b) Mini Project:

ii. Techniques for seed production and hybrid seeds production soybean, castor and sesame.

c) Other Activities (Specify):

GPB511.4. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Cotton, and Jute.

Item	Approximate Hours
CI	**6**
LI	**8**
SW	**2**
SL	**1**
Total	**17**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1. Students are able to understand the origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship of cotton. **SO4.2.** Students are able to understand the breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of cotton. **SO4.3.** Students are able to understand the breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Development and maintenance of male sterile lines – Hybrid development and seed production – Scenario of Bt	1. Evaluating the germplasm of cotton for yield, quality and resistance parameters, learning the procedures on development of Bt cotton. 2. Visit to Cotton Technology Laboratory and Spinning Mills. 3. Learning on the Standard Evaluation System (SES) and descriptors.	**Unit 4. Important botanical status and reproductive structures of crops and genetics of cotton and jute.** 1. **Cotton:** Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship 2. **Cotton:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. 3. **Cotton:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Development and maintenance of male sterile lines – Hybrid	1. Concepts of breeding in cotton and jute.

cottons, evaluation procedures for Bt cotton of cotton. **SO4.4.** Students are able to understand the origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship of jute. **SO4.5.** Students are able to understand the breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of jute. **SO4.6.** Students are able to understand the breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement of jute.	4. Use of software for database management and retrieval.	development and seed production – Scenario of Bt cottons, evaluation procedures for Bt cotton. 4. **Jute:** Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship 5. **Jute:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. 6. **Jute:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.	

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Important concepts of genetics and breeding cotton and jute.

b. Mini Project:

i. Techniques for seed production and hybrid seeds production cotton and jute.

c. Other Activities (Specify):

GPB511.5. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Sugarcane, Forage crops, and Seed spices.

Item	Approximate Hours
CI	**6**
LI	**8**
SW	**2**
SL	**1**
Total	**17**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Students are able to understand the evolution and distribution of species and forms, wild relatives and germplasm of Sugarcane.	1. Practical learning on the cultivation of fodder crop species on	**Unit-5. Important botanical status and reproductive structures of crops and genetics of Sugarcane, Forage crops and Seed spices.**	6. Concepts of breeding in Sugarcane, Forage

SO5.2. Students are able to understand the cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, etc. of Sugarcane. **SO5.3.** Students are able to understand the evolution and distribution of species and forms – Wild relatives and germplasm; Cytogenetics and genome relationship of Forage crops. **SO5.4.** Students are able to understand the breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance, etc. of Forage crops**.** **SO5.5.** Students are able to understand the origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship. Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of Seed spices. **SO5.6.** Students are able to understand the breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement; Achievements of important spice crops of Seed spices.	sewage water, analysing them for yield components and palatability. 2. Laboratory analysis of forage crops for crude protein, digestibility percent and other quality attributes. 3. Visit to animal feed producing factories. 4. Learning the practice of value addition; Visiting the animal husbandry unit and learning the animal experiments related with palatability and digestibility of fodder.	1. **Sugarcane:** Evolution and distribution of species and forms, wild relatives and germplasm. 2. **Sugarcane:** Cytogenetics and genome relationship – Breeding objectives- yield, quality characters, biotic and abiotic stress resistance, etc. 3. **Forage crops:** Evolution and distribution of species and forms – Wild relatives and germplasm; Cytogenetics and genome relationship. 4. **Forage crops:** Breeding objectives- yield, quality characters and palatability studies; Biotic and abiotic stress resistance, etc. 5. **Seed spices:** Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship. Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. 6. **Seed spices:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement; Achievements of important spice crops.	crops and Seed spices.

SW-5 Suggested Sessional Work (SW):

e. Assignments:

i. Hybrid seed production technology in Sugarcane, Forage crops and Seed spices.

f. Mini Project:

i. Examples of MAS used for improvement in Sugarcane, Forage crops and Seed spices.

e. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
GPB511.1. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Rice, Maize, and Small millets.	**8**	**2**	**1**	**11**
GPB511.2. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Pigeon pea, Groundnut, and Other pulses.	**10**	**2**	**1**	**13**
GPB511.3. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Soybean, Castor and Sesame.	**14**	**2**	**1**	**17**
GPB511.4. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Cotton, and Jute.	**14**	**2**	**1**	**17**
GPB511.5. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Sugarcane, Forage crops, and Seed spices.	**14**	**2**	**1**	**17**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	**Important botanical status and reproductive structures of crops and genetics of rice, maize, and small millets.**	**3**	**3**	**2**	**8**
CO 2	**Important botanical status and reproductive structures of crops and genetics of Pigeon pea, Groundnut and Other pulses.**	**4**	**4**	**2**	**10**

CO 3	**Important botanical status and reproductive structures of crops and genetics of soybean, castor and sesame.**	**5**	**3**	**4**	**12**
CO 4	**Important botanical status and reproductive structures of crops and genetics of cotton and jute.**	**4**	**3**	**3**	**10**
CO 5	**Important botanical status and reproductive structures of crops and genetics of Sugarcane, Forage crops and Seed spices.**	**3**	**4**	**3**	**10**
Total		**19**	**17**	**14**	**50**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Crop Breeding I (Kharif Crops)** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

16. Improved Lecture
17. Case Method
18. Group Discussion
19. Demonstration
20. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
21. Brainstorming
22. Smart board

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Breeding of Field Crops	Chopra, V.L. Parthasarathy VA.	Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.	2000
2	Vol. II Medicinal and Aromatic Plant	Chaddha. K.L. and Rajendra Gupta.	Malhotra Publishing House, New Delhi.	1995
3	Advances in Plant Breeding.	Mandal, A. K., P.K. Ganguli and S.P. Banerjee.	CBS Publishers and Distributors, New Delhi	1991
4	Crop Improvement: Challenges in the Twenty-First Century.	Manjit S. Kang	International Book Distributing Co. Lucknow	2004
5	Breeding of Field Crops	Poehlman, J.M.	AVI Publishing Co. INC, East Port, Conneacticut, USA.	1987
6	New Dimensions and Approaches for Sustainable Agriculture.	Kannaiyan S, Uthamasamy S, Theodore R.K. and Palaniswamy S.	Directorate of Extension Education, TNAU, Coimbatore.	2002
7	Sorghum Hybrid Seed Production and	Murty D.S. Tabo R. and Ajayi O.	ICRISAT, Patancheru, India	1994

	Management.			
8	Manual on Rice Breeding.	Nanda JS.	Kalyani Publishers.	1997
9	Spices and Plantation Crops Vol.1 (Part A) Breeding of Horticultural Crops Vol.1 (Part-B),	Parthasarathy V.A.	Today and Tomorrow Printers and Publishers	2017

Curriculum Development Team:

j. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
k. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
l. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
m. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
n. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
o. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
p. Dr. Bineeta Singh, Associate Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
q. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
r. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 511
Course Title: - Crop Breeding I (Kharif Crops)

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to cont	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their soluti	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								emporary agriculture.					ons.			contemporary agriculture.		
GPB510.1: Student will be able to understand seed quality concept and Genetic purity in seed production.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB510.2: Students will have the ability to apply the knowledge gained about nucleus seed production and its maintenance.	1	2	1	2	2	1	1	2	3	2	3	2	1	1	1	1	1	1

GPB510.3: To understand principles of seed production in different crops.	1	2	3	2	2	1	1	2	2	3	2	1	1	1	1	1	1	1
GPB510.4: Student will be able to understand hybrid seed production of crop plants.	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1
GPB510.5: Students will get knowledge on seed certification and minimum Seed Certification Standards (MSCS) for	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

different crops.																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Crop Breeding I (Kharif Crops)

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB510.1**: Student will be able to understand seed quality concept and Genetic purity in seed production.	**SO1.1 SO1.2 SO1.3**	General procedure of seed certification,	Unit-1. Importance of seed as basic input in agriculture; Seed quality concept and importance.1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB510.2**: Students will have the ability to apply the knowledge gained about nucleus seed production and its maintenance.	**SO2.1 SO2.2 SO2.3 SO2.4 SO2.5**	Identification of weed and other crop seeds as per specific crops.	Nucleus seed production and its maintenance 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB510.3**: To understand principles of seed production in different crops.	**SO3.1 SO3.2 SO3.3**	To study about field inspection at different stages of a crop.	Principles of seed production. 3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB510.4**: Student will be able to understand hybrid seed production of crop plants.	**SO4.1 SO4.2**	Specifications for tags and labels to be used for certification purpose.	Varietal and hybrid seed production techniques 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB510.5**:Students will get knowledge on seed certification and minimum Seed Certification Standards (MSCS) for different crops.	**SO5.1 SO5.2**	Path coefficient analysis and interpretation.	Seed certification - history, concept, objectives Central seed certification board Seed certification agency/ organization and staff requirement 5.1, 5.2	As mentioned in page number ……

Semester I

Course Code: STAT-502
Course Title: Statistical Methods for Applied Science

Pre-requisite: Statistical knowledge helps you use the proper methods to collect the data, employ the correct analyses, and effectively present the results. Statistics is a crucial process behind how we make discoveries in science, make decisions based on data, and make predictions.

Rationale: Statistical methods involved in carrying out a study include planning, designing, collecting data, analysing, drawing meaningful interpretation and reporting of the research findings. The statistical analysis gives meaning to the meaningless numbers, thereby breathing life into a lifeless data.

Course Outcomes: CO1 This course will help students to know the applications of Statistics and learn and apply these techniques in the agriculture field of their study.
CO2 It can be used to find the best solution to any problem be it simple or complex.
CO3 Concept of correlation, various correlation coefficients- Pearson's correlation coefficient, Spearman's rank correlation coefficient, partial correlation coefficient and Multiple correlation coefficient.
CO4 To understand the process of hypothesis testing and its significance. Testing of hypothesis using Non-Parametric tests like Median test, Runs test, U test, Kruskal Wallis test etc. and ability to use them judiciously for the testing of given data.
CO5 Apply the different sampling methods for designing and selecting a sample from a population. Compare the pairs of treatment means using different methods when null hypothesis in rejected in ANOVA.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	STAT-502	Statistical Methods for Applied Science	2	01	02	01	6	3

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies), **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C: Credits.**
Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment: Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ ESA)
			Class/Home Assignment 1 number 5 marks each (CA)	Class Test 2 (2 best out) 15 marks each (CT)	Practical Exam (PA)	Class Attendance (AT)	Total Marks (CA+CT+ PA+AT)		
	STAT-502	Statistical Methods for Applied Science	5	30	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self-Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

STAT-502.1 Know the applications of Statistics and learn and apply these techniques in the agriculture field.

Approximate Hours

Item	Appx. Hrs.
CI	6
LI	2
SW	1
SL	2
Total	11

Session Out Comes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO1.1 Apply laws of probability to concrete problems. **SO1.2** Perform statistical inference in several circumstances and interpret the results in an applied context. **SO1.3** Communicate concepts in probability and statistics using both technical and non-technical language.**SO1.4** Use a statistical software package for computations with data,	1) To impart knowledge on Statistical concepts like Exploratory data analysis.	**Unit-1.** Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation. **1.1**. Box-plot **1.2** Descriptive statistics **1.3** Exploratory data analysis **1.4** Theory of probability. **1.5** Random variable **1.6**Mathematical expectation	1. Prepare the assignment on Random variable and mathematical expectation.

SW-1 Suggested Sessional Work (SW):

a. Assignments: Prepare the assignment on Random variable and mathematical expectation.

b. Mini Project: -

c. Other Activities (Specify):

STAT-502 CO-2 Find the best solution to any problem be it simple or complex.

Approximate Hours

Item	Appx. Hrs.
CI	6
LI	8
SW	1
SL	2
Total	17

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO2.1 Recognize the binomial probability distribution and apply it appropriately. **SO2.2** Recognize the Poisson probability distribution and apply it appropriately. **SO2.3** Recognize and understand discrete probability distribution functions, in general. **SO2.4** Recognize the standard normal probability distribution and apply it appropriately. **SO2.5** Compare normal probabilities by converting to the standard normal distribution.	1- Fitting of Binomial distributions. 2- Fitting of Poisson distributions. 3- Fitting of Negative Binomial distributions. 4- Fitting of Normal distributions.	**Unit-2** Discrete and continuous probability distributions, Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, *t* and *F* distributions. Tests of significance based on Normal, chi-square, *t* and *F* distributions. **1.1** Discrete and continuous probability distributions **1.2** Binomial, Poisson, Negative Binomial **1.3**. Normal distribution, Beta and Gamma distributions and their applications **1.4** Concept of sampling distribution: chi-square, *t* and *F* distributions. **1.5** Tests of significance based on Normal, chi-square. **1.6** Tests of significance based on *t* and *F* distributions.	1. Prepare the assignment on Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications .

SW-1 Suggested Sessional Work (SW):

Assignments: Prepare the assignment on Simple Problems Based on Probability. Binomial & Poisson Distributions.

a. Other Activities (Specify):

STAT-502.3 Concept of correlation, various correlation coefficients- Pearson's correlation coefficient, Spearman's rank correlation coefficient, partial correlation coefficient and Multiple correlation coefficient.

Approximate Hours

Item	Appx. Hrs.
CI	6
LI	6
SW	1
SL	2
Total	15

Session Out Comes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO3.1 Create and analyze scatter plots. **SO3.2** Discuss basic ideas of linear regression and correlation. **SO3.3** Create and interpret a line of best fit. **SO3.4** Calculate and interpret the correlation coefficient.	1- Large sample tests, testing of hypothesis based on eXact sampling distributions ~ chi square, t and F. 2- Large sample tests, testing of hypothesis based on eXact sampling distributions ~t-test. 3- Large sample tests, testing of hypothesis based on eXact sampling distributions ~F- test.	**Unit-3** Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. **1.1**. Definition of Correlation **1.2** Types of Correlation **1.3**. Scatter Diagram **1.4**. Karl Pearson's Coefficient of Correlation **1.5** Definition of Regression. **1.6**. Linear Regression Equations	1. Prepare the assignment on Karl Pearson's Coefficient of Correlation. Linear Regression Equations.

SW-1 Suggested Sessional Work (SW):

Assignments: Prepare the assignment on Karl Pearson's Coefficient of Correlation. Linear Regression Equations.

b. Other Activities (Specify):

STAT-502 CO-4 Understand the process of hypothesis testing and its significance. Testing of hypothesis using non-Parametric tests like Median test, runs test, U test, Kruskal Wallis test etc. and ability to use them judiciously for the testing of given data.

Approximate Hours

Item	Appx Hrs.
CI	6
LI	8
SW	1
SL	2
Total	17

Session Out Comes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO4.1 Conduct and interpret hypothesis tests for a single population mean, population standard deviation known. **SO4.2** Conduct and interpret hypothesis tests for a single population mean, population standard deviation unknown. **SO4.3** Describe hypothesis testing in general and in practice **SO4.4** Interpret the chi-square probability distribution as the sample size changes. **SO4.5** Conduct and interpret chi-square goodness-of-fit hypothesis tests.	1- Confidence interval estimation and 2- Correlation analysis 3- Regression analysis 4- Fitting of Linear and Quadratic Model.	**Unit-4** Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table. **1.1** Introduction to Test of Significance **1.2** One sample **1.3** Two sample test t for Means **1.4** Definition of Chi-Square **1.5** Application of Chi-square test **1.6** Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table	1. Prepare the assignment on Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table.

SW-1 Suggested Sessional Work (SW):

Assignments: Prepare the assignment on Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table

c. Other Activities (Specify):

STAT-502 CO-5 Apply the different sampling methods for designing and selecting a sample from a population. Compare the pairs of treatment means using different methods when null hypothesis in rejected in ANOVA.

Approximate Hours

Item	Appx Hrs.
CI	6
LI	6
SW	1
SL	2
Total	15

Session Out Comes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO5.1 Recognize and differentiate between key terms. **SO5.2** Apply various types of sampling methods to data collection. **SO5.3** Create and interpret frequency tables.	1- Non-parametric tests. 2- ANOVA: One way 3- ANOVA: Two Way	**Unit-5** Introduction to Analysis of Variance, Analysis of One Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample. **1.1** Introduction to Analysis of Variance **1.2**. Analysis of One Way Classification **1.3**. Introduction to Sampling Methods **1.4** Sampling versus Complete Enumeration **1.5** Simple Random Sampling with and without replacement **1.6** Use of Random Number Tables for selection of Simple Random Sample.	1. Prepare the assignment on Introduction to Analysis of Variance, Analysis of One Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration.

SW-1 Suggested Sessional Work (SW):

Assignments:

Other Activities (Specify)

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (C l)	Laboratory Lecture (L I)	Sessional Work (SW)	Self-Learning (S l)	Total hour (C l + LI+ SW +Sl)
01: This course will help students to know the applications of Statistics and learn and apply these techniques in the agriculture field of their study.	06	02	01	02	15
02: It can be used to find the best solution to any problem be it simple or complex.	06	08	01	02	15
03: Concept of correlation, various correlation coefficients- Pearson's correlation coefficient, Spearman's rank correlation coefficient,	06	06	01	02	15

partial correlation coefficient and Multiple correlation coefficient.					
04: To understand the process of hypothesis testing and its significance. Testing of hypothesis using Non-Parametric tests like Median test, Runs test, U test, Kruskal Wallis test etc. and ability to use them judiciously for the testing of given data.	06	08	01	02	15
05: Apply the different sampling methods for designing and selecting a sample from a population. Compare the pairs of treatment means using different methods when null hypothesis in rejected in ANOVA.	06	06	01	02	15

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit title	Marks Distribution			Total Marks
		R	U	A	
CO-1	This course will help students to know the applications of Statistics and learn and apply these techniques in the agriculture field of their study.	02	02	02	06
CO-2	It can be used to find the best solution to any problem be it simple or complex.	02	03	03	08
CO-3	Concept of correlation, various correlation coefficients- Pearson's correlation coefficient, Spearman's rank correlation coefficient, partial correlation coefficient and Multiple correlation coefficient.	02	04	04	10
CO-4	To understand the process of hypothesis testing and its significance. Testing of hypothesis using Non-Parametric tests like Median test, Runs test, U test, Kruskal Wallis test etc. and ability to use them judiciously for the testing of given data.	03	04	05	12
CO-5	Apply the different sampling methods for designing and selecting a sample from a population. Compare the pairs of treatment means using different methods when null hypothesis in rejected in ANOVA.	04	05	05	14
	Total	13	18	19	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Statistical Methods for Applied Science will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion

5. Role Play
6. Demonstration
7. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
8. Brainstorming

Suggested Learning Resources:

S. No.	**Title**	**Author**	**Publisher**	**Edition &** Year
01	An Outline of Statistical Theory	Goon AM, Gupta MK &Dasgupta B.	The World Press	1977 1st adition
02	Fundamentals of Statistics	Goon AM, Gupta MK &Dasgupta B	The World Press	1983. First edition
03	Introduction to Mathematical Statistics	Hoel PG	John Wiley	05th Edition 1971
04	An Introduction to Multivariate Statistical Analysis	T.W. Anderson	John Wiley.	3rd Edition 2009
05	Introduction to Mathematical Statistics	Robert V. Hogg, Joseph W. McKean, Allen T. Craig	Hogg	7th Edition 2012

Curriculum Development Team:

1. Professor B.B. Beohar, Director Planning, & Director Extension, A.K.S. University
2. Dr. V.K. Vishwakarma, Head Department of Agricultural Economics, FAST
3. Mr. Navneet Raj Rathore, Teaching Associate, Department of Agricultural Economics, FAST

Cos, POs and PSOs Mapping
Course Code: STAT-502
Course Title: - Statistical Methods for Applied Science

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	Student will identify the current scenario, crop diversity, climatic requirement and breeding techniques of different vegetable and flower crops.	Student will expertise in latest vegetable production technologies, vegetable breeding techniques and post-harvest management of vegetables	The student will have expertise in nursery-raising techniques and protected cultivation of vegetables and flower crops.	The student will have expertise in different climatic conditions required for common vegetable as well as under utilized vegetable cultivation.	Student will plan about the big scale commercial project and also manage the research trails under vegetable and flower crops	Student will apply various statistical methods to analyze their master research work	Student will understand about library technques, technical writing skill, IPR, laboratory techniques and rese	Student will identify different cool season, warm season and underutilized vegetable crops	Student will practice different breeding techniques used in vegetable and flower produc	Student will recognize different underutilized vegetable and spice crops	Student will apply different vegetable processing and post-harvest-handling methods for vegetables and	Student will understand role of microclimate in vegetable and flower crop production under different protected	After gaining experience, they will get the positions of specialists for handling plantation, nurseries and	Student will recognize different flower, ornamental crops and their nursery managem	Student will practice turfgrass, indoor plant and interios capingmanagement	Student will apply various information services, technical writings and communication skills in their aca	Student will apply basic concepts in laboratory techniques during their research work	Student will apply basic statistical tools during their research w

							archethics in manuscript writing		tion		flowers	structures	other protected cultivation projects	ent		demics		ork
STAT-502.1 This course will help students to know the applications of Statistics and learn and apply these techniques in the agriculture field of	1	2	3	1	1	1	1	1	1	1	2	3	1	3	2	1	1	1

their study.																		
STAT-502.2 It can be used to find the best solution to any problem be it simple or complex.	1	1	3	1	2	1	1	1	2	3	2	1	1	1	1	1	1	1
STAT-502.3 Concept of correlation, various correlation coefficients- Pearson's correlation coefficient, Spearman's rank correlation coefficient, partial correlation	3	1	3	2	1	1	1	1	1	2	1	1	3	1	1	1	1	1

coefficient and Multiple correlation coefficient.																		
STAT-502.4 To understand the process of hypothesis testing and its significance. Testing of hypothesis using Non-Parametric tests like Median test, Runs test, U test, Kruskal Wallis test etc. and ability to use them	3	1	2	3	1	1	1	2	3	1	2	3	2	1	1	1	1	1

judiciously for the testing of given data																		
STAT-502.5 Apply the different sampling methods for designing and selecting a sample from a population. Compare the pairs of treatment means using different methods when null hypothesis in rejected in ANOVA.	3	3	2	3	2	1	1	2	2	2	2	2	3	1	1	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Statistical Methods for Applied Science

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	STAT-502.CO 1: This course will help students to know the applications of Statistics and learn and apply these techniques in the agriculture field of their study.	**SO1.1** **SO1.2** **SO1.3** **SO1.4**	1.1. To impart knowledge on Statistical concepts like Exploratory data analysis.	**Unit-1.0** Box-plot, Descriptive statistics, Exploratory data analysis, Theory of probability, Random variable and mathematical expectation. 1.1, 1.2, 1.3. 1.4, 1.5, 1.6	As mentioned in page number …
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	STAT-502.CO 2: It can be used to find the best solution to any problem be it simple or complex.	**SO2.1** **SO2.2** **SO2.3** **SO2.4** **SO2.5**	2.1. Fitting of Binomial distributions. 2.2. Fitting of Poisson distributions. 2.3. Fitting of Negative Binomial distributions 2.4. Fitting of Normal distributions.	**Unit-2.0 –** Discrete and continuous probability distributions, Binomial, Poisson, Negative Binomial, Normal distribution, Beta and Gamma distributions and their applications. Concept of sampling distribution: chi-square, *t* and *F* distributions. Tests of significance based on Normal, chi-square, *t* and *F* distributions. 2.1, 2.2, 2.3, 2.4, 2.5, 2.6	As mentioned in page number …
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	STAT-502.CO 3: Concept of correlation, various correlation coefficients- Pearson's correlation coefficient, Spearman's rank correlation coefficient, partial correlation	**SO3.1** **SO3.2** **SO3.3** **SO3.4**	3.1. Large sample tests, testing of hypothesis based on exact sampling distributions ~ chi square, t and F. 3.2. Large sample tests, testing of hypothesis based on exact sampling distributions ~ t-	**Unit-3.0** Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. 3.1, 3.2, 3.3, 3.4, 3.5, 3.6	As mentioned in page number …

	coefficient and Multiple correlation coefficient.		test. 3.3. Large sample tests, testing of hypothesis based on exact sampling distributions ~ F-test		
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	STAT-502.CO 4: To understand the process of hypothesis testing and its significance. Testing of hypothesis using Non-Parametric tests like Median test, Runs test, U test, Kruskal Wallis test etc. and ability to use them judiciously for the testing of given data.	**SO4.1** **SO4.2** **SO4.3** **SO4.4** **SO4.5**	4.1.Confidence interval estimation and. 4.2. Correlation analysis. 4.3. Regression analysis. 4.4. Fitting of Linear and Quadratic Model.	**Unit-4.0** Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2 ×2 Contingency Table. 4.1, 4.2, 4.3. 4.4, 4.5, 4.6	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	STAT-502.CO 5: Apply the different sampling methods for designing and selecting a sample from a population. Compare the pairs of treatment means using different methods when null hypothesis in rejected in ANOVA.	**SO5.1** **SO5.2** **SO5.3**	5.1. Non-parametric tests. 5.2. ANOVA: One way 5.3. ANOVA: Two Way	**Unit-5.0** Introduction to Analysis of Variance, Analysis of One Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample. 5.1, 5.2, 5.3. 5.4, 5.5, 5.6.	As mentioned in page number ……

Semester-I

Course Code: **PGS 501**

Course Title: **Library and Information Services**

Pre-requisite: Student should have basic knowledge of library because course aims to familiarize the learners with the basic concept of use of library services.

Rationale: To impart to the students an understanding of knowledge classification and the theories of library classification, to develop skills in document classification and content analysis.

To select, evaluate and acquire library materials in varied formats to meet and respond to the needs of our diverse community.
To promote literacy and disseminate useful daily information to the people and encourage lifelong learning through its reading materials and resources.

To provide opportunity, ensuring freedom and equal access to information for all members of the community, to educate and enlighten them.

To maintain and preserve books, materials and resources with historical, cultural, social, economic and archival value, and other related materials in an organized collection to provide members of the community these materials and enriched their personal and professional lives.

To provide materials and resources that entertain and inspire as well as services offering space for people and information to come together, and programs that would create library awareness and consciousness.

Course Outcomes:

CO1. Compare and critique approaches to information systems, structures, and standards.

CO2. Able to understand about various concepts of Library, its functions, objective.

CO3. Connect foundational concepts, theories, and principles of information organization and access to professional contexts.

CO4. Design and develop systems and services that provide access to information.

CO5. Analyze evidence to address information challenges and opportunities.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
	PGS 501	Library and Information Services	1	0	1	2	4	1

Legend:

CI: Classroom Instruction (Includes different instructional strategies.Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performance sin laboratory workshop, field or

other locations using different instructional strategies), **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	**Scheme of Assessment (Marks)**							
			Progressive Assessment (PRA)						**End Semester Assessment (ESA)**	**Total Marks** (PRA+ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		
	PGS 501	Library and Information Services	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion

Topic Covered:

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical:

Introduction to library and its services; Role of libraries in education, research and technology transfer, Classification systems and organization of library; Sources of information-, Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources;

Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Sic Access Catalogue and other computerized library services; Use of Internet including search engines resources; ere sources access methods.

CO.1: Able to understand about the origin of Library and information Services.

Approximate Hours

Item	Appx Hrs.
Cl	1
LI	0
SW	1
SL	2
Total	4

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**(SL)**
SO1.1 Understand the Concept, Definition & Characteristics of Library **SO1.2**Understand the Importance & Functions of Library **SO1.3** Understand the Role of Library and Information Services		1.1 Introduction to library, 1.2 Types of library, 1.3 Role of library in society 1.4 Role of Education sector, 1.5 Classification scheme, 1.6 Types of Information sources 1.7 Abstracting and indexing services, 1.8 Use of Databases, OPAC 1.9 Computerized library services 1.10 Library Services 1.11 Online Public Access Catalogue 1.12 Types of Information Centers 1.13 Library Automation 1.14 Create a Digital Library 1.15 Use of e resources	1. How to Accessioning of Books on software 2 How to Books search in Library through the OPAC 3. Difference Between Library and Information Services

SW-1 Suggested Sessional Work (SW):

Assignments: Introduction to library and its services; Role of libraries in education, research and technology transfer, Classification systems and organization of library; Sources of information-, Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources.

Reference Books:

Foundations of Library and Information Science By Pawan Tripathi, Ansh Book International

Management Basics for Information Professionals by G. Edward Evans, Patricia Layzell Ward, Neal Schuman Publishers

Library Classification by Purushotham Tiwari APH Publishing Corporation

Cos, POs and PSOs Mapping
Course Code: PGS 501
Course Title: - Library and Information Services

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO 2	PSO3	PSO4	PSO5	PSO 6	PSO7	PSO 8	PSO 9	PSO 10	PSO 11
	Student will identify the current scenario, crop diversity, climatic requirement and breeding techniques of different vegetable and flower crops.	Student will expertise in latest vegetable production technologies, vegetable breeding techniques and post-harvest management of vegetables	The student will have expertise in nursery-raising techniques and protected cultivation of vegetables and flower crops.	The student will have expertise in different climatic conditions required for common vegetable as well as under utilized vegetable cultivation.	Student will plan about the big scale commercial project and also manage the research trails under vegetable and flower crops	Student will apply various statistical methods to analyze their master research work	Student will understand about library technique, technical writing skill, IPR, laboratory techniques and research ethics in manuscript writing	Student will identify different cool season, warm season and underutilized vegetable crops	Student will practice different breeding techniques used in vegetable and flower production	Student will recognize different underutilized vegetable and spice crops	Student will apply different vegetable processing and post-harvest-handling methods for vegetables and flowers	Student will understand role of microclimate in vegetable and flower crop production under different protected structures	After gaining experience, they will get the positions of specialists for handling plantation, nurseries and other protected cul	Student will recognize different flower, ornamental crops and their nursery management	Student will practice turfgrass, indoor plant and interios capingmanagement	Student will apply various information services, technical writings and communication skills in their academics	Student will apply basic concepts in laboratory techniques during their research work	Student will apply basic statistical tools during their research work

													tiv ati on pro ject s					
PG S 501 Abl e to und erst and abo ut vari ous con cep ts of Lib rar y, its fun ctio ns, obj ecti ve and con nec t fou nda tion al con cep ts, the orie s, and pri nci ple s of	1	1	1	1	1	3	3	1	1	1	1	1	1	1	1	3	3	2

information organization and access to professional contexts.bulb and tuber crops.																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Library and Information Services

POs & PSOs No.	**COs No.& Titles**	**SOs No.**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**PGS 501 CO1** Able to understand about various concepts of Library, its functions, objective and connect foundational concepts, theories, and principles of information organization and access to	**SO1.1** **SO1.2** **SO1.3**	1.1 Introduction to library, 1.2 Types of library 1.3 Role of library in society 1.4 Role of Education sector, 1.5 Classification scheme, 1.6 Types of Information sources 1.7 Abstracting and indexing services, 1.8 Use of Databases, OPAC 1.9 Computerized library services 1.10 Library Services 1.11 Online Public Access Catalogue 1.12 Types of Information Centers 1.13 Library Automation		As mentioned in page number ……

	professional contexts bulb and tuber crops.		1.14 Create a Digital Library 1.15 Use of e resources		

Semester- I

Course Code: **PGS502**

Course Title: **Technical writing and communication.**

Pre- requisite: Understanding the principles of various technical writing including thesis, reviews, abstracts and developing communication skills through the proper use of language.

Rationale: The basic purpose of technical writing is to convey complex information in a simple manner. It explains a topic in detail using proper abstract and citations having communication skills being accessible to a general audience.

Course Outcomes:

PGS 502.1: Learning the various form of scientific writing and implementing skills for Formulation of research based documents.

PGS 502.2: Acquisition of technical communication skill and articulate in English (verbal as writing)

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
	PGS 502	Technical writing and communication.	0	2	0	0	2	0+1

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies), **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		

	PGS 502	Technical writing and communication	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PGS 502.1: **Learning the various form of scientific writing and implementing skills for Formulation of research based documents.**

Approximate Hours

Item	Approximate Hours
CI	**00**
LI	**08**
SW	**01**
SL	**02**
Total	**11**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1. To understand about various form writing research documents. SO1.2. To understand about various technical writing approaches for scientific strengting of research documents. SO1.3. To understand about editing and press reading method to avoid plagiarism.	**Technical writing** 1. Various form of scientific writing – thesis, technical papers, reviews, manuals etc. 2.Various part of thesis and research communication Title page, Authorship content page, Preface, Introduction, Review of literature Material and methods, Experimental result, Discussion citations etc. 3. Commonly used abbreviations in the thesis and research communication. 4. Illustrations, photography and drawing with suitable captions pagination numbering of tables and illustrations. 5. Writing of numbers and dates in scientific write ups. 6. Editing and press reading. 7. Writing of review articles.		Enlisting and write description of research communication contents.

SW-1 Suggested Sessional Work (SW):

d. Assignments:

i. Various part of thesis and research communications.

ii. Writing of abstract, summaries, précis, citations.
iii. Commonly used abbreviations in the thesis and research communication.
iv. Write down the principal of editing and press reading.

e. Mini Project:

f. Other Activities (Specify):

PGS 502.2: Acquisition of technical communication skill and articulate in English (verbal as writing).

Approximate Hours

Item	Approximate Hours
CI	**00**
LI	**07**
SW	**01**
SL	**02**
Total	**10**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. To understand the types, forms, tenses clauses and their uses. **SO2.2.** To understand common errors, punctuation in the sentences. **SO2.3.** To understand part of speech or word class and their uses. **SO2.4.** To understand discussion in groups and interviews.	**Communication skill-** 1 Grammar (Tenses, part of speed, clauses, punctuation marks) 2 Error analysis (common error), concord, collocation, phonetic, symbols and transcription. 3 Accentual pattern: weak forms in connected speech. 4 Participation in group discussion 5 Facing of interview. 6 Presentation of scientific paper.		Enlisting and write the description of communication using proper language skills.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

1 Writing types of clauses.

1 Writing the sentences using correct punctuation.

2 Writing the types and forms of tenses.

b. Mini Project:

civ. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PGS 502.1: Learning the various form of scientific writing and implementing skills for Formulation of research based documents.	0	2	1	3
PGS 502.2: Acquisition of technical communication skill and articulate in English	0	2	1	3

(verbal as writing)				

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	**Technical writing**	00	05	05	10
	1.1 Various form of scientific writing – thesis, technical papers, reviews, manuals etc.	03	03	04	10
	1.2 Various part of thesis and research communication				
	- Title page				
	- Authorship content page				
	- Preface				
	- Introduction	00	05	05	10
	- Review of literature	03	02	05	10
	- Material and methods	00	00	10	10
	- Experimental result				
	- Discussion	00	05	05	10
	1.3 citations etc.	04	02	04	10
		03	02	05	10
	1.4 Commonly used abbreviations in the thesis and research communication.				
	1.5 Illustrations, photography and drawing with suitable captions pagination numbering of tables and illustrations.				
	1.6 Writing of numbers and dates in scientific write ups.				
	1.7 Editing and press reading				
	1.8 Writing of review articles.				
CO 2	**Communication skill-**				
	1.1 Grammar (Tenses, part of speed, clauses, punctuation marks)	03	02	05	10
		02	03	05	10
	1.2 Error analysis (common error), concord, collocation, phonetic, symbols and transcription.	04	04	00	08
		05	02	00	07
	1.3 Accentual pattern: weak forms in connected speech.	00	05	05	10
	1.4 Participation in group discussion	00	05	05	10

	1.5 Facing of interview. **1.6 Presentation of scientific paper.**				

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Technical writing and communication** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

23. Improved Lecture
24. Tutorial
25. Case Method
26. Group Discussion
27. Role Play
28. Demonstration
29. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
30. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Spoken English	Barnes and Noble. Robert C. (Ed.).	Flourish Your Language	2005
2	Technical communication	Mike markel Stular A. Selber	Bedford/St. Martins, 12th edition	2017
3	The Essentials of Technical communication	Elizabeth tebeaux sam dragga.	Oxford university press,4th edition	2017
4	Technical writing prosess	Kieran morgan and sanja spajic	Better on paper publications, 1th edition	2015
5	Developing quality technical information	Moira Mcfadden lanyi, Deirdrelongo	IBM press 3th edition	2014

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Abhishek Singh, HOD, Dept. of Horticulture, Faculty of Agriculture Science and Technology AKS University.
4. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of G&PB, Faculty of Agriculture Science and Technology AKS University.

Cos, POs and PSOs Mapping
Course Code: PGS502
Course Title: - Technical writing and communication

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	Student will identify the current scenario, crop diversity, climatic requirement and breeding techniques of different vegetable and flower crops.	Student will expertise in latest vegetable production technologies, vegetable breeding techniques and post-harvest management of vegetables	The student will have expertise in nursery-raising techniques and protected cultivation of vegetables and flower crops.	The student will have expertise in different climatic conditions required for common vegetable as well as under utilized vegetable cultivation.	Student will plan about the big scale commercial project and also manage the research trails under vegetable and flower crops	Student will apply various statistical methods to analyze their master research work	Student will understand about library technqiues, technical writing skill, IPR, laboratory techniques and research ethics in manuscr	Student will identify different cool season, warm season and underutilized vegetable crops	Student will practice different breeding techniques used in vegetable and flower production	Student will recognize different underutilized vegetable and spice crops	Student will apply different vegetable processing and post-harvest handling methods for vegetables and flowers	Student will understand role of microclimate in vegetable and flower crop production under different protected structures	After gaining experience, they will get the positions of specialists for handling plantation, nurseries and	Student will recognize different flower, ornamental crops and their nursery management	Student will practice turfgrass, indoor plant and interioscaping management	Student will apply various information services, technical writings and communication skills in their academics	Student will apply basic concepts in laboratory techniques during their research work	Student will apply basic statistical tools during their research work

							ipt writing						other protected cultivation projects					
PGS 502.1: Learning the various form of scientific writing and implementing skills for Formulation of	1	1	1	1	1	2	3	1	1	1	1	1	1	1	1	3	3	3

research based documents.																		
PGS 502.2: Acquisition of technical communication skill and articulate in English (verbal as writing)	1	1	1	1	1	3	2	1	1	1	1	1	1	1	1	2	3	3

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Technical writing and communication

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**PGS 502.CO1**: Learning the various form of scientific writing and implementing skills for formulation of research based documents.	**SO1.1** **SO1.2** **SO1.3**	Technical writing 1. Various form of scientific writing – thesis, technical papers, reviews, manuals etc. 2. Various part of thesis and research communication - Title page - Authorship content page - Preface - Introduction - Review of literature - Material and methods - Experimental result - Discussion 3. citations etc. 4. Commonly used abbreviations in the thesis and research communication . 5. Illustrations, photography and drawing with suitable captions pagination numbering of tables and illustrations. 6. Writing of numbers and dates in scientific write ups. 7. Editing and press reading . 8. Writing of review articles.		As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**PGS 502.CO2:** Acquisition of technical communication skill and articulate in English (verbal as writing)	**SO2.1** **SO2.2** **SO2.3** **SO2.4**	1. Grammar (Tenses, part of speed, clauses, punctuation marks) 2. Error analysis (common error), concord, 3. collocation, phonetic, symbols and transcription. 4. Accentual pattern: weak forms in connected speech. 5. Participation in group discussion 6. Facing of interview. 7. Presentation of scientific paper.		As mentioned in page number ……

Detailed Syllabus
M.Sc. Ag. in Genetics & Plant breeding
Semester- II

Course Code: **GPB 505**

Course Title: **Principles of Cytogenetics**

Pre- requisite: Student should have basic knowledge of cell, chromosome and variations of chromosomes.

Rationale: The very purpose of this course is to acquaint the students with cell cycle and architecture of chromosome in prokaryotes and eukaryotes, special types of chromosomes, techniques for karyotyping. This course aims to impart knowledge of variations in chromosomes numbers and their structures. It acquaints the students for the production and use of haploids, apomictic populations and their role in genetics and breeding.

Course Outcomes:

GPB 505.1: Student will be able to understand Cell cycle and architecture of chromosome.

GPB 505.2: Students will have the ability to apply the knowledge gained about Structural and numerical variations of chromosomes.

GPB 505.3: To understand Fertilization barriers, Polyploidy and genetic problems in crops with apomixes.

GPB 505.4: Student will be able to explain Reversion of autopolyploid to diploids; Genome mapping in polyploids

GPB 505.5: Students will get knowledge on Chromosome manipulations

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
	GPB 505	Principles of Cytogenetics	2	2	1	1	6	2+1=3

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Cous e Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 3 marks	Class Test 2 (2 best out of 3) 10 marks each	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+ SA+CAT +AT)		

			each (CA)	(CT)						
	GPB 505	Principles of Cytogenetics	15	30	0	0	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB 505.1: Student will be able to understand cell cycle and architecture of chromosome.

Approximate Hours

Item	Approximate Hours
CI	**7**
LI	**16**
SW	**1**
SL	**1**
Total	**25**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1. Student will be able to understand cell cycle. **SO1.2.** Students are able to explain architecture of chromosome in prokaryotes and eukaryotes. **SO1.3.** To know Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere. **SO1.4.** Understand artificial chromosome construction and its uses. **SO1.5.** Understand Special types of chromosomes and variation in chromosome structure. **SO1.6.** To know evolutionary significance; Introduction to techniques for karyotyping. **SO1.7.** Understand Chromosome banding and painting -In situ hybridization and various applications.	1. Learning the cytogenetical laboratory techniques. 2. Various chemicals to be used for fixation. 3. Various chemicals to be used for dehydration. 4Various chemicals to be used for, embedding, staining, cleaning, etc. 5 Microscopy: various types of microscopes. 6. Preparing specimen for observation. 7. Studies on mitosis crop plants. 8. Studies on meiosis in crop plants.	**Unit-1. Cell cycle and architecture of chromosome** 1.1. Cell cycle 1.2. Architecture of chromosome in prokaryotes and eukaryotes. 1.3. Chromonemata, chromosome matrix, chromomeres, centromere, secondary constriction and telomere. 1.4. Artificial chromosome construction and its uses 1.5. Special types of chromosomes and variation in chromosome structure. 1.6. Evolutionary significance; Introduction to techniques for karyotyping. 1.7. Chromosome banding and painting -In situ hybridization and various applications.	**1.** Special types of chromosomes

SW-1 Suggested Sessional Work (SW):

g. Assignments:
Architecture of chromosome in prokaryotes

h. Mini Project:

i. Other Activities (Specify):

GPB 505.2: Students will have the ability to apply the knowledge gained about Structural and numerical variations of chromosomes.

Approximate Hours

Item	Approximate Hours
CI	**8**
LI	**8**
SW	**1**
SL	**1**
Total	**18**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Understand Structural variations of chromosomes and their implications. **SO2.2.** Students are able to explain Numerical variations of chromosomes and their implications **SO2.3.** Symbols and terminologies for chromosome numbers. **SO2.4.** To know euploidy, haploids, diploids and polyploids **SO2.5.** Student will be able to understand utilization of aneuploids in gene location. **SO2.6.** Knowledge about Variation in chromosome behaviour, somatic segregation and chimeras. **SO2.7.** Students are able to explain Endomitosis and somatic reduction; Evolutionary significance of chromosomal aberrations, balanced lethal. **SO2.8.** Chromosome complexes; Inter-varietal chromosome substitutions.	1. Fixative preparation and fixing specimen for light microscopy studies in cereals. 2. Using micrometres. 3. Studying the pollen grain size in wheat and mustard. 4. Studying the pollen grain size in maize and pearel millet	**Unit-2. Variations of chromosomes.** 1. Structural variations of chromosomes and their implications 2. Numerical variations of chromosomes and their implications 3.Symbols and terminologies for chromosome numbers 4. Euploidy, haploids, diploids and polyploids 5. Utilization of aneuploids in gene location 6. Variation in chromosome behaviour, somatic segregation and chimeras, 7. Endomitosis and somatic reduction; Evolutionary significance of chromosomal aberrations, balanced lethal 8. Chromosome complexes; Inter-varietal chromosome substitutions.	1.Numerical variations of chromosomes and their implications

SW-2 Suggested Sessional Work (SW):

c. Assignments: Utilization of aneuploids in gene location

d. Mini Project:

Other Activities (Specify):

GPB 505.3: To understand Fertilization barriers, Polyploidy and genetic problems in crops with apomixes.

Item	Approximate Hours
CI	**6**
LI	**4**
SW	**1**
SL	**1**
Total	**12**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1. Understand fertilization barriers in crop plants at pre-and post fertilization levels; In-vitro techniques to overcome the fertilization barriers in crops; Polyploidy **SO3.2.** Understand Genetic consequences of polyploidization and role of polyploids in crop breeding **SO3.3.** To know autopolyploid and allopolyploids. **SO3.**4. Knowledge about Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer. **SO3.5.** Student will be able to understand Alien addition and substitution lines, creation and utilization. **SO3.6.** Students are able to explain apomixis, evolutionary and genetic problems in crops with apomixes.	1.Pollen germination in vivo 2. Pollen germination in-vitro.	**Unit 3 Fertilization barriers and Polyploidy** **1.** Fertilization barriers in crop plants at pre-and post fertilization levels; In-vitro techniques to overcome the fertilization barriers in crops; Polyploidy **2.** Genetic consequences of polyploidization and role of polyploids in crop breeding **3.** Evolutionary advantages of autopolyploid vs allopolyploids. **4** Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer. **5.** Alien addition and substitution lines, creation and utilization. **6.** Apomixis, evolutionary and genetic problems in crops with apomixes.	**1.** Role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping and gene blocks transfer.

SW-3 Suggested Sessional Work (SW):

a. **Assignments:**
   Alien addition and substitution lines, creation and utilization.
b. **Mini Project:**
c. **Other Activities (Specify):**

GPB 505.4: Student will be able to explain Reversion of autopolyploid to diploids; Genome mapping in polyploids.

Item	Approximate Hours
CI	**6**
LI	**2**
SW	**1**
SL	**1**
Total	**10**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1. Understand Reversion of autopolyploid to diploids. **SO4.2** Student will be able to understand genome mapping in polyploids. **SO4.3.** Knowledge about Interspecific hybridization and allopolyploids. **SO.4.4.** Students are able to explain Synthesis of new crops (wheat, Triticale, Brassica, and cotton). **SO.4.5.** Understand hybrids between species with same chromosome number, alien translocations. **SO4.6.** To know Gene transfer using amphidiploids bridge species.	1. Demonstration of polyploidy.	**Unit 4. Reversion of polyploids.** 1.Reversion of autopolyploid to diploids 2.Genome mapping in polyploids. 3. Interspecific hybridization and allopolyploids. 4. Synthesis of new crops (wheat, Triticale, Brassica, and cotton). 4. Hybrids between species with same chromosome number, alien translocations. 5. Hybrids between species with different chromosome number. 6. Gene transfer using amphidiploids bridge species.	1.Interspecific hybridization and allopolyploids.

SW-4 Suggested Sessional Work (SW):

a. **Assignments:**
   Hybrids between species with same chromosome number, alien translocations.
b. **Mini Project:**
c. **Other Activities (Specify):**

GPB 505.5: Students will get knowledge on Chromosome manipulations.

Item	Approximate Hours
CI	**3**
LI	**0**
SW	**1**
SL	**1**
Total	**5**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Understand Chromosome manipulations in wide hybridization. **SO5.2.** Knowledge about Production and use of haploids and dihaploids in genetics and breeding. **SO5.3.** Students are able to explain Production and use of doubled haploids in genetics and breeding.		**Unit-5 Chromosome manipulations** 1. Chromosome manipulations in wide hybridization. 2. Production and use of haploids and dihaploids in genetics and breeding. 3. Production and use of doubled haploids in genetics and breeding.	Production and use of haploids and dihaploids in genetics and breeding.

SW-5 Suggested Sessional Work (SW):

g. Assignments:

h. Mini Project:

Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)+ **LI**	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
GPB 505.1: Student will be able to understand Cell cycle and architecture of chromosome.	**23**	**1**	**1**	**25**
GPB 505.2: Students will have the ability to apply the knowledge gained about Structural and numerical variations of chromosomes.	**16**	**1**	**1**	**18**
GPB 505.3: To understand Fertilization barriers, Polyploidy and genetic problems in crops with apomixes.	**10**	**1**	**1**	**12**
GPB 505.4: Student will be able to explain Reversion of autopolyploid to diploids; Genome mapping in polyploids.	**8**	**1**	**1**	**10**
GPB 505.5: Students will get knowledge on Chromosome manipulations	**3**	**1**	**1**	**05**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	Cell cycle and architecture of chromosome	**3**	**6**	**2**	**11**
CO 2	Variations of chromosomes.	**2**	**5**	**2**	**9**
CO 3	Fertilization barriers and Polyploidy	**2**	**7**	**2**	**11**
CO 4	Reversion of polyploids.	**4**	**4**	**2**	**10**
CO 5	Chromosome manipulations.	**4**	**4**	**1**	**9**
Total Marks		**15**	**26**	**9**	**50**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Principles of Cytogenetics** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks.

Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

31. Improved Lecture
32. Case Method
33. Group Discussion
34. Role Play
35. Demonstration
36. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
37. Brainstorming
38. Smart Board

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	World of the Cell.	Becker K and Hardin J.	Pearson Edu.	2004.
2	Discussions in Cytogenetics.	Charles B.	Prentice Hall Publications.	1993.
3	Cytogenetics	Gupta PK.	Rastogi Pubishers	2010.
4	Cell and Molecular Biology: Concepts and Experiments.	Karp G.	John Wiley & Sons.	1996
5	Cytogenetics of aneuploids.	Khush GS.	Elsevier. 1 edition.	1973
6	Chromosome Techniques: Theory and Practice.	Sharma AK and Sharma A.	Butterworth Heinemann publisher	1988
7	Introduction to Cytogenetics	Ganesh Prasad	Kalyani Publishers	2013
8	Fundamentals of Cytogenetics and Genetics	Mahabal Ram	PHI	2010
9	Understandings ion Cytogenetic Techniques	V & H P Gurushankara Vasudev	Vasudev, V & H P Gurushankara	2017

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
4. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
5. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
6. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
7. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
8. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
9. Mr. Ankit Kumar Bhagat, Teaching Associate, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology, AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 505
Course Title: - Principles of Cytogenetics

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain inter disciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to contemp	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain inter disciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to con	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								orary agriculture.								temporary agriculture.		
GPB 505.1: Student will be able to understand Cell cycle and architecture of chromosome.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB 505.2: Students will have the ability to apply the knowledge gained about Structural and numerical variations of chromosomes.	1	2	1	2	2	1	1	2	3	2	3	2	1	1	1	1	1	1
GPB 505.3	1	2	3	2	2	1	1	2	2	3	2	1	1	1	1	1	1	1

: To understand Fertilization barriers, Polyploidy and genetic problems in crops with apomixes.																		
GPB 505.4: Student will be able to explain Reversion of autopolyploid to diploids; Genome mapping in polyploids.	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1
GPB 505.5: Stude	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

nts will get knowledge on Chromosome manipulations																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Principles of Cytogenetics

POs & PSOs No.	**COs No.& Titles**	**SOs No.**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 505.1:** Student will be able to understand Cell cycle and architecture of chromosome.	**SO1.1 SO1.2 SO1.3**	Fixative preparation and fixing specimen for light microscopy studies in cereals.	Unit-1. Cell cycle and architecture of chromosome.1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 505.2:** Students will have the ability to apply the knowledge gained about Structural and numerical variations of chromosomes.	**SO2.1 SO2.2 SO2.3 SO2.4 SO2.5**	2. Using micrometres. 3. Studying the pollen grain size in wheat and mustard.	Structural variations of chromosomes and their implications 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 505.3:** To understand Fertilization barriers, Polyploidy and genetic problems in crops with apomixes.	**SO3.1 SO3.2 SO3.3**	4. Studying the pollen grain size in maize and pearel millet	Fertilization barriers in crop plants at pre-and post fertilization levels; In-vitro techniques to overcome the fertilization barriers in crops; Polyploidy 3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 505.4:** Student will be able to explain Reversion of autopolyploid to diploids; Genome mapping in polyploids.	**SO4.1 SO4.2**		Reversion of autopolyploid to diploids Genome mapping in polyploids. 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8,	**GPB 505.5:** Students will get knowledge on Chromosome manipulations	**SO5.1 SO5.2**		Chromosome manipulations in wide hybridization 5.1, 5.2	As mentioned in page number

9, 10, 11					……

Semester- II

Course Code: **GPB 506***

Course Title: **Molecular Breeding and Bioinformatics***

Pre- requisite: Student should have basic knowledge of genetics, plant breeding and molecular marker.

Rationale: The course will provide deep knowledge to the students on genotyping and kinds of markers including biochemical and molecular, mapping populations, allele mining. This will also add ways to perform marker-assisted selection and gene pyramiding to evolve superior varieties

Course Outcomes:

GPB 506.1: Student to know about various molecular tools and approaches for genotyping and their uses in crop improvement.

GPB 506.2: Students will have the ability to apply the knowledge gained about QTLs analysis in crop plants.

GPB 506.3: To understand genome sequencing and nanotechnology.

GPB 506.4: Student will be able to explain recombinant DNA technology and Biotechnology applications in crop improvement.

GPB 506.5: Students will get knowledge about International regulations and biosafety issues of GMOs

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
	GPB 506*	Molecular Breeding and Bioinformatics*	2	2	1	1	6	2+1=3

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Cous e Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignm	Class Test 2 (2 best out of 3)	Seminar one (SA)	Class Activity any one	Class Attendance (AT)	Total Marks (CA+CT		

			ent 5 number 3 marks each (CA)	10 marks each (CT)		(CAT)		+SA+CAT+AT)		
	GPB 506*	Molecular Breeding and Bioinformatics*	15	30	0	0	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB 506.1: Student to know about various molecular tools and approaches for genotyping and their uses in crop improvement.

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	**0**
SW	**1**
SL	**1**
Total	**8**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1. Student will be able to understand genotyping. **SO1.2.** Students are able to explain biochemical and molecular markers. **SO1.3.** Student will be able to understand RFLP, RAPD, AFLP, SSR, SNPs, ESTs, etc. **SO1.4.** Understand Functional markers; Mapping populations **SO1.5.** Students are able to explain molecular mapping and tagging of agronomically important traits. **SO1.6.** To know Statistical tools		**Unit-1. Genotyping; Biochemical and Molecular markers.** 1. Genotyping 2 Biochemical and Molecular markers; Morphological, biochemical 3 DNA-based markers 4. Functional markers; Mapping populations (F2s, back crosses, RILs, NILs and DH); 5. Molecular mapping and tagging of agronomically important traits. 6 Statistical tools in marker	1. Mapping populations

in marker analysis.		analysis.	

SW-1 Suggested Sessional Work (SW):

j. Assignments:

Mapping populations (F2s, back crosses, RILs, NILs and DH);

k. **Mini Project:**

l. Other Activities (Specify):

GPB 506.2: Students will have the ability to apply the knowledge gained about QTLs analysis in crop plants.

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	**0**
SW	**1**
SL	**1**
Total	**8**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Understand allele mining; Marker-assisted selection for qualitative and quantitative traits. **SO2.2.** Students are able to explain QTLs analysis in crop plants. **SO2.3.** Students will have the ability to apply the knowledge gained about marker-assisted backcross breeding for rapid introgression. **SO2.4.** To know Genomics- assisted breeding. **SO2.5.** Student will be able to understand Generation of EDVs. **SO2.6.** Knowledge about Gene pyramiding.		**Unit-2. Allele mining.** 1. Allele mining; Marker-assisted selection for qualitative and quantitative traits. 2. QTLs analysis in crop plants. 3. Marker-assisted backcross breeding for rapid introgression. 4. Genomics- assisted breeding. 5. Generation of EDVs. 6. Gene pyramiding.	1. QTLs analysis in crop plants.

SW-2 Suggested Sessional Work (SW):

e. Assignments:

Marker-assisted selection for qualitative and quantitative traits.

f. Mini Project:

Other Activities (Specify):

GPB 506.3: To understand genome sequencing and nanotechnology.

Item	Approximate Hours
CI	**6**
LI	**0**
SW	**1**
SL	**1**
Total	**8**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO 3.1. Understand Introduction to Comparative Genomics**.** **SO3.2.** Knowledge about Large scale genome sequencing strategies. **SO3.3.** To know Human genome project; Arabidopsis genome project **SO3.**4. Knowledge Rice genome project; Comparative genomics tools. **SO3.5.** Student will be able to understand Introduction to proteomics; 2D gel electrophoresis; chromatography and sequencing by Edman degradation and mass spectrometry; Endopeptidases **SO3.6.** Students are able to explain Nanotechnology and its applications in crop improvement.		**Unit 3 Genome sequencing and Nanotechnology.** **1.** Introduction to Comparative Genomics**.** **2.** Large scale genome sequencing strategies. 3. Human genome project; Arabidopsis genome project **4** Rice genome project; Comparative genomics tools. **5.** Introduction to proteomics; 2D gel electrophoresis; chromatography and sequencing by Edman degradation and mass spectrometry; Endopeptidases; 6. Nanotechnology and its applications in crop improvement.	Human genome project.

SW-3 Suggested Sessional Work (SW):

d. Assignments:

Nanotechnology and its applications in crop improvement

e. Mini Project:

f. Other Activities (Specify):

GPB 506.4: Student will be able to explain recombinant DNA technology and Biotechnology applications in crop improvement.

Item	Approximate Hours
CI	**7**
LI	**30**
SW	**1**
SL	**1**
Total	**39**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1. Understand Recombinant DNA technology. **SO4.2**. Student will be able to understand Clean transformation techniques, vector-mediated gene transfer **SO4.3.** Knowledge about physical methods of gene transfer. **SO4.4.** Students are able to explain Production of transgenic plants in various field crops: and commercial releases. **SO4.5.** Understand Biotechnology applications in male sterility/ hybrid breeding, molecular farming; **SO4.6**. Student will be able to understand application of Tissue culture in molecular breeding. **SO4.7.** Knowledge about MOs and related issues (risk and regulations) GMO.	1. Requirements for plant tissue culture laboratory. 2. Techniques in plant tissue culture. 3. Media components 4. Media preparation. 5. Aseptic manipulation of various explants, observations on the contaminants occurring in media, interpretation. 6. Inoculation of explants, callus induction and plant regeneration. 7. Standardizing the protocols for regeneration. 8. Hardening of regenerated plants. 9. Establishing a greenhouse 10 Hardening procedures 11.Visit to commercial micro propagation unit 12. DNA isolation 13. DNA purity and quantification tests. 14. GUS assay in transformed cells/ tissues. 15.Transformation using Agrobacterium strains	**Unit 4. Recombinant DNA technology and Application of Tissue culture in molecular breeding.** 1.Recombinant DNA technology, transgenes ,method of transformation and selectable markers 2. Clean transformation techniques, vector-mediated gene transfer 3. physical methods of gene transfer; 4. Production of transgenic plants in various field crops: cotton, wheat, maize, rice, soybean, oilseeds, sugarcane, etc. and commercial releases. 5. Biotechnology applications in male sterility/ hybrid breeding, molecular farming; 6. Application of Tissue culture in molecular breeding 7. MOs and related issues (risk and regulations); GMO.	1. Production of transgenic plants in various field crops**.**

SW-4 Suggested Sessional Work (SW):

d. Assignments:

Biotechnology applications in male sterility/ hybrid breeding, molecular farming;

e. Mini Project:

f. Other Activities (Specify):

GPB 506.5: Students will get knowledge about International regulations and biosafety issues of GMOs.

Item	Approximate Hours
CI	**5**
LI	**0**
SW	**0**
SL	**1**
Total	**6**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Understand International regulations, biosafety issues of GMOs **SO5.2**. Knowledge about Regulatory procedures in major countries including India. **SO5.3**. Students are able to understand ethical, legal and social issues. **SO5.4.** Knowledge about Intellectual property rights. **SO5.5.**Students will get knowled ge about bioinformatics.		**Unit-5 International regulations of GMOs and bioinformatics.** 1 International regulations, biosafety issues of GMOs 2. Regulatory procedures in major countries including India. 3. Ethical, legal and social issues. 4. Intellectual property rights. 5. Introduction to bioinformatics: bioinformatics tools, biological data bases (primary and secondary), implications in crop improvement.	Intellectual property rights.

SW-5 Suggested Sessional Work (SW):

i. **Assignments:**

j. **Mini Project:**

Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
GPB 506.1: Student to know about various molecular tools and approaches for genotyping and their uses in crop improvement.	**6**	1	1	**8**
GPB 506.2: Students will have the ability to apply the knowledge gained about QTLs analysis in crop plants.	**6**	1	1	**8**
GPB 506.3: To understand genome sequencing and nanotechnology.	**6**	1	1	**8**
GPB 506.4: Student will be able to explain recombinant DNA technology and Biotechnology applications in crop improvement.	**37**	1	1	**39**
GPB506.5: Students will get knowledge about International regulations and biosafety issues of GMOs	**5**	0	1	**6**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	Genotyping; Biochemical and Molecular markers	**4**	**6**	**2**	**12**
CO 2	Allele mining.	**2**	**5**	**2**	**9**
CO 3	Genome sequencing and Nanotechnology.	**2**	**6**	**2**	**10**
CO 4	Recombinant DNA technology and Application of Tissue culture in molecular breeding.	**4**	**4**	**3**	**11**
CO 5	International regulations of GMOs and bioinformatics.	**2**	**4**	**2**	**8**
Total Marks		**14**	**25**	**11**	**50**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Molecular Breeding and Bioinformatics will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

39. Improved Lecture
40. Group Discussion
41. Demonstration
42. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
43. Brainstorming
44. Smart Board

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Data Analysis and Visualization in Genomics and Proteomics.	Azuaje F and Dopazo J..	John Wiley and Sons	2005
2	Essential Molecular Biology: a practical Approach.	Brown TA.	Oxford university press,	1991
3	Introduction to Plant Biotechnology	Chawala HS.	Oxford & IBH Publishing Co. Pvt. Ltd.	2000
4	Genetic Engineering and Biotechnology: Concepts, Methods and Applications	Chopra VL and Nasim A.	Oxford & IBH.	1990
5	Elements of Biotechnology	Gupta PK.	Rastogi Publ	1997
6	An Introduction to Recombinant DNA Technology – Basic Experiments in Gene Manipulation.	Hackett PB, Fuchs JA and Messing JW.	Benjamin Publ. Co.	1988
7	Proteomics in Functional Genomics: Protein Structure Analysis.	Jollès P and Jörnvall H.	Birkhäuser.	2000
8	Genes XII.	Lewin B.	Jones & Bartlett learning,	2017
9	Biotechnology, Expanding	Singh BD.	Kalyani Publishers, New	2005.

	Horizons		Delhi.	

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
4. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
5. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
6. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
7. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
8. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
9. Mr. Ankit Kumar Bhagat, Teaching Associate, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology, AKS University.

Cos, POs and PSOs Mapping

Course Code: GPB 506
Course Title: - Molecular Breeding and Bioinformatics

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to contemporary	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to contempor	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								agriculture.								ary agriculture.		
GPB 506.1: Student to know about various molecular tools and approaches for genotyping and their uses in crop improvement.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB 506.2: Students will have the ability to apply the knowledge gained about QTLs analysis in crop plants.	1	2	1	2	2	1	1	2	3	2	3	2	1	1	1	1	1	1
GPB 506.3: To	1	2	3	2	2	1	1	2	2	3	2	1	1	1	1	1	1	1

understand genome sequencing and nanotechnology.																		
GPB 506.4: Student will be able to explain recombinant DNA technology and Biotechnology applications in crop improvement.	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1
GPB506.5: Students will get knowledge about International regulations and biosafety	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

issues of GMOs																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Molecular Breeding and Bioinformatics

POs & PSOs No.	**COs No.& Titles**	**SOs No.**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 506.1:** Student to know about various molecular tools and approaches for genotyping and their uses in crop improvement.	**SO1.1 SO1.2 SO1.3**	Requirements for plant tissue culture laboratory.	Unit-1. Genotyping; Biochemical and Molecular markers. 1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 506.2:** Students will have the ability to apply the knowledge gained about QTLs analysis in crop plants.	**SO2.1 SO2.2 SO2.3 SO2.4 SO2.5**	2. Techniques in plant tissue culture.	Allele mining; Marker-assisted selection for qualitative and quantitative traits. 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 506.3:** To understand genome sequencing and nanotechnology.	**SO3.1 SO3.2 SO3.3**	3. Media components	Genome sequencing and Nanotechnology. 3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 506.4:** Student will be able to explain recombinant DNA technology and Biotechnology applications in crop improvement.	**SO4.1 SO4.2**	4. Media preparation.	Recombinant DNA technology and Application of Tissue culture in molecular breeding. 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB506.5:** Students will get knowledge about International regulations and biosafety issues of GMOs	**SO5.1 SO5.2**	5. Aseptic manipulation of various explants, observations on the contaminants occurring in media, interpretation.	International regulations of GMOs and bioinformatics. 5.1, 5.2	As mentioned in page number ……

Semester- II

Course Code: GPB 508

Course Title: Mutagenesis and Mutation Breeding

Pre- requisite: To impart the knowledge about general principles of mutagenesis for crop improvement and various tests/ methods for detection of mutations.

Rationale: After completing this course will make the student well versed with the process of mutation and its use in crop improvement. This course will also give in depth knowledge of mutations in genomics, allele mining and TILLING.

Course Outcomes:

GPB 508.1 This course will make the student well versed with the mutation and its history, nature and classification of mutations.

GPB 508.2 This course will make the student well versed with the mutagenic agents and effect of mutations.

GPB 508.3 This course will make the student well versed with the chemical mutagens, their properties and mode of action

GPB 508.4 This course will make the student well versed with the process of observing mutagen effects in M1, M2 and M3 generation.

GPB 508.5 This course will make the student well versed with the use of mutagens in creating oligogenic and polygenic variations and Handling of segregating M2 generations.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
	GPB 508	Mutagenesis and Mutation Breeding	2	2	0	0	4	(2+1) = 3

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+ CAT+AT)		
	GPB 508	Mutagenesis and Mutation	15	30	0	0	5	50	50	100

		Breeding								

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB 508.1 This course will make the student well versed with the mutation and its history, nature and classification of mutations.

Approximate Hours

Item	Approximate Hours
CI	**4**
LI	**2**
SW	**1**
SL	**1**
Total	**8**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1. Students able to explain the mutation and its history and nature **SO1.2.** Students able to explain the classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations. **SO1.3.** Students able to explain the detection of mutations. **SO1.4.** Students able to explain the paramutations in crops plants.	1. Precautions on handling of mutagens.	**Unit-1 Mutation history, nature and Classification.** **1.** Mutation and its history and nature 2. Classification of mutations: spontaneous and induced mutations, micro and macro mutations, pre and post adaptive mutations. 3. Detection of mutations. 4. Paramutations in crops plants.	1. Classification and Detection of mutations**.**

W-1 Suggested Sessional Work (SW):

a. Assignments:

j. History, nature and Paramutations in crops plants.

b. Mini Project:

c. Other Activities (Specify):

GPB 508.2 This course will make the student well versed with the mutagenic agents and effect of mutations.

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	**12**
SW	**2**
SL	**1**

	Total	21

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO2.1. Students are able to understand the mutagenic agents: physical – radiation types and sources: Ionizing and non-ionizing radiations. **SO2.2.** Students are able to understand the radiobiology: mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects – RBE and LET relationships. **SO2.3.** Students are able to understand the effect of mutations on DNA – repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects. **SO2.4.** Students are able to understand the dosimetry -Objects and methods of treatment. **SO2.5.** Students are able to understand the factors influencing mutation: dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects. **SO2.6.** Students are able to understand the radiation sensitivity and modifying factors: External and internal sources – Oxygen, water content, temperature and nuclear volume.	1. Dosimetry-Studies of different mutagenic agents. 2. Physical mutagens and Chemical mutagens. 3. Learning on Radioactivity. 4. Learning about gamma chamber. 5. Radiation hazards: Monitoring – safety regulations and safe transportation of radioisotopes 6. Learning on safe disposal of radioisotopes.	**Unit-2. - Mutagenic agents and Effect of mutations on DNA.** **1.** Mutagenic agents: physical – radiation types and sources: Ionizing and non-ionizing radiations. 2. Radiobiology: mechanism of action of various radiations (photoelectric absorption, Compton scattering and pair production) and their biological effects – RBE and LET relationships. 3. Effect of mutations on DNA – repair mechanisms operating at DNA, chromosome, cell and organism level to counteract the mutation effects. 4. Dosimetry -Objects and methods of treatment. 5. Factors influencing mutation: dose rate, acute vs chronic irradiation, recurrent irradiation, enhancement of thermal neutron effects. 6. Radiation sensitivity and modifying factors: External and internal sources – Oxygen, water content, temperature and nuclear volume.	**9.** Mutagenic agents, radiobiology and effect of mutations on DNA.

SW-2 Suggested Sessional Work (SW):

2. Assignments:

1. Radiation sensitivity and modifying factors External and internal sources**.**

1. Mini Project:

4. Radiobiology: mechanism of action of various radiations.

cv. Other Activities (Specify):

GPB 508.3 This course will make the student well versed with the chemical mutagens, their properties and mode of action.

Item	Approximate Hours
CI	**6**
LI	**6**

SW	**2**
SL	**1**
Total	**15**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1. Students are able to understand the chemical mutagens: Classification – base analogues, antibiotics, alkylating agents, acridine dyes. **SO3.2.** Students are able to understand the other mutagens: their properties and mode of action. **SO3.3.** Students are able to understand the dose determination and factors influencing chemical mutagenesis. **SO3.4.** Students are able to understand the treatment methods using physical and chemical mutagens, Combination treatments. **SO3.5.** Students are able to understand the other causes of mutation – direct and indirect action. **SO3.6.** Students are able to understand the comparative evaluation of physical and chemical mutagens.	1. Hazards due to chemical mutagens – Treating the plant propagules at different doses of physical and chemical mutagens. 2. Procedures in combined mutagenic treatments. 3. Raising the crop for observation; Mutagenic effectiveness and efficiency, calculating the same from earlier literature.	**Unit 3 Chemical mutagens their properties and mode of action.** **1.** Chemical mutagens: Classification – base analogues, antibiotics, alkylating agents, acridine dyes. 2. Other mutagens: their properties and mode of action. 3. Dose determination and factors influencing chemical mutagenesis. 4. Treatment methods using physical and chemical mutagens, Combination treatments. 5. Other causes of mutation – direct and indirect action. 6. Comparative evaluation of physical and chemical mutagens.	**1**. Treatment methods using physical and chemical mutagens.

SW-3 Suggested Sessional Work (SW):

d) Assignments:

iii. Comparative evaluation of physical and chemical mutagens.

e) Mini Project:

i. Treatment methods using physical and chemical mutagens, Combination treatments.

f) Other Activities (Specify):

GPB 508.4 This course will make the student well versed with the process of observing mutagen effects in M1, M2 and M3 generation.

Item	Approximate Hours
CI	**7**
LI	**6**
SW	**2**
SL	**1**
Total	**16**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1. Students are able to understand the observing mutagen effects in M1 generation: plant injury, lethality, sterility, chimeras, etc. **SO4.2.** Students are able to understand the observing mutagen effects in M2 generation. **SO4.3.** Students are able to understand the estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations. **SO4.4.** Students are able to understand the mutations in traits with continuous variation **SO4.5.** Students are able to understand the factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage, etc. **SO4.6.** Students are able to understand the individual plant based mutation analysis and working out effectiveness and efficiency in M3 generation **SO4.7.** Students are able to understand the comparative evaluation of physical and chemical mutagens for creation of variability in the some species- Case studies.	1. Study of M1 generation & M2 generation – Parameters. 2. Mutation breeding in cereals and pulses- achievements made and an analysis. 3. Mutation breeding in oilseeds and cotton- achievements and opportunities.	**Unit 4. Observing mutagen effects in M1, M2 and M3 generation.** 1. Observing mutagen effects in M1 generation: plant injury, lethality, sterility, chimeras, etc. 2. Observing mutagen effects in M2 generation. 3. Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations. 4. Mutations in traits with continuous variation 5. Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage, etc. 6. Individual plant based mutation analysis and working out effectiveness and efficiency in M3 generation 7. Comparative evaluation of physical and chemical mutagens for creation of variability in the some species- Case studies.	Estimation of mutagenic efficiency and effectiveness – spectrum of chlorophyll and viable mutations.

SW-4 Suggested Sessional Work (SW):

g. Assignments:

ii. Factors influencing the mutant spectrum: genotype, type of mutagen and dose, pleiotropy and linkage, etc.

h. Mini Project:

ii. Comparative evaluation of physical and chemical mutagens for creation of variability.

i. Other Activities (Specify):

GPB 508.5 This course will make the student well versed with the use of mutagens in creating oligogenic and polygenic variations and Handling of segregating M2 generations.

Item	Approximate Hours
CI	**7**
LI	**4**

SW	**2**
SL	**1**
Total	**14**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Students are able to understand the use of mutagens in creating oligogenic and polygenic variations – Case studies. **SO5.2.** Students are able to understand the in-vitro mutagenesis – Callus and pollen irradiation. **SO5.3.** Students are able to understand the handling of segregating M2 generations and selection procedures. **SO5.4.** Students are able to understand the validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement, etc.) in different crops **SO5.5.** Students are able to understand the procedures for micromutations breeding/ polygenic mutations **SO5.6.** Students are able to understand the achievements of mutation breeding- varieties released across the world, problems associated with mutation breeding. **SO5.7.** Students are able to understand the use of mutagens in genomics, allele mining, TILLING.	1. Mutation breeding in forage crops and vegetatively propagated crops. 2. Procedure for detection of mutations for polygenic traits in M2 and M3 generations.	**Unit 5. Use of mutagens and Handling of segregating M1, M2, and M3 generations.** **1.** Use of mutagens in creating oligogenic and polygenic variations – Case studies. 2. In-vitro mutagenesis – Callus and pollen irradiation. 3. Handling of segregating M2 generations and selection procedures. 4. Validation of mutants; Mutation breeding for various traits (disease resistance, insect resistance, quality improvement, etc.) in different crops. 5. Procedures for micromutations breeding/ polygenic mutations. 6. Achievements of mutation breeding- varieties released across the world, problems associated with mutation breeding. 7. Use of mutagens in genomics, allele mining, TILLING.	7. Validation of mutants.

SW-5 Suggested Sessional Work (SW):

k. Assignments:

ii. In-vitro mutagenesis – Callus and pollen irradiation.

l. Mini Project:

ii. Mutation breeding for various traits in different crops.

f. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
GPB 508.1 This course will make the student well versed with the mutation and its history, nature and classification of mutations.	**6**	**1**	**1**	**8**
GPB 508.2 This course will make the student well versed with the mutagenic agents and effect of mutations.	**18**	**2**	**1**	**21**
GPB 508.3 This course will make the student well versed with the chemical mutagens, their properties and mode of action	**12**	**2**	**1**	**15**
GPB 508.4 This course will make the student well versed with the process of observing mutagen effects in M1, M2 and M3 generation.	**13**	**2**	**1**	**16**
GPB 508.5 This course will make the student well versed with the use of mutagens in creating oligogenic and polygenic variations and Handling of segregating M2 generations.	**11**	**2**	**1**	**14**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	**Mutation history, nature and Classification.**	**4**	**3**	**3**	**10**
CO 2	**Mutagenic agents and Effect of mutations on DNA.**	**5**	**2**	**4**	**11**
CO 3	**Chemical mutagens their properties and mode of action.**	**3**	**3**	**3**	**9**
CO 4	**Observing mutagen effects in M1, M2 and M3 generation.**	**4**	**2**	**4**	**10**
CO 5	**Use of mutagens and Handling of segregating M1, M2, and M3 generations.**	**3**	**4**	**3**	**10**
Total		**19**	**14**	**17**	**50**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Mutagenesis and Mutation Breeding** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

45. Improved Lecture
46. Group Discussion and Demonstration
47. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
48. Brainstorming
49. Smart board

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Cellular Radiobiology	Alper T.	Cambridge Univ. Press, London	1979
2	The Molecular Theory of Radiation Biology	Chadwick K.H. and Leenhouts H.P.	SpringerVerlag	1981
3	Mutation Detection: A Practical Approach	Cotton R, Edkin E and Forrest S.	Oxford Univ. Press	2000
4	Manual on Mutation Breeding	International Atomic Energy Agency	International Atomic Energey Agency, Vienna, Italy	1970
5	Plant Mutation Breeding and Biotechnology.	Shu QY, Forster BP and Nakagawa N.	Gutecnberg Press Ltd. Rome Italy	2012
6	Genetics.	Singh BD.	Kalyani Publishers, New Delhi	2003
7	Genetics. 3rd Ed.	Strickberger MW.	Prentice Hall.	2005

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
4. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
5. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
6. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
7. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
8. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
9. Mr. Ankit Kumar Bhagat, Teaching Associate, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology, AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 508
Course Title: - Mutagenesis and Mutation Breeding

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain inter disciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to contemp	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain inter disciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to con	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								orary agriculture.								temporary agriculture.		
GPB 508.1 This course will make the student well versed with the mutation and its history, nature and classification of mutations.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB 508.2 This course will make the student well versed with the mutagenic agents and effect of mutations.	1	2	1	2	2	1	1	2	3	2	3	2	1	1	1	1	1	1

GPB 508.3 This course will make the student well versed with the chemical mutagens, their properties and mode of action	1	2	3	2	2	1	1	2	2	3	2	1	1	1	1	1	1	1
GPB 508.4 This course will make the student well versed with the process of observing mutagen effects in M1, M2 and M3 generation.	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1
GPB 508.5 This	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

course will make the student well versed with the use of mutagens in creating oligogenic and polygenic variations and Handling of segregating M2 generations.																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Mutagenesis and Mutation Breeding

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 508.1** This course will make the student well versed with the mutation and its history, nature and classification of mutations.	**SO1.1 SO1.2 SO1.3**	Study of M1 generation & M2 generation – Parameters.	Unit-1. Mutation history, nature and Classification. 1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 508.2** This course will make the student well versed with the mutagenic agents and effect of mutations.	**SO2.1 SO2.2 SO2.3 SO2.4 SO2.5**	Mutation breeding in cereals and pulses- achievements made and an analysis.	Mutagenic agents and Effect of mutations on DNA. 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 508.3** This course will make the student well versed with the chemical mutagens, their properties and mode of action	**SO3.1 SO3.2 SO3.3**	Mutation breeding in oilseeds and cotton- achievements and opportunities	Chemical mutagens their properties and mode of action. 3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 508.4** This course will make the student well versed with the process of observing mutagen effects in M1, M2 and M3 generation.	**SO4.1 SO4.2**		Observing mutagen effects in M1, M2 and M3 generation. 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 508.5** This course will make the student well versed with the use of mutagens in creating oligogenic and polygenic variations and Handling of segregating M2 generations.	**SO5.1 SO5.2**		Use of mutagens and Handling of segregating M1, M2, and M3 generations. 5.1, 5.2	As mentioned in page number ……

Semester- II

Course Code: GPB 512

Course Title: Crop Breeding II (Rabi Crops)

Pre- requisite: To provide insight into recent advances in improvement of Rabi cereals, legumes, oilseeds, fibre and vegetative propagated crops using conventional and modern biotechnological approaches.

Rationale: After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of important rabi field crops.

Course Outcomes:

GPB512.1. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Wheat, Oats and Barley.

GPB512.2. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Chickpea, and Other pulses.

GPB512.3. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Rapeseed, Mustard, Sunflower and Safflower.

GPB512.4. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Mesta, minor fibre crops and Forage crops.

GPB512.5. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Seed spices.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
	GPB 512	Crop Breeding II (Rabi Crops)	2	2	0	0	4	(2+1) = 3

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+ CAT+AT)		
	GPB 512	Crop Breeding II (Rabi Crops)	15	30	0	0	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB512.1. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Wheat, Oats and Barley.

Approximate Hours

Item	Approximate Hours
CI	**8**
LI	**8**
SW	**2**
SL	**1**
Total	**19**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1. Students able to explain the origin, evolution, mode of reproduction, chromosome number. Genetics – cytogenetics and genome relationship of Wheat. **SO1.2.** Students able to explain the breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of Wheat. **SO1.3.** Students able to explain the breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement of Wheat. **SO1.4.** Students able to explain the origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship of Oats. **SO1.5.** Students able to explain the breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of Oats. **SO1.6.** Students able to explain the breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released	1. Floral biology, emasculation and pollination techniques in wheat. 2. Floral biology, emasculation and pollination techniques in oats. 3. Floral biology, emasculation and pollination techniques barley. 4. Study of segregating populations in cereals.	**Unit-1 Important botanical status and reproductive structures of crops and genetics of wheat, oats, and barley.** **1. Wheat:** Origin, evolution, mode of reproduction, chromosome number. Genetics – cytogenetics and genome relationship. **2. Wheat:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. **3. Wheat:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. **4. Oats:** Origin, evolution, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship. **5. Oats:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. **6. Oats:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for	1. **Genetics of wheat, oats, and barley.**

varieties, examples of MAS used for improvement of Oats. **SO1.7.** Students able to explain the origin, evolution, center of origin, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship of Barley. **SO1.8.** Students able to explain the breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement of Barley.		improvement. **7. Barley:** Origin, evolution, center of origin, mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship **8. Barley:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc., breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement.	

SW-1 Suggested Sessional Work (SW):

d. Assignments:

k. Floral biology, emasculation and hybridization techniques in wheat, oats, and barley.

e. Mini Project:

iv. Centers of origin, distribution of species wild relatives of wheat, oats, and barley.

f. Other Activities (Specify):

GPB512.2. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Chickpea, and Other pulses.

Approximate Hours

Item	Approximate Hours
CI	**6**
LI	**4**
SW	**2**
SL	**1**
Total	**13**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Students are able to understand the origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship of Chickpea. **SO2.2.** Students are able to understand the breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of Chickpea. **SO2.3.** Students are able to understand the breeding approaches,	1. Floral biology, emasculation and pollination techniques in chickpea, rajma. 2. Study of segregating populations Pulses.	**Unit-2. - Important botanical status and reproductive structures of crops and genetics of Chickpea, and Other pulses.** **1. Chickpea:** Origin, evolution mode of reproduction, chromosome number; Genetics – cytogenetics and genome relationship. **2. Chickpea:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. **3. Chickpea:** Breeding	**10.** Learn about qualitative and quantitative characters different pulse crops.

introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement of Chickpea. **SO2.4.** Students are able to understand the origin, evolution, mode of reproduction, chromosome number; Genetics. cytogenetics and genome relationship of other pulses. **SO2.5.** Students are able to understand the breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of other pulses. **SO2.6.** Students are able to understand the breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them of other pulses.		approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. **4. Other pulses:** Lentil, field pea, Rajma, Horse gram: Origin, evolution, mode of reproduction, chromosome number; Genetics. cytogenetics and genome relationship **5. Other pulses:** Lentil, field pea, Rajma, Horse gram: Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. **6. Other pulses:** Lentil, field pea, Rajma, Horse gram: Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement. Interspecific crosses attempted and its implications, reasons for failure, ways of overcoming them.	

SW-2 Suggested Sessional Work (SW):

3. Assignments:

4. Plant genetic resources, its utilization and conservation in different pulse crops**.**

1. Mini Project:

5. Study of genetics, handling of germplasm of different pulse crops.

cvi. Other Activities (Specify):

GPB512.3. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Rapeseed, Mustard, Sunflower and Safflower.

Item	Approximate Hours
CI	**6**
LI	**8**
SW	**2**
SL	**1**
Total	**17**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)

SO3.1. Students are able to understand the origin, evolution, mode of reproduction, chromosome number. Genetics – cytogenetics and genome relationship of rapeseed and mustard. **SO3.2.** Students are able to understand the breeding objectives; yield, quality characters, biotic and abiotic stress resistance, etc. of rapeseed and mustard. **SO3.3.** Students are able to understand the breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Oil quality, Improvement for oil quality of rapeseed and mustard. **SO3.4.** Students are able to understand the origin, mode of reproduction, chromosome number; Genetics, cytogenetics and genome relationship of Sunflower, Safflower. **SO3.5.** Students are able to understand the breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of Sunflower, Safflower. **SO3.6.** Students are able to understand the of breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement of Sunflower, Safflower.	1. Floral biology, emasculation and pollination techniques in rapeseed mustard. 2. Floral biology, emasculation and pollination techniques in sunflower. 3. Study of range of variation for yield and yield components. 4. Study of segregating populations oilseed crops.	**Unit 3 Important botanical status and reproductive structures of crops and genetics of Rapeseed, Mustard, Sunflower and Safflower.** **1. Rapeseed and Mustard:** Origin, evolution, mode of reproduction, chromosome number. Genetics – cytogenetics and genome relationship. **2. Rapeseed and Mustard:** Breeding objectives; yield, quality characters, biotic and abiotic stress resistance, etc. **3. Rapeseed and Mustard:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement, Oil quality, Improvement for oil quality. **4. Sunflower, Safflower:** Origin, mode of reproduction, chromosome number; Genetics, cytogenetics and genome relationship. **5. Sunflower, Safflower:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. **6. Sunflower, Safflower:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, heterosis breeding, released varieties, examples of MAS used for improvement.	**1**. Concepts of breeding in Rapeseed, Mustard, Sunflower and Safflower.

SW-3 Suggested Sessional Work (SW):

g) Assignments:

iv. Important concepts of genetics and breeding Rapeseed, Mustard, Sunflower and Safflower.

h) Mini Project:

ii. Techniques for seed production and hybrid seeds production Rapeseed, Mustard, Sunflower and Safflower.

i) Other Activities (Specify):

GPB512.4. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Mesta, minor fibre crops and Forage crops.

Item	Approximate Hours
CI	**6**
LI	**6**
SW	**2**
SL	**1**
Total	**15**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1. Students are able to understand the origin, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship of Mesta and minor fibre crops. **SO4.2.** Students are able to understand the breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of Mesta and minor fibre crops. **SO4.3.** Students are able to understand the breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement of Forage crops of Mesta and minor fibre crops. **SO4.4.** Students are able to understand the origin, evolution mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship. **SO4.5.** Students are able to understand the Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of Forage crops. **SO4.6.** Students are able to understand the breeding approaches,	1. Use of descriptors for cataloguing. 2. Learning on the crosses between different species. 3. Trait based screening for stress resistance.	**Unit 4. Important botanical status and reproductive structures of crops and genetics of Mesta, minor fibre crops and Forage crops.** **1. Mesta and minor fibre crops:** Origin, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship. **2. Mesta and minor fibre crops:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. **3. Mesta and minor fibre crops:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, released varieties, examples of MAS used for improvement. **4. Forage crops:** Origin, evolution mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship. **5. Forage crops:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. **6. Forage crops:** Breeding approaches, introgression of alien gene(s) (if required), biotic and	Concepts of breeding in Mesta, minor fibre crops and Forage crops.

introgression of alien gene(s) (if required), biotic and abiotic stress resistance of Forage crops.		abiotic stress resistance.	

SW-4 Suggested Sessional Work (SW):

j. Assignments:

iii. Important concepts of genetics and breeding Mesta, minor fibre crops and Forage crops.

k. Mini Project:

iii. Techniques for seed production and hybrid seeds production Mesta, minor fibre crops and Forage crops.

l. Other Activities (Specify):

GPB512.5. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Seed spices.

Item	Approximate Hours
CI	**4**
LI	**4**
SW	**2**
SL	**1**
Total	**11**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Students are able to understand the origin, evolution, mode of reproduction, chromosome number of Seed spices. **SO5.1.** Students are able to understand the genetics– cytogenetics and genome relationship of Seed spices. **SO5.1.** Students are able to understand the breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. of Seed spices. **SO5.1.** Students are able to understand the breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, scope of heterosis breeding, released varieties, examples of MAS used for crop improvement of Seed spices.	1. Learning on the Standard Evaluation System (SES) and descriptors. 2. Use of software for database management and retrieval.	**Unit 5. Important botanical status and reproductive structures of crops and genetics of Seed spices.** **1. Seed spices:** Origin, evolution, mode of reproduction, chromosome number. **2. Seed spices:** Genetics–cytogenetics and genome relationship. **3. Seed spices:** Breeding objectives: yield, quality characters, biotic and abiotic stress resistance, etc. **4. Seed spices:** Breeding approaches, introgression of alien gene(s) (if required), biotic and abiotic stress resistance, scope of heterosis breeding, released varieties, examples of MAS used for crop improvement.	8. Concepts of breeding in Seed spices.

SW-5 Suggested Sessional Work (SW):

m. Assignments:

iii. Hybrid seed production technology in Seed spices.

n. Mini Project:

iii. Examples of MAS used for improvement in Seed spices.

g. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
GPB512.1. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Wheat, Oats and Barley.	**16**	**2**	**1**	**19**
GPB512.2. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Chickpea, and Other pulses.	**10**	**2**	**1**	**13**
GPB512.3. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Rapeseed, Mustard, Sunflower and Safflower.	**14**	**2**	**1**	**17**
GPB512.4. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Mesta, minor fibre crops and Forage crops.	**12**	**2**	**1**	**15**
GPB512.5. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Seed spices.	**8**	**2**	**1**	**11**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	**Important botanical status and reproductive structures of crops and genetics of wheat, oats, and barley.**	**3**	**3**	**2**	**8**
CO 2	**Important botanical status and reproductive structures of crops and genetics of Chickpea, and Other pulses.**	**4**	**4**	**3**	**11**
CO 3	**Important botanical status and reproductive structures of crops and genetics of Rapeseed, Mustard, Sunflower and Safflower.**	**5**	**3**	**3**	**11**
CO 4	**Important botanical status and reproductive structures of crops and genetics of Mesta, minor fibre crops and Forage crops.**	**4**	**2**	**4**	**10**
CO 5	**Important botanical status and reproductive structures of crops and genetics of Seed spices.**	**3**	**4**	**3**	**10**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Crop Breeding I (Kharif Crops)** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

50. Improved Lecture
51. Case Method
52. Group Discussion
53. Demonstration
54. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
55. Brainstorming
56. Smart board

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Identifying Characteristics of Crop Varieties.	Agarwal R.L.	Oxford & IBH.	1996
2	Genetics, Cytogenetics and Breeding of Crop Plants. Vol. I. Pulses and Oilseeds.	Bahl P.N. and Salimath P.M.	Oxford & IBH.	1996
3	Technological Innovations in Major World Oil crops. Vol. I.	Gupta S.K.	Springer, USA.	2012
4	Technological Innovations in Major World Oil crops. Vol. II.	Gupta S.K.	Springer, USA.	2012
5	Breeding of Oilseed Crops for Sustainable Production.	Gupta S.K.	Academic Press, USA.	2016
6	New Dimensions and Approaches for Sustainable Agriculture.	Kannaiyan S, Uthamasamy S, Theodore R.K. and Palaniswamy S.	Directorate of Extension Education, TNAU, Coimbatore.	2002
7	Spices and Plantation Crops Vol.1 (Part A) Breeding and Genetics.	Parthasarathy V.A.	John Wiley & Sons.	2017

Curriculum Development Team:

s. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
t. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
u. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
v. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
w. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
x. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
y. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
z. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
aa. Mr. Ankit Kumar Bhagat, Teaching Associate, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology, AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 512
Course Title: - Crop Breeding II (Rabi Crops)

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to contemp	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to con	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								orary agriculture.					.			temporary agriculture.		
GPB512.1. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Wheat, Oats and Barley.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB512.2. After completing this course, the student will be able	1	2	1	2	2	1	1	2	3	2	3	2	1	1	1	1	1	1

to know about important botanical status and reproductive structures of crops and genetics of Chick pea, and Other pulses.																		
GPB512.3. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops	1	2	3	2	2	1	1	2	2	3	2	1	1	1	1	1	1	1

and genetics of Rapeseed, Mustard, Sunflower and Safflower.																		
GPB5 12.4. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Mesta, minor fibre crops and Forage crops.	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1

GPB512.5. After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Seed spices.	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Crop Breeding II (Rabi Crops)

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB512.1.** After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Wheat, Oats and Barley.	**SO1.1 SO1.2 SO1.3**	Learning on the Standard Evaluation System (SES) and descriptors.	Unit-1. Important botanical status and reproductive structures of crops and genetics of wheat, oats, and barley. 1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB512.2.** After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Chickpea, and Other pulses.	**SO2.1 SO2.2 SO2.3 SO2.4 SO2.5**	Use of software for database management and retrieval.	Important botanical status and reproductive structures of crops and genetics of Chickpea, and Other pulses. 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB512.3.** After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Rapeseed, Mustard, Sunflower and Safflower.	**SO3.1 SO3.2 SO3.3**	Mutation breeding in oilseeds and cotton-achievements and opportunities	Important botanical status and reproductive structures of crops and genetics of Rapeseed, Mustard, Sunflower and Safflower. 3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB512.4.** After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Mesta, minor fibre crops and Forage crops.	**SO4.1 SO4.2**		**Mesta and minor fibre crops:** Origin, mode of reproduction, chromosome number; Genetics–cytogenetics and genome relationship. 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB512.5.** After completing this course, the student will be able to know about important botanical status and reproductive structures of crops and genetics of Seed spices.	**SO5.1 SO5.2**		Important botanical status and reproductive structures of crops and genetics of Seed spices. 5.1, 5.2	As mentioned in page number ……

Semester-II

Course Code: STAT 512

Course Title: EXPERIMENTAL DESIGNS

Pre-requisite: Experimental design is the process of carrying out research in an objective and controlled fashion so that precision is maximized and specific conclusions can be drawn regarding a hypothesis statement. Generally, the purpose is to establish the effect that a factor or independent variable has on a dependent variable.

Rationale: Experimental design is used to establish the effect an independent variable has on a dependent variable. An experimental design helps a researcher to objectively analyze the relationship between variables, thus increasing the accuracy of the result.

Course Outcomes: CO1 Understand of basic concepts of design of experiments. Introduction to planning valid and economical experiments within given resources.

CO2 Analyze completely randomized design, Randomized block design, Latin square design. The conditions and circumstances under which results of the experiment are valid should be extensive.

CO3 Understand and compute Full and confounded factorial designs with two and three levels. Fractional factorial designs with two levels.

CO4 Understand the purpose for balanced incomplete block design, resolvable designs and their applications. Split and Strip plot design will help students to know the applications of DOE and learn and apply these techniques in the field experiment.

Scheme of Studies:

Board of Study	**Course Code**	**Course Title**			**Scheme of studies(Hours/Week)**			**Total Credits (C)**
			Cl	**LI**	**SW**	**SL**	**Total Study Hours (CI+LI+SW+SL)**	
Program Core (PCC)	STAT 512	EXPERIMENTAL DESIGNS	2	01	02	01	6	3

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies), **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C: Credits.**

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	**Scheme of Assessment (Marks)**						
			Progressive Assessment (PRA)					**End Semester Assessment (ESA)**	**Total Marks** (PRA + ESA)
			Class/Home Assignment 1 number 5 marks each (CA)	Class Test 2 (2 best out) 15 marks each (CT)	Practical Exam (PA)	Class Attendance(AT)	Total Marks (CA+CT +PA+AT)		

	STAT 512	ED	5	30	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self-Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

STAT 512 CO-1 Understand of basic concepts of design of experiments. Introduction to planning valid and economical experiments within given resources.

Approximate Hours

Item	Appx. Hrs.
CI	3
LI	4
SW	1
SL	2
Total	10

Session Out Comes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO1.1 Design of Experiment is a tool to develop an experimentation strategy that maximizes learning using a minimum of resources. **SO1.2** Extensively used by engineers and scientists involved in the improvement of manufacturing processes to maximize yield and decrease variability. **SO1.3** It is widely used in many fields with broad application across all the natural and social sciences, to name a few: Biostatistics, Agriculture, Marketing, Software engineering, Industry etc.	1-Uniformity trial data analysis. 2- formation of plots and blocks, Fairfield Smith Law	**Unit-1.** Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control. **1.1**. Need for designing of experiments **1.2** characteristics of a good design **1.3** Basic principles of designs- randomization, replication and local control	1. Prepare the assignment on Basic principles of designs- randomization, replication and local control.

SW-1 Suggested Sessional Work (SW):

a. Assignments: Prepare the assignment on Basic principles of designs- randomization, replication and local control.

b. Mini Project: -

c. Other Activities (Specify):

STAT 512 CO-2 Analyze completely randomized design, Randomized block design, Latin square design. The conditions and circumstances under which results of the experiment are valid should be extensive.

Approximate Hours

Item	Appx. Hrs.
CI	5
LI	6
SW	1
SL	2
Total	14

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO2.1 Good experimental design is important in all research, it helps to ensure the data collection, data analysis and conclusions from a study, are valid (true). **SO2.2** Experiments are designed to test hypotheses, or specific statements about the relationship between variables.	1- Analysis of data obtained from CRD 2- - Analysis of data obtained from RBD 3- - Analysis of data obtained from LSD	**Unit-2** Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design. **1.1** Uniformity trials **1.2** size and shape of plots and blocks **1.3**. Analysis of variance; Completely randomized design **1.4** Analysis of variance; randomized block design **1.5** Analysis of variance; Latin square design.	1. Prepare the assignment on Analysis of variance; Completely randomized design, randomized block design and Latin square design.

SW-1 Suggested Sessional Work (SW):

Assignments: Prepare the assignment on Simple Problems Based on Analysis of variance; Completely randomized design, randomized block design and Latin square design.

d. Other Activities (Specify):

STAT 512 CO-3 Understand and compute Full and confounded factorial designs with two and three levels. Fractional factorial designs with two levels.

Approximate Hours

Item	Appx. Hrs.
CI	6
LI	14
SW	1
SL	2
Total	23

Session Out Comes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO3.1 Experimental methods introduce exogeneity, allowing researchers to draw conclusions about the effects of an event or a program. **SO3.2.** An experimental design helps a researcher to objectively analyze the relationship between variables, thus increasing the accuracy of the result.	1- Analysis of factorial experiments without confounding. 2- Analysis of factorial experiments with confounding. 3- Analysis with missing data in CRD. 4- Analysis with missing data in RBD. 5- Analysis with missing data in LSD. 6- Split plot designs. 7- Strip plot designs	**Unit-3** Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment. **1.1**. Factorial experiments, (symmetrical) **1.2** Factorial experiments, (asymmetrical) **1.3** orthogonality **1.4** partitioning of degrees of freedom **1.5**. Confounding in symmetrical factorial experiments **1.6**. Factorial experiments with control	1. Prepare the assignment on Factorial experiments with control treatment.

SW-1 Suggested Sessional Work (SW):
Assignments: Prepare the assignment on Factorial experiments with control treatment.
Other Activities (Specify):

STAT 512 CO-4 Understand the purpose for balanced incomplete block design, resolvable designs and their applications. Split and Strip plot design will help students to know the applications of DOE and learn and apply these techniques in the field experiment.

Approximate Hours

Item	Appx Hrs.
CI	16
LI	6
SW	1
SL	2
Total	25

Session Out Comes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO4.1.Ensure your experiment is unbiased. **SO4.2** Make sure your experiment is adequately powered. **SO4.3** Consider the range of applicability of your experiment.	7- Transformation of data. 8- Analysis of resolvable designs 9- Fitting of response surfaces.	**Unit-4** Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures. **1.1** Split plot **1.2** strip plot designs **1.3** Analysis of covariance **1.4** Missing plot techniques in randomized block. **1.5** Missing plot techniques in Latin square designs. **1.6** Transformations **1.7** crossover designs **1.8** balanced incomplete block design **1.9** resolvable designs **1.10** Applications of resolvable designs Lattice design **1.11** Lattice design **1.12** Applications of Lattice design **1.13** Alpha design-concepts. **1.14** Randomisation procedure. **1.15** Interpretation of results. **1.16** Response surfaces. Experiments with mixtures	2. Prepare the assignment on Analysis of covariance and missing plot techniques in randomized block and Latin square designs

SW-1 Suggested Sessional Work (SW):

Assignments: Prepare the assignment on Analysis of covariance and missing plot techniques in randomized block and Latin square designs

Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (C l)	Laboratory Lecture (L I)	Sessional Work (SW)	Self Learning (S l)	Total hour (C l + LI+ SW +S l)
01: Understand of basic concepts of design of experiments. Introduction to planning valid and economical experiments within given resources.	03	04	01	02	10
02: Analyze completely randomized design, Randomized block design, Latin square design. The conditions and circumstances under which results of the experiment are valid should be extensive.	05	06	01	02	14
03: Understand and compute Full and confounded factorial designs with two and three levels. Fractional factorial designs with two levels.	06	14	01	02	25
04: Understand the purpose for balanced incomplete block design, resolvable designs and their applications. Split and Strip plot design will help students to know the applications of DOE and learn and apply these techniques in the field experiment.	16	06	01	02	25

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit title	Marks Distribution			Total Marks
		R	U	A	
CO-1	Understand of basic concepts of design of experiments. Introduction to planning valid and economical experiments within given resources.	04	04	04	12
CO-2	Analyze completely randomized design, Randomized block design, Latin square design. The conditions and circumstances under which results of the experiment are valid should be extensive	04	04	04	12
CO-3	Understand and compute Full and confounded factorial designs with two and three levels. Fractional factorial designs with two levels.	04	04	04	12
CO-4	Understand the purpose for balanced incomplete block design, resolvable designs and their applications. Split and Strip plot design will help students to know the	05	04	05	14

	applications of DOE and learn and apply these techniques in the field experiment.				
	Total	17	16	17	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Experimental Designs will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

9. Improved Lecture
10. Tutorial
11. Case Method
12. Group Discussion
13. Role Play
14. Demonstration
15. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
16. Brainstorming

Suggested Learning Resources:

S. No.	**Title**	**Author**	**Publisher**	**Edition &** Year
01	Basic Concepts and Application of Experimental Designs and Analysis	Felix Kusanedzie Sylverster Achio Edmund Ameko	Science PG	2015
02	Theory and Analysis of Experimental Designs	B.L. Agrawal	CBS	2011
03	Design and Analysis of Experiments	Angela Dean Daniel Voss	Springer	2017

Curriculum Development Team:

1. Professor B.B. Beohar, Director Planning, & Director Extension, A.K.S. University
2. Dr. V.K. Vishwakarma , Head Department of Agricultural Economics, FAST
3. Mr. Navneet Raj Rathore, Teaching Associate, Department of Agricultural Economics, FAST

Cos, POs and PSOs Mapping
Course Code: STAT 512
Course Title: - EXPERIMENTAL DESIGNS

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	Student will identify the current scenario, crop diversity, climatic requirement and breeding techniques of different vegetable and flower crops.	Student will expertise in latest vegetable production technologies, vegetable breeding techniques and post-harvest management of vegetables	The student will have expertise in nursery-raising techniques and protected cultivation of vegetables and flower crops.	The student will have expertise in different climatic conditions required for common vegetable as well as under utilized vegetable cultivation.	Student will plan about the big scale commercial project and also manage the research trails under vegetable and flower crops	Student will apply various statistical methods to analyze their master research work	Student will understand about library technique, technical writing skill, IPR, laboratory techniques and research ethics in manuscript writing	Student will identify different cool season, warm season and underutilized vegetable crops	Student will practice different breeding techniques used in vegetable and flower production	Student will recognize different underutilized vegetable and spice crops	Student will apply different vegetable processing and post-harvest-handling methods for vegetables and flowers	Student will understand role of microclimate in vegetable and flower crop production under different protected structures	After gaining experience, they will get the positions of specialists for handling plantation, nurseries and other protected cultivation projects	Student will recognize different flower, ornamental crops and their nursery management	Student will practice turfgrass, indoor plant and interioscaping management	Student will apply various information services, technical writings and communication skills in their academics	Student will apply basic concepts in laboratory techniques during their research work	Student will apply basic statistical tools during their research work
STAT 512.1 Understand of	1	1	1	1	2	3	2	1	1	1	1	2	1	1	2	3	3	3

basic concepts of design of experiments. Introduction to planning valid and economical experiments within given resources.																		
STAT 512.2 Analyze completely randomized design, Randomized block design, Latin square design. The conditions and circumstances under which results of the experiment are valid should be	1	1	1	1	2	2	2	1	2	2	1	1	1	1	1	2	2	3

extensive.																		
STAT 512.3 Understand and compute Full and confounded factorial designs with two and three levels. Fractional factorial designs with two levels.	1	1	1	1	1	3	1	1	1	2	1	1	2	1	1	3	2	3
STAT 512.4 Understand the purpose for balanced incomplete block design, resolvable designs and their applications. Split and Strip plot design	1	1	1	1	2	3	1	1	1	1	2	2	2	1	1	3	3	3

will help students to know the applications of DOE and learn and apply these techniques in the field experiment.																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Statistical Methods for Applied Science

POs & PSOs No.	**COs No.& Titles**	**SOs No.**	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	STAT 512.CO 1: Understand of basic concepts of design of experiments. Introduction to planning valid and economical experiments within given resources.	**SO1.1 SO1.2 SO1.3**	1.1. Uniformity trial data analysis. 1.2 Formation of plots and blocks, Fairfield Smith Law	**Unit-1.0** Need for designing of experiments, characteristics of a good design. Basic principles of designs- randomization, replication and local control. 1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	STAT 512.CO 2: Analyze completely randomized design, Randomized block design, Latin square design. The conditions and circumstances under which results of the experiment are valid should be extensive.	**SO2.1 SO2.2**	2.1. Analysis of data obtained from CRD 2.2. Analysis of data obtained from RBD 2.3. Analysis of data obtained from LSD	**Unit-2.0 –** Uniformity trials, size and shape of plots and blocks; Analysis of variance; Completely randomized design, randomized block design and Latin square design. 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……

PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	STAT 512.CO 3: Understand and compute Full and confounded factorial designs with two and three levels. Fractional factorial designs with two levels.	**SO3.1** **SO3.2**	3.1 Analysis of factorial experiments without confounding. 3.2 Analysis of factorial experiments with confounding. 3.3Analysis with missing data in CRD. 3.4 Analysis with missing data in RBD. 3.5 Analysis with missing data in LSD. 3.6 Split plot designs. 3.7Strip plot designs	**Unit-3.0** Factorial experiments, (symmetrical as well as asymmetrical). orthogonality and partitioning of degrees of freedom, Confounding in symmetrical factorial experiments, Factorial experiments with control treatment. 3.1, 3.2, 3.3, 3.4, 3.5, 3.6	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	STAT 512.CO 4: Understand the purpose for balanced incomplete block design, resolvable designs and their applications. Split and Strip plot design will help students to know the applications of DOE and learn and apply these techniques in the field experiment.	**SO4.1** **SO4.2** **SO4.3**	4.1Transformation of data. 4.2Analysis of resolvable designs 4.3 Fitting of response surfaces.	**Unit-4.0** Split plot and strip plot designs; Analysis of covariance and missing plot techniques in randomized block and Latin square designs; Transformations, crossover designs, balanced incomplete block design, resolvable designs and their applications ~ Lattice design, alpha design-concepts, randomisation procedure, analysis and interpretation of results. Response surfaces. Experiments with mixtures. 4.1, 4.2, 4.3. 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15, 4.16	As mentioned in page number ……

Semester- II

Course Code: **PGS 503**

Course Title: **Intellectual Property and Its Management in Agriculture**

Pre- requisite: To teach the physiology of Intellectual Property and Its Management in Agriculture

Rationale: The main objective of this course is to equip students and stakeholders with knowledge of Intellectual Property Rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge based economy.

Course outcomes:

PGS 503.1: Students will be able to understand Historical perspectives and need for the introduction of Intellectual Property Right.

PGS 503.2: Students will be able to understand National Biodiversity protection initiatives. Convention on Biological Diversity.

PGS 503.3: Students will be able to understand Research Collaboration Agreement, License agreement

Scheme of Studies:

Board of Study	Course Code	Course Title			Scheme of studies (Hours/Week)			Total Credits(C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PGS)	PGS 503	Intellectual Property and Its Management in Agriculture	1	0	1	1	3	1

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T)and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW&SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)						
			Progressive Assessment (PRA)					End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment1 number	Class Test2 (2 best out) 20 marks	Practical Exam (PA)	Class Attendance (AT)	Total Marks (CA+CT+PA+AT)		

			5 marks each (CA)	each (CT)					
PGS	PGS 503	Intellectual Property and Its Management in Agriculture	5	40	0	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PGS 503.1: Students will be able to understand Historical perspectives and need for the introduction of Intellectual Property Right.

Approximate Hours

Item	AppXHrs
Cl	04
LI	0
SW	01
SL	02
Total	07

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO1.1 Student will understand the Historical perspectives and need for the introduction of Intellectual Property Right. **SO1.2** Student will recognize the TRIPs and various provisions in TRIPS Agreement. **SO1.3** Student will understand different Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs		**Unit-1.0** Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs. **1.1** Historical perspectives and need for the introduction of Intellectual Property Right regime. **1.2** TRIPs and various provisions in TRIPS Agreement. **1.3** Intellectual Property and Intellectual Property Rights (IPR). **1.4** Benefits of securing IPRs.	1. Role of IPR and its benefits. 2. Role of TRIPS and its benefits

SW-1 Suggested Sessional Work (SW):

a. Assignments: 1. *Preparation of file and write the role of IPR and TRIPS and their purpose.*

PGS 503.2: Students will be able to understand National Biodiversity protection initiatives. Convention on Biological Diversity.

Approximate Hours

Item	AppXHrs
Cl	06
LI	0
SW	02
SL	03
Total	11

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self -Learning (SL)
SO2.1 Students will understand the Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout **SO2.2**Students will understand the trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection. **SO2.3** Students will identify the role of Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection.		**Unit-2** Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection. **2.1** Indian Legislations for the protection of various types of Intellectual Properties. **2.2** Fundamentals of patents, copyrights, geographical indications, designs and layout. **2.3** trade secrets and traditional knowledge and trademarks. **2.4** protection of plant varieties and farmers' rights and biodiversity protection. **2.5** Protectable subject matters, protection in biotechnology. **2.6** Protection of other biological materials, ownership and period of protection.	1. Basic Indian Legislature. 2. Plant varieties and farmers' rights act (2001). 3. Biodiversity act (2002).

SW-2 Suggested Seasonal Work (SW):

Assignments:

I. Note on Plant varieties and farmers' rights act (2001).

II. Note on Biodiversity act (2002).

PGS 503.3: Students will be able to understand Research Collaboration Agreement, License agreement.

Approximate Hours

Item	AppXHrs
Cl	05
LI	0
SW	02
SL	01
Total	08

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO3.1 Students will identify the National Biodiversity protection initiatives and Convention on Biological Diversity. **SO3.2** Students will understand the International Treaty on Plant Genetic Resources for Food and Agriculture and Licensing of technologies. **SO3.2** Students will understand the Material transfer agreements, Research collaboration Agreement and License Agreement.		**Unit-3:** National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement. **3.1** National Biodiversity protection initiatives. **3.2** Conventions on Biological Diversity. **3.3** International Treaty on Plant Genetic Resources for Food and Agriculture. **3.4** Licensing of technologies and Material transfer agreements. **3.5** Research collaboration Agreement and License Agreement.	1. Plant Genetic Resources.

SW-3 Suggested Sessional Work (SW):

a. **Assignments**:

i. Note on Plant Genetic Resources.

ii. Note on National Biodiversity protection initiatives

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
PGS 503.1: Students will be able to understand Historical perspectives and need for the introduction of Intellectual Property Right.	04	01	02	07
PGS 503.2: Students will be able to understand National Biodiversity protection initiatives. Convention on Biological Diversity.	06	02	03	11
PGS 503.3: Students will be able to understand Research collaboration Agreement, License agreement.	05	02	01	08

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	**Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs.**	7	8	5	**20**
CO 2	**Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection.**	6	5	4	15
CO 3	**National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.**	5	4	6	15
Total		18	17	15	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Intellectual Property and Its Management in Agriculture** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks.

Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Group Discussion
6. Visit to organic fields
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:
(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Intellectual Property Rights in Agricultural Biotechnology	• Erbisch FH and Maredia K	CABI.	1998
2	Intellectual Property Rights: Unleashing Knowledge Economy	• Ganguli P	McGraw-Hill.	2001
3	Intellectual Property Rights: Key to New Wealth Generation		NRDC and Aesthetic Technologies.	2001
4	State of Indian Farmer. Vol. V. Technology Generation and IPR Issues	• Ministry of Agriculture, Government of India	Academic Foundation	2004
5	Intellectual Property Rights in Animal Breeding and Genetics	• Rothschild M and Scott N	CABI	2003

Curriculum Development Team:

bb. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.

cc. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.

dd. Dr. Abhishek Singh, HOD, Dept. of Horticulture, Faculty of Agriculture Science and Technology AKS University.

ee. Mr. Ayodhya Prasad Pandey. Assitant professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.

Cos, POs and PSOs Mapping

Course Code: PGS503

Course Title: - Intellectual Property and Its Management in Agriculture

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	Student will identify the current scenario, crop diversity, climatic requirement and breeding techniques of different vegetable and flower crops.	Student will expertise in latest vegetable production technologies, vegetable breeding techniques and post-harvest management of vegetables	The student will have expertise in nursery-raising techniques and protected cultivation of vegetables and flower crops.	The student will have expertise in different climatic conditions required for common vegetable as well as under utilized vegetable cultivation.	Student will plan about the big scale commercial project and also manage the research trails under vegetable and flower crops	Student will apply various statistical methods to analyze their master research work	Student will understand about library techniques, technical writing skill, IPR, laboratory techniques and research	Student will identify different cool season, warm season and underutilized vegetable crops	Student will practice different breeding techniques used in vegetable and flower production	Student will recognize different underutilized vegetable and spice crops	Student will apply different vegetable processing and post-harvest-handling methods for vegetables and flo	Student will understand role of microclimate in vegetable and flower crop production under different protected	After gaining experience, they will get the positions of specialists for handling plantation, nur	Student will recognize different flower, ornamental crops and their nursery management	Student will practice turfgrass, indoor plant and interioscaping management	Student will apply various information services, technical writings and communication skills in their aca	Student will apply basic concepts in laboratory techniques during their research work	Student will apply basic statistical tools during their research work

							ethics in manuscript writing		on		wers	structures	series and other protected cultivation projects			demics		
PGS 503.1: Students will be able to understand Historical perspectives and need for the	1	1	1	1	1	2	3	1	1	1	1	1	1	1	2	1	2

introduction of Intellectual Property Right																		
PGS 503. 2: Students will be able to understand National Biodiversity protection initiatives. Convention on on Biological Diversity.	1	1	1	1	1	3	2	1	1	1	1	1	1	1	1	2	1	3
PGS 503.	2	2	1	2	1	1	3	1	1	1	2	1	1	1	1	1	2	2

3: Students will be able to understand Research Collaboration Agreement, License agreement																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Intellectual Property and Its Management in Agriculture

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**PGS 503.CO1**: Students will be able to understand Historical perspectives and need for the introduction of Intellectual Property Right	**SO1.1** **SO1.2** **SO1.3**		**Unit-1.0** Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs. 1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**PGS 503.CO2:** Students will be able to understand National Biodiversity protection initiatives. Convention on Biological Diversity.	**SO2.1** **SO2.2** **SO2.3**		**Unit-2** Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection. 2.1, 2.2, 2.3, 2.4, 2.5, 2.6	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**PGS 503.CO3:** Students will be able to understand Research Collaboration Agreement, License agreement	**SO3.1** **SO3.2** **SO3.3**	1.	**Unit-3:** National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement. 3.1, 3.2, 3.3, 3.4, 3.5	

Semester II

Course Code: PGS 504

Course Title: Basic Concepts in Laboratory Techniques

Pre requisite: No specific requirements

Rationale: Studying basic laboratory techniques are fundamental for scientific research, ensuring accurate experimentation and data analysis. Mastery of these skills cultivates precision, reproducibility, and safety, forming the cornerstone of scientific inquiry across disciplines and facilitating advancements in knowledge and technology.

Course Outcomes: CO1_ PGS504 Student will learn about basic instrumentation, its principles, working and use. They will learn about Making solutions of different concentrations, learn acid base interaction. Also, student will learn about Procedural outline of various experiments. Student will learn about Basics of plant tissue culture and seed viability testing.

Scheme of Studies

Board of Study	Course Code	Course Title	Scheme of Studies (Hours/Week)					Total Credit (C)
			CI	LI	SW	SL	Total Study Hours	
NC	PGS504	Basic Concepts in Laboratory Techniques	00	2	00	00	2	01

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies), **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Practical

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						**End Semester Assessment** (ESA)	**Total Marks** (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+ CAT+AT)		
NC	PGS504	Basic Concepts in Laboratory Techniques	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

Laboratory techniques are important for any person conducting an experiment. Every procedure needs to be complete with accuracy and precision with proper safety measures. Student will understand the safety and details of working in scientific laboratory. Student will familiarize with various instruments and their principles. Student will practice and visualize common experimental procedures.

PGS504 Basic Concept of Laboratory Techniques

Approximate Hours

Item	Appx Hrs
CI	**00**
LI	**30**
SW	**00**
SL	**00**
Total	**30**

Session Outcomes (SOs)	Laboratory Instructions (LI)	Classroom Instructions (CI)	Self-Learning (SL)
SO.L1 Identify safety measures while in Lab **SO.L2** Recognize use of glasswares. **SO.L3** Discover handling of glasswares. **SO.L4** Recognize Drying of solvents/ chemicals; **SO.L5** Describe working with chemicals. **SO.L6** Describe working with solutions. **SO.L7** Articulate the technique of formulating doses of agrochemicals **SO.L8** Discover handling techniques of solutions **SO.L9** Identify the handling of acid and bases **SO.L10** Discover the formulation of buffer and solutions of specific pH. **SO.L11** Identify the use of lab instruments **SO.L12** Recognize and categorize the media requirements and its types **SO.L13** Discover the methods and application of viability of germplasm **SO.L14** Illustrate procedure for plant tissue culture **SO.L15** Recognize flowering plant by its taxonomical	L1. Safety measures while in Lab; L2. Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; L3. Washing, drying and sterilization of glassware; L4. Drying of solvents/ chemicals; L5. Handling of chemical substances; Weighing and preparation of solutions of different strengths and their dilution; L6. Handling techniques of solutions; L7. Preparation of different agro-chemical doses in field and pot applications; L8. Preparation of solutions of acids; L9. Neutralisation of acid and bases; L10. Preparation of buffers of different strengths and pH values; L11. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing; L12. Preparation of media and methods of sterilization; L13. Seed viability testing, testing of pollen viability; L14. Tissue culture of crop plants; L15. Description of flowering plants in botanical terms in relation to taxonomy		

description			

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self-Learning (SL)	Total hour (CL+SW+SL)
Basic Concept of Laboratory Techniques	0+30	0	0	30

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO1	**Basic Concept of Laboratory Techniques**		**30**	**70**	**100**

Suggested Learning Resources:

Sl. No.	Title	Author	Publisher	Edition and Year
01	Laboratory Techniques in Organic Chemistry	Jerry R. Mohrig, David G. Alberg, and Gretchen M. Adams	W. H. Freeman and Company.	2014
02	Biotechnology: Expanding Horizons	B D Singh	Kalyani Publishers	2005

Cos, POs and PSOs Mapping
Course Code: PGS 504
Course Title: - Basic Concepts in Laboratory Techniques

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO 3	PSO 4	PSO 5	PSO6	PSO 7	PSO 8	PSO 9	PSO 10
	Student will identify the current scenario, crop diversity, climatic requirement and breeding techniques of different vegetable and flower crops.	Student will expertise in latest vegetable production technologies, vegetable breeding techniques and post-harvest management of vegetables	The student will have expertise in nursery-raising techniques and protected cultivation of vegetables and flower crops.	The student will have expertise in different climatic conditions required for common vegetable as well as underutilized vegetable cultivation.	Student will plan about the big scale commercial project and also manage the research trails under vegetable and flower crops	Student will apply various statistical methods to analyze their master research work	Student will understand about library techniques, technical writing skill, IPR, laboratory techniques and research ethics in manuscript writing	Student will identify different cool season, warm season and underutilized vegetable crops	Student will practice different breeding techniques used in vegetable and flower production	Student will recognize different underutilized vegetable and spice crops	Student will apply different vegetable processing and post-harvest-handling methods for vegetables and flowers	Student will understand role of microclimate in vegetable and flower crop production under different protected structures	After gaining experience, they will get the positions of specialists for handling plantation, nurseries and other pro	Student will recognize different flowe	Student will practice turf grass, indoor plant and interioscaping management	Student will apply various information	Student

													tected cultivation projects	r, ornamental crops and their nursery manageme	t	ion services, technical writings and communi	n laboratory techniques during their researc

														nt		cation skills in their academics	h w c r k
PGS504 Student will learn about basic instrumentation, its principles,	1	1	1	1	2	3	2	1	1	1	1	1	1	1	1	2	3

working and use. They will learn about Making solutions of different concentrations, learn acid base interaction. Also,student will learn about Procedural outline of various experiments. Student will learn about Basics of plant tissue culture and seed viability testing. .																	

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Basic Concepts in Laboratory Techniques

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	PGS 504.CO 1 Student will learn about basic instrumentation, its principles, working and use. They will learn about Making solutions of different concentrations, learn acid base interaction. Also, student will learn about Procedural outline of various experiments. Student will learn about Basics of plant tissue culture and seed viability testing.	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5** **SO1.6** **SO1.7** **SO1.8** **SO1.9** **SO1.10** **SO1.11** **SO1.12** **SO1.13** **SO1.14** **SO1.15**	L1. Safety measures while in Lab; L2. Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; L3. Washing, drying and sterilization of glassware; L4. Drying of solvents/ chemicals; L5. Handling of chemical substances; Weighing and preparation of solutions of different strengths and their dilution; L6. Handling techniques of solutions; L7. Preparation of different agro-chemical doses in field and pot applications; L8. Preparation of solutions of acids; L9. Neutralisation of acid and bases; L10. Preparation of buffers of different strengths and pH values; L11. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electric wiring and earthing; L12. Preparation of media and		As mentioned in page number ……..

			methods of sterilization; L13. Seed viability testing, testing of pollen viability; L14. Tissue culture of crop plants; L15. Description of flowering plants in botanical terms in relation to taxonomy		

Semester- III

Course Code: **GPB 507**

Course Title: **Breeding For Quality and Special Traits**

Pre- requisite: Students should have able to basic knowledge of developmental biochemistry grain quality parameters genetic resources management achievement and genetic engineering protocols with generation transgenics.

Rationale: To provide insight into recent advances in improvement of quality traits in cereals, millets, legumes, oilseeds, forage and industrial crops using conventional and modern biotechnological approaches

Course Outcomes:

GPB507.1: The knowledge of this course will expose the student to know about basic developmental biochemistry and genetics of nutritional improvement of human perspective.

GPB507.2: The knowledge of this course will expose the student to know about breeding for grain quality parameters and its analysis.

GPB507.3: Student will be able to understand genetic resource management for sustaining nutritive quality in crops.

GPB507.4: The knowledge of this course will expose the student to know about breeding for quality improvement, cooking quality and achieve more PUFA in oil crops.

GPB507.5: The knowledge of this course will expose the student to know about genetic engineering protocols for quality improvement and nutritional genomics and second generation transgenics.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
	GPB 507	Breeding For Quality and Special Traits	2	2	0	0	4	(2+1)= 3

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies) **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+ CAT+AT)		
	GPB 507	Breeding For Quality and	15	30	0	0	5	50	50	100

		Special Traits								

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB507.1: The knowledge of this course will expose the student to know about basic developmental biochemistry and genetics of nutritional improvement of human perspective.

Approximate Hours

Item	Approximate Hours
CI	**5**
LI	**0**
SW	**2**
SL	**1**
Total	**8**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self -Learning (SL)
SO1.1. Students are able to Understand developmental biochemistry and genetics. **SO1.2.** Students are able to explain anti-nutritional factors **SO1.3.** Students are able to Understand carbohydrates and other minerals. **SO1.4.** Students are able to Understand the process of nutritional improvement in human perspective.		**Unit-1 Developmental biochemistry and genetics of nutritional and anti-nutritional factors.** **1.1.** Developmental biochemistry. **1.2.** genetics of carbohydrates, proteins. **1.3**. genetics of fats, vitamins, amino acids. **1.4**. anti-nutritional factors in genetics. **1.5**. Nutritional improvement - A human perspective	1.Genetics of carbohydrates. 2.Nutritional improvements.

SW-1 Suggested Sessional Work (SW):

a. **Assignments:** anti-nutritional factors; Nutritional improvement - A human perspective.
b. **Mini Project:** Developmental biochemistry and genetics of carbohydrates.
c. **Other Activities (Specify):**

GPB507.2: The knowledge of this course will expose the student to know about breeding for grain quality parameters and its analysis.

Approximate Hours

Item	Approximate Hours
CI	**7**
LI	**10**
SW	**2**
SL	**1**
Total	**20**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Students are able to Understand the quality parameters and its analysis. **SO2.2.** Students are able to Understand the breeding strategies, achievements and its application. **SO2.3.** Students are able to Understand the molecular basis quality traits. **SO2.4.** Students are able to Understand the process of post harvest manipulations. **SO2.5.** Students are able to Understand the process breeding for backing quality. **SO2.6.** Students are able to Understand the molecular and cytogenetic. **SO2.7.** Students are able to Understand the differentiation about golden and aromatic rice.	1. Grain quality evaluation in rice. 2. Correlating ageing and quality improvement in rice. 3. Quality analysis in millets. 4. Estimation of anti-nutritional factors like tannins in different varieties/ hybrids: A comparison. 5. Quality parameters evaluation in wheat.	**Unit-2. Breeding for grain quality parameters and its analysis** 2.1. quality parameters in rice and its analysis 2.2. Golden rice and aromatic rice. 2.3. Breeding strategies, achievements and application in Indian context. 2.4. Molecular basis of quality traits and their manipulation in rice 2.5. Post harvest manipulation for quality improvement 2.6. Breeding for baking qualities in wheat 2.7. molecular and cytogenetic.	**1.** Analysis Golden rice and aromatic rice. **2.** Baking qualities in wheat.

SW-2 Suggested Sessional Work (SW):

a. Assignments: Molecular basis of quality traits and their manipulation in rice.

b. Mini Project:

1. quality parameters in rice and its analysis.

c. Other Activities (Specify):

GPB507.3: Student will be able to understand genetic resource management for sustaining nutritive quality in crops.

Item	Approximate Hours
CI	**6**
LI	**0**
SW	**2**
SL	**1**
Total	**9**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1. Students are able to Understand the Breeding for quality improvement in Sorghum, pearl millet. **SO3.2.** Students are able to Understand the Breeding for quality improvement in barley and oats. **SO3.3.** Students are able to Understand the Quality protein maize, specialty corns, **SO3.4.** Students are able to Understand the Concept and breeding strategies. **SO3.5.** Students are able to Understand the Breeding for quality improvement in important forage crops for stay green traits. **SO3.6.** Students are able to Understand the Genetic resource management for sustaining nutritive quality in crops.		**Unit 3 Genetic resource management for sustaining nutritive quality in crops**. **3.1**. Breeding for quality improvement in Sorghum, pearl millet. **3.2.** Breeding for quality improvement in barley and oats. **3.3.** Quality protein maize, specialty corns, **3.4.** Concept and breeding strategies. **3.5.** Breeding for quality improvement in important forage crops for stay green traits. **3.6.** Genetic resource management for sustaining nutritive quality in crops.	**1**. Analysis of breeding quality improvement in crops. **2**. analysis of concept and breeding strategies.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Analysis of **N**utritive quality in crops.

b. Mini Project:

a. concept and breeding strategies.

Other Activities (Specify):

GPB507.4: The knowledge of this course will expose the student to know about breeding for quality improvement, cooking quality and achieve more PUFA in oil crops.

Item	Approximate Hours
CI	**7**
LI	**12**
SW	**2**
SL	**1**
Total	**22**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO 4.1. Students are able to Understand the Breeding for quality improvement in pulses- Chickpea, pigeonpea. **SO4.2.** Students are able to Understand the Breeding for quality improvement in pulses- green gram and black gram and Cooking quality. **SO 4.3.** Students are able to Understand the Breeding for quality in oilseeds - groundnut, mustard, soybean. **SO 4.4.** Students are able to Understand the Breeding for quality in sesame, sunflower and minor oilseeds. **SO 4.5.** Students are able to Understand the Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops. **SO 4.6.** Students are able to Understand the Genetic manipulation for quality improvement in cotton. **SO 4.7.** Students are able to Understand the Breeding for quality improvement in Sugarcane, potato.	1. Quality parameters evaluation in pulses and oilseeds. 2. Evaluation of quality parameters in cotton. 3. Evaluation of quality parameters in sugarcane. 4. Evaluation of quality parameters in potato. 5. Value addition in crop plants. 6. Post-harvest processing of major field crops.	**Unit 4. Breeding for quality improvement, cooking quality and achieve more PUFA in oil crops.** 4.1. Breeding for quality improvement in pulses- Chickpea, pigeonpea. 4.2. Breeding for quality improvement in pulses- green gram and black gram and Cooking quality. 4.3. Breeding for quality in oilseeds -groundnut, mustard, and soybean. 4.4. Breeding for quality in sesame, sunflower and minor oilseeds. 4.5. Molecular basis of fat formation and manipulation to achieve more PUFA in oil crops. 4.6. Genetic manipulation for quality improvement in cotton. 4.7. Breeding for quality improvement in Sugarcane, potato.	**3.** Breeding for quality improvement in various pulses crops. **4.** manipulation to achieve more PUFA in oil crops.

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Breeding for quality improvement in Sugarcane, potato

b. Mini Project:

i. Molecular basis of fat formation.

c. Other Activities (Specify):

GPB507.5: The knowledge of this course will expose the student to know about genetic engineering protocols for quality improvement and nutritional genomics and second generation transgenics.

Item	Approximate Hours
CI	**5**
LI	**8**
SW	**2**
SL	**1**
Total	**16**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Genetic engineering protocols for quality improvement: Achievements made. **SO5.2.** Biofortification in crops. **SO5.3** Classification and importance of Biofortification. **SO5.4.** Nutritional genomics. **SO5.5**. Second generation transgenics.	1. Quality improvement in crops through tissue culture techniques. 2. Evaluating the available populations like RIL, NIL, etc. for quality improvement using MAS procedures. 3. Successful example of application of MAS for quality trait in rice. 4. Successful example of application of MAS for quality trait in mustard, maize, etc.	**Unit-5. Genetic engineering protocols for quality improvement.** 1. Genetic engineering protocols for quality improvement: Achievements made. 2. Biofortification in crops. 3. Classification and importance of Biofortification. 4. Nutritional genomics. 5. Second generation transgenics.	1. Genetic engineering protocols. 2. Classification and importance, Nutritional genomics.

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Classification and importance, Nutritional genomics.

b. Mini Project:

iv. Protocols for quality improvement.

c. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
GPB507.1: The knowledge of this course will expose the student to know about basic developmental biochemistry and genetics of nutritional improvement of human perspective.	**5**	**2**	**1**	**8**
GPB507.2: The knowledge of this course will expose the student to know about breeding for grain quality parameters and its analysis.	**17**	**2**	**1**	**20**
GPB507.3: Student will be able to understand genetic resource management for sustaining nutritive quality in crops.	**6**	**2**	**1**	**9**
GPB507.4: The knowledge of this course will expose the student to know about breeding for quality improvement, cooking quality and achieve more PUFA in oil crops.	**19**	**2**	**1**	**22**
GPB507.5: The knowledge of this course will expose the student to know about genetic engineering protocols for quality improvement and nutritional genomics and second generation transgenics.	**13**	**2**	**1**	**16**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	Developmental biochemistry and genetics of nutritional and anti-nutritional factors.	3	4	3	10
CO 2	Breeding for grain quality parameters and its analysis.	4	4	3	11
CO 3	Genetic resource management for sustaining nutritive quality in crops.	3	3	3	9
CO 4	Breeding for quality improvement, cooking quality and achieve more PUFA in oil crops.	4	3	4	11
CO 5	Genetic engineering protocols for quality improvement transgenics.	5	2	2	9
Total		19	16	15	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Breeding For Quality and Special Traits** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Group Discussion
3. Visit to cement plant
4. Demonstration
5. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)

6. Brainstorming

2. Suggested Learning Resources:

3. (a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Principles and procedures of plant breeding"	Chahal GS and SS Ghosal.	Biotechnological and Conventional approaches, Narosa Publications	2002
2	Plant Breeding. Oxford & IBH. 2018.	Chopra VL	Oxford & IBH. 2018	2018
3	Fibre Science and Technology.	Ghosh P.	Tata McGraw Hill.	2004
4	Advances in Botanical Research	Gupta SK.	Vol. 45 Academic Press	2007
5	Plant Breeding	Singh BD.	Kalyani Publishers, New Delhi	1997
6	Genetic Improvement of Oilseed Crops	Nigam J.	Oxford & IBH.	1996

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
4. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
5. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
6. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
7. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
8. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 507
Course Title: - Breeding For Quality and Special Traits

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to cont	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their soluti	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								emporary agriculture.					ons.			contemporary agriculture.		
GPB507.1: The knowledge of this course will expose the student to know about basic developmental biochemistry and genetics of nutritional improvement of human perspective.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB507.2: The knowledge of this course will expose the student to know	1	2	1	2	2	1	1	2	1	2	3	2	1	1	1	1	1	1

about breeding for grain quality parameters and its analysis.																		
GPB507.3: Student will be able to understand genetic resource management for sustaining nutritive quality in crops.	1	2	3	2	2	1	1	2	2	2	2	1	1	1	1	1	1	1
GPB507.4: The knowledge of this course will expose the student to know about breeding for qualit	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1

y improvement, cooking quality and achieve more PUFA in oil crops.																		
GPB507.5: The knowledge of this course will expose the student to know about genetic engineering protocols for quality improvement and nutritional genomics and second generation transgenics.	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Breeding For Quality and Special Traits

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB507.1:** The knowledge of this course will expose the student to know about basic developmental biochemistry and genetics of nutritional improvement of human perspective.	**SO1.1 SO1.2 SO1.3**	Quality parameters evaluation in pulses and oilseeds.	Unit-1. Developmental biochemistry and genetics of nutritional and anti-nutritional factors. 1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB507.2:** The knowledge of this course will expose the student to know about breeding for grain quality parameters and its analysis.	**SO2.1 SO2.2 SO2.3 SO2.4 SO2.5**	Evaluation of quality parameters in cotton.	Breeding for grain quality parameters and its analysis. 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB507.3**: Student will be able to understand genetic resource management for sustaining nutritive quality in crops.	**SO3.1 SO3.2 SO3.3**	Evaluation of quality parameters in sugarcane.	Genetic resource management for sustaining nutritive quality in crops. 3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB507.4**: The knowledge of this course will expose the student to know about breeding for quality improvement, cooking quality and achieve more PUFA in oil crops.	**SO4.1 SO4.2**	Evaluation of quality parameters in potato.	Breeding for quality improvement, cooking quality and achieve more PUFA in oil crops. 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB507.5**: The knowledge of this course will expose the student to know about genetic engineering protocols for quality improvement and nutritional genomics and second generation transgenics.	**SO5.1 SO5.2**	Value addition in crop plants.	Genetic engineering protocols for quality improvement. 5.1, 5.2	As mentioned in page number ……

Semester- III

Course Code: GPB 516

Course Title: Breeding For Stress Resistance and Climate Change

Pre- requisite: To apprise about various abiotic and biotic stresses influencing crop yield, mechanisms and genetics of resistance and methods to breed stress tolerant varieties.

Rationale: After completion of this course the student will be able to well verse with the stress and its causes. This will enable the students for the development of RIL, NIL, etc. for pest resistance and Use of standard MAS procedures.

Course Outcomes:

GPB 516.1: Students are able to understand concept and impact of climatic change and breeding for abiotic and biotic stress resistance with their classification.

GPB 516.2: Students will have the ability to apply the knowledge gained about Concept of resistance pathogen invasions- Biochemical and molecular mechanisms, gene-for-gene hypothesis.

GPB 516.3: To understand principles of detection of genetically modified crops and seed treatment, packing and seed storage.

GPB 516.4: Students will get knowledge on about the genetic of abiotic stress resistance, genes and genomics in breeding Utilizing MAS procedures deficiency.

GPB 516.5: Students are gain knowledge about the Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
	GPB 516	Breeding For Stress Resistance and Climate Change	2	1	0	0	3	2+1= **3**

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies), **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ESA)
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)		

	GPB 516	**Breeding For Stress Resistance and Climate Change**	15	30	0	0	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB 516.1: Students are able to understand concept and impact of climatic change and breeding for abiotic and biotic stress resistance with their classification.

Item	**Approximate Hours**
CI	**3**
LI	**4**
SW	**2**
SL	**1**
Total	**10**

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO1.1 Students are able to explain Concept and impact of climatic change. **SO1.2** Students are able to explain Importance of plant breeding with special reference to biotic and abiotic stress resistance. **SO1.3** Students are able to explain Classification of biotic stresses – major pests and diseases of economically important crops.	**1**. Understanding the climatologically parameters and predisposal of biotic and abiotic stress. 2. Screening crops for drought and flood resistance.	**Unit-1. Concept and impact of climatic change and breeding for abiotic and biotic stress resistance.** **1.** Concept and impact of climatic change. **2.** Importance of plant breeding with special reference to biotic and abiotic stress resistance. **3.** Classification of biotic stresses – major pests and diseases of economically important crops.	**1**. Plant breeding with special reference to biotic and abiotic stress resistance.

SW-1 Suggested Sessional Work (SW):

d. Assignments:

Major pests and diseases of economically important crops.

e. Mini Project:

Classification of biotic and abiotic stresses.

f. Other Activities (Specify):

GPB 516.2: Students will have the ability to apply the knowledge gained about Concept of resistance pathogen invasions- Biochemical and molecular mechanisms, gene-for-gene hypothesis.

Item	Approximate Hours
CI	**7**
LI	**6**
SW	**2**
SL	**1**
Total	**16**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1. Students are able to explain Concepts of resistance to insect and pathogen resistance. **SO2.2**. Students are able to explain Analysis and inheritance of resistance variation. **SO2.3**. Students are able to explain Host defence responses to pathogen invasions- Biochemical and molecular mechanisms. **SO2.4**. Students are able to explain Acquired and induced immunity and systemic acquired resistance (SAR). **SO2.5**. Students are able to explain Host-pathogen interaction, gene-for-gene hypothesis. **SO2.6**. Students are able to explain Molecular evidence for its operation and exceptions. **SO2.7**. Students are able to explain Concept of signal transduction and other host-defence mechanisms against viruses and bacteria.	**1.** factors-ways of combating them for diseases caused by fungi and bacteria. **2.**Phenotypic screening techniques for sucking pests and chewing pests. **3.** Breeding for pest resistance. Foundation and Certified seed production of Sorghum.	**Unit-2. Concept of resistance pathogen invasions and Molecular evidence.** **1**. Concepts of resistance to insect and pathogen resistance. **2**. Analysis and inheritance of resistance variation. **3**. Host defence responses to pathogen invasions- Biochemical and molecular mechanisms. **4**. Acquired and induced immunity and systemic acquired resistance (SAR). **5**. Host-pathogen interaction, gene-for-gene hypothesis. **6**. Molecular evidence for its operation and exceptions. **7**. Concept of signal transduction and other host-defence mechanisms against viruses and bacteria.	**1.** Host-pathogen interaction, gene-for-gene hypothesis. **2.** Mechanisms against viruses and bacteria.

SW-2 Suggested Sessional Work (SW):

c. Assignments:

Host defence responses to pathogen invasions- Biochemical and molecular mechanisms.

d. Mini Project:

Acquired and induced immunity and systemic acquired resistance (SAR).

ci. Other Activities (Specify):

GPB 516.3: To understand principles of detection of genetically modified crops and seed treatment, packing and seed storage.

Item	Approximate Hours
CI	**9**
LI	**6**
SW	**2**
SL	**1**
Total	**18**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1. Students are able to explain Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants. **SO3.2.** Students are able to explain Quantitative resistance/ adult plant resistance and slow rusting resistance. **SO 3.3.** Students are able to explain Classical and molecular breeding methods - Measuring plant resistance using plant fitness. **SO 3.4.** Students are able to explain Students are able to explain Behavioural, physiological and insect gain studies. **SO 3.5.** Students are able to explain Phenotypic screening methods for major pests and diseases. **SO 3.6.** Students are able to explain Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications. **SO 3.7.** Students are able to explain Classification of abiotic stresses - Stress inducing factors, moisture stress/ drought and water logging and submergence, Acidity, salinity/ alkalinity/ sodicity; High/ low temperature, wind, etc. **SO 3.8.** Students are able to explain Stress due to soil factors and mineral toxicity. **SO 3.9.** Students are able to explain Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.	**1.** Phenotypic screening techniques for nematodes and borers; Ways of combating them. **2**.Study about Classical and molecular breeding methods **3**. Stress due to soil factors and mineral toxicity.	**Unit 3 Mechanism of resistance classical and molecular breeding method.** **1.** Types and genetic mechanisms of resistance to biotic stresses –Horizontal and vertical resistance in crop plants. **2.** Quantitative resistance/ adult plant resistance and slow rusting resistance. **3.** Classical and molecular breeding methods - Measuring plant resistance using plant fitness. **4.** Behavioural, physiological and insect gain studies. **5.** Phenotypic screening methods for major pests and diseases. **6.** Recording of observations; Correlating the observations using marker data – Gene pyramiding methods and their implications. **7.** Classification of abiotic stresses - Stress inducing factors, moisture stress/ drought and water logging and submergence, Acidity, salinity/ alkalinity/ sodicity; High/ low temperature, wind, etc. **8.** Stress due to soil factors and mineral toxicity. **9.** Physiological and Phenological responses; Emphasis of abiotic stresses in developing breeding methodologies.	1.Classical and molecular breeding methods - Measuring plant resistance using plant fitness.

SW-3 Suggested Sessional Work (SW):

c. **Assignments:**
   Stress due to soil factors and mineral toxicity.
d. **Mini Project:**
   Gene pyramiding methods and their implications.
e. **Other Activities (Specify):**

GPB 516.4: **Students will get knowledge on about the genetic of abiotic stress resistance, genes and genomics in breeding Utilizing MAS procedures deficiency.**

Item	Approximate Hours
CI	**6**
LI	**6**
SW	**2**
SL	**1**
Total	**15**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO4.1. Students are able to explain Genetics of abiotic stress resistance. **SO4.2.** Students are able to explain Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence, high and low/ freezing temperatures. **SO4.3.** Students are able to explain Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum. **SO4.4.** Students are able to explain Utilizing MAS procedures for identifying resistant types in important crops like wheat, cotton. **SO4.5.** Students are able to explain Breeding for resistance to stresses caused by toxicity. **SO4.6.** Students are able to explain Deficiency and pollutants/ contaminants in soil, water and environment.	**1.** Use of standard MAS procedures. Breeding strategies - Weeds – ecological, environmental impacts on the crops. **2**. Symptoms and data recording; use of MAS procedures. **3.** Traits to be observed at plant and insect level.	**Unit 4. Genetic of abiotic stress resistance, genes and genomics.** **1.** Genetics of abiotic stress resistance. **2.** Genes and genomics in breeding cultivars suitable to low water regimes and water logging and submergence, high and low/ freezing temperatures. **3.** Utilizing MAS procedures for identifying resistant types in important crops like rice, sorghum. **4.** Utilizing MAS procedures for identifying resistant types in important crops like wheat, cotton. **5.** Breeding for resistance to stresses caused by toxicity. **6.** Deficiency and pollutants/ contaminants in soil, water and environment.	Deficiency and pollutants/ contaminants in soil, water and environment.

SW-4 Suggested Sessional Work (SW):

d. **Assignments:**
   Breeding for resistance to stresses caused by toxicity.
e. **Mini Project:**
   Utilizing MAS procedures for identifying resistant types
f. **Other Activities (Specify):**

GPB 516.5: Students are gain knowledge about the Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops.

Item	Approximate Hours
CI	**5**
LI	**8**
SW	**2**
SL	**1**
Total	**16**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO5.1. Students are able to explain Use of crop wild relatives as a source of resistance. **SO5.2.** Students are able to explain Biotic and abiotic factors in major field crops. **SO5.3.** Students are able to explain Transgenics in management of biotic and abiotic stresses. **SO5.4.** Students are able to explain Transgenics use of toxins, protease inhibitors, lectins, chitinases. **SO5.5.** Students are able to explain Bt for diseases and insect pest management.	**1**. Evaluating the available populations like RIL, NIL, etc. **2**. Breeding for herbicide resistance. **3**. Factors to be considered and breeding strategies. **4**. To study about the Quality parameters evaluation.	**Unit-5. Use of crop wild relatives as a source of resistance and Transgenics in management of biotic and abiotic stresses.** **1.** Use of crop wild relatives as a source of resistance. **2.** Biotic and abiotic factors in major field crops. **3.** Transgenics in management of biotic and abiotic stresses. **4.** Transgenics use of toxins, protease inhibitors, lectins, chitinases. **5.** Bt for diseases and insect pest management.	**1.** Biotic and abiotic factors in major field crops.

SW-5 Suggested Sessional Work (SW):

a. Assignments:

Transgenics in management of biotic and abiotic stresses.

b. Mini Project:

Bt for diseases and insect pest management.

c. **Other Activities (Specify):**

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
GPB 516.1: Students are able to understand concept and impact of climatic change and breeding for abiotic and biotic stress resistance with their classification.	**7**	**2**	**1**	**10**
GPB 516.2: Students will have the ability to apply the knowledge gained about Concept of resistance pathogen invasions- Biochemical and molecular mechanisms, gene-for-gene hypothesis.	**13**	**2**	**1**	**16**
GPB 516.3: To understand principles of detection of genetically modified crops and seed treatment, packing and seed storage.	**15**	**2**	**1**	**18**
GPB 516.4: Students will get knowledge on about the genetic of abiotic stress resistance, genes and genomics in breeding Utilizing MAS procedures deficiency.	**12**	**2**	**1**	**15**
GPB 516.5: Students are gain knowledge about the Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops.	**13**	**2**	**1**	**16**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	Concept and impact of climatic change and breeding for abiotic and biotic stress resistance.	**3**	**4**	**4**	**11**
CO 2	Concept of resistance pathogen invasions and Molecular evidence.	**4**	**3**	**3**	**10**
CO 3	Mechanism of resistance classical and molecular breeding method.	**5**	**3**	**2**	**10**
CO 4	Genetic of abiotic stress resistance, genes and genomics.	**4**	**3**	**2**	**9**
CO 5	Use of crop wild relatives as a source of resistance and Transgenics in management of biotic and abiotic stresses.	**3**	**4**	**3**	**10**
Total		**19**	**17**	**14**	**50**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Breeding For Stress Resistance and Climate Change** will be held with written examination of 50 marks.

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Group Discussion and Demonstration
3. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)

4. Brainstorming
5. Smart Board

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Plant Breeding for Stress Environments.	Blum A.	CRC Press.	2017
2	Breeding Plants for Less Favorable Environments.	Christiansen M.N. & Lewis C.F.	Wiley International.	1982
3	Plant Resistance to Herbivores and Pathogens: Ecology, Evolution and Genetics.	Fritz R.S. & Simms E.L. (Eds.).	The University of Chicago Press	1992
4	Plant Cold Hardiness and Freezing Stress	Li PH & Sakai A	Academic Press	1982
5	Developing Resistant Plants - The Ideal Method of Controlling Insects	Luginpill P.	Forgotten Books	2019
6	Breeding Plants Resistant to Insects.	Maxwell FG & Jennings PR. (Eds.).	John Wiley & Sons.	1980
7	Insect Resistance in Crop Plants	Painter RH.	MacMillan, New York	1968
8	Plant Breeding for Pest and Disease Resistance	Russel GE.	Butterworths	1978
9	Frost Survival of Plants	Sakai A & Larcher W	Springer Berlin, Heidelberg	2012
10	Adaptation of Plants to Water and High Temperature Stress	Turener NC & Kramer PJ.	John Wiley & Sons.	1980
11	Host-Pathogen Interactions in Plant Disease	Van der Plank JE	Academic Press	1982

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Brindaban Singh, HOD, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
4. Dr. R. P. Joshi, Professor, CoA, Rewa, JNKVV, Jabalpur M.P.
5. Dr. Hitesh Kumar, Associate Professor, Dept. of Genetics and Plant Breeding, BAU Banda U.P.
6. Mr. K. K. Bagri, Assistant Seed Certification Officer, SSCA M.P.
7. Mr. Rajbeer Singh Gaur, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
8. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.
9. Mr. Ankit Kumar Bhagat, Teaching Associate, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology, AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 516
Course Title: - Breeding For Stress Resistance and Climate Change

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions.	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to contemp	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.	To disseminate information about diverse methods of cutting-edge and creative genetics and plant breeding research.	Disseminate comprehensive practical understanding of crop hybridization, in-bred line development, and germplasm screening.	This program will provide opportunities for students to understand the major constraints of crop production and their solutions	The students will develop a understanding and analyzing present difficulties in local and global agriculture and how they may impact future agriculture.	To develop scientifically trained personnel for community service, particularly in rural regions in field of agriculture	To gain interdisciplinary understanding of genetics and breeding techniques for the cultivation of various crops growing from traditional to con	To give students a comprehensive introduction to genetics and plant breeding as they apply to various crops.	The student will be familiar with the various plant reproductive systems, genetic diversity, and breeding and selection techniques.

								orary agriculture.					.			temporary agriculture.		
GPB 516.1: Students are able to understand concept and impact of climatic change and breeding for abiotic and biotic stress resistance with their classification.	1	2	1	1	2	1	1	2	3	3	2	2	1	1	1	1	1	1
GPB 516.2: Students will have the ability to apply the knowledge gained about Concept of	1	2	1	2	2	1	1	2	3	2	3	2	1	1	1	1	1	1

resistance pathogen invasions-Biochemical and molecular mechanisms, gene-for-gene hypothesis.																		
GPB 516.3: To understand principles of detection of genetically modified crops and seed treatment, packing and seed storage.	1	2	3	2	2	1	1	2	2	3	2	1	1	1	1	1	1	1
GPB 516.4: Students will get knowledge on	3	2	2	2	1	1	1	3	1	2	1	1	2	1	1	1	1	1

about the genetic of abiotic stress resistance, genes and genomics in breeding Utilizing MAS procedures deficiency.																		
GPB 516.5: Students are gain knowledge about the Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops.	2	3	2	3	2	1	1	1	2	2	1	2	1	1	1	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Breeding For Stress Resistance and Climate Change

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 516.1:** Students are able to understand concept and impact of climatic change and breeding for abiotic and biotic stress resistance with their classification.	**SO1.1 SO1.2 SO1.3**	Evaluating the available populations like RIL, NIL, etc.	Unit-1. Concept and impact of climatic change and breeding for abiotic and biotic stress resistance. .1.1, 1.2, 1.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 516.2:** Students will have the ability to apply the knowledge gained about Concept of resistance pathogen invasions- Biochemical and molecular mechanisms, gene-for-gene hypothesis.	**SO2.1 SO2.2 SO2.3 SO2.4 SO2.5**	**2**. Breeding for herbicide resistance.	Concept of resistance pathogen invasions and Molecular evidence. 2.1, 2.2, 2.3, 2.4, 2.5	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 516.3:** To understand principles of detection of genetically modified crops and seed treatment, packing and seed storage.	**SO3.1 SO3.2 SO3.3**	**3**. Factors to be considered and breeding strategies.	Mechanism of resistance classical and molecular breeding method. 3.3, 3.2, 3.3	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 516.4**: Students will get knowledge on about the genetic of abiotic stress resistance, genes and genomics in breeding Utilizing MAS procedures deficiency.	**SO4.1 SO4.2**	**4**. To study about the Quality parameters evaluation	Genetic of abiotic stress resistance, genes and genomics. 4.1, 4.2	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 516.5:** Students are gain knowledge about the Use of crop wild relatives as a source of resistance to biotic and abiotic factors in major field crops.	**SO5.1 SO5.2**	Path coefficient analysis and interpretation.	Use of crop wild relatives as a source of resistance and Transgenics in management of biotic and abiotic stresses 5.1, 5.2	As mentioned in page number ……

Semester- III

Course Code: GPB 591

Course Title: Master Seminar

Pre- requisite: Students should have knowledge about basic and futuristic technologies subjected to ICT technology and Genetics and Plant Breeding.

Rationale: Student will become familiar with fundamental application of ICT technologies related with Genetics and Plant Breeding that will support students in their career skills and leadership development in order to shape tomorrow's social and educational development in Genetics and Plant Breeding sector.

Course Outcomes:

GPB 591.1. Students will design professional orientation on the topic with their choice of interest which will helps in development of academic and social sector pertaining to Genetics and Plant Breeding.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study Hours CI+LI+SW+SL	
	GPB 591	Master Seminar	0	2	1	1	4	(0+1) = 1

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies), **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks(PRA + ESA)
			Class/Home Assignment 5 number3 markseach(CA)	ClassTest 2(2 bestout of3)10 marks each(CT)	Seminarone	Class Activityanyone(CAT)	Class Attendance(AT)	Total Marks(CA+CT+SA+CAT+AT)		
	GPB 591	Master Seminar	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should show case their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB591.1. Students will design professional orientation on the topic with their choice of interest which will helps in development of academic and social sector pertaining to Genetics and Plant Breeding.

Approximate Hours

Item	Approximate Hours
CI	**0**
LI	**30**
SW	**0**
SL	**2**
Total	**32**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 The research seminar allows students to work with ICT technologies in Genetics and Plant Breeding. **SO1.2.** Research seminar helps the students to refine their skills and knowledge of the subject. **SO1.3.**Research seminar developvocational qualities in students.	**1.** Selection of topic and collection of presentation materials by using the ICT tools related to the Genetics and Plant Breeding on selected topic. **2.** Presentation of acquired material in PPT form.		**1.** Finding the topic related material. **2.** Preparation of PPT related to concerned topic.

SW-1 Suggested Sessional Work (SW):

g. Assignments:

h. Mini Project:

i. Other Activities (Specify)

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self - Learning (Sl)	Total hour (Cl+SW+Sl)
GPB591.1. Students will design professional orientation on the topic with their choice of interest which will helps in development of academic and social sector pertaining to Genetics and Plant Breeding.	**30**	**0**	**2**	**32**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO 1	Students will design professional orientation on the topic with their choice of interest which will helps in development of academic and social sector pertaining to Genetics and Plant Breeding.	**-**	**-**	**100**	**100**

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Master Seminar** will be 100 marks.

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. PPT Presentation
2. Group Discussion
3. Demonstration
4. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
5. Brainstorming
6. Smart board

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Research publications			
2	Science direct			
3	Research gate			
4	Pubmade			
5	Academia			
6	Multi authored books			
7	Book chapters			
8	As per directions of course instructor.			

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Abhishek Singh, HOD, Dept. of Horticulture, Faculty of Agriculture Science and Technology AKS University.
4. Dr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of G&PB, Faculty of Agriculture Science and Technology AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 591
Course Title: - Master Seminar

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	Student will identify the current scenario, crop diversity, climatic requirement and breeding techniques of different vegetable and flower crops.	Student will expertise in latest vegetable production technologies, vegetable breeding techniques and post-harvest management of vegetables	The student will have expertise in nursery-raising techniques and protected cultivation of vegetables and flower crops.	The student will have expertise in different climatic conditions required for common vegetable as well as under utilized vegetable cultivation.	Student will plan about the big scale commercial project and also manage the research trails under vegetable and flower crops	Student will apply various statistical methods to analyze their master research work	Student will understand about library technique, technical writing skill, IPR, laboratory technique and research ethics in manuscript writing	Student will identify different cool season, warm season and underutilized vegetable crops	Student will practice different breeding techniques used in vegetable and flower production	Student will recognize different underutilized vegetable and spice crops	Student will apply different vegetable processing and post-harvest-handling methods for vegetables and flowers	Student will understand role of microclimate in vegetable and flower crop production under different protected structures	After gaining experience, they will get the positions of specialists for handling plantation, nurseries and other protected cultivati	Student will recognize different flower, ornamental crops and their nursery management	Student will practice turfgrass, indoor plant and interios capingmanagement	Student will apply various information services, technical writings and communication skills in their academics	Student will apply basic concepts in laboratory techniques during their research work	Student will apply basic statistical tools during their research work

													on projects					
VSC 591.1 Students will design professional orientation on the topic with their choice of interest which will helps in development of academic and social sector pertaining to vegetable science.	3	3	2	3	3	1	1	3	3	3	3	3	2	1	1	1	1	1

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Master Seminar

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	**GPB 591**.CO 1: Students will design professional orientation on the topic with their choice of interest which will helps in development of academic and social sector pertaining to vegetable science.	**SO1.1** **SO1.2** **SO1.3**	1.1 Selection of topic and collection of presentation materials by using the ICT tools related to the vegetable science on selected topic. 1.2 Presentation of acquired material in PPT form.	**Unit-1.0**	As mentioned in page number ……

Semester- III

Course Code: GPB 599

Course Title: Master's Research (Research/Thesis)

Pre- requisite: Conduct research to resolving the problem of farmers and society by applying advanced technology adopted in field of Genetics and Plant Breeding.

Rationale: The basic purpose of master's research is to understand the application of research methodology tools to do research on particular topic related to vegetable science and follow technical writing skill to design the synopsis, thesis, research paper, abstract, articles, etc as per results obtained during research studies.

Course Outcomes:

GPB 599.1. Prepare various research activities related to Genetics and Plant Breeding field and compose manuscript i.e., synopsis related to particular topic.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study HoursCI+LI+SW+SL	
	GPB 599	Master Research	0	30	0	0	30	(0+15) = 15

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies), **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C:** Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA + ESA)
			Class/Home Assignment 5 number3 marks each (CA)	Class Test 2(2 best out of 3)10 marks each (CT)	Seminar one	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+ SA+ CAT+AT)		
	GPB 599	Master Research	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB 599.1. Prepare various research activities related to Genetics and Plant Breeding field and compose manuscript i.e., synopsis related to particular topic.

Approximate Hours

Item	Approximate Hours
CI	**0**
LI	**30**
SW	**0**
SL	**30**
Total	**60**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1. Plan the proposal of research related to the topic taken with the help of guide **SO2.** Design the layout according to topic **SO3.** Describe the terminology related to the topic **SO4.** Plan the methodology to conduct the research on the topic **SO5.** Select the data to be taken during research	**1.** Submission of research proposal consisting concern programme **2**. Explain definition of the problems reference to topic **3**. Explanation of results **4**. Arrange the references of past work of 10 years **5**. Collection of data by focusing their objectives and observations to be taken mentioned in their synopsis		**1.** Finding of reviews related with the topic of research. **2.** Preparation of manuscripts related to concerned topic.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
GPB 599.1. Prepare various research activities related to Genetics and Plant Breeding field and compose manuscript i.e., synopsis related to particular topic.		**30**	**30**	**60**
Total		**30**	**30**	**60**

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

7. Improved Lecture
8. Group Discussion
9. Demonstration
10. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Research publications			
2	Science direct			
3	Research gate			
4	Pubmade			
5	Academia			
6	Multi authored books			
7	Book chapters			

Curriculum Development Team:

a. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
b. Dr. Neeraj Verma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
c. Dr. Abhishek Singh, HOD, Dept. of Horticulture, Faculty of Agriculture Science and Technology AKS University.
d. Dr. Doomar Singh, HoD, Plant Pathology
e. Dr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of G&PB, Faculty of Agriculture Science and Technology AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 599
Course Title: - Master's Research (Research/Thesis)

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	Student will identify the current scenario, crop diversity, climatic requirement and breeding techniques of different vegetable and flower crops.	Student will expertise in latest vegetable production technologies, vegetable breeding techniques and post-harvest management of vegetables	The student will have expertise in nursery-raising techniques and protected cultivation of vegetables and flower crops.	The student will have expertise in different climatic conditions required for common vegetable as well as underutilized vegetable cultivation.	Student will plan about the big scale commercial project and also manage the research trails under vegetable and flower crops	Student will apply various statistical methods to analyze their master research work	Student will understand about library techniques, technical writing skill, IPR, laboratory techniques and research ethics in manuscript writ	Student will identify different cool season, warm season and underutilized vegetable crops	Student will practice different breeding techniques used in vegetable and flower production	Student will recognize different underutilized vegetable and spice crops	Student will apply different vegetable processing and post-harvest-handling methods for vegetables and flowers	Student will understand role of microclimate in vegetable and flower crop production under different protected structures	After gaining experience, they will get the positions of specialists for handling plantation, nurseries and other protect	Student will recognize different flower, ornamental crops and their nursery management	Student will practice turfgrass, indoor plant and interios capingmanagement	Student will apply various information services, technical writings and communication skills in their academics	Student will apply basic concepts in laboratory techniques during their research work	Student will apply basic statistical tools during their research work

							ing						ed cul tiv ati on pro ject s					
GPB 599 .1.Prepa re various researc h activitie s related to concern field and compos e manusc ript i.e., synopsi s related to particul ar topic.	2	2	2	3	2	3	2	3	2	2	1	2	2	1	1	2	2	3
GPB 599 . Propose researc h method ology tools for conduct	2	2	2	1	3	3	2	1	3	3	2	2	2	1	1	1	2	3

ing research on selected topic of vegetable science field of horticulture and prepare Final manuscript i.e., Thesis																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Master's Research (Research/Thesis)

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	GPB 599 .1. Prepare various research activities related to concern field and compose manuscript i.e., synopsis related to particular topic.	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**	**1.1**Submission of research proposal consisting concern programme **1.2** Explain definition of the problems reference to topic **1.3** Explanation of results **1.4** Arrange the references of past work of 10 years **1.5** Collection of data by focusing their objectives and observations to be taken mentioned in their synopsis		As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	GPB 599 .2. Propose research methodology tools for conducting research on selected topic of vegetable science field of horticulture and prepare Final manuscript i.e., Thesis	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**	**1.1** Perform research work as per their topic by using various tools and production technology methods in particular season of crop. **1.2** Collection of data **1.3** Analysis and interpretation of data **1.4** Submission of final thesis based on the research topic		As mentioned in page number ……

Semester III

Course Code: - PGS 505

Course Title: - Agricultural Research, Research Ethics and Rural Development Programmes

Pre requisite: -Student should have basic knowledge of agricultural research, research ethics, and agricultural history along with fellowship program, rural development programme.

Rationale: - The students studying agricultural research and research ethics should possess understanding about method of research application, research ethics and fellowship for research and other scholars in construction agricultural development. This encompasses familiarity with the invention and evolution of agricultural research and development of agricultural programme, students ought to acquire fundamental insights into various agricultural technologies, their applications, as well as the Indian needs in agricultural developments.

Course Outcomes:

PGS 505.1: Identify the history, levels of research, economic and social welfare through research programme.

PGS 505.2: Apply the functioning, role and significant of regional, national and international research.

PGS 505.3: Asses the agricultural research, research ethics with operating and safety of laboratory.

PGS 505.4: Analyze the various development programmes and their functioning with its impact on agricultural development

PGS 505.5: Evaluate the role and functioning of panchayati raj, NGO and evaluation of different rural development program.

Scheme of studies

Categories of course	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			C l	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Non credit course (NCC)	**PGS 505**	Agricultural Research, Research Ethics and Rural Development Programmes	01	00	02	01	04	01

Legend: CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others), **LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies), **SW:** Sessional Work (includes assignment, seminar, mini project etc.), **SL:** Self Learning, **C: Credits.**

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Categories of course	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks (PRA+ ESA
			Class/ Home Assignment 5 numbe	Class Test 2 (2 best out of 3) 10 marks	Seminar one (SA)	Class Activity any one (CA	Class Attendance (AT)	Total Marks (CA+CT+SA+ CAT+A		

			r 3 marks each (CA)	**each (CT)**		**T)**		**T)**		**)**
(NCC)	PGS 505	Agricultural Research, Research Ethics and Rural Development Programmes	15	30	00	00	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PGS 505 CO-1 Identify the history, levels of research, economic and social welfare through research programme

Approximate Hours

Item	AppX Hrs
C l	3
LI	0
SW	2
SL	1
Total	06

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO1.1- Introduce about the history of agriculture in brief **SO1.2** - Brief the basic concept global agricultural research system. **SO1.3 - Discuss** about the need, scope, opportunities; Role in promoting food security of global agricultural research system. **SO1.4-** Describes the reducing poverty and protecting the environment through global agricultural research system **SO1.5** Asses the functions and use of national Agricultural Research Systems (NARS) and		**Unit-I** **History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions;** **1.1-** History of agriculture in brief **1.2-**Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment **1.3-** National Agricultural Research	**1.1-** Prepare the assignment on Global agricultural research system

Regional Agricultural Research Institutions.		Systems (NARS) and Regional Agricultural Research Institutions	

SW-1 Suggested Sessional Work (SW):

a. Assignments: Prepare the assignment on Global agricultural research system

b. Mini Project: -

c. Other Activities (Specify):

PGS 505 CO 2: Apply the functioning, role and significant of regional, national and international research.

Approximate Hours

Item	AppX Hrs
C l	3
LI	0
SW	1
SL	2
Total	06

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO2.1 introduce to the Consultative Group on International Agricultural Research (CGIAR) **SO2.2** learned about the International Agricultural Research Centers (IARC), **SO2.3** Briefing the partnership with NARS, role as a partner in the global agricultural research system **SO2.4** Briefing the strengthening capacities at national levels; International fellowships for scientific mobility **SO2.5** Discuss to the strengthening capacities at regional levels; International fellowships for scientific mobility.		**Unit-II Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility** **2.1** Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centers (IARC) **2.2** Partnership with NARS, role as a partner in the global agricultural research system. **2.3** Strengthening capacities at national and regional levels; International fellowships for scientific mobility.	**2.1 –** Prepare the assignment on partnership with NARS, role as a partner in the global agricultural research system

SW-1 Suggested Sessional Work (SW):

a. Assignments: Prepare the assignment on partnership with NARS, role as a partner in the global agricultural research system.

b. Mini Project: , **c. Other Activities (Specify):**

PGS 505 CO 3: Asses the agricultural research, research ethics with operating and safety of laboratory.

Approximate Hours

Item	AppX Hrs
C l	3
LI	0
SW	2
SL	1
Total	06

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO3.1 Identify to the Research ethics **SO3.2** Discuss to the research integrity, research safety in laboratories **SO3.3** Apply the welfare of animals used in research **SO3.4** Discuss to computer ethics and standards **SO3.5** Describe the problems in research ethics		**Unit-3** **Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics** **3.1-**Research ethic and research integrity **3.2-** Research safety in laboratories, welfare of animals used in research. **3.3-** Computer ethics, standards and problems in research ethics.	**3.1** Prepare the assignment on Research ethic and research integrity.

SW-1 Suggested Sessional Work (SW):

a. Assignments: Prepare the assignment on Research ethic and research integrity

b. Mini Project:

PGS 505 CO 4: Analyze the various development programmes and their functioning with its impact on agricultural development

Approximate Hours

Item	App X Hrs
Cl	3
LI	0
SW	2
SL	1
Total	06

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1.1 Identify the Concept and connotations of rural development. **SO1.2** Apply the rural development policies and strategies **SO1.3** Asses the Rural development programmes:		**Unit-4.0 - I Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP)**	**1.1-** Prepare the assignment on Community Development Programme.

Community Development Programme, Intensive Agricultural District Programme. **SO1.4** Describes the Special group – Area Specific Programme. **SO1.5** Brief the Integrated Rural Development Programme (IRDP)		**4.1** Concept and connotations of rural development, rural development policies and strategies **4.2** Rural development programmes: Community Development Programme, Intensive Agricultural District Programme **4.3** Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP)	

SW-1 Suggested Sessional Work (SW):

a. Assignments: Prepare the assignment on Community Development Programme

b. Mini Project: Prepare a project report of leadership styles and influence process; leadership theories, leadership styles and effective leader

c. Other Activities (Specify):

PGS 505 CO 5: Evaluate the role and functioning of panchayati raj, NGO and evaluation of different rural development program.

Approximate Hours

Item	AppX Hrs
Cl	06
LI	00
SW	02
SL	02
Total	10

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Class room Instruction (CI)**	**Self-Learning (SL)**
SO1.1 Indentify Panchayati Raj Institutions and Co-operatives. **SO1.2** Identify the Voluntary Agencies **SO1.3-** Identify the Non-Governmental Organisations **SO1.4** Discuss the , Critical evaluation of rural development policies **SO1.5** Briefs the programmes. Constraints in implementation of rural policies and programmes		**Unit-5.0 Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.** **5.1** Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations **5.2** Critical evaluation of rural development policies and programmes **5.3** Constraints in implementation of rural policies and programmes	**1.1 -** Prepare the assignment on Panchayati Raj Institutions,

SW-1 Suggested Sessional Work (SW):

a. Assignments: Prepare the assignment on Panchayati Raj Institutions,

b. Mini Project:

c. Other Activities (Specify):

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (C l)	Laboratory Lecture (L I)	Sessional Work (SW)	Self Learning (S l)	Total hour (C l + LI+ SW +S l)
PGS505.1 Identify the history, levels of research, economic and social welfare through research programme	3	0	2	1	06
PGS505.2: Apply the functioning, role and significant of regional, national and international research.	3	0	2	1	06
PGS505.3: Asses the agricultural research, research ethics with operating and safety of laboratory.	3	0	2	1	06
PGS505.4: Analyze the various development programmes and their functioning with its impact on agricultural development	3	0	2	1	06
PGS505.5: Evaluate the role and functioning of panchayati raj, NGO and evaluation of different rural development program.	3	0	2	1	06

Suggested Specification Table (For ESA)

CO	Unit title	Marks Distribution			Total Marks
		R	U	A	
CO-1	Identify the history, levels of research, economic and social welfare through research programme.	02	03	00	05
CO-2	Apply the functioning, role and significant of regional, national and international research.	02	05	03	10
CO-3	Asses the agricultural research, research ethics with operating and safety of laboratory.	00	08	07	15
CO-4	Analyze the various development programmes and their functioning with its impact on agricultural development.	02	05	08	15
CO-5	Evaluate the role and functioning of panchayati raj, NGO and evaluation of different rural development program	00	03	02	05
		6	24	20	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Introduction to Portland cement will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

17. Improved Lecture
18. Tutorial

19. Group Discussion
20. Visit to Industry
21. Demonstration
22. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Face book, Twitter, Whatsapp, Mobile, Online sources)
23. Brainstorming

Suggested Learning Resources:

S. No.	Title	Author	Publisher	Edition & Year
01	Indian Agriculture - Four Decades of Development	Bhalla GS & Singh G.	Sage Publ	2001
02	Manual on International Research and Research Ethics	Punia MS	CCS, Haryana Agricultural University, Hisar.	
03	Rural Development Strategies and Role of Institutions Issues, Innovations and Initiatives.	Rao BSV.	Mittal Publ	2007
	Rural Development - Principles, Policies and Management	Singh K.	Sage Publ	1998.

Curriculum Development Team:

1. Professor B.B. Beohar, Director Planning, & Director Extension, A.K.S. University
2. Dr. V.K. Vishwakarma , Head Department of Agricultural Economics, FAST
3. Dr. Ashutosh Kumar Singh, Associate professor Department of Agricultural Economics, FAST
4. Dr. Yogesh Tiwari , Assistant Professor Department of Agricultural Economics, FAST
5. Mr. Ayodhya Prasad Pandey, Assistant Professor, Dept. of Genetics and Plant Breeding, Faculty of Agriculture Science and Technology AKS University.

Cos, POs and PSOs Mapping
Course Code: PGS 505
Course Title: - Agricultural Research, Research Ethics and Rural Development Programmes

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	Student will identify the current scenario, crop diversity, climatic requirement and breeding techniques of different vegetable and flower crops.	Student will expertise in latest vegetable production technologies, vegetable breeding techniques and post-harvest management of vegetables	The student will have expertise in nursery-raising techniques and protected cultivation of vegetables and flower crops.	The student will have expertise in different climatic conditions required for common vegetable as well as underutilized vegetable cultivation.	Student will plan about the big scale commercial project and also manage the research trails under vegetable and flower crops	Student will apply various statistical methods to analyze their master research work	Student will understand about library technique, technical writing skill, IPR, laboratory techniques and research ethics in man	Student will identify different cool season, warm season and underutilized vegetable crops	Student will practice different breeding techniques used in vegetable and flower production	Student will recognize different underutilized vegetable and spice crops	Student will apply different vegetable processing and post-harvest-handling methods for vegetables and flowers	Student will understand role of microclimate in vegetable and flower crop production under different protected structur	After gaining experience, they will get the positions of specialists for handling plantation, nurseries and oth	Student will recognize different flower, ornamental crops and their nursery management	Student will practice turfgrass, indoor plant and interios capingmanagement	Student will apply various information services, technical writings and communication skills in their academic	Student will apply basic concepts in laboratory techniques during their research work	Student will apply basic statistical tools during their research work

							uscript writing					es	er protected cultivation projects			s		
PGS 505 CO-1 Identify the history, levels of research, economic and social welfare through research programme	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2	1	2
PGS 505 CO 2: Apply the	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2	1	2

functioning, role and significant of regional, national and international research.																		
PGS 505 CO 3: Asses the agricultural research, research ethics with operating and safety of laboratory.	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2	1	2

PGS 505 CO 4: Analyze the various development programmes and their functioning with its impact on agricultural development	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2	1	2
PGS 505 CO 5: Evaluate the role and functioning of panc	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2	1	2

hayati raj, NGO and evaluation of different rural development program.																		

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map: Agricultural Research, Research Ethics and Rural Development Programmes

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	PGS 505 CO-1 Identify the history, levels of research, economic and social welfare through research programme	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**		**Unit-1.0** History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions 1.1, 1.2, 1.3.	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	PGS 505 CO 2: Apply the functioning, role and significant of regional, national and international research.	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**		**Unit-2.0 –** Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility 2.1, 2.2, 2.3.	As mentioned in page number ……
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	PGS 505 CO 3: Asses the agricultural research, research ethics with operating and safety of laboratory.	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**		**Unit-3.0** Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics	As mentioned in page number ……

				3.1, 3.2, 3.3.	
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	PGS 505 CO 4: Analyze the various development programmes and their functioning with its impact on agricultural development	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**		**Unit-4.0** Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) 4.1, 4.2, 4.3.	As mentioned in page number …
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	PGS 505 CO 5: Evaluate the role and functioning of panchayati raj, NGO and evaluation of different rural development program.	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**		**Unit-5.0** Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes 5.1, 5.2, 5.3.	As mentioned in page number …

Semester- IV

Course Code: GPB 599

Course Title: Research/Thesis

Pre- requisite: Conduct research to resolving the problem of farmers and society by applying advanced technology adopted in field of Genetics and Plant Breeding.

Rationale: The basic purpose of master's research is to understand the application of research methodology tools to do research on particular topic related to Genetics and Plant Breeding and follow technical writing skill to design the synopsis, thesis, research paper, abstract, articles, etc as per results obtained during research studies.

Course Outcomes:

GPB 599 Propose research methodology tools for conducting research on selected topic of Genetics and Plant Breeding field and prepare Final manuscript i.e. Thesis

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Study HoursCI+LI+SW+SL	
	GPB 599	Master Research	0	30	0	0	30	(0+15) = 15

Legend:

CI: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),**LI:** Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)**SW:** Sessional Work (includes assignment, seminar, mini project etc.),**SL:** Self Learning,**C:**Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment (ESA)	Total Marks(PRA + ESA)
			Class/Home Assignment 5 number3 markseach(CA)	ClassTest 2(2 bestout of3)10 marks each(CT)	Seminarone	Class Activityanyone(CAT)	Class Attendance(AT)	Total Marks(CA+CT+SA+CAT+AT)		
	GPB 599	Master Research	0	0	0	0	0	0	100	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

GPB 599 Propose research methodology tools for conducting research on selected topic of Genetics and Plant Breeding field and prepare Final manuscript i.e. Thesis.

Approximate Hours

Item	Approximate Hours
CI	**0**
LI	**30**
SW	**0**
SL	**30**
Total	**60**

Session Outcomes (SOs)	Laboratory Instruction (LI)	Class room Instruction (CI)	Self-Learning (SL)
SO1. Choose the topic and objectives for the research. **SO2.** Select the suitable data during the research. **SO3.** Assemble the data taken during the research for interpretation. **SO4.** Arrange the whole work with the interpretate data. **SO5.** Formulate the hypothesis according the final composition.	**1** Perform research work as per their topic by using various tools and production technology methods in particular season of crop. **2**. Collection of data **3**. Analysis and interpretation of data **4**. Submission of final thesis based on the research topic		**1.** Finding of reviews related with the topic of research. **2.** Preparation of manuscripts related to concerned topic.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Instruction (LI)	Self-Learning (Sl)	Total hour (Cl+SW+Sl)
GPB 599 Propose research methodology tools for conducting research on selected topic of Genetics and Plant Breeding field and prepare Final manuscript i.e. Thesis		**30**	**30**	**60**
Total		**60**	**60**	**60**

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

6. Improved Lecture
7. Group Discussion
8. Demonstration
9. Brainstorming

Suggested Learning Resources:

(a) Books:

S. No.	Title	Author	Publisher	Edition & Year
1	Research publications			
2	Science direct			
3	Research gate			
4	Pubmade			
5	Academia			
6	Multi authored books			
7	Book chapters			

Curriculum Development Team:

1. Dr. S.S. Tomar, DEAN, Faculty of Agriculture Science and Technology, AKS University.
2. Dr. NeerajVerma, PG Coordinator, Faculty of Agriculture Science and Technology, AKS University.
3. Dr. Abhishek Singh, HOD, Dept. of Horticulture, Faculty of Agriculture Science and Technology AKS University.
4. Dr. Doomar Singh, HoD, Plant Pathology
5. Mr. Ayodhya Prasad Pandey Assistant Professor, Dept. of G&PB, Faculty of Agriculture Science and Technology AKS University.

Cos, POs and PSOs Mapping
Course Code: GPB 599
Course Title: - Research/Thesis

Course Outcomes	PO 1	PO 2	PO-3	PO-4	PO-5	PO-6	PO 7	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11
	Student will identify the current scenario, crop diversity, climatic requirement and breeding techniques of different vegetable and flower crops.	Student will expertise in latest vegetable production technologies, vegetable breeding techniques and post-harvest management of vegetables	The student will have expertise in nursery-raising techniques and protected cultivation of vegetables and flower crops.	The student will have expertise in different climatic conditions required for common vegetable as well as under utilized vegetable cultivation.	Student will plan about the big scale commercial project and also manage the research trails under vegetable and flower crops	Student will apply various statistical methods to analyze their master research work	Student will understand about library techniques, technical writing skill, IPR, laboratory techniques and research ethics in manuscript	Student will identify different cool season, warm season and underutilized vegetable crops	Student will practice different breeding techniques used in vegetable and flower production	Student will recognize different underutilized vegetable and spice crops	Student will apply different vegetable processing and post-harvest-handling methods for vegetables and flowers	Student will understand role of microclimate in vegetable and flower crop production under different protected structures	After gaining experience, they will get the positions of specialists for handling plantation, nurseries and other pro	Student will recognize different flower, ornamental crops and their nursery management	Student will practice turfgrass, indoor plant and interios capingmanagement	Student will apply various information services, technical writings and communication skills in their academics	Student will apply basic concepts in laboratory techniques during their research work	Student will apply basic statistical tools during their research work

							writing						tected cultivation projects					
GPB-599.1.Prepare various research activities related to concern field and compose manuscript i.e., synopsis related to particular topic.	2	2	2	3	2	3	2	3	2	2	1	2	2	1	1	2	2	3
GPB-599.2. Propose research methodology tools for conducting	2	2	2	1	3	3	2	1	3	3	2	2	2	1	1	1	2	3

research on selected topic of vegetable science field of horticulture and prepare Final manuscript i.e., Thesis																		

Legend: 1- Low,2 – Medium, 3- High

Course Curriculum Map: Master Seminar

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	GPB-599.1. Prepare various research activities related to concern field and compose manuscript i.e., synopsis related to particular topic.	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**	**1.1**Submission of research proposal consisting concern programme **1.2** Explain definition of the problems reference to topic **1.3** Explanation of results **1.4** Arrange the references of past work of 10 years **1.5** Collection of data by focusing their objectives and observations to be taken mentioned in their synopsis		As mentioned in page number …
PO 1,2,3,4,5,6,7 PSO 1,2, 3, 4, 5, 6, 7, 8, 9, 10, 11	GPB-599.2. Propose research methodology tools for conducting research on selected topic of vegetable science field of horticulture and prepare Final manuscript i.e., Thesis	**SO1.1** **SO1.2** **SO1.3** **SO1.4** **SO1.5**	**1.1** Perform research work as per their topic by using various tools and production technology methods in particular season of crop. **1.2** Collection of data **1.3** Analysis and interpretation of data **1.4** Submission of final thesis based on the research topic		As mentioned in page number ……