University of Agricultural Sciences, Bengaluru

COURSE CURRICULUM

(As per fifth Deans' Committee's recommendations)

Effective from the Academic Year 2016-17

B. Tech. (Biotechnology)

College of Agriculture

Hassan-573 225

2018

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PREAMBLE

B.Sc. (Agri Biotechnology) undergraduate (UG) programme at College of Agriculture, Hassan, University of Agricultural Sciences (UAS), Bengaluru started in the academic year 2007-08. After five years, course curriculum was revised and implemented from the academic year 2012-13. Though many Agricultural Universities offered Biotechnology UG degree programme, it was not brought under ICAR Deans' committee. The ICAR constituted an expert committee including members from UAS, Bengaluru to revise the curriculum which is applicable to all the Agricultural Universities of the country. Two workshops were conducted to finalize the course titles and course content for UG Biotechnology degree Programme. Finalized syllabus was included under ICAR Deans' committee. This curriculum was recommended to all the Agricultural Universities offering UG Biotechnology programme with an option to include subjects of local needs to a maximum extent of 20 per cent.

Course curriculum recommended by fifth Deans' committee was examined both at College level and at University level. After several rounds of deliberations course curriculum was presented before the Board of Studies (UG) held on 17 August 2016 for approval. After incorporating all the suggestions given by Board of Studies (UG) committee, curriculum was presented before the 182nd Academic council held on 20, August 2016. As per recommendations of fifth Deans' committee degree nomenclature has been changed from B.Sc. (Agri. Biotechnology) to B. Tech. (Biotechnology). New curriculum as per fifth Deans' committee's recommendation was approved for B. Tech. (Biotechnology) degree programme with effective from the academic year 2016-17.

New curriculum comprises a total of 183 credit hours by enhancing from existing 164 credit hours. The curriculum includes Basic Sciences and humanities courses (20 credits), Agriculture and allied courses (45 credits), Biotechnology core courses (76 credits) and Student READY Programme (40 credits). This curriculum with enhanced biotechnology content (63%) is a very comprehensive and up to date. Further, emphasis is also given to skill development.

University of Agricultural Sciences, Bengaluru constituted a new Board of Studies (UG) on 21 December 2016 for each of the degree programmes offered. Board of Studies (UG), faculty of Agri. Biotechnology, in its first meeting held on 13 January 2017 approved to create four new sections within the Department of Agriculture Biotechnology for smooth conduct of UG degree programme. Sections created are Plant Biotechnology (PBT), Microbial and Environmental Biotechnology (MEB), Biochemistry (BCM) and Bioinformatics (BIT). All biotechnology core courses are distributed into to these four sections. All courses are given alpha numeric code. First three letters of the code indicates the department offering the course. First digit indicates year in which course is offered (1 to 4), second digit indicates semester in which it is offered (1 or 2) and last digit indicates number of courses offered in that semester from a particular department/section. Course curriculum of B. Tech. (Biotechnology) as per the fifth Deans' committee's recommendation was notified vide No.R/PS/AC-182/Addl.Agenda It.1/2016-17 dated 11 January 2017. Course curriculum with revised course numbers was notified vide No.R/SA/AC-183-P(B)Tt.14 BT-4/2017-18 dated 6 July 2017. The detailed course curriculum is prepared and presented for the benefit of students and academicians.

University of Agricultural Sciences, Bengaluru

College of Agriculture, Hassan

CONTENT

ABBREVIATIONS

AEC	Agricultural Economics
AEG	Agricultural Engineering
AET	Agricultural Entomology
AEX	Agricultural Extension
AGR	Agronomy
AMB	Agricultural Microbiology
ASC	Animal Science
AST	Agricultural Statistics
BCM	Biochemistry
BIO	Biology
BIT	Bioinformatics
BWEP	Biotechnology Work Experience Programme
CPH	Crop Physiology
CSC	Computer Science
ENG	English
EDT	Educational Tour
FES	Forestry and Environmental Science
FSN	Food Science and Nutrition
GPB	Genetics and Plant Breeding
HRT	Horticulture
KAN	Kannada
MAT	Mathematics
MEB	Microbial Environmental Biotechnology
NSS	National Service Scheme
PAT	Plant Pathology
PBT	Plant Biotechnology
PED	Physical Education
PHY	Physics
RAWE	Rural Agricultural Work Experience
READY	Rural and Entrepreneurship Awareness Development Yojana
SAC	Soil Science and Agricultural Chemistry
SER	Sericulture
SST	Seed Science and Technology

ABSTRACT OF COURSES

B. Tech. (Biotechnology)

Particulars		Courses	
		No. of courses	Credit Hrs
I	Basic Sciences and Humanities	11	10+10=20
II	Agriculture and Allied Subjects	19	27+18=45
III	Biotechnology Core Subjects		
	i. Plant Biotechnology	18	31+13=44
	ii. Microbial & Environmental Biotechnology	5	8+3=11
	iii. Biochemistry	4	6+4=10
	iv. Bioinformatics	4	8+3=11
IV	Student READY Programme (0+40)		
	i. In house skill Development Modules	1	0+20=20
	ii. RAWE for Biotech students	1	0+1=1
	iii. Problem Identification, Project Formulation and Presentation	1	0+3=3
	iv. Entrepreneurial Development In-house/ Outside Institution	1	0+16=16
V	Remedial courses	1	1+1/2+0=2
	Total	**66**	**91+92=183**

LIST OF COURSES

I BASIC SCIENCES AND HUMANITIES

*Non-gradial courses

NSS to be spread over in first four semesters;

PED to be spread over in first two semesters

II AGRICULTURAL AND ALLIED SCIENCES

III BIOTECHOLOGY CORE SUBJECTS

(i) PLANT BIOTECHNOLOGY SECTION

(ii) MICROBIAL AND ENVIRONMENTAL BIOTECHNOLOGY SECTION

(iii) BIOCHEMISTRY SECTION

(iv) BIOINFORMATICS SECTION

IV STUDENT READY PROGRAMME

V REMEDIAL COURSES

*Non-gradial courses

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SEMESTERWISE DISTRIBUTION OF COURSES

I YEAR I SEMESTER

Course No.	Course Title	Credit hrs
AEC 112	Introduction to Economics and Marketing	2+1
CSC 111	Computer Science and Agri-Informatics	1+1
ENG 111	Comprehension and Communication Skills in English	1+1
FES 112	Biodiversity and its Conservation	2+0
SAC 112	Introduction to Soil Science	1+1
BCM 111	Plant Biochemistry	1+1
MEB 111	Introductory Microbiology	1+1
PBT 111	Cell Biology	2+0
PBT 112	Introduction to Biotechnology	2+1
KAN 111/112	Kannada-I*	0+1
PED 111	Physical Education and Yoga Practices*	0+1
NSS 111	National Service Scheme*	0+1
BIO 111/ MAT 111	Introductory Biology/Elementary Mathematics#	1+12+0
	Total	**13+7=20**

I YEAR II SEMESTER

Course No.	Course Title	Credit hrs
AGR 123	Agronomy of Field Crops	1+1
ASC 121	Livestock Production and Technology	1+1
FSN 121	Food Science and Processing	1+1
MAT 123	Biomathematics	2+1
HRT 122	Fundamentals and Production Technology of Horticultural Crops	2+1
PBT 122	Molecular Biology	2+1
PBT 123	Plant Tissue Culture	2+1
PBT 124	Classical and Molecular Cytogenetics	2+1
KAN 121/122	Kannada-II*	0+1
PED	Physical Education and Yoga Practices*	0+1
NSS	National Service Scheme*	0+1
	Total	**13+8=21**

*Non-gradial courses / # Remedial Courses

NSS to be spread over in first four semesters;

PED to be spread over in first two semesters

II YEAR I SEMESTER

Course No.	Course Title	Credit hrs
AEX 211	Communication and Diffusion of Agricultural Innovations	1+1
CPH 211	Fundamentals of Crop physiology	2+1
PAT 211	Fundamentals of Plant Pathology	2+1
PHY 211	Biophysics	2+1
AET 212	Introduction to Insect Pest management	1+1
AEG 212	Protected Cultivation Structures	1+0
BCM 211	Enzymology and Enzyme Technologies	2+0
PBT 211	Fundamentals of Electronics and Instrumentation in Biotechnology	1+1
PBT 212	Introduction to Genetics	2+1
PBT 213	Recombinant DNA Technology	1+1
NSS	National Service Scheme*	0+1
	Total	**15+8=23**

II YEAR II SEMESTER

Course No.	Course Title	Credit hrs
AMB 221	Soil and Applied Microbiology	1+1
CPH 223	Physiology of Biotic and Abiotic Stresses	1+1
FES 221	Environmental Studies and Disaster Management	2+0
GPB 221	Fundamentals of Plant Breeding	2+1
SST 223	Principles of Seed Science and Technology	1+1
BIT 221	Introductory Bioinformatics	2+1
MEB 221	Food Biotechnology	1+1
PBT 221	Molecular Genetics	2+0
PBT 222	Plant Genetic Transformation	1+1
PBT 223	Molecular Marker Technology	2+0
NSS	National Service Scheme*	0+1
	Total	**15+7=22**

*Non-gradial courses

III YEAR I SEMESTER

Course No.	Course Title	Credit hrs
AST 311	Biostatistics	2+1
GPB 312	Breeding of Field Crop	2+1
BCM 311	Biochemical Techniques	1+2
BCM 312	Immunology	2+1
BIT 311	Genomics and Proteomics	2+0
MEB 311	Microbial Genetics	2+0
MEB 312	IPR, Biosafety and Bioethics	2+0
PBT 311	Epigenetics and Gene Regulation	1+1
PBT 312	Nanobiotechnology	2+0
PBT 313	Animal Biotechnology	2+1
EDT 311	Educational tour *	0+1
	Total	**18+7=25**

*Non-gradial courses

III YEAR II SEMESTER

Course No.	Course Title	Credit hrs
AEC 322	Production and Financial Management	1+1
AEX 321	Entrepreneurship Development and Business Communication	1+1
SER 321	Introduction to Sericulture	1+1
BIT 321	Computational Biology	2+1
BIT 322	Metabolomics and System Biology	2+1
MEB 321	Green Biotechnology	2+1
PBT 321	Molecular Breeding in Field Crops	2+1
PBT 322	Molecular Diagnostics	2+1
PBT 323	Sericultural Biotechnology	1+0
PBT 324	Molecular Pharming and Biopharmaceuticals	2+1
	Total	**16+9=25**

IV YEAR I SEMESTER

Course No.	Course Title	Credit hrs
BWE	Student READY – In-house Skill Development Modules	0+20
BWE 411	Student READY-Rural Agricultural Work Experience for biotech students	0+1
	Total	**0+21=21**

IV YEAR II SEMESTER

Course No.	Course Title	Credit hrs
BWE 421	Student READY – Problem Identification Project Formulation, and its Presentation	0+3
BWE 422	Student READY - Entrepreneurial Development in Biotechnology (On-campus/Off Campus)	0+16
	Total	**0+19=19**

SEMESTER-WISE DISTRIBUTION OF CREDIT HOURS

YEAR	Semester	Credit hours
I	I	13+7=20
I	II	13+8=21
II	I	15+8=23
II	II	15+7=22
III	I	18+7=25
III	II	16+9=25
IV	I	0+21=21
IV	II	0+19=19
Gradial courses		90+86=176
Non-gradial courses		5
Remedial courses		2
Total		**183**

I Basic Sciences and Humanities

1. CSC 111 Computer Science and Agri- Informatics 1+1

Theory

UNIT I

Introduction to Computers, organization and architecture of Computers, Memory Concepts, Units of Memory, Operating System, definition and UNIX, WINDOWS.

Basic Computer networks, Internet and World Wide Web (WWW), Editing and Formatting a document, Database, concepts and types, creating database.

UNIT II

Introduction to Computer C-Programming language, concepts and standard input/output operations. Introduction to ICT and uses in agriculture. Introduction to Computer-controlled devices (automated systems) for Agri-input management, Smartphone apps in Agriculture. Introduction to Bioinformatics and Omics database NCBI, searching and accessing genome sequences and protein sequences.

UNIT III

Introduction to GIS and its applications in Agriculture. Introduction to MIS and Decision Support System and its applications in Agriculture.

Practical

Introduction of different operating systems such as DOS and WINDOWS. Creating Files & Folders. Introduction of programming languages. Use of MS-WORD and MS Power-point for creating, editing and presenting a scientific Document. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data. MS-ACCESS: Creating Database,

preparing queries and reports, demonstration of Agri-information system. Introduction to World Wide Web (WWW). Demonstration of HTML page design of e-Agriculture. Omics database of NCBI searching and accessing genome sequences and protein sequences, alignment of two genome sequences and alignment of two protein sequences.

2. ENG 111 Comprehension and Communication Skills in English 1+1

Theory

UNIT I

Reading Comprehension, Vocabulary- Antonym, Synonym, Homophones, Homonyms, often confused words. Exercises to help the students in the enrichment of vocabulary based on TOEFL and other competitive examinations.

UNIT II

Functional grammar: Articles, Prepositions, Verb, Subject verb Agreement, Transformation, Synthesis, Direct and Indirect Narration. Writing Skills: Paragraph writing, Précis writing, Report writing, Proposal writing and Letter Writing. Interview Skills. Resume/CV Preparation and Job applications. Synopsis Writing.

Practical

Listening Comprehension: Listening to short talks, lectures, speeches (scientific, commercial and general in nature). Oral Communication: Phonetics, stress and intonation, Conversation practice. Presentation skills and Public speaking. Reading skills: Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; Group discussion.

3. FES 112 Biodiversity and Its Conservation 2+0

Theory

UNIT I

Concepts of biodiversity, bioresource and wildlife management, conservation strategies: *in situ* and *ex situ* conservation; Wild life conservation projects in India; Protection of biodiversity for its suitable utilization; Threats to biodiversity; WCU Red data book; Biodiversity hotspots in India; National bureaus of genetic resources.

UNIT II

Sustainable development; Diversification of cropping system; Diversity of indigenous livestock; Vulnerability and extinction of flora and fauna; Endangered species in various ecosystems; Germplasm banks; Environmental impact assessment; Bioremediation and biosafety; Introduction to regulatory agencies and legislation.

UNIT-III

Differential equations: Solution of ordinary differential equations of first degree and first order and their application for determination of volume of blood and drug distribution; Epidemic models, Simultaneous differential equation of first order and their applications to predator models; Simultaneous Linear differential equations with constant Co-efficients and their applications to simple biological problem;

Numerical analysis: Numerical methods for solving algebraic and transcendental equations.

Practical

Tutorials on Taylor's and Maclaurin's expansions; Partial differentiation; Euler's theorem; Change of variable, total derivative, implicit function, maxima and minima, Eigen values and Eigen vectors of matrix, reduction formulae, definite integrals and their properties; Epidemic models, predator models; Determination of volume of blood

and drug distribution; Ordinary differential equation of first order, linear differential equation of higher older and their applications to biological problems, numerical methods.

4. ಕನ್ನಡ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ/ For Kannada Students

KAN 111 Kannada-I 0+1

ಅ. ಕಾವ್ಯ–ಕಥೆ: ಜನಪದ ಗೀತೆಗಳು–ಜನಪದರು; ಶರಣರ ವಚನಗಳು–ಜೇಡರದಾಸಿಮಯ್ಯ, ಬಸವಣ್ಣ, ಆಯ್ದಕ್ಕಿ ಲಕ್ಕಮ್ಮ; ಹೊಸ ಬಾಳಿನ ಗೀತೆ–ಕುವೆಂಪು; ತಿಳಿದವರೇ ಹೇಳಿ–ವೈದೇಹಿ; ಜೀತ– ಡಾ॥ ಬೆಸಗರಹಳ್ಳಿ ರಾಮಣ್ಣ; ಒಂದು ಖಾಸಗಿ ಪತ್ರ–ವಿನಯಾ ಒಕ್ಕುಂದ.

ಆ. ಕೃಷಿ ಬರಹ: ಆಧುನಿಕ ಪೂರ್ವ ಕನ್ನಡ ಕೃಷಿ ಸಾಹಿತ್ಯ ಪರಿಚಯ – ಡಾ॥ ಜಿ. ವೀರಭದ್ರಗೌಡ, ಕನ್ನಡದಲ್ಲಿ ಕೃಷಿವಿಜ್ಞಾನ ಸಾಹಿತ್ಯದ ಉಗಮ ಮತ್ತು ವಿಕಾಸ–ಡಾ॥ ಜೆ. ಬಾಲಕೃಷ್ಣ, ಎಲ್ ಫಾರ್ ಲೈನ್ ಅಲ್ಲ: ಲಕ್ಷ್ಮಣಯ್ಯ–ಡಾ॥ ಟಿ.ಎಸ್. ಚನ್ನೇಶ್, ಅಹಾರವೆಂಬ ಆಯುಧ–ನಾಗೇಶ ಹೆಗಡೆ

ಇ. ಪ್ರಾಯೋಗಿಕ: ಅನುವಾದ, ಪಾರಿಭಾಷಿಕ ಪದರಚನೆಯ ವಿಧಾನಗಳು.

5. KAN 121 Kannada-II 0+1

ಅ. ಕಾವ್ಯ–ಕಥೆ–ಜನಪದ – ಸಂಸ್ಕೃತಿ ಮತ್ತು ಕನ್ನಡ ಪ್ರಜ್ಞೆ– ಸಂಕೀರ್ಣಬೇವಿನಹಟ್ಟಿ ಕಾಳಮ್ಮನ ಸಾಲು–ಜನಪದ, ಗೋವಿನ ಹಾಡು–ಜನಪದ, ಕರ್ನಾಟಕ ಜಾನಪದ ಲೋಕದೃಷ್ಟಿ–ಪುರುಷೋತ್ತಮ ಬಿಳಿಮಲೆ, ಕೆರೆಗೆ ಹಾರ–ಜನಪದ, ನೇರೆಂಬ ಜೀವ ದ್ರವ–ಜೆ. ಬಾಲಕೃಷ್ಣ, ಸೂಫಿ ಕತೆಗಳು, ಕನ್ನಡದ ಶುದ್ಧತೆ–ಕೆ.ವಿ. ನಾರಾಯಣ, ವಚನಕಾರರು ಮತ್ತು ಭಾಷೆ, ಕದಂಬರ ಕನ್ನಡ ಲಿಪಿ–ಷ. ಶೆಟ್ಟರ್, ಅವನತಿ–ಪೂರ್ಣಚಂದ್ರ ತೇಜಸ್ವಿ, ಇಲ್ಲಿ ಯಾರೂ ಮುಖ್ಯರಲ್ಲ, ಯಾರೂ ಅಮುಖ್ಯರಲ್ಲ...–ಕೃಪಾಕರ ಸೇನಾನ, ಕೃಷಿ ಗಾದೆಗಳು–ಜನಪದ, ಕೃಷಿ ಗಾದೆಗಳ ಅವಲೋಕನ–ಜಿ. ವೀರಭದ್ರಗೌಡ.

ಈ. ಪ್ರಾಯೋಗಿಕ ಕನ್ನಡದಲ್ಲಿ ಕೃಷಿ ಸಾಹಿತ್ಯ ಪ್ರಕಾರಗಳು ಮತ್ತು ಅವುಗಳ ರಚನಾ ಸ್ವರೂಪ; ವ್ಯವಹಾರ ಕನ್ನಡ – ಪತ್ರಲೇಖ.

II. ಕನ್ನಡೇತರ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ/ For Non Kannada Speaking Students

KAN 112 (0+1) Kannada-I 0+1

Development of listening and speaking skills with Kannada structure pattern - Introducing each other - Conversation between friends - Enquiring about family - Plan to go for a movie - Routine activities of a student - In a book shop - Introducing College/University

- Conversation between a farmer and a Scientist - Data collection in a village – Conversation on going on a tour.Development of writing and reading skills with Kannada structure pattern - Kannada Script practice and reading.

KAN 122 (0+1) Kannada-II 0+1

Development of listening and speaking skills with Kannada structure pattern - Conversation between a Doctor and a Patient; About Children's Education; Halebid-Belur; Discussing about Examination and Future Plan.Development of writing and reading skills with Kannada structure pattern : Translation of simple sentences English into Kannada, Selected lesson for reading (Nada Geete, Kannada Habbagalu, Prekshaniya Sthalagalu, Kannada Kavi, Kannada Vignani).

6. MAT 123 Biomathematics non-kannadiga students 2+1

Theory

UNIT-I

Differential Calculus: Successive differentiation, Leibnitz's Theorem, Mean value Theorem, Rolle's theorem; Lagrange's Mean value Theorem theorem; Taylor's and Maclaurin's series; Partial differentiation, Euler's theorem on homogeneous function, change of variable; Jacobians, maxima and minima of two or more variables.

Matrices: Matrix, Elementary transformations, Rank of a Matrix, Eigen values and Eigen vectors of a matrix;

Integral Calculus: Reduction formulae, Double and Triple Integrals.

7. PHY 211 Biophysics 2+1

Theory

UNIT I

Quantum mechanics; Electronic structure of atoms; The wave particle duality, wave length of de-Broglie waves; Phase and group

velocity; Some basic concepts of quantum mechanics; Schrodinger's wave equations; Particle in a box; Quantum mechanical tunneling; Ist and IInd law of thermodynamics; Enthalpy; Entropy; Statistical and thermodynamic definition of entropy; Helmholtz free energy, Equilibrium thermodynamic; Near-equilibrium thermodynamic; Gibbs free energy; Chemical potential; Thermodynamic analysis of membrane transport.

UNIT II

Hydration of macromolecules; Role of friction; Diffusion; Sedimentation; The ultracentrifuge; Viscosity; Rotational diffusion; Light scattering, Small angle x-ray scattering; Ultraviolet and visible spectroscopy; Circular dichroism(CD) and optical rotatory dispersion(ORD); Fluorescence spectroscopy; Infrared spectroscopy; Raman spectroscopy; Electron spin resonance; NMR spectroscopy; Light microscopy.

UNIT III

Electron optics; Transmission electron microscope (TEM); Scanning electron microscope(SEM); Preparation of the specimen for electron microscopy; Image reconstruction; Electron diffraction; Tunnelling electron microscope; Atomic force microscope; Crystals and symmetries, crystal systems, point group and space groups; Growth of crystals of biological molecules; X-ray diffraction.

Practical

Refractive index and dispersive power of the prism using spectrometer; Calibration of prism spectrometer; Newton's rings; Polarimeter; Diffraction grating; Resolving power of telescope and grating; Ostwald viscometer; Planck's constant using photovoltaic cell; Photospectrometer; Photoelectric effect; Stefan's constant; Thermal diffusivity in metals. .

8. AST 311 Bio Statistics 2+1

Theory

UNIT I

Introduction to Statistics and its Applications in Agricultural Biotechnology, Classification & Frequency Distributions of data, Graphical Representations of Data: Histogram, Frequency Polygon, Frequency curve and Cumulative frequency curve (Ogives).

Measures of Central Tendency: Concepts & Definition, Characteristics of ideal Average, Arithmetic Mean, Median, Mode (both for Ungrouped and Grouped data), Quartiles, Deciles & Percentiles Geometric Mean and Harmonic Mean (only for Ungrouped data).

Measures of Dispersion: Concepts & Definition, Measures of Dispersion: Range, Absolute Mean Deviation from mean and median, Quartile deviation, Variance and Standard Deviation, and Coefficient of dispersion (both for Ungrouped and Grouped data). Moments, Measures of Skewness and Kurtosis (only for Ungrouped).

UNIT II

Theory of Probability: Concept & Definition, Permutation & Combinations, Addition and Multiplication theorems (without proof). Theoretical Probability distributions: Binomial, Poisson and Normal Distribution, their Properties & Applications.

Simple Correlation Analysis: Definition, Measures of Correlation: Scatter diagram, Karl Pearson product moment and Spearman's rank correlation coefficients and their properties. Simple Linear Regression Analysis: Definition, Fitting of simple linear regression, Y on X and X on Y, Properties of regression coefficient, interrelation between correlation and regression.

Introduction to Sampling Theory, Sampling versus Complete Enumeration, Methods of Sampling: Probability & Non-probability

sampling, Simple Random Sampling (with and without replacement), Sampling distribution and standard error.

UNIT III

Test of Significance: Introduction, Null & Alternative hypothesis, Types of Errors, Level of significance and degrees of freedom, Critical & Acceptance regions. Large sample tests: Z-Test for Means - One and Two sample means for known and Unknown population variance. Small sample test: Student's t-test for Means - One and Two sample means, Paired t-test and F-test for two population variances. Chi-Square test: Test for Goodness of Fit, Test for independence of attributes for *rXc* contingency table, 2x2 contingency table with Yates correction. Chi-square test for heterogeneity, detection and estimation of linkage.

Introduction to Analysis of Variance and its Assumptions, Concept of design of experiments: Basic Principle of Experimental Design: Randomization, Replication & Local control, Basic Designs: CRD, RCBD and LSD, their advantages and disadvantages. Introduction to population genetics, Hardy-Weinberg Laws, random mating populations.

Practical

Construction of Frequency Distribution tables. Graphical Representation of Data: Histogram, Frequency polygon, Frequency curve and Cumulative frequency curve (Ogives). Computation of Measures of Central Tendency: Arithmetic Mean, Median, Mode (both for Ungrouped and Grouped data) Quartiles, Deciles & Percentiles, Geometric Mean and Harmonic Mean (only for Ungrouped data). Computation of Measures of Dispersion: Range, Mean Deviation, Quartile deviation Standard Deviation, Variance and Coefficient of dispersion (both for Ungrouped and Grouped data). Computation of Moments, Measures of Skewness and Kurtosis (only for Ungrouped), Problems on permutation and combination. Computation of Simple

Probability, Addition and Multiplication rules. Computation of probabilities using Binomial, Poisson and Normal Distributions. Computation of Correlation Coefficient: Karl Pearson product moment and Spearman's rank correlation coefficients. Fitting of Simple linear Regression Equations Y on X, & X on Y. Problems on Large sample tests: Z-Test for Means - One and Two sample means for known and Unknown population variance. Small sample test: Student's t-test for Means - One and Two sample means, Paired t-test and F-test two population variances. Problems on Chi-Square test: Test for Goodness of Fit, Test for independence of attributes for *rXc* contingency table, 2x2 contingency table with Yates correction. Chi-square test for heterogeneity, detection and estimation of linkage. Problems on CRD, RCBD & LSD.

9. NSS 111 National Service Scheme 0+1

Part I

Introduction and basic components of NSS: Orientation: history, objectives, principles, symbol, badge; regular programes under NSS, organizational structure of NSS, code of conduct for NSS volunteers, points to be considered by NSS volunteers awareness about health.

NSS programmes and activities: Concept of regular activities, special camping, day camps, basis of adoption of village/slums, conducting survey, analysing guiding financial patterns of scheme, youth programme/ schemes of GOI, coordination with different agencies and maintenance of diary.

Understanding youth: Definition, profile, profile, categories, issues and challenges of youth; and opportunities for youth who is agent of the social change

Community mobilization: Mapping of community stakeholders, designing the message as per problems and their culture; identifying methods of mobilization involving youth-adult partnership

Social harmony and national integration: Indian history and culture, role of youth in nation building, conflict resolution and peace-building

Volunteerism and shramdan: Indian tradition of volunteerism, its need, importance, motivation and constraints; shramdan as part of volunteerism

Citizenship, constitution, human rights, human values and ethics: Basic features of constitution of India, fundamental rights and duties, human rights, consumer awareness and rights and rights to information, human values and ethics.

Family and society: Concept of family, community (PRIs and other community based organisations) and society

Part II

Importance and role of youth leadership: Meaning, types and traits of leadership, qualities of good leaders; importance and roles of youth leadership

Life competencies: Definition and importance of life competencies, problem-solving and decision-making, inter personal communication

Youth development programmes: Development of youth programmes and policy at the national level, state level and voluntary sector; youth-focused and youth-led organstions

Health, hygiene and sanitation: Definition needs and scope of health education; role of food, nutrition, safe drinking water, water born diseases and sanitation (Swachh Bharat Abhiyan) for health; national health programmes and reproductive health.

Youth health, lifestyle, HIV AIDS and first aid: Healthy lifestyles, HIV AIDS, drugs and substance abuse, home nursing and first aid

Youth and yoga: History, philosophy, concept, myths and misconceptions about yoga; yoga traditions and its impacts, yoga as a tool for healthy lifestyle, preventive and curative method.

Part III

Vocational skill development: To enhance the employment potential and to set up small business enterprises skills of volunteers, a list of 12 to 15 vocational skills will be drawn up based on the local conditions and opportunities. Each volunteer will have the option to select two skill-areas out of this list.

Issues related environment: Environmental conservation, enrichment and sustainability, climatic change, natural resource management (rain water harvesting, energy conservation, forestation, waste land development and soil conservations) and waste management.

Disaster management: Introduction and classification of disaster, rehabilitation and management after disaster; role of NSS volunteers in disaster management.

Entrepreneurship development: Definition, meaning and quality of entrepreneur; steps in opening of an enterprise and role of financial and support service institution.

Formulation of production oriented project: Planning, implementation, management and impact assessment of project

Documentation and data reporting: Collection and analysis of data, documentation and dissemination of project reports.

Part IV

Youth and crime: Sociological and psychological factors influencing youth crime, cyber crime, pear mentoring in preventing crime and awareness for juvenile justice.

Civil/self defence: Civil defence services, aims and objectives of civil defence; needs and training of self defence

Resource mobilization: Writing a project proposal of self fund units (SFUs) and its establishment

Additional life skills: Positive thinking, self-confidence and esteem, setting life goals and working to achieve them, management of stress including time management.

10 PED 111 Physical Education and Yoga Practices 0+1

PART I

Physical Education–Definition, Meaning, Scope and importance; Types of tournaments; Construction and laying out of the track and field. Teaching skills and rules, demonstration and practice of Football, Basketball, Kabaddi, Ball Badminton and Table Tennis. Teaching of some of the Asanas.

PART-II

Teaching skills and rules demonstration and practice of Hockey, Kho-Kho, Track events and field events. Teaching of weight training, circuit training and calisthenics. Teaching of some of the Asanas.

Note: Compulsory Uniform: Boys- White Half pants, Tee Shirts, Shoes and socks.

Girls- White Tee Shirt and Track pants.

11. EDT 311 Educational Tour 0+1

All India Educational Tour for a duration of 15 days shall be conducted.

II Agriculture and Allied Sciences

1. AEC 112 Introduction to Economics and Marketing 2+1

Theory

UNIT I

Economics – Terms and definitions; Consumption, demand, supply and price; Factors of production; Gross Domestic Product; Role of Biotechnology/ Agriculture sector in national GDP.

UNIT II

Marketing – definition; Marketing process; Need for marketing; Role of marketing; Marketing functions; Classification of markets; Marketing of various channels; Price spread; Marketing efficiency; Constraints in marketing of agricultural produce; Market intelligence.

UNIT III

Basic guidelines for preparation of project reports, SWOT analysis, Crisis Management.

Practical

Techno-economic parameters for preparation of projects; Preparation of bankable projects for various biotechnology/ agricultural products and value added products; Identification of marketing channel; Calculation of price spread; study of market structure; Visit to different markets, market institutions; Study of SWC, CWC and STC; Analysis of information of daily prices; Marketed and marketable surplus of different commodities.

2. SAC 112 Introduction to Soil Science 1+1

Theory

UNIT I

Soil as a natural body, Pedological and Edaphological concepts of soil; Soil forming rocks and minerals; Weathering processes and Factors of soil formation; Soil Profile, Components of soil; Soil

physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity; Elementary knowledge of soil taxonomy classification and soils of India.

UNIT II

Soil Chemical properties - Soil colloids –types and properties of Soil Colloids; Layer silicate clays – Classification and properties of different silicate clays, Origin of charges, Ion exchange, sources of charge, cation exchange capacity, base saturation; Soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability;

UNIT III

Soil organic matter: composition, properties and its influence on soil properties; History of soil fertility & Productivity – Definition, and Management.

Practical

Study of soil forming rocks and minerals, Study of soil profile & its Characteristics, Study of soil sampling tools, Collection of soil sample, its processing and storage. Determination of soil density, Porosity, Soil texture & Soil colour Determination of soil pH and electrical conductivity. Estimation of organic matter content of soil Determination of cation exchange capacity and Base saturation Deternination Availabe Nitrogen, Phosphorus & Potassium Field Visits to study Land forms in relation to soil development.

3. ASC 121 Livestock Production and Management 1+1

Theory

UNIT I

Livestock history in India: Vedic, medieval and modern era; Demographic distribution of livestock and role in economy; Introductory animal husbandry; Breeds of livestock; Cattle, Buffalo, Sheep, Goat and Pig; Important traits of livestock; General

management and feeding practices of animals; Handling and restraining of animals; Housing systems.; Common farm management practices including disinfection, isolation, quarantine and disposal of carcass; Common vices of animals and their prevention; Diseases and parasite control & hygiene care

UNIT II

History and economic importance of poultry; Poultry breeds; Reproductive system of male and female birds; Formation and structure of eggs; Important economic traits of poultry, Egg production, Egg weight, Egg quality; Fertility and Hatchability, Plumage characteristics and comb types.

Care and management of chicks, grower and layers/broiler; Brooding management; Hatchery practices; Poultry Diseases, control and hygiene care;

Practical

Visit to livestock farms/demonstration centres; Breeds of cattle, buffalo, sheep, goat and Pigs; Familiarization with body parts of animals; Handling and restraining of cattle, buffalo, sheep, goat and swine; Male and female reproductive system and Artificial Insemination; Feeding of livestock; Methods of identification: marking, tattooing, branding, tagging; Milking methods; Record Keeping

Visit to the Poultry farm; Poultry breeds; Body parts of chicken, duck, quail and turkey; Housing, equipment, nesting and brooding requirements; Male and female reproductive system; Methods of identification and sexing; Hatchery layout and equipment; Identification of diseases and control of parasites, Vaccination; Maintenance of farm records;

4. FSN 121 Food Science and Processing 1+1

Theory

UNIT I

Definition: Food and nutrition; Food production and consumption trends in India; Major deficiencies of calories, proteins, vitamins and micronutrients; Food groups and concept of balanced diet; RDA.

UNIT II

Causes of food spoilage; Principles of processing and preservation of food by heat, low temperature, drying and dehydration, chemicals and fermentation; Preservation through ultraviolet and ionizing radiations.

UNIT III

Post-harvest handling and technology of fruits, vegetables, cereals, oilseeds, milk, meat and poultry; Food safety, adulteration and food laws; Status of food industry in India.

Practical

Physical and chemical quality assessment of cereals, fruits, vegetables, egg, meat and poultry; Value added products from cereals, millets, fruits, vegetables, milk, egg and meat; Visit to local processing units.

5. HRT 122 Fundamentals and Production Technology of Horticultural Crops 2+1

Theory

UNIT I

Horticulture-definition and branches; Importance and scope; Classification of horticultural crops; Plant propagation - methods and propagating structures.

UNIT II

Production technology of Mango, Banana, Mandarin Grapes, Guava, Sapota, Papaya, Coffee, Tea, Coconut, Arecanut, Cashew nut, Pepper, Cardamom, Potato, Tomato, Chilli, Cabbage, Cauliflower, Carrot, Onion, Okra, French bean, Cucumber, Watermelon, Rose, Chrysanthemum and Jasmine with respect to origin, distribution, uses, area and production, soil and climatic requirements, commercial varieties/ hybrids, planting methods, nutrition, irrigation, weed management, pruning and training, inter and mixed cropping, harvesting and yield.

Practical: Orchard layout and planting systems; Pruning and training methods; Growth regulators; Irrigation and nutrient management practices; Description and identification of varieties of the above crops.

6. AGR 123 Agronomy of Field Crops 1+1

Theory

UNIT I

Classification of crops; Principles of tillage; crop rotation, cropping systems, relay cropping and mixed cropping;

UNIT II

Crop production technology for major cereal crops viz., paddy, wheat, maize, pearl millet, sorghum, Finger millet. Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, yield potential,

UNIT III

Crop production technology for major oilseed crops *viz.*, groundnut, sesame, rapeseed, mustard; Major varieties, sowing time, method of sowing, spacing, inter-culturing, fertilizer and water requirement, time of harvest, yield potential,

UNIT IV

Crop production technology for major pulse and commercial crops viz., pigeon pea, cowpea, green gram, black gram, sugarcane and cotton.

Practical

Identification of seed of different crops and their varieties; Establishments of cereals pulses oilseeds crops in crop museum, Preparation of nursery for paddy. Study of morphological characteristics of different crops. Study of different crops and their nutritional values. Use of bio fertilizer in pulses and oilseeds. Quality parameters in sugarcane and cotton; Fertilizer application methods.

7. AEX 211 Communication and Diffusion of Agricultural Innovations 1+1

Theory

UNIT I

Communication: meaning and definition; Principles and Functions of Communication. Models and barriers to communication. Agriculture journalism; diffusion and adoption of innovation: concept and meaning, process and stages of adoption. Extension teaching methods: meaning, classification, individual, group and mass contact methods, ICT Applications in TOT (New and Social Media), media mix strategies. Attributes of an effective leader; Stress and conflict management; Time management: Personal organization, prioritizing and balancing; Cosmopolitan culture; Impact of non verbal communication; Science of body language; Role of team work.

UNIT II

Diffusion and Adoption of Innovations–Meaning, Definition, Models and adoption Process, Innovation–Decision Process – Elements, Adopter categories and their characteristics, Factors influencing adoption process; Capacity building of Extension

Personnel and Farmers-Meaning, Definition, Types of training, Training of farmers, farm women and Rural youth–FTC and KVK.

Practical

Simulated exercises on communication; Identifying the Problems, Fixing the Priorities and selecting the most important problem for preparation of a project. Developing a project based on identified problem in a selected village. Organization of Group discussion and Method demonstration. Visit to KVK / FTC. Planning and Writing of scripts for Radio and Television. Audio Visual aids – Meaning, Importance and Classification. Visit to community radio and television studio for understanding the process of programme production. Planning & Preparation of visual aids - Charts, Posters, Over Head Projector (OHP) Transparencies, Power Point Slides. Planning and Preparation of Agricultural Information materials – Leaflet, Folder, Pamphlet, News Stories, Success Stories. Field diary and lab record; indexing, footnote and bibliographic procedures. Handling of Public Address Equipment (PAE) System, Still camera, Video Camera and Liquid Crystal Display (LCD) Projector. Development of schedules, Questionnaires and field visits for Data Collection.

8. CPH 211 Fundamentals of Crop Physiology 2+1

Theory

UNIT I

Introduction: Importance of physiology in agriculture. Plant-water relations: Structure, properties and functions of water; concept of diffusion, osmosis and water potential; Water balance of plants: Water in soil; Water absorption and translocation in plant; soil-plant-atmosphere continuum; Theories explaining water translocation. Transpiration: Significance of Transpiration; transpiration in relation to crop productivity, Stomatal physiology, Concept of water use efficiency. Mineral Nutrition: Importance of plant nutrients; Classification of plant nutrients; Nutrient uptake- Soil, root and

microbes interaction, Microbial association for improved uptake of nutrients; Functions of plant nutrients- Deficiency and toxicity symptoms of plant nutrients; Hydroponics, aeroponics. Mechanism of ion absorption and translocation. Membrane transporters and carriers.

UNIT II

Photosynthesis: Mechanism of carbon fixation by C_3, C_4 and CAM pathway and their significance; Plant responses to elevated CO_2, climate change; Relation of photosynthesis and crop productivity; Starch and sucrose synthesis; Translocation of assimilates; Source and sink concept; Photorespiration; Factors affecting photosynthesis and productivity; Dry matter partitioning; Harvest index of crops. Respiration: Significance; Respiratory metabolism, Alternative respiration, Factors regulating respiratory rates.

UNIT III

Plant Growth and Development: Concept of plant growth and morphogenesis; Growth and yield parameters and their measurements; Hormones and plant growth regulators in modulating crop growth;Physiological importance of Auxins, GA, Cytokinin, ABA, Ethylene, Brassinosteroids and strigolactones; biosynthesis and mode of action of plant hormones; applications of growth regulators in agriculture, horticulture and industry. Photoperiodism and vernalization: Basic concepts and their relevance in crop productivity; Phytochromes and their role. Seed dormancy and viability: Basic concepts, seed germination and seedling vigour. Stress Physiology: Plant responses to abiotic stresses; key concepts and definition; acclimation and adaptation mechanisms.

Practical: Preparation of standard solutions; Methods of measuring water status in plant tissue; Determination of soil water status; Determination of stomatal frequency and index; Measurement of stomatal conductance and transpiration; Measurement of water

use efficiency at single leaf level; Extraction, separation and quantification of photosynthetic pigments; Measurement of photosynthetic rate; Measurement of growth and yield parameters; Measurement of respiration rate; Deficiency symptoms of nutrients and their identification; growth hormone bioassay; Seed dormancy and methods to break seed dormancy; Measurement of Seed viability and seedling vigor; effect of moisture stress on seed germination and seedling vigor.

UNIT III

Seed physiology: basic definitions, germination process, dormancy, types & methods to break seed dormancy; Physiological aspects of growth and development of major crops: basic growth parameters and growth analysis, role of physiological growth parameters in crop productivity; Abiotic stress physiology: types of abiotic stress and their effect on crop growth and productivity.

Practical

Study of plant cells, structure and distribution of stomata, imbibitions, osmosis, plasmolysis, measurement of root pressure, rate of transpiration, estimation of relative water content Separation of photosynthetic pigments through Rate of transpiration, Photosynthesis, respiration, tissue test for mineral nutrients, , Measurement of photosynthetic CO_2 assimilation by Infra Red Gas Analyser (IRGA); bioassays to study the effect of plant growth regulators/hormones; growth and yield analysis.

9. PAT 211 Fundamentals of Plant Pathology 2+1

Theory

UNIT I

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Cause and classification of plant diseases. Important plant pathogenic organisms,

fungi, bacteria, fastidious vascular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic agents.

Fungi: general characters, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Binomial system of nomenclature, rules of nomenclature. Classification of fungi, keys to phylum, classes, order and families.

UNIT 2

Bacteria and mollicutes: general morphological characters. Basic methods of classification and reproduction. Keys to major plant pathogenic bacterial genera. Viruses: nature, morphology,replication and transmission and classification of plant viruses. Keys to important plant virus families / genera.

Nematodes: General morphology and reproduction, classification, keys to important plant pathogenic nematode genera, symptoms and nature of damage caused by plant nematodes.

Phanerogamic plant parasites: Common characteristic of important parasites, disease development, survival and spread.

Growth and reproduction of plant pathogens. Liberation / dispersal and survival of plant pathogens. Types of parasitism and variability in plant pathogens. Pathogenicity: phenomenon of by Fungi, Bacteria, Viruses, molicutes and neamtodes

UNIT 3

Pathogenesis**:** Penetration and colonization. Role of enzymes, toxins and growth regulators in disease development and their classification. Defence mechanism in plants: structural, biochemical (pre and post-infection) and host plant resistances. Effect of pathogens on plant physiological processes *viz*., photosynthesis, respiration, translocation and transcription.

Principles and methods of plant disease management: *Avoidance of the pathogen*: *Exclusion of inoculum: Eradication* of the pathogen*: Avoidance,* Biological methods of disease control: Breeding for disease resistance: Biotechnological approaches of diseases management.

Practical

Acquaintance with various laboratory equipment. Study of symptoms of various plant diseases caused by fungi, viruses, bacteria, nematodes and mollicutes. Field visit to get acquaint with plant disease symptom. Collection and preservation of plant disease specimens. Study of morphology of fungi, viruses, bacteria, nematodes and Phtytoplasma. Study of life cycle / disease cycle of major fungal, bacterial, viral, nematode pathogens. Macroscopic and microscopic examination of plant pathogens including staining techniques for bacteria. Preparation of culture media and sterilization. Different methods of isolation and purification of fungi, bacteria, viruses and extraction of nematodes. Study of different methods of artificial inoculation / transmission and proving Koch's postulates for different plant pathogens. Study of different methods of disease diagnosis/ detection.

10. AET 212 Introduction to Insect Pest Management 1+1

Theory

UNIT I

Insects: General (Basic) information; Insect classification based on Economic importance. Definition of pest and management. Importance of insects in agri-ecosytems; life-cycle of insects (metamorphosis); feeding habits; concepts; population, GEP, DB, EIL, ETL and pest status (types of pests) ; causes of insect-pest outbreak;

UNIT II

Basic information on principles and methods of pest management; Study of useful insects (productive insects, predators,

parasitoids, soil builders, weed killers, insect as food, medicinally important etc.,)

UNIT III

IPM concepts with bio-technology as one of the tools; bio-ecology and management of pests of a few major crops and storage pests.

Practicals

Study of general structure of insects, Study of feeding habits, study of major insect pests of cereals, study of insect pests of pulses, study of insect pests of commercial crops, study of insect pests of fruits, Plantation and vegetables, study of insect pests of stored products, study of plant protection appliances, study of useful insects (productive insects, predators, parasitoids, soil builders, weed killers, insect as food, medicinally important)

11. AEG 212 Protected Cultivation Structures 1+0

Theory: Greenhouse technology, Introduction, Types of Greenhouses; Calculation of air rate exchange in an active summer winter cooling system. Plant response to Green house environment, Planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Greenhouse equipment, materials of construction for traditional and low cost greenhouses. The study of various growing media used in raising of greenhouse crops and their preparation and pasterurization / sterilization. Design of containment facility for transgenic crops Irrigation systems used in greenhouses. Cost estimation and economic analysis. Choice of crops for cultivation under greenhouses, Problems/constraints of greenhouse cultivation and future strategies. Nutrient film technique (NFT)/ hydroponics. Visit to commercial green houses.

12. AMB 221 Soil and Applied Microbiology 1+1

Theory

UNIT I

Occurrence and distribution of microorganisms in nature. Soil as a habitat for microbes. Soil microorganisms - bacteria, fungi, algae, protozoa and viruses. Soil enzymes. Role of microorganisms in biogeochemical cycles of carbon, nitrogen, potassium, phosphorus, sulphur and secondary and tertiary nutrients. Soil biotechnology - utilization of microorganisms in improving soil productivity. Microbial interactions - neutralism, commensalism, synergism, mutualism, competition, amensalism, parasitism and predation. Plant microbe interactions and their biotechnological implications, rhizosphere microflora, symbiotic and free living nitrogen fixing microorganisms, ectomycorrhizal and endomycorrhizal associations.

UNIT II

Microbiology of hydrosphere and atmosphere. Microorganisms associated with animals and insects. Potentials and limitations of using microorganisms as agents of biological control of insect pests and diseases. Pesticide micro-flora interactions. Biodegradation, bioconversion of industrial, domestic and agricultural wastes. Industrial use of microorganisms - biochemical processes involved and biotechnological applications. Microbiology of milk and milk products. Single cell protein. Role of microorganisms in biochemical transformation of raw and processed foods. Food spoilage, food poisoning and food borne infections. Principles and methods of Food preservation.

Practical

Determination of enzyme activities in soil. Mineralization of carbon, nitrogen, phosphorus and sulphur. Plant microbe interactions: free living nitrogen fixers, legume - *Rhizobium* symbiosis, mycorrhizal symbiosis, microbial inoculants, Azolla - *Anabena* symbiosis, *Casurina* - *Frankia* symbiosis, Study of epiphytic microorganisms.

Study of beneficial microorganisms in Agriculture - Biofertilizer preparation, Compost making, Biogas production etc. Cultivation of mushrooms. Microbiological examination of water and effluents. Microorganisms in bread and wine making. Microflora associated with vertebrates and invertebrates. Microbiological examination of raw processed foods. Microbiological examination of milk and milk products.

13. FES 221 Environmental Studies and Disaster Management 2+0

Theory

UNIT I

Multidisciplinary nature of environmental studies Definition, scope and importance.

Natural Resources: Renewable and non-renewable resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, mining, and their effects on forest b) Water resources: Use and over-utilization of surface and ground water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. d) Energy resources: Growing energy needs, use of alternate energy sources. e) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

UNIT II

Ecosystems: Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.

Biodiversity at global, National and local levels, India as a mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT III

Environmental Pollution: definition, cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution. Solid Waste Management: causes, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.

UNIT IV

Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion. Wasteland reclamation. Consumerism and waste products. Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness.

Human Population and the Environment: population growth, variation among nations, population explosion, Environment and human health: Role of Information Technology in Environment and human health.

Human Population and the Environment: population growth, variation among nations, population explosion, Environment and human health: Role of Information Technology in Environment and human health.

UNIT V

Disaster Management: Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, avalanches, volcanic eruptions.

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, forest fire, road accidents, rail accidents, air accidents, sea accidents.

Disaster Management- Effect to mitigate natural disaster at national and global levels. International strategy for disaster reduction. Role of NGOs, and media. Central, state, district and local administration; Disaster response of Armed forces, Police and other organizations.

14 GPB221 Fundamentals of Plant Breeding 2+1

Theory

UNIT I

Definition, history, objectives and accomplishments of plant breeding, modes of reproduction-its relevance on genetic consequences, breeding methods and cultivar options and its of plant breeding, pollination control systems-self-incompatibility and male sterility.

UNIT II

Domestication, Acclimatization and Introduction; Centers of origin/diversity, Plant genetic resources, their conservation and utilization, genetic basis and breeding methods in self- pollinated crops - mass and pure line selection, components of genetic variation; heritability and genetic advance; hybridization techniques and handling of segregating populations; multiline concept, concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross pollinated crops, modes of selection; Population improvement methods- Ear to row method, modified Ear

to Row, recurrent selection schemes; heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties;

UNIT III

Breeding methods in asexually propagated crops, clonal selection and hybridization;; wide hybridization and pre-breeding; polyploidy in relation to plant breeding, mutation breeding-methods and uses; Breeding for important biotic and abiotic stresses; Biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding; Intellectual Property Rights, Patenting, Plant Breeders and & Farmer's Rights.

Practical: Plant Breeder's kit, Study of germplasm of various crops. Study of floral structure of self-pollinated and crospollinated crops. Emasculation and hybridization techniques in self & cross pollinated crops. Study of male sterility system. Methods of calculating mean, range, variance, standard deviation, heritability. Designs used in plant breeding experiments, analysis of Randomized Block Design, prediction of performance of double and three-way cross hybrids.

15. SST 223 Principles of Seed Science and Technology 1+1

Theory

UNIT-I

Introduction to seed science and technology, seed and its importance. Seed quality – characteristics of quality seeds, factors affecting seed quality and its maintenance. History and development of seed industry, Seed programmes, types, planning and execution.

UNIT II

Different classes of seed, generation system of seed multiplication, seed replacement and varietal replacement rates- seed multiplication ratio, seed renewal and seed plan, Agencies involved in seed production at state and national level. Seed certification – control of seed source, field inspection, field counts, field standards.

Principles of seed production- genetic, agronomic and economic principles, Maintenance of genetic purity during seed production. Deterioration of crop varieties — factors and their control, Requirements for hybrid seed production and types of hybrids. Systems and techniques of hybrid seed production, male sterility, self incompatibility, CHA and EGMS.

UNIT III

Planning for breeder, foundation, certified class and truthfully labeled seed production. Seed production- foundation and certified seed production in major cereals (Rice, Maize, Sorghum and Bajra), pulses (Red gram, Bengal gram, Soybean), oilseeds (Sunflower, Safflower and Groundnut) and vegetables (Tomato, Brinjal, Chilli), Gourds and melons. Seed crop harvesting methods and management. Seed processing—objectives and principles; Seed treatment-importance and types, equipments used for seed treatment.

Practicals

Identification of seeds of agricultural/ horticulture crops. Study of seed structure in monocot and dicot seeds in agricultural and horticulture crops Study of floral biology in self, cross and often cross pollinated crops. Identification of different varieties based on seed morphological characters in agriculture and horticulture crops. Study of seed dormancy and breaking methods in problematic crops. Isolation types, measurement and determination in self and cross pollinated crops. Carrying out field inspection and taking field counts. Study of different contaminants and practicing rouging. Practicing hybrid seed production techniques – hand emasculation and pollination in cotton, bhendi, tomato, brinjal. Carrying out detassling techniques in hybrid maize seed production. Diagnostic identification of A, B, R lines and off-types in seed production of sunflower, paddy, sorghum and bajra. Studies on planting ratio, border rows and synchronization and supplementary pollination techniques in hybrid seed production in sunflower and paddy. Determination of

physiological maturity in agri-horticultural crops. Visit to seed certification agency and grow out test farms. Visit to seed production plots (OPV and hybrids) of public and private organizations. Calculation of economics of seed production (OPV and Hybrids). Visit to seed production under protected cultivation.

16. CPH 223 Physiology of Biotic and Abiotic Stresses 1+1

Theory

UNIT I

Definition of stress, classifications, impact of stress on crops and agricultural production. General responses of plants to stresses. Acclimation and adaptations. Osmo-regulation in plants under stress. Compatible solutes-definition, characters and classification.

UNIT II

Major abiotic stresses like drought, flood, salinity, high temperature, high light etc. Stresses impact on plants (physiology and growth) and their physiological mechanisms to combat against stress. Physiological strategies adopted by plants to drought; drought escape, drought avoidance (water savers and water spenders) and tolerance mechanism. Late embryogenesis abundant (LEA) proteins and their classifications. Definition of anoxia and hypoxia. Definition of halophytes and salinity tolerance. Impact of salinity on plant physiology and growth. Salt exclusion and inclusion strategies adapted to avoid salinity stress. Definition of salinity induced response (SIR). High temperature stress in plants; definition of temperature induced response (TIR) or Induced thermo-tolerance. Heat shock proteins (HSP) definition, classification, mechanism of HSP in stress tolerance. Calcium mediated heat tolerance.

UNIT III

Major biotic stresses like insect damage, fungus, bacteria, etc Stress impact on plants (physiology and growth) and their physiological mechanisms to avoid and or control damages. Plant

strategies against the pest damage. Systematic Acquired Resistance (SAR) and Pathogen Related (PR) protein. Plant communication systems within and between the plants. Plant mechanisms to avoid and deceive the pathogen and pests attack.

Molecular physiological-biochemical mechanisms stress plant. Visit to various institutes and laboratories.

Practical

Study the effect of drought and salinity stress on germination and seedling growth in crops. Determination of tissue water status under stress and control conditions. To study the Salinity Induction response (SIR) and Temperature induced response (TIR) in crop species. Sullivans heat tolerance test. Determination of osmolyte (Proline) content in crop species under stress. To study Oxidative stress using Methyle Viologen. Impact assessment of insect damage on specific crops. Determination of biotic stress in crop species based on morphological symptoms. Analyzing the physiological response of crop species to specific pathogen or pest.

17. GPB 312 Breeding of Field Crops 2+1

Unit I

Application of genetic, cytogenetic and biotechnological techniques in breeding of: Wheat, triticale, rice, maize, bajra, Ragi sorghum, cotton, sugarcane, potato & Tobacco important pulses,: Pigeon pea, Bengal gram, Green gram, Black gram and Soybean; oilseeds, Sunflower, Ground nut, Sesamum, Mustard, and safflower and forage crops including their origin and germplasm sources.

UNIT II

Breeding for biotic and abiotic stress resistance; Ideotype concept; Problems and present status of crop improvement in India with emphasis on the work done in state National and International centres of crop improvement.

Practical

Handling of segregating generations: Pedigree method, bulk method, back cross methods; Field layout of experiments; Field trials, maintenance of records and registers; Estimation of variability parameters; Estimation of heterosis and inbreeding depression; Estimation of heritability; Estimation of combining ability effects; Prediction of hybrid performance.

Parentage of released varieties/hybrids; Study of quality characters; Sources of donors for different characters; seed sampling; seed quality; seed viability; seed vigour; seed health testing; Visit to seed production plots.

18. AEX 321 Entrepreneurship Developments and Business Communication 1+1

Theory

UNIT I

Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation, Government policy and programs and institutions for entrepreneurship development. Impact of economic reforms on Agribusiness/ Agrienterprises, Entrepreneurial Development Process;

UNIT II

Business Leadership Skills; Developing organizational skill (controlling, supervising, problem solving, monitoring & evaluation), Developing Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill. Supply chain management and Total quality management, Project Planning Formulation and report preparation. Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise.

Practical

Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement motivation, exercise in creativity,

time audit through planning, monitoring and supervision, identification and selection of business idea, preparation of business plan and proposal writing. Visit to entrepreneurship development institute and entrepreneurs.

19. SER 321 Introduction to Sericulture 1+1

Theory

UNIT I

Introduction, origin & history, statistics and distribution of sericulture, Mulberry varieties. Types of silks, Species of silkworms and their host plants. Raising of mulberry saplings, mulberry cultivation practices for irrigated and rainfed conditions, separate chawki garden. Intergrated nutrient Management. Pests and diseases of mulberry and their management. Life cycle of silkworms. Morphology and anatomy of *Bombyx mori* L.

UNIT II

Commercially exploited breeds of silkworm. Steps in silkworm egg production at grainage, egg sheets and loose egg production technology**.** Tier system of silkworm seed multiplication, seed area concept. Preservation and handling of eggs**,** egg incubation. Disinfection and hygiene in silkworm rearing**.** Silkworm rearing plan, Rearing house plan and equipments. Importance of chawki rearing, chawki rearing centres. Harvesting, transportation and preservation of leaves. Methods of silkworm rearing, shoot feeding, shelf rearing, raering operations, environmental conditions and their management. Importance of feeding, bed cleaning, spacing, care during moulting. Picking and mounting ripened silkworms. Harvesting of cocoons, grading, cocoon sorting, defective cocoons, and sale of cocoon in silk cocoon markets. Mechanization in sericulture. Pests and diseases of silkworms and their management. Post cocoon technology, Steps in reeling – storage- cocoon drying/stifling, cocoon cooking, brushing, reeling and re- reeling. Different methods of silk reeling. Raw Silk Marketing- Silk Exchange– functions, Silk trade -import-export**.**

Sericulture byproducts and their utilization for additional income. Economics of Sericulture.

Practicals

Mulberry varieties, Host plants of non-mulberry silkworms. Preparation of land, preparation of planting material and planting of mulberry, pruning, harvesting and storage of mulberry leaves. Pests and diseases of mulberry. Species of silkworms – life cycle of *Bombyx mori* L. Mulberry pests and diseases. Identification of cocoons of important breeds. External morphology of life stages – egg-larva-pupa and moth of *Bombyx mori* L. Study of silk gland and digestive system of *Bombyx mori* L. Disinfectants - rearing bed and general disinfectants**.** Grainage techniques. Study of rearing house plan and equipments for shoot feeding and shelf rearing. Methods Incubation of silkworm eggs and brushing. Identification of silkworms settling for moult, at moult, out of moult. Feeding, bed cleaning and spacing. Identification and picking of ripe worms, mounting, types of mountages, cocoon harvesting and grading. Pests and diseases of mulberry silkworm. Single cocoon reeling, study of reeling equipment.

20. AEC 322 Production and Financial Management 1 + 1

Theory

UNIT I

Production: Laws of returns: Law of variable proportions (factor-product), factor-factor and product-product relationships, Law of equi-marginal return. Production function in decision making, Meaning and concept of cost, types of costs and their interrelationship.

UNIT III

Management: Definition, importance and functions; Levels of management; Management functions, Planning: Definition, steps in planning, types of plan; organizing: Meaning of organizing and organization; developing leadership skills; Supply chain management.

UNIT III

Credit: meaning, definition, need, classification. Credit analysis: 3 Rs, and 3Cs of credits. Finance management: Definition, scope, objective; Time value of money and its accounting, Different systems of accounting: Financial accounting, cost accounting, management accounting; corporate social responsibility: Importance, business ethics.

Overview of project management: evolution, forms and environment of project management; Project life cycle; Project selection: Project identification and screening, project appraisal, project charter, project proposal, project scope, statement of work; Project planning and formulation. Planning and scheduling of activity networks, network scheduling, precedence diagrams, critical path method, program evaluation and review technique, assumptions in PERT and CPM.

Project cost estimating: Types of estimates and estimating methods, dynamic project planning and scheduling, time-cost trade-offs, resource considerations in projects, resource profiles and leveling, limited resource allocation; Project implementation, monitoring and control: Project management process and role of project manager, team building and leadership in projects, organizational and behavioral issues in project management, Project completion and future directions: Project completion and review; Project report preparation; Computers in project management.

Practicals

Laws of returns: Law of variable proportions (factor-product), factor-factor and product-product relationships for profit maximization. Determination of most profitable level of capital use. Optimum allocation of scarce capital among different enterprises. Estimation of credit requirement of farm business - Project cost estimating methods Sources of Project selection and Project identification. Time value of money –Future value of single cash flow

& annuity, present value of single cash flow, annuity & perpetuity. Simple interest & Compound interest. Project appraisal – undiscounted techniques Payback period, annual rate of return, Average returns per rupee; Discounted techniques – BC ratio, Net present value, Internal rate of return, Modified internal rate of return, Profitability index, sensitivity analysis

Project planning and scheduling: Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). Preparation and analysis of balance sheet and income statement – case studies. Loan repayment plans Appraisal of a loan proposal – case studies.

III Biotechnology Core Subjects

i. Plant Biotechnology Section

1. PBT 111 Cell Biology 2+0

Theory

UNIT I

Origin and evolution of cell; Introduction to microscopy; Sub-cellular structure of prokaryotic and eukaryotic cells; Membrane structure and function: plasma membrane, cell wall and extracellular matrix;

UNIT II

Structural organization and function of intracellular organelles and organelle biogenesis: Nucleus, mitochondria, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, plastids, vacuoles. Membrane modifications in functioning cell to cell interaction – gap junction desmosomes, tight junctions, plasmodesmata.

UNIT III

Cell surface component and their role in cell recognition and function of cytoskeleton and its role in motility; Cell membrane transport; Introduction to cell signalling; Cell growth, cell cycle and its control; Cell death and cell renewal.

2. PBT 112 Introduction to Biotechnology 2+1

Theory

UNIT I

History, definitions, concepts, scope and importance of Biotechnology: Plant, microbial, animal, medical, environmental, industrial, Marine, Agricultural and food Biotechnology; Nanobiotechnology.

UNIT II

Introduction to recombinant DNA technology and its applications: Vectors, DNA restriction and modifying enzymes, gene cloning; Introduction to genomics and proteomics: Molecular markers, DNA sequencing; Genetic transformation and transgenic organisms; Bioinformatics. Biosafety guidelines.

Practical

Orientation to the laboratories: glass houses, screen houses, transgenic facilities and field area; General guidelines for working in Biotechnology laboratories; Familiarization with basic equipment's used in biotechnology; Selection of chemicals (different grade), buffer preparation, calculations and scientific notations used in laboratories.

3. PBT 122 Molecular Biology 2+1

Theory

UNIT I

History of molecular biology; Central dogma of life; Structure of DNA and RNA; Gene structure and function; DNA replication; transcription; Genetic code and translation in prokaryotes and Eukaryotes; Structure of prokaryotic and eukaryotic nuclear and organelle genomes; Gene regulation in prokaryotes: Lac operon concept, tryp concept. Biosynthesis of purines pyramidines and their regulation

UNIT II

Introduction to microbial genetics; conjugation, transformation and transduction; Tools in molecular biology: Role of enzymes in molecular biology; Principles of Polymerase Chain Reaction; Electrophoresis; PCR and hybridization based molecular markers. \

Practical

Preparation of bacterial competent cells and transformation; Spontaneous and auxotrophic mutation; Chemical and UV mutagenesis in bacteria; Identification of mutants using replica plating

techniques; Isolation and purification of plant and animal DNA; Measurement of nucleic acid concentration using spectrophotometer and gel electrophoresis; Purification of plasmid DNA; DNA amplification using RAPD, microsatellite primers and analysis; CAPS primers; Generation of linkage maps and mapping of qualitative genes; Estimation of genetic similarities and generation of dendrograms.

4. PBT 123 Plant Tissue Culture 2+1

Theory

UNIT I

History of plant tissue culture; concept of totipotency; Concept of aseptic culture practices; Components of *in vitro* culture media and role of different macro and micro nutrients, vitamins, plant growth regulators and growth supplements; Sterilization techniques.

UNIT II

Various plant cell, tissue and organ culture techniques and uses; Somatic cell cultures; morphogenesis: organogenesis and somatic embryogenesis; Micropropagation: *In vitro* grafting, meristem culture; Anther, pollen, embryo, ovule, ovary culture; Protoplast culture and somatic hybridization; Somaclonal variation.

Practical

Good laboratory practices; Media preparation and sterilization; Surface sterilization of explants; Establishment of callus/cell suspension cultures; Micropropagation; Embryo culture; Anther and pollen culture; Induction of plant regeneration; Hardening and transfer to soil.

5. PBT 124 Classical and Molecular Cytogenetics 2+1

Theory

UNIT I

Introduction and history; Mitosis and meiosis; Structure of chromatin; chromosome landmarks Specialized chromosomes;

Differential staining of the chromosomes- Q-banding, G banding, C banding, R banding; *In situ* hybridization-FISH, GISH.

UNIT II

Changes in chromosome number: aneuploidy- monosomy, trisomy and tetrasomy, haploidy and polyploidy- autopolyploidy and allopolyploidy; Crop evolution: Wheat, Tobacco, Cotton, Triticale and Brassica; Methods of doubled haploid production; Structural aberrations of chromosomes: deletions, duplications, inversions and translocations; Locating genes on chromosomes; Genome analysis.

Practical

Preparation of chromosome stains; Pollen fertility; Preparation of mitotic and meiotic slides of plant/animal cells; Preparation of karyotypes; C/G banding of the chromosomes; Genomic *in situ* hybridization; Microphotography.

6. PBT 211 Fundamentals of Electronics and Instrumentation in Biotechnology 1+1

Theory

UNIT I

Electronics: PN junction diode, diode forward and reverse characteristics; Diode as a circuit element; Application of PN junction diode such as: half wave, full wave bridge rectifier, clipper, clamper and voltage multiplier circuit; Construction and working of bipolar transistor, load line concept, analysis and design of various biasing methods of NPN transistor with common emitter configuration; AC model and analysis of small signal NPN transistor with common emitter configuration; Concept of generalized instrumentation system; Transducers for the measurement of temperature using thermometer and thermocouple, linear displacement measurement using LVDT; Force measurement using the strain gauge.

UNIT II

Principles and working of laboratory equipments: Table top, refrige and ultra centrifuges; Laminar air flow; Autoclaves, pH meter; Fermenters; Temperature control shakers, BOD shakers; Gel electrophoresis, 2-D gel electrophoresis, gel documentation, gel driers; ELISA readers; Freeze driers/lyopholizers; Spectrophotometers; Gene pulser; Particle gun; Plant growth chambers; Thermal cyclers; Real time PCR; DNA synthesizer; DNA sequencer; Microscopes: Light, stereo, phase contrast and inverted.

Practical

To familiarize laboratory equipment and its equipment working; Forward and reverse VI Characteristics of a PN junction diode; To study half wave, full wave and bride rectifier using diode; Clipper, Clamper and Voltage multiplier circuit; To determine input V-I Characteristics of bipolar transistor for common emitter configuration; To determine output V-I Characteristics of bipolar transistor for common emitter configuration; To analyse a biasing circuits for CE transistor; To design and test a biasing circuits for CE transistor; To study the measure of temperature using the available sensor; To measure displacement with the available sensor; To study force with the available sensor.

7. PBT 212 Introduction to Genetics 2+1

Theory

UNIT I

History of Genetics; Mendel's principles and rediscovery; Cell division: Chromosomes structure and function, Nucleosome solenoid model; Chromosome theory of inheritance; Sex-linked, sex-limited and sex-influenced inheritance**;** Genic balance theory of Sex determination and sex differentiation

UNIT II

Multiple allelism; Linkage and crossing-over; Gene-gene interaction; Genetic analysis in prokaryotes and eukaryotes; Extra

chromosomal inheritance and maternal effects; Mutations; Hardy-Weinberg law ; Quantitative inheritance; Multiple factor hypothesis; Introduction to Human genetics; Genetic basis of evolution

Practical

Life cycle in model plants and animals; microscopy; Mitosis and meiosis; Monohybrid crosses (segregation); Dihybrid crosses (independent assortment); Tri and polyhybrid crosses; Probability and use of Chi-square; Sex-linked inheritance; Multiple allelism; Detection and estimation of linkage. Linkage map construction.

8. PBT 213 Recombinant DNA Technology 1+1

Theory

UNIT I

Recombinant DNA technology; Restriction endonucleases: Types and uses; DNA ligases; Vectors: plasmids, cosmids, phagemids, BACs, PACs, YACs, transposon vectors, expression vectors, shuttle vectors, binary plant vectors, co-integrating vectors, RNAi Vector

UNIT II

Competent cells; Gene isolation and cloning; Genetic transformation of *E. coli*; Gel electrophoresis; Preparation of probes; Recombinant protein production in *E.coli* and its purification

Practical

Orientation to recombinant DNA lab; preparation of stock solutions and buffers; Plasmid DNA isolation; Genomic DNA isolation; Quality and quantity determination of DNA; restriction digestion of DNA; Agarose gel electrophoresis, SDS-PAGE; PCR; Genetic transformation of *E. coli*; Screening of recombinant DNA clones in *E. coli*.

9. PBT 221 Molecular Genetics 2+0

Theory

UNIT I

Structures, properties and modification of DNA; Molecular mechanisms of DNA replication, repair, mutation, and recombination; Centromere and telomere sequences and DNA packaging; Synthesis and processing of RNA and proteins; Regulation of gene expression;

UNIT II

Repetitive DNA sequences and transposable elements; Gene identification and isolation Promoters and their isolation; Transcription factors – their classification and role in gene expression; Epigenetic control of gene expression; Small RNAs, RNA interference and its applications.

10. PBT 222 Plant Genetic Transformation 1+1

Theory

UNIT I

History of plant genetic transformation; Generation of gene construct and maintenance; Genetic transformation: *Agrobacterium* mediated, biolistics, electroporation, liposome, Polyethylene glycol, *in planta* and Chloroplast Transformation.

UNIT II

Selection and characterization of transgenic plants using selectable and reportable markers; PCR; qRT-PCR; Southern, Northern, Western blotting and ELISA techniques; Application of genetic transformation: for quality, yield, biotic, and abiotic stresses; Biosafety aspects of transgenic plants and regulatory framework.

Practical

Preparation of stock solutions, Preparation of competent cells of *Agrobacterium tumefaciens*; Restriction mapping of plasmid, Construction of binary vector and its transfer to an *Agrobacterium*

strain; Confirmation of transformed bacterial colonies; *Agrobacterium tumefaciens* mediated and biolistic plant transformation; Colony hybridization.

11. PBT 223 Molecular Marker Technology 2+0

UNIT I

Introduction to Molecular Markers, Types of molecular markers-RFLP; PCR based markers like RAPD,SCAR, SSR, STS, CAPS, AFLP, SNP and their variants; Primer designing; Uses of molecular markers: Application as a genetic tool for genotyping and gene mapping; Mapping populations: F_2, DH, RILs, NILs; Mapping functions; Bulked segregant analysis; Linkage maps; Physical maps. Single marker analysis. QTL definition and mapping method.

UNIT II

Application of molecular markers: Assessing genetic diversity, variety protection; Marker-assisted breeding for accelerated introgression of trait/transgene and quantitative traits; Human and animal health: Association with genetic-based diseases, Paternity determinations; Forensic studies.

12. PBT 311 Epigenetics and Gene regulation 2+1

Theory

UNIT I

DNA methylation and histone modifications: DNA methylases, methyl binding proteins and histone modifiers; Epigenetic changes in response to external stimuli leading to changes in gene regulation; Role of DNA methylation in plant development: mutant case studies.

UNIT II

Introduction to small RNAs: History, biogenesis; *In silico* predictions, target gene identification, methylation of heterochromatin by HeT-A associated siRNAs; Gene regulation by small RNA Other classes of siRNAs; Role in epigenetics; Jacob Monod model; RNA editing, Genome imprinting.

Practical

In silico study of structural components of histone modifiers and DNA methylases of model plants; *In silico* prediction of siRNAs and miRNAs; Small RNAs electrophoresis using PAGE; Blotting of small RNAs on nylon membrane; miRNA target finding; Detection of small RNAs using fluorescent labelled probes; Bisulphite sequencing for methylation; qRT-PCR for quantitative analysis of small RNAs in developmental phases

13. PBT 312 Nanobiotechnology 2+0

Theory

UNIT I

Introduction to nanotechnology; Concepts and Terminology; Approaches to make nano scale objects, Top down and bottom up approaches; Moore's law; Nano-Bio Interface; Biological based Nanosystems, molecular motors, biosensors and other devices.

UNIT II

Self assembly of molecules for nanotechnology applications; Biomimetics, Biotemplating and *de novo* designed nanostructures and materials; DNA-Nanotechnology; Nano-medicine, Nanomanipulations, material design, synthesis and their applications. Application of nanotechnology in agriculture; Biosafety aspects of nanobiotechnology.

14. PBT 313 Animal Biotechnology 2+1

Theory

UNIT-I

History and development of animal biotechnology; Basic techniques in animal cell culture: Introduction to embryo biotechnology: oocyte collection and maturation; Sperm preparation; in vitro fertilization; Cryopreservation of oocyte, sperm and embryos; Embryo transfer technology.

UNIT II

Breeds of livestock and their characteristics; Marker assisted breeding of livestock; Introduction to animal genomics: Rumen and its environment: Rumen microbes- manipulation of rumen microbes for better utilization of feed; Introduction to nutrigenomics; Milk biome; Manipulation of lactation by biotechnological tools; Application of biotechnology in meat and meat products.

UNIT III

Genome and protein based diagnostics of important animal diseases: FMD, brucellosis, Pestedes Petits Ruminants (PPR) , Mastitis, Blue tongue, Newcastle disease; Introduction to vaccinology: live attenuated vaccines, killed vaccines, cell culture based vaccines, recombinant vaccines.

Practical

Basic cell culture techniques; oocyte aspiration from ovaries; sperm preparation; In vitro fertilization; PCR based detection of animal pathogens; PCR-RFLP; Immuno histochemical localization of protein marker in tissues/cells – meat species identification by PCREDIT.

15. PBT 321 Molecular Breeding in Field Crops 2+1

Theory

UNIT I

Principles of plant breeding; Breeding methods for self and cross and often cross pollinated crops; Heterosis breeding; Limitations of conventional breeding; Development of specific mapping populations.

UNIT II

QTL mapping using structured populations; Detection of QTL effects; Fine mapping of genes/QTL; Map basedgene/QTL isolation and development of gene based markers.

UNIT III

Marker assisted selection (MAS): Foreground and background selection; Marker assisted backcross breeding; MAS for major and minor genes, Marker assisted pyramiding, Marker assisted recurrent selection;Transgenic breeding; MAS for specific traits with examples; Commercial applications of MAS.

Practical

Working on some genotyping and phenotyping datasets for Linkage mapping using softwares such as Mapmaker, MapDisto and QTL mapping softwares such as WinQTL cartographer; Use of gene based and closely linked markers for foreground and background selection for target traits in target crops; Marker assisted detection of the transgene.

16. PBT 322 Molecular Diagnostics 2+1

Theory

UNIT I

Principle and applications of molecular diagnostic tests; Nucleic acid based diagnostics for detection of pathogenic organisms: Application of restriction endonuclease analysis for identification of pathogens; Polymerase chain reaction (PCR) and its variants; Reverse transcriptase polymerase chain reaction (RT PCR); isothermal amplification (LAMP); LCR, nucleic acid sequence-based amplification (NASBA); Real-Time PCR; DNA Probes; Southern blotting; Northern blotting; Protein based assays: SDS-PAGE, Western Blot, Dot-blot, ELISA and lateral flow device.

UNIT II

Advantages of Molecular diagnostics over conventional diagnostics; serodiagnostics; DNA array technology; Protein array; tissue array; Biosensors and nanotechnology; Development and validation of diagnostic tests.

Practical

Preparations of buffers and reagents; Collection of clinical and environmental and Plant samples for molecular detection of pathogens (bacteria/virus); Extraction of nucleic acids (DNA & RNA) from the clinical specimens; Restriction endonuclease digestion and analysis using agarose gel electrophoresis; Polymerase chain reaction for detection of pathogens in Plant and animal tissues; RT-PCR for detection of RNA viruses; PCR based detection of meat adulteration in processed and unprocessed meats; PCR based detection of pathogens in milk, eggs and meat; Lateral flow assay; ELISA.

17. PBT 323 Sericultural Biotechnology 1+0

Theory

UNIT I

Importance of Biotechnology in Sericulture. Mulberry genome structure, Tissue culture and transformation Goals of mulberry improvement. Mulberry genome structure. Conventional methods of mulberry propagation (Cuttings, Seeds and Grafting) and their limitations. Mulberry tissue culture, Requirements (Explants, Growth regulators, Genotypes), General methodology, advantages of mulberry tissue culture. Mulberry transformations methods, advantages, limiting factors, Inplanta transformation of mulberry.

UNIT II

Silkworm genome structure. Molecular aspects of regulation of silk synthesis. Silkworm Transformation. History of insect Transgenesis with examples. Vectors and Methods of silkworm transformation. Improvement of silkworm transformation procedures. Applications of silkworm Transgenesis. Genome manipulation for crop improvement in mulberry and Non mulberry silkworms. Immunological techniques in silkworm disease diagnosis. Artificial silk production. Application of molecular markers in mulberry silkworm improvement. Silkworm as a Bioreactor for the production of commercially important proteins and metabolites.

18. PBT 324 Molecular Pharming and Biopharmaceuticals 2+1

Theory

UNIT I

Concept of molecular pharming and production of biopharmaceuticals; Hosts for biopharmaceutical production Bacteria, Yeast, Mammalian cell culture, insects, Animals and Plants; Fermentation and cell culture processing; Protein purification and processing; Industrial fermentation: batch and continuous cultures, production of biopharmaceuticals, immobilization techniques.

UNIT II

Biopharmaceutical analytical techniques; Biopharma drug discovery and development; production of specific vaccines and therapeutic proteins.

Practical

Isolation & purification of proteins from microbes and plants; Production of recombinant proteins in prokaryotes; Analysis of proteins by one and two dimensional gel electrophoresis; Affinity chromatography; Immunoblotting; Cell culture and immobilization techniques. Visit to biopharmaceutical industry.

ii. Microbial and Environmental Biotechnology section

1. MEB 111 Introductory Microbiology 1+1

Theory

UNIT I

Origin and evolution of Microbial life. Brief history of microbiology. Microscopes and microscopy. Overview of cell structure of prokaryotes and eukaryotes. General properties of viruses, overview of plant, animal and bacterial viruses, viriods and prions. Different groups of Microorganisms- Bacteria, Fungi, Algae and Protozoa. Microbial nutrition and culture media.

UNIT II

Overview of microbial metabolism: glycolysis, citric acid cycle, anaerobic respiration, photosynthesis and fermentation. Microbial growth - measurement of growth, effect of environmental factors on growth. Qualitative and quantitative methods for the study of microorganisms.

UNIT III

Microbial genetics: genetic recombination, conjugation, transformation, transduction, mutation and mutants, plasmids, transposons and insertion sequences, cloning vectors. Control of microbial growth: heat sterilization, radiation sterilization, filter sterilization, chemical growth control, disinfectants, antiseptics and antibiotics. Microbial ecology- Microorganisms in nature and their interaction, methods in microbial ecology, Microbial interactions with higher organisms – plants and animals. Concepts of Immunology - Cells and organs of immune system, antigen- antibody reactions, types of immunity, polyclonal and monoclonal antibodies.

Practical

Equipments used in a microbiology laboratory. Microscopy – principles and applications. Preparation of different culture media and sterilization methods. Isolation, pure culture and preservation of microorganisms. Staining techniques- simple, negative, capsule, endospore, Gram's staining etc. Qualitative and quantitative methods for the study of microorganisms. Influence of environmental factors on microorganisms. Biochemical activities of bacteria. Microscopic observation of bacteria, fungi, algae and protozoa.

2. MEB 221 Food Biotechnology 1+1

Theory

UNIT I

Food Biotechnology: Introduction, history and importance; Applications of biotechnology in food processing: Enzymes for food processing such as beta-galactosidase, chymosin, glucose isomerase

and á-amylase. Recent developments and application of biotechnology in quality and quantity improvement of functional foods from plant sources–Vitamin, carotene, anthocyanin, proteins, Starch and oil, risk factors and safety regulations; Food spoilage and preservation process; Food and beverage fermentation: Alcoholic and non alcoholic beverages, food additives and supplements.

UNIT II

Industrial use of micro organisms; Commercially exploited microbes: *Saccharomyces*, *Lactobacillus, Penecillium, Acetobactor, Bifidobacterium*, *Lactococcus* and *Streptococcus*; Dairy fermentation and fermented products; Prebiotics and probiotics; Genetic engineering for food quality and shelf life improvement; Bioactive peptides; Labelling of GM foods.

Practical

Isolation, culture and maintenance of biotechnologically important micro-organisms; Use of laboratory and industrial scale shakers; Batch and continuous cultures; Use of fermentors; Detection of pathogens in food and feed; Detection of GM food; Visit to food processing industry**.**

3. MEB 311 Microbial Genetics 2+0

Theory

UNIT I

Introduction and scope of microbial genetics. Nucleic acid structure. Prokaryotic chromosome structure: bacterial chromosome, supercoiling of the genome, circular and super helical DNA. Fidelity and error in DNA replication. Microbial genome- source of variation in microbial population, Extrachromosomal elements. Transposable elements-discovery, classification, regulation and utility. Transposons-mutagenesis. Mechanism of gene transmission between microbial cells – transformation, transduction and conjugation- Insertion of F plasmid into the chromosome, *Hfr* transfer, F' transfer, Mechanism of plasmid mediated gene transfer.

UNIT II

Plasmid curing. Regulation of gene expression –operator, promoter, terminator, attenuator, operon concept- *lac* operon and *trp* operon as models. Bacterial mutants –estimation of mutation rate, isolating mutants. Replica plate technique Restoring functions lost by mutation-reversion and suppression. Mutagenesis. Phages-life cycle of lytic and temperate phages, restriction modification. Lateral gene transfer-. Yeast vectors transformation, selecting markers,. Yeast as a model system for expression of recombinant genes. Yeast Genetics – Genome and its organization, life cycle, mating type switch, vectors, yeast selection markers and transformation.

4. MEB 312 Biotech IPR, Biosafety and Bioethics 2+0

Theory

UNIT I

Introduction to Intellectual Property, concepts and types; International treaties for protection of IP's; Indian Legislations for the protection of various types of Intellectual Property; Patent search, filing process; Material transfer agreements.

UNIT II

Biodiversity definition, importance and geographical causes for diversity; Species and population biodiversity, maintenance of ecological biodiversity hot spots in India; Convention on biological diversity; Cartagena Protocol of bio-safety, and risk management for GMO's; Bio-safety guidelines, rules and regulations and regulatory frame work for GMOs in India.

5. MEB 321 Green Biotechnology 2+1

Theory

UNIT I

Green biotechnology: Definition, concept and implication; Bio-fertilizers and bio-pessticides; Plant growth promoting rhizobacteria; Production of biofuels, biodiesel and bioethanol; Biomass

enhancement through biotechnological interventions; Generation of alternate fuels in plants; Identification and manipulation of micro-organisms for biodegradation of plastics and polymers; GMOs for bioremediation andphytoremediation, their roles; Strategies for detection and control of soil, air and water pollutants.

UNIT II

Carbon sequestration; Methanogenic microbes for methane reduction; Microbes for phytic acid degaradation; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Marker-free transgenic development strategies; Development of disease resistant and pest resistant crops through biotechnological tools.

Practical

Identification and efficiency assays of micro-organisms for biodegradation and bioremediation; Isolation of *Bacillus thuringiensis* and plant growth promoting rhizobacteria; Production of biofertilizers, biopesticides and biofuel; Assays for removal of oil spillage**.**

iii. Biochemistry Section

1. BCM 111 Plant Biochemistry 1+1

Theory

UNIT I

Biochemistry- Introduction and importance, Plant cell- Structure and organellar functions. Biomolecules–Structure, properties and reactions: amino acids, peptides and proteins, lipids, carbohydrates, nucleotides and nucleic acids. Enzymes- Factors affecting the activities, classifications, immobilization and other industrial applications.

UNIT II

Metabolism – Basic concepts. glycolysis, citric acid cycle, pentose phosphate pathway β-oxidation of fatty acids, electron transport and oxidative phosphorylation. General reactions of amino acids degradation. Metabolic regulation. Secondary metabolites- terpenoids, alkaloids, phenolics.

Practical: Protein denaturation- heat, pH, precipitation of proteins with heavy metals, Estimation of crude protein, Estimation of protein by Lowry method, Enzymes assays; Extraction of nucleic acids; Extraction of oil from oil seeds; Estimation of crude fat, Estimation of iodine number and saponification value of an oil, Quantitative and qualitative determination of sugars, Paper chromatography for the separation of sugars, Determination of phenols, chlorophyll and ascorbic acid.

2. BCM 211 Enzymology and Enzyme Technologies 2+0

Theory

UNIT I

Classification and nomenclature of enzymes; General characteristics of enzymes, active site, cofactors, prosthetic groups; Metalloenzymes; Theory of enzymatic catalysis and specificity:

Transition state theory, the coordinate diagram-for exothermic and endothermic uncatalyzed reactions, energy barrier, concept of activation energy, importance of the energy barrier in biological systems; Physical and thermodynamic factors contributing the energy barrier, concept of binding energy and the stabilization of the transition state. Mechanism of Enzyme catalysis.

UNIT II

Enzyme kinetics**:** Importance of enzyme kinetics, Kinetic factors influencing enzyme reaction velocity. Effect of substrate concentration. The Michaelis-Menton (MM) Theory, derivation of MM equation, Concept of Steady-state kinetics; Significance of Km, Vmax, Kcat (Turnover number), Kcat/Km (Specificity constant), Kinetic Perfection in Enzymatic Catalysis; effect of pH, temperature, determination of Km and Vmax; Enzyme inhibition: competitive, non-competitive and uncompetitive; Regulation of enzyme activity: (1) Allosteric control (2) Reversible covalent modification (3) Proteolytic activation (4) Multiple forms of the enzyme Isoenzymes, schizomers and isoschizomers; Ribozymes; Immobilization of enzymes; Applications of enzymes: biotechnology, industry, environment, agriculture, food and medicine.

3. BCM 311 Biochemical Techniques 1+2

Theory:

UNIT I

Principles and techniques of Chromatography - adsorption, partition, and ion-exchange, affinity. Gas chromatography, HPLC and their application.

UNIT II

Precipitation of biomolecules- salt, solvent, pH, Dialysis. Centrifugation techniques and their application – Differential, density gradient and ultra centrifugation.

UNIT III

Principle of electrophoresis, AGE, Native PAGE, SDS-PAGE, Iso-electric Focusing Amino acid analysis and Protein sequencing, Nucleic acid sequencing, Blotting techniques- Southern, Northern and Western Blotting.

Practicals

Preparation of buffers and measurement of pH. Spectrophotometry, Preparation of standard curve. Separation of amino acids by TLC, Isolation, purification and assay of enzymes; Determination of optimum pH and optimum temperature of enzymes; Thermostability of enzymes; Activators and inhibitors of enzyme catalysis; Determination of kinetic parameters of enzymes; Immobilization of enzymes; Isoenzymes analysis.

4. BCM 312 Immunology 2+1

Theory

UNIT I

History and scope of immunology; Components of immune system: organs, tissues and cells, Immunoglobulin structure and functions; Molecular organization of immunoglobulins and classes of antibodies; Antibody diversity; antigens, haptens, antigens antibody interactions; Immuno-regulation and tolerance.

UNIT II

Allergies and hypersensitive response; Adaptive and Innate immunity, Cells of Adaptive immunity, features of T and B cells; Autoimmunity organ specific and systemic; Immunodeficiency; Vaccines; Immunological techniques; Immunological application in plant science, monoclonal antibodies and their uses; Molecular diagnostics.

Practical

Preparation of buffers and reagents; Raising of antisera in laboratory animals; Collection and preservation of antisera – separation, filtration and aliquoting. Precipitation and agglutination test; HA, HI test; Immunoblotting, immunoelectrophoresis and fluorescent antibody test; Enzyme immunoassays including ELISA variants, western blotting;

iv. Bioinformatics Section

1. BIT 221 Introductory Bioinformatics 2+1

Theory

UNIT I

Introduction to bioinformatics; scope of bioinformatics; Importance of computers in biological data processing local and remote-server based data processing. Physical and virtual links to remote data servers, Different Internet protocols for remote data access. Major biological data resources accessible through world wide web.

UNIT II

Introduction to biological database and different data structures, Primary databases: Nucleotide sequence databases (GenBank, EMBL), protein sequence databases; Secondary databases: SwissProt/ TrEMBL, conserved domain database, Pfam;

Macro molecule Structure databases: Protein Data Bank (PDB), MMDB, SCOP, CATH; File formats: Genbank, EMBL, Fasta, PDB, Flat file, ASN.1, XML.

UNIT III

Introduction to sequence alignment and its applications: Pair wise and multiple sequence alignment, concept of local and global alignment; Algorithms: Dot Matrix method, dynamic programming methods (Needleman–Wunsch and Smith–Waterman); Tools of MSA: ClustalW, TCoffee; Phylogeny; Introduction to BLAST and FASTA.

Practical

Basic computing: Introduction to LINUX; Nucleotide information resource: EMBL, GenBank, DDBJ, Unigene; Protein information resource: SwissProt, TrEMBL, Uniprot; Structure databases: PDB, MMDB; Search Engines: Entrez, ARSA, SRS;

Similarity Searching: BLAST and interpreting results; Multiple sequence alignment: ClustalW; Structure visualization of DNA and proteins using Rasmol.

2. BIT 311 Genomics and Proteomics 2+0

Theory

UNIT I

Introduction to Genomics, Functional Genomics and Proteomics; Structural genomics: Classical ways of genome analysis, BAC and YAC libraries; Physical mapping of genomes; Next generation sequencing; Genome analysis and gene annotation; Genome Projects: *E. coli*, Arabidopsis, Bovine, Human; Comparative Genomics: Orthologous and Paralogous sequences, Synteny, Gene Order, Phylogenetic footprinting.

UNIT II

Functional genomics: Differential gene expression techniques: ESTs, cDNA-AFLP, microarray, Differential display, SAGE, RNAseq, Real time PCREDIT

UNIT III

Introduction to proteomics; Analysis of proteome: Native PAGE, SDS PAGE, 2D PAGE; Edmann Degradation; Chromatographic techniques: HPLC, GC, Mass Spectrometry: MALDI-TOF, LC-MS; Post Translational modifications.

3. BIT 321 Computational Biology 2+1

Theory

UNIT I

Introduction to computational biology; Web based servers and software for genome analysis: Ensembl, UCSC genome browser, MUMMER, BLASTZ; Sequence submission.

UNIT II

Protein interaction databases: BIND, DIP, GRID, STRING, PRIDE; Principles of Protein structure prediction; Fold Recognition (threading); Homology modeling; SCOP, CATH,PDB, PROSITE, PFAM; Methods for comparison of 3D structures of proteins.

UNIT III

Phylogenetic analysis: Evolutionary models, tree construction methods, statistical evaluation of tree methods; PHYLIP, dendroscope, MEGA; DNA barcoding database-BOLD.

Practical

Application of Genome browsers in genomic research; Exploring protein-protein interaction databases; Working with protein structural classification databases; SNP and SSR identification tools; PHYLIP.

4. BIT 322 Metabolomics and System Biology 3(2+1)

Theory

UNIT I

Metabolomics overview, major metabolic pathways: Glycolysis, Kreb's cycle, oxidative phosphorylation, amino acid, fatty acid and nucleotide metabolism, their control and integration; Metabolic flux and metabolic profiling; Catalytic mechanisms and enzyme kinetics, Michaelis-Menton kinetics; Conformational change, allosteric regulations, regulation of metabolic pathways; Signal transduction: Inter and intra cellular communications; Receptor ligand interaction; Structural components of signal pathways: G-protein, Jak-stat, receptor tyrosine kinase.

UNIT II

Signal Flow: Pathway to networks, small scale system biology experiments; System analysis of complex diseases, system pharmacology; Assembling large data sets in genomics and proteomics, computational analysis of large data sets, building

networks; Mathematical representation of cell biological system, time and space.

Practical

Metabolic pathway databases KEGG, BRENDA, Biosilico, Protein-protein interaction databases, Swiss 2D PAGE, E-PCR; Creating networks using Cytoscape, DAVID, MAS3; in silico functional annotation using GO, AGRIGO, PANTHER, BLAST2GO.

IV. STUDENT READY PROGRAMME

Semester-I

1. BWE 411 In –house Skill Development Modules (21 weeks) 0+20
2. BWE 412 RAWE for Agri. Biotech students (2 weeks) 0+1

Semester-II

3. BWE 421 Student READY: Problem Identification, Project Formulation and Presentation (3 weeks) 0+3
4. BWE 422 Entrepreneurial Development in Biotechnology (on campus/ off campus) (18 weeks) 0+16

V Remedial Courses

1. BIO 111 Introductory Biology 1+1

Theory

Introduction to the living world, diversity and characteristics of life, origin of life, Evolution and Eugenics. Binomial nomenclature and classification Cell and cell division. Morphology of flowing plants. Seed and seed germination. Plant systematic- *viz.*, Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.

Practical

Morphology of flowering plants–root, stem and leaf and their modifications. Inflorence, flower and fruits. Cell, tissues & cell division. Internal structure of root, stem and leaf. Study of specimens and slides. Description of plants.

2. MAT 111 Introductory Mathematics 2+0

Straight line: Distance formula, section formula (internal and external division), Change of axes (only origin changed), Equation of co-ordinate axes, Equation of lines parallel to axes, Slope-intercept form of equation of line, Slope–point form of equation of line, Two point form of equation of line, Intercept form of equation of line, Normal form equation of line, General form of equation of line, Point of intersection of two straight Lines, Angles between two st. lines, Parallel lines, Perpendicular lines, Angle of bisectors between two lines, Area of triangle and quadrilateral.

Circle: Equation of circle whose centre and radius is known, General equation of circle, Equation of circle passing through three given points, Equation of circle whose diameters is line joining two points (X_1, y_1) & (X_2, y_2), Tangent and Normal to a given circle at given point (simple problems), Condition of tangency of a line $y = mx + c$ to the given circle $x^2 + y^2 = a^2$.

Differential calculus: Definition of function, limit and continuity, Simple problems on limit, Simple on continuity, Differentiation of x^n. e^x, sin x & cos x from first principal, Derivatives of sum, difference, product and quotient of two functions, Differentiation of functions of functions (Simple problem based on it). Logarithmic differentiation (Simple problem based on it), Differentiation by substitution method and simple problem based on it, Differentiation of Inverse Trigonometric functions. Maxima and Minima of the functions of the form y=f (x) (Simple problem based on it).

Integral Calculus: Integration of simple function, Integration of product of two functions, Integration by substitution method, Definite Integral (Simple problem based on it), Area under simple well – known curves (Simple problem based on it).

Matrices and Determinants: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3^{rd} order, Properties of determinants up to 3rd order and their evaluation.

Quotes

I never teach my pupils I only provide the conditions in which they can learn
- *Albert Einstein*

Intelligence plus character-that is the goal of true education
- *Martin Luther king, Jr.*

Some of the brightest minds in the country can be found on the last benches of the class room
- *Dr.APJ Abdul Kalam*

Education is not the learning of facts, but the training of the mind to think
- *Albert Einstein*

Education is the manifestation of perfection present already in man. Divinity is the manifestation of the religion already in man
- *Swami Vivekananda*

The highest education is that which does not merely give us information but makes our life in harmony with all existence
- *Rabindrnath Tagore*

One child, one teacher, one pen and one book can change the whole world
- *Malala Yousafzai*

By education, I mean an all-around drawing of the best child and man in body, mind and spirit
- *Mahatma Gandhi*