

Date-September 21, 2023

To

The Principal Secretary to Governor
Raj Bhawan, Patna

Sub: Submission of Uniform syllabus for 4 year Undergraduate courses of Bachelor of Science under CBCS in the Botany.

Sir,

With reference to letter No. BSU (UGC)-02/2023-1473/GS (I) dated 14.09.2023, a meeting of the panel of experts in Botany was held on 21.09.2023 to finalize the Syllabus for Botany. We are submitting the syllabus.

Yours sincerely,

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**Uniform Syllabus for 4-Year
Undergraduate Programme of Bachelor
of Science (Hons.) under CBCS in the
subject Botany**

Pradeep Singh Samyukta Akshay Meisam
CR H. S. Gupta Jayant. Shobha Anu
Shobha

Course Structure of different Semesters

Semester –I

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Phycology and Microbiology (T)	MJC-1 (T)	4-1-0	4	100
2	Phycology and Microbiology (P)	MJC-1 (P)	0-0-6	2	100
3	Minor Course selected from other Department	MIC-1	4-1-0	3	100
4	Multidisciplinary Course 1	MDC-1	4-1-0	3	100
5	English Communication/MIL	AEC-1	2-1-0	2	100
6	Skill Enhancement Course (from Basket)	SEC-1	1-0-3	3	100
7	Value Added Course (from Basket)	VAC-1	1-0-3	3	100
Total Credit-20					

Semester –II

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Biomolecules and Cell Biology (T)	MJC-2 (T)	4-1-0	4	100
2	Biomolecules and Cell Biology (P)	MJC-2 (P)	0-0-6	2	100
3	Minor Course selected from other Department	MIC-2	4-1-0	3	100
4	Multidisciplinary Course 2	MDC-2	4-1-0	3	100
5	Environmental Science	AEC-2	2-1-0	2	100
6	Skill Enhancement Course (from Basket)	SEC-2	1-0-3	3	100
7	Value Added Course (from Basket)	VAC-2	1-0-3	3	100
Total Credit-20					

Semester –III

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Mycology and Phytopathology (T)	MJC-3 (T)	4-1-0	3	100
2	Mycology and Phytopathology (P)	MJC-3 (P)	0-0-6	2	100
3	Archegoniate (T)	MJC-4 (T)	4-1-0	3	100
4	Archegoniate (P)	MJC-4 (P)	0-0-4	1	100
5	Minor Course selected from other Department	MIC-3	4-1-0	3	100
6	Multidisciplinary Course 3	MDC-3	4-1-0	3	100
7	Disaster Risk Management	AEC-3	2-1-0	2	100
8	Skill Enhancement Course (from Basket)	SEC-3	1-0-3	3	100
					Total Credit-20

Semester –IV

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Morphology and Anatomy (T)	MJC-5 (T)	4-1-0	3	100
2	Morphology and Anatomy (P)	MJC-5 (P)	0-0-6	2	100
3	Economic Botany	MJC-6 (T)	5-1-0	5	100
4	Genetics	MJC-7 (T)	5-1-0	5	100
5	Minor Course selected from other Department	MIC-4	4-1-0	3	100
6	Courses on NCC/NSS/NGOs/Social Service/Scout & Guide/Sports	AEC-4	2-1-0	2	100
					Total Credit-20

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Semester –VII

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Plant Metabolism	MJC-13 (T)	5-1-0	5	100
3	Research Methodology	MJC-14 (T)	5-1-0	5	100
4	Recombinant DNA Technology & Plant Biotechnology (T)	MJC-15 (T)	4-1-0	4	100
5	Recombinant DNA Technology & Plant Biotechnology (P)	MJC-15 (P)	0-0-6	2	100
6	Minor Course selected from other Department	MIC-9	4-1-0	4	100
Total Credit-20					

Semester –VIII

Sl. No.	Name of the Course	Type of Course	L-T-P	Credit	Marks
1	Horticultural practices and Post-Harvest Management Technology	MJC-16 (T)	4-1-0	4	100
3	Minor Course selected from other Department	MIC-10	4-1-0	4	100
4	Research Project/Dissertation	RP-1	-	12	
Total Credit-20					

*L/T/P: number of classes per week

Prof. ——— M. Singh ——— Saunmya ——— Akshay ——— Misha..
OP ——— M. S. G. ——— M. G. ——— M. G. ——— M. G.
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SEMESTER-I

MJC-1 (T): Phycology and Microbiology

Course Objective

This Course aims to enhance the knowledge of Algae and Microbes. Algae have significant importance in industry and also used as food and fodder. As microbes are everywhere and affect almost all aspects of our lives, the study of microbes is necessary.

Course Outcomes

After the completion of the course, the students will be able to:

- CO1: Classify the plant kingdom
- CO2: Describe the diversity, structure and importance of viruses and bacteria
- CO3: Describe the general account of mycoplasma
- CO4: Explain the thallus organization, economic importance and the life cycle of various algae

MJC-1 (T) Phycology and Microbiology (Theory : 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Classification of Plant Kingdom and their important features (Whittaker 1969)	02
2	Algae: General characteristics; Classification; Range of thallus organization and reproduction; Significant contributions of important Phycologists (F.E. Fritsch, G.M. Smith, H.D. Kumar, M.O.P. Iyengar); Structure, Life history and affinities of the following genera: <i>Nostoc</i> , <i>Volvox</i> , <i>Oedogonium</i> , <i>Chara</i> , <i>Vaucheria</i> , <i>Batrachospermum</i> and <i>Ectocarpus</i> ; Economic Importance of Algae	14
3	Virus: Discovery, Nature and General structure, DNA virus (Bacteriophage)- Structure and its replication (Lytic and lysogenic Cycle), RNA virus (TMV), Corona virus (elementary idea); Economic importance of viruses	10
4	Bacteria: Discovery, Characteristics and Cell Structure, Types- Archaeobacteria and Eubacteria, Reproduction- vegetative, asexual and genetic recombination (Conjugation, Transformation and Transduction); Economic importance of bacteria with reference to their role in agriculture and industry; Role of Microbes in Biological nitrogen fixation; General account of Mycoplasma.	14
TOTAL		40

Suggested Readings:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Prescott, L.M., Harley J.P. and Klein D.A. (2005). Microbiology, McGraw Hill, India. 6th edition
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Campbell, N.A., Reece J.B., Urry L.A., Cain M.L., Wasserman S.A. Minorsky P.V., Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
5. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
6. Vashishtha, B.R., Sinha, A.K and Singh, V.P. (2010). Botany for degree students: Algae, S. Chand & Company Ltd. 2nd edition
7. Srivastava, H.N. (2005). Algae, Pradeep Publication. 12th edition.
8. Dubey R.C. and Maheshwari D.K. (2005). A Text Book of Microbiology, S. Chand & Company Ltd. 2nd edition.

MJC-1 (P)	Phycology and Microbiology (Practical: 2 credits)	Number of Classes
Practical 1. Electron micrographs/Models of viruses–T-Phage and TMV 2. Line drawings/Photographs of Lytic and Lysogenic Cycle 3. Types of Bacteria to be observed from photographs 4. Gram staining of bacteria. 5. Phycology: Study of vegetative and reproductive structures of the forms prescribed in the syllabus through temporary slides preparation.		40

SEMESTER-I

MIC-1 (T): Phycology and Microbiology

Course Objective

This Course aims to enhance the knowledge of Algae and Microbes. Algae have significant importance in industry and also used as food and fodder. As microbes are everywhere and affect almost all aspects of our lives, the study of microbes is necessary.

Course Outcomes

After the completion of the course, the students will be able to:

- CO1:** Describe the diversity, structure and importance of viruses and bacteria
CO2: Explain the thallus organization, economic importance and the life cycle of various algae

MIC-1 (T) Phycology and Microbiology (Theory: 2 credits)		
Unit	Topics to be covered	No. of Lectures
1	Five kingdom classification Algae: Characteristics, Morphology and life cycle of <i>Nostoc</i> , <i>Oedogonium</i> and <i>Chara</i>	07
2	Virus: Discovery and General Structure, DNA Virus (Bacteriophage)-Structure and its replication (Lytic and Lysogenic Cycle), RNA Virus (TMV), Economic importance of Viruses.	06
3	Bacteria: Discovery, Characteristics and Cell structure, Reproduction-vegetative, asexual and genetic recombination (Conjugation, Transformation and Transduction), Economic importance of Bacteria.	07
TOTAL		20

Suggested Readings:

1. Lee, R.E. (2008) Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Prescott, L.M., Harley J.P., Klein D.A. (2005). Microbiology, McGraw Hill, India. 6th edition
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
4. Pelczar, M.J. (2001) Microbiology, 5th edition, Tata McGraw-Hill Co, New Delhi.
5. Vashishtha, B.R., Sinha, A.K. Singh, V.P. (2010). Botany for degree students: Algae, S. Chand & Company Ltd. 2nd edition
6. Srivastava, H.N. (2005). Algae, Pradeep Publication. 12th edition.
7. Dubey R.C., Maheshwari D.K. (2005). A Text Book of Microbiology, S. Chand & Company Ltd. 2nd edition.

MIC-1 (P) Phycology and Microbiology (Practical: 1 credit)	No. of Classes
(a) Algae- Study of Vegetative and reproductive structures of the forms prescribed in the syllabus through slides. (b) Models and microphotographs of viruses and bacteria.	20

SEMESTER-I

MDC-1 (T): Phycology and Microbiology

Course Objective

This Course aims to enhance the knowledge of Algae and Microbes. Algae have significant importance in industry and also used as food and fodder. As microbes are everywhere and affect almost all aspects of our lives, the study of microbes is necessary.

Course Outcomes

After the completion of the course, the students will be able to:

CO1: Describe the diversity, structure and importance of viruses and bacteria

CO2: Explain the thallus organization, economic importance and the life cycle of various algae

MDC-1 (T) Phycology and Microbiology (Theory: 2 credits)		
Unit	Topics to be covered	No. of Lectures
1	Algae: Characteristics, Morphology and life cycle of <i>Nostoc</i> , <i>Oedogonium</i> and <i>Chara</i>	07
2	Virus: Discovery and General Structure, DNA Virus (Bacteriophage)-Structure and its replication (Lytic and Lysogenic Cycle), RNA Virus (TMV) Economic importance of Viruses.	06
3	Bacteria: Discovery, Characteristics and cell structure, Reproduction-Vegetative, asexual and genetic recombination (Conjugation, Transformation and Transduction), Economic importance of Bacteria.	07
	TOTAL	20

Suggested Readings:

1. Prescott, L.M., Harley J.P., Klein D.A. (2005). Microbiology, McGraw Hill, India. 6th edition
2. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi.
3. Vashishtha, B.R., Sinha, A.K. Singh, V.P. (2010). Botany for degree students: Algae, S. Chand & Company Ltd. 2nd edition
4. Srivastava, H.N. (2005). Algae, Pradeep Publication. 12th edition.
5. Dubey R.C., Maheshwari D.K. (2005). A Text Book of Microbiology, S. Chand & Company Ltd. 2nd edition.

MDC-1 (P) Phycology and Microbiology (Practical: 1 credit)	No. of Classes
(a) Algae: Study of Vegetative and reproductive structures of the forms prescribed in the syllabus through temporary slides preparation. (b) Models and microphotographs of viruses and bacteria.	20

Semester-II

MJC-2 (T): Biomolecules and Cell Biology

Course Objective

Students should be able to understand the biological Micromolecules. The accurate measurement and monitoring of the concentration of specific Bio molecules in a living system are crucial to ensure the well-being of the cells and living organism.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1:** Describe the structure, properties and functions of bio molecules
CO2: Explain the classification, properties and functions of enzymes
CO3: Describe cell wall, cell membrane and the structure and functions of cellular organelles
CO4: Explain the eukaryotic cell cycle, mitosis and meiosis

MJC-2 (T) Biomolecules and Cell Biology (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Biomolecules: Structure, classification and function of Carbohydrates, amino acids, proteins, lipids and nucleic acid	12
2	Enzymes: Classification, nomenclature, physico-chemical properties mechanism of action and regulation	10
3	Cell: Cell theory; Structure of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory); Cell wall and Cell membrane, structure and function of cell organelles: nucleus, mitochondria, ribosomes, golgi apparatus, endoplasmic reticulum, lysosomes, chloroplast and vacuoles; Structure of chromosome with nucleosome concept	14
4	Cell cycle; Cell division: Mitosis and Meiosis	04
TOTAL		40

Suggested Readings:

1. Campbell, M.K. (2012) Biochemistry, 7thed., Published by Cengage Learning.
2. Campbell, P.N. and Smith AD (2011) Bio chemistry Illustrated, 4thed., Published by Churchill Living stone.
3. Tymoczko J.L., Berg J.M. and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H. Freeman
4. Berg J.M, Tymoczko J.L and Stryer L (2011) Bio chemistry, W.H. Freeman and Company.
5. Nelson D.L and Cox M.M (2008) Lehninger Principles of Biochemistry, 5thEdition., W.H. Freeman and Company.
6. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
7. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8thedition.
8. Cooper, G.M and Hausman, R.E. (2009) The Cell: A Molecular Approach, 5thedition. ASM.

MJC-2 (P)	Biomolecules and Cell Biology (Practical: 2 credits)	Number of Classes
Practical 1. Estimation of protein and sugar 2. Detection of tannin, alkaloid and flavonoid in the given plant sample 3. Separation of amino acids by paper chromatography technique 4. Study of cell and its organelles with the help of electron microphotographs 5. Study of different stages of mitosis and meiosis		40

SEMESTER -II

MIC-2 (T): Biomolecules and Cell Biology

Course Objective

Students should be able to understand the Micromolecules. The accurate measurement and monitoring of the concentration of specific Bio molecules in a living system are crucial to ensure the well-being of the cells and living organism.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1:** Describe the structure and properties of bio molecules
- CO2:** Explain the classification, properties and functions of enzymes
- CO3:** Describe cell wall, cell membrane and the structure, chemistry and functions of cellular organelles
- CO4:** Explain mitotic and meiotic cell divisions

MIC 2 (T) Biomolecules and Cell Biology (Theory: 2 credits)		
Unit	Topics to be covered	No. of Lectures
1	Bio-molecules: Structure, classification and function of Carbohydrates, Amino acids, Protein	06
2	Enzymes: Nomenclature, Classification, mode of action	04
3	Cell Biology: a. Structure of the cell as seen under Electron Microscope b. Characteristics of Prokaryotic & Eukaryotic Cells c. Structure of Chromosome d. Mitosis and meiosis	10
	TOTAL	20

Suggested Readings:

- Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.
- Tymoczko J.L, Berg J.M and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
- Berg J.M, Tymoczko J.L and Stryer L (2011) Bio chemistry, W.H. Freeman and Company.
- Nelson D.L and Cox M.M (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
- Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A .6th edition.
- Hardin, J., Becker, G.S, Kliensmith, L.J. (2012) Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
- Cooper, G.M .and Hausman, R.E. (2009) The Cell: A Molecular Approach, 5th edition. ASM.

MIC-2 (P) Biomolecules and Cell Biology (Practical: 1 credit)	No. of Classes
1. Detection of Carbohydrates and Protein 2. Study of different stages of mitosis and meiosis	20

SEMESTER -II

MDC-2 (T): Biomolecules and Cell Biology

Course Objective

Students should be able to understand the Micromolecules. The accurate measurement and monitoring of the concentration of specific Bio molecules in a living system are crucial to ensure the well-being of the cells and living organism.

Course Outcomes

After the completion of the course, the student will be able to:

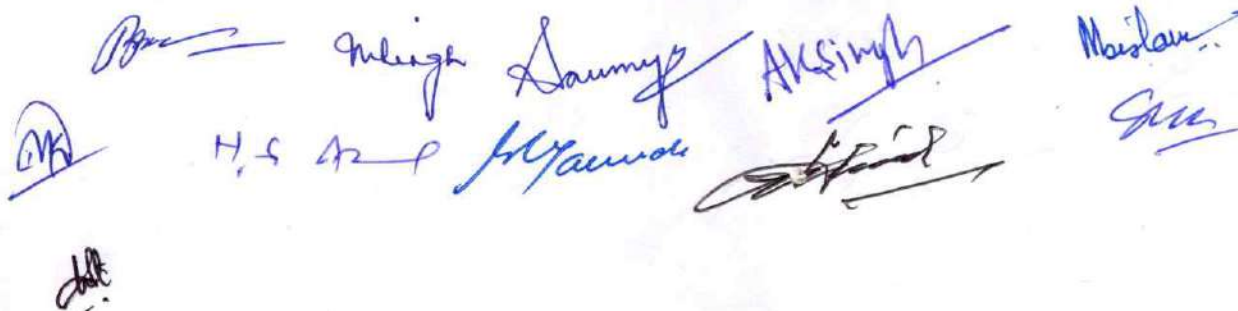
- CO1: Describe the structure and properties of bio molecules
CO2: Explain the classification, properties and functions of enzymes
CO3: Describe cell wall, cell membrane and the structure, chemistry and functions of cellular organelles
CO4: Explain mitotic and meiotic cell divisions

MDC-2 (T) Biomolecules and Cell Biology (Theory: 2 credits)		
Unit	Topics to be covered	No. of Lectures
1	Bio molecules- Structure, classification and function of Carbohydrates, Amino acids, Protein	06
2	Enzymes- Nomenclature, Classification, mode of action	04
3	Cell Biology- a. Structure of the cell as seen under Electron Microscope b. Characteristics of Prokaryotic & Eukaryotic Cells c. Structure of Chromosome d. Mitosis and meiosis	10
TOTAL		20

Suggested Readings:

- Campbell, M.K (2012) Biochemistry, 7th ed., Published by Cengage Learning.
- Tymoczko J.L, Berg J.M and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
- Berg J.M, Tymoczko J.L and Stryer L (2011) Bio chemistry, W.H. Freeman and Company.
- Nelson D.L and Cox M.M (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company.
- Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A .6th edition.

MDC-2 (P) Biomolecules and Cell Biology (Practical: 1 credit)	No. of Classes
1. Detection of Carbohydrates and Protein 2. Study of different stages of mitosis and meiosis	20



SEMESTER -III

MJC-3 (T): Mycology and Phytopathology

Course Objective

Students will acquire sound theoretical knowledge and understanding of the fundamentals of fungal groups and lichens, their ecology, classification, characteristics, reproduction and economic importance. Moreover, few fungi are fatal for plants, as they cause serious diseases. Study of their control measures are important for their further spread.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1:** Develop an understanding about the thallus organization, nutrition, economic importance and life cycle of various fungi
CO2: Understand the terms, scope and importance of plant pathology
CO3: Describe the etiology, symptoms and control measures of plant diseases
CO4: Learn about various associations: Lichens and Mycorrhizae

MJC-3 (T)		Mycology and Phytopathology (Theory: 3 credits)
Unit	Topics to be covered	No. of Lectures
1	Fungi: General characteristics; Thallus organization; Nutrition; Cell wall composition; Reproduction and Classification	10
2	Structure and life history of the following genera: <i>Synchytrium</i> , <i>Albugo</i> , <i>Peziza</i> , <i>Puccinia</i> and <i>Alternaria</i>	10
3	Phytopathology: Terms and concepts; General symptoms; Host-Pathogen relationships; disease cycle; prevention and control of plant diseases	10
4	Etiology, symptoms and control of the following diseases: Citrus canker, Little leaf of brinjal, Early and Late blight of potato, Black stem rust of wheat and White rust of crucifers, Red rot of sugarcane. General account of Lichens, types & economic importance; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance	10
TOTAL		40

Suggested Readings:

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
2. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
4. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.
5. Vashishtha, B.R. Sinha, A.K. (2005). Botany for degree Students Part II, S. Chand & Company Ltd. 2nd edition.
6. Bilgrami, K.S. Dubey, H.C. (2005). A text book of Modern Plant Pathology, Vikas Publishing Home Pvt. Ltd. 2nd edition.

MJC-3 (P)	Mycology and Phytopathology (Practical: 2 credits)	No. of Classes
Practical: 1. Mycology: Study of vegetative and reproductive structures of <i>Rhizopus</i> and <i>Peziza</i> (ascocarp) through temporary preparations and permanent slides 2. Lichen: Study of growth forms of lichens (crustose, foliose and fruticose) on different substrates (Photographs); Mycorrhizae: ectomycorrhizal and endomycorrhiza (Photographs) 3. Phytopathology: Study of Host-parasite relationship of <i>Synchytrium</i> , <i>Albugo</i> , <i>Alternaria</i> and <i>Puccinia</i> through temporary preparations and permanent slides 4. Photographs of fungal spores 5. Herbarium specimens/Photographs of Citrus Canker; TMV, Early blight of potato, Black stem rust of wheat and White rust of crucifers		40

SEMESTER –III

MJC-4 (T): Archegoniate

Course Objective

This course is designed to let students have a basic knowledge of bryophytes, pteridophytes and gymnosperms, in terms of their life cycle, evolution and diversity. Students will have in-depth knowledge about their economic importance.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Develop awareness about morphology, diversity and evolution of bryophytes, pteridophytes and gymnosperms
 CO2: Compare the life cycle of various bryophytes, pteridophytes and gymnosperms
 CO3: Understand the economic importance of the bryophytes, pteridophytes and gymnosperms
 CO4: Know the importance of studying fossils

MJC-4 (T)		Archegoniate (Theory: 3 credits)
Unit	Topics to be covered	No. of Lectures
1	Distinguishing features of archegoniates; Alternation of generation	02
2	Bryophytes: General Characteristics, Adaptation to land habit, Classification (up to family); Vegetative reproduction; Range of thallus organization; Structure, life history and affinities of the following genera- <i>Marchantia</i> , <i>Anthoceros</i> and <i>Sphagnum</i> ; Ecological and economic importance of bryophytes	12
3	Pteridophytes: General characteristics, classification (up to family), stelar evolution, apogamy and apospory, morphology, anatomy and reproduction of <i>Psilotum</i> , <i>Selaginella</i> (with special reference to seed habit), <i>Equisetum</i> and <i>Marsilea</i> ; Ecological and economic importance; Fossil Pteridophyte- <i>Rhynia</i>	14
4	Gymnosperm: General characteristics, classification (up to family), morphology, anatomy and reproduction of <i>Cycas</i> , <i>Pinus</i> and <i>Gnetum</i> ; Ecological and economic importance; Fossil Gymnosperm – <i>Lyginodendron</i>	12
TOTAL		40

Suggested Readings:

1. Vander-Poorteri 2009 Introduction to Bryophytes, COP.
2. Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta, S. Chand. Delhi, India.
3. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms,, New Age International (P) Ltd Publishers, New Delhi, India.
4. Vashistha, P.C., Sinha, A.K. Kumar, A. (2006). Botany for degree students: Gymnosperm, S. Chand & Company Pvt. Ltd.
5. Srivastava, H.N. (2002). Gymnosperm, Pradeep Publications. 10th edition.
6. Rashid A. (1999). An introduction to Pteridophyta Vikas Publishing Home Pvt. Ltd. 2nd edition.
7. Puri P. (1996). Bryophyta: Morphology, Growth and Differentiation, Atma Ram and Sons, 2nd edition.

MJC-4 (P)	Archegoniate (Practical: 1 credit)	No. of Classes
Practical: 1. Bryophytes: Study of vegetative and reproductive structures of <i>Marchantia</i>, <i>Anthoceros</i>, <i>Sphagnum</i> through temporary preparations and permanent slides 2. Pteridophytes: Study of vegetative and reproductive structures of <i>Psilotum</i>, <i>Selaginella</i>, <i>Equisetum</i> and <i>Marsilea</i> through temporary preparations and permanent slides 3. Gymnosperms: Study of vegetative and reproductive structures of <i>Cycas</i>, <i>Pinus</i> and <i>Gnetum</i> through temporary preparations and permanent slides		20

MIC-3 (T): Mycology and Phytopathology**Course Objective**

Students will acquire sound theoretical knowledge and understanding of the fundamentals of fungal groups and lichens, their ecology, classification, characteristics, reproduction and economic importance. Moreover, few fungi are fatal for plants, as they cause serious diseases. Study of their control measures are important for their further spread.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Describe the thallus organization, nutrition, economic importance and life cycle of various fungi
 CO2: Explain the diversity, structure and importance of lichen and mycorrhiza
 CO3: Describe the terms, scope and importance of plant pathology
 CO4: Describe the etiology, symptoms and control measures of plant diseases

MIC-3 Mycology and Phytopathology (Theory: 2 credits)		
Unit	Topics to be covered	No. of Lectures
1	Fungi: General characteristics; Thallus organization General account of Lichens, types & economic importance; Mycorrhiza-Ectomycorrhiza, Endomycorrhiza and their significance	06
2	Structure and life history of the following genera: <i>Synchytrium</i> and <i>Puccinia</i>	06
3	Etiology, symptoms and control of the following diseases: Citrus canker, Little leaf of brinjal, Late blight of potato, White rust of crucifers	08
	TOTAL	20

Suggested Readings :

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
2. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
4. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.
5. Vashishtha, B.R. Sinha, A.K. (2005). Botany for degree Students Part II, S. Chand & Company Ltd. 2nd edition.
6. Bilgrami, K.S. Dubey, H.C. (2005). A text book of Modern Plant Pathology, Vikas Publishing Home Pvt. Ltd. 2nd edition.

MIC-3 (P)	Mycology and Phytopathology (Practical: 1 credit)	No. of Classes
Practical :		20
1. Photographs of above mentioned diseases.		
2. Temporary slide preparation of diseases studied in theory		

MDC-3: Horticultural Practices**Course Objective**

The course will let the students understand the basic scope and importance of horticulture and gain in-depth knowledge of various fruits, vegetables and ornamental plants.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Understand the scope and importance of horticulture
 CO2: Obtain knowledge of different fruits, vegetables and ornamental plants.
 CO3: Know the basics of horticulture practices for fruits, vegetables and ornamental plants
 CO4: Understand the importance of Post-harvest technology.

MIC-10 Horticultural Practices (Theory: 3 credits)		
Unit	Topics to be covered	No. of Lectures
1	Introduction: Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Urban horticulture and ecotourism.	06
2	Ornamental plants: Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, carnations, cacti and succulents] Fruit and vegetable crops: Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties banana, mango, chillies and cucurbits).	12
3	Horticultural techniques: Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Propagation Methods: asexual (grafting, cutting, layering, budding)	12
	TOTAL	30

Suggested Readings :

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA

SEMESTER – IV**MJC-5 (T): Morphology and Anatomy****Course Objective**

This course will introduce the concept of tissue system, its relevance and presence in the plant body. Students will also acquire knowledge about normal and anomalous secondary growth in plant system. Tissue organization in relation to environment will be studied. Students will acquire the knowledge about the morphological features of plant.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Know the morphological characters of plants.
 CO2: Understand the tissue system and the normal as well as anomalous secondary growth in plants.
 CO3: Learn about the structural adaptations in plants growing in different environmental conditions
 CO4: Describe the structure and function of periderm

MJC-5 (T) Morphology and Anatomy (Theory: 3 credits)		
Unit	Topics to be covered	No. of Lectures
1	Brief account of inflorescence, flowers, fruits and seeds	08
2	Meristem and permanent tissue; Root and shoot meristem, simple and complex tissue Mechanical Tissues – Structure, distribution and function	10
3	Normal secondary growth; Anomalous secondary growth in <i>Tinospora</i> , <i>Bignonia</i> , <i>Boerhaavia</i> , and <i>Dracaena</i>	10
4	Organization of tissue in relation to environment: Hydrophytes, Xerophytes, Halophytes and Epiphytes Periderm – Origin, structure and function	12
TOTAL		40

Suggested Readings:

1. Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy, Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy, The Benjamin/Cummings Publisher, USA.
4. Esau, K. (1977). Anatomy of Seed Plants, John Wiley & Sons, Inc., Delhi.
5. Vasishtha, P.C. (2004). Plant Anatomy, Pradeep Publication. 17th edition.
6. Grewal, R.C. (2011). Plant Anatomy, Campus Book International. 1st edition.
7. Singh S.K. Srivastava. S. (2014). Anatomy of angiosperms, Campus Books International. 1st edition.

MJC-5 (P)	Morphology and Anatomy (Practical: 2 credits)	No. of Classes
Practical 1. Study of anatomical details through permanent slides/temporary stain mounts/ Photographs 2. Distribution and types of parenchyma, collenchyma and sclerenchyma through permanent slides/temporary stain mounts/ Photographs 3. Study of anomalous secondary growth in <i>Tinospora</i> , <i>Bignonia</i> , <i>Boerhaavia</i> , and <i>Dracaena</i> through temporary preparations and permanent slides 4. Study of morphological and anatomical adaptations in hydrophytes and xerophytes through specimens and temporary slide preparations.		40

SEMESTER – IV

MJC-6: Economic Botany

Course Objective

Students will acquire sound theoretical knowledge and understanding of the botanical characteristics, economic importance and distribution pattern of crops, fruits, vegetables, timber and fiber-yielding plants etc. Students will also study uses of medicinal, sugar and starch yielding plants.

Course Outcomes

After the completion of the course, the student will be able to:

CO1: Create awareness about plants of economic importance

CO2: Know about their distribution patterns

CO3: Acquire skill in identification of medicinal plants

CO4: Learn about their cultivation and economic importance

MJC-6 (T)	Economic Botany (Theory: 5 credits)	
Unit	Topics to be covered	No. of Lectures
1	Botanical characteristics, cultivation and uses of Cereals (Wheat, Maize and Rice), Legumes (Gram, Garden pea), Oil and Fats (Mustard and Groundnut) yielding plants	14
2	Botanical characteristics, cultivation and uses of Spices (Coriander, Chilli and Turmeric), Fruits and Vegetables (Mango, Litchi, Cauliflower, Brinjal)	12
3	Botanical characteristics, cultivation, processing and uses of Beverages (Tea and Coffee), Narcotics, Timber and Fiber yielding plant (Sal, Teak, Cotton, Jute), Rubber and Gum yielding plants	14
4	Botanical characteristics, cultivation and uses of ten (10) Medicinal plants of Bihar; Sugar (Sugarcane) and Starch (Potato) yielding plants.	10
	TOTAL	50

Suggested Readings :

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
2. Chrispeels, M.J. and Sadava, D.E. (2003). Plants, Genes and Agriculture, Jones & Bartlett Publishers.
3. Pandey, B.P. (2005). Economic Botany, S. Chand & Company Pvt. Ltd. 6th edition.
4. Kochner, S.N. (2016). Economic Botany: A Comprehensive Study, Cambridge University Press. 5th edition.
5. Sharma, V. K., Shenai, S. K. (2013). Economically Important Medicinal Plants, Campus Book International. 1st edition.



MJC-7 : Genetics

This course is designed to facilitate students to understand the basic concepts of genetics, especially Mendelian laws of inheritance and its variations. Chromosomal disorders leading to various genetic disorders, mutations etc. will be introduced.

After the completion of the course, the student will be able to:

- CO1: Understand Mendelian laws of inheritance and its variations
CO2: Comprehend the effect of chromosomal abnormalities leading to genetic disorders
CO3: Know the details of mutations and their uses
CO4: Know about the sex determination and sex linked inheritance

Suggested Readings :

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th edition.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics, Benjamin Cummings, U.S.A. 10th edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis, W. H. Freeman and Co., U.S.A. 10th edition.
5. Verma, P.S. Agarwal, V.K. (2010). Genetics, S. Chand & Company Pvt. Ltd. 2nd edition.
6. Singh, B.D. (2014). Genetics, Kalyani Publishers. 2nd edition.
7. Gupta P.K. (2001). Genetics, Rastogi Publication. 3rd edition.

SEMESTER – IV

MIC-4 (T): Morphology and Anatomy

Course Objective

This course will introduce the concept of tissue system, its relevance and presence in the plant body. Students will also acquire knowledge about normal and anomalous secondary growth in plant system. Tissue organization in relation to environment will be studied. Students will acquire the knowledge about the morphological features of plant.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Explain the tissue system in plants and their functions
- CO2: Understand the normal and anomalous secondary growth in plants and their causes
- CO3: Learn about the structural adaptations in plants growing in different environmental conditions
- CO4: Describe the structure and function of periderm

MIC-4 Morphology and Anatomy (Theory: 2 credits)		
Unit	Topics to be covered	No. of Lectures
1	Brief account of inflorescence, flowers, fruits and seeds	05
2	Meristem and permanent tissue.	05
3	Normal secondary growth; Anomalous secondary growth in <i>Tinospora</i> , <i>Boerhaavia</i> , and <i>Dracaena</i>	05
4	Organization of tissue in relation to environment: Hydrophytes, Xerophytes, Halophytes and Epiphytes	05
TOTAL		20

Suggested Readings :

1. Dickison, W.C. (2000). Integrative Plant Anatomy, Harcourt Academic Press, USA.
2. Fahn, A. (1974). Plant Anatomy, Pergmon Press, USA.
3. Mauseth, J.D. (1988). Plant Anatomy, The Benjamin/Cummings Publisher, USA.
4. Esau, K. (1977). Anatomy of Seed Plants, John Wiley & Sons, Inc., Delhi.
5. Vasishtha, P.C. (2004). Plant Anatomy, Pradeep Publication. 17th edition.
6. Singh S.K. Srivastava. S. (2014). Anatomy of angiosperms, Campus Books International. 1st edition.

MIC-4 Morphology and Anatomy (Practical: 1 credit)		No. of Classes
Practical		20
1.	Study of anatomical details through slides/ Photographs	
2.	Study of morphological and anatomical adaptations in hydrophytes and xerophytes through specimens and slide	

SEMESTER – V

MJC-8 (T): Molecular Biology

Course Objective

Hereditary material DNA and RNA will be introduced. Concepts like transcription, translation and gene regulation in both prokaryotes and eukaryotes will be explained. Students will also have an understanding of various modern biological techniques. The techniques gained through hands-on methods opens a choice of joining the industrial laboratory work force after graduation.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Decipher the structures and chemical properties of DNA and RNA and their role
- CO2: Understand various steps in transcription and translation in prokaryotes and eukaryotes
- CO3: Know about gene regulation in prokaryotes and eukaryotes
- CO4: Gain knowledge of modern biology techniques

MJC-8 (T) Molecular Biology (Theory: 3 credits)		
Unit	Topics to be covered	No. of Lectures
1	Nucleic acids: structures of DNA and RNA, forms of DNA, DNA replication and role of DNA polymerases, different forms of RNA and their role, Genetic code	12
2	Central dogma, Transcription and Translation in prokaryotes and eukaryotes	10
3	Gene regulation in prokaryotes (Lac operon) and eukaryotes	08
4	Blotting techniques: northern, southern & western blotting, DNA fingerprinting, Gel Electrophoresis, Polymerase Chain Reaction	10
TOTAL		40

Suggested Readings:

1. Watson J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., Losick, R. (2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
3. Russell, P. J. (2010). Genetics- A Molecular Approach. Benjamin Cummings, U.S.A. 3rd edition.
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis, W. H. Freeman and Co., U.S.A. 10th edition.
5. Karp Gerald (2010). Cell Biology, John Wiley and Sons., Inc. 6th edition

MJC-8 (P) Molecular Biology (Practical: 2 credits)		No. of Classes
Practical 1. DNA isolation from plant sources. 2. DNA estimation by diphenylamine reagent/UV Spectrophotometry 3. Study of DNA replication mechanisms through photographs 4. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs		40

SEMESTER – V

MJC-9 (T): Plant Ecology and Phytogeography

Course Objective

This course is designed to develop an in depth knowledge of the core concepts and principles of ecology and phytogeography. Students will acquire information about soil properties, types of pollution and biogeochemical cycles. Students will also get to understand the importance of conservation of biodiversity, and important climatic events like global warming and ozone hole.

Course Outcomes

After the completion of the course, the student will have to:

- CO1:** Knowledge of plant communities and ecological adaptations in plants
- CO2:** Understand about the soils on the basis of physical, chemical and biological components
- CO3:** Know about the types of pollution and their control measures
- CO4:** Get idea about the conservation of biodiversity, types and control of pollution phyto-geographical regions of India and non-conventional energy

MJC-9 (T) Plant Ecology and Phytogeography (Theory: 3 credits)		
Unit	Topics to be covered	No. of Lectures
1	Environment, Ecology, Biosphere, Biome, habitat, niche; Adaptation of hydrophytes and xerophytes Biotic interactions: Beneficial and harmful interactions (symbiosis, commensalism, amensalism, herbivory, predation, parasitism)	06
2	Population ecology: Characteristics and Regulations Community ecology: Concept of ecological amplitude; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession (Hydrosere and Xerosere) Ecosystem: Structure and function of ecosystem, food chains and webs, Principles and models of energy flow, ecological pyramids	12
3	Soil: Origin, Formation, Composition (Physical, Chemical and Biological), Soil profile and importance Water: Precipitation types (rain, fog, snow, hail, dew), Soil water and Water table	10
4	Biogeochemical cycles: Gaseous and sedimentary cycles, Hydrological cycle Environmental pollution: Air pollution, water pollution, noise pollution, radioactive pollution and their control measures, global Warming and Ozone hole Phytogeography: Major vegetational belts of India, Basic concept of wetlands with special reference to Bihar; Conservation of biodiversity	12
TOTAL		40

Suggested Readings :

1. Odum, E.P. (2005). Fundamentals of ecology, Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation, Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment, Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach, Oxford University Press. U.S.A.
5. Dash, M.C., Dash, S.P. (2009). Fundamentals of Ecology, Tata McGraw Hill. 3rd edition.
6. Shukla, R.S., Chandel, P.S. (2010). A text book of Plant Ecology, S. Chand & Company Pvt. Ltd. 2nd edition.

MJC-9 (P)	Plant Ecology and Phytogeography (Practical: 2 credits)	No. of Classes
1. Determination of pH of various soil and water samples 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid soil tests 3. Study of morphological and anatomical adaptations of hydrophytes and xerophytes 4. Study of biotic interactions of the following: Stem parasite (<i>Cuscuta</i>), Root parasite (<i>Orobanche</i>) Epiphytes, Predation (Insectivorous plants) through specimens/photographs 5. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law 6. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus field visit		40

SEMESTER – V

MIC-5: Economic Botany

Course Objective

Students will acquire sound theoretical knowledge and understanding of the botanical characteristics, economic importance and distribution pattern of crops, fruits, vegetables, timber and fiber-yielding plants etc. Students will also study uses of medicinal, sugar and starch yielding plants.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Create awareness about plants of economic importance
CO2: Know about their distribution patterns
CO3: Identify them on the basis of their botanical features
CO4: Learn about their cultivation and economic importance

Unit	MIC-5 Economic Botany (Theory: 3 credits)	No. of Lectures
	Topics to be covered	
1	Botanical characteristics, cultivation and uses of Cereals (Wheat), Legumes (Garden pea), Oil and Fats (Mustard) yielding plants	10
2	Botanical characteristics, cultivation and uses of Spices (Chilli), Fruits and Vegetables (Mango, Brinjal)	10
3	Botanical characteristics, cultivation, processing and uses of Beverages (Tea), Timber and Fiber yielding plant (Sal, Cotton) Botanical characteristics, cultivation and uses of five Medicinal plants	10
	TOTAL	30

Suggested Readings :

1. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
 2. Wickens, G.E. (2001). Economic Botany: Principles & Practices, Kluwer Academic Publishers, The Netherlands.
 3. Chrispeels, M.J. and Sadava, D.E. (2003). Plants, Genes and Agriculture, Jones & Bartlett Publishers.
 4. Pandey, B.P. (2005). Economic Botany, S. Chand & Company Pvt. Ltd. 6th edition.
 5. Kochner, S.N. (2016). Economic Botany: A Comprehensive Study, Cambridge University Press. 5th edition.
 6. Sharma, V. K., Shenai, S. K. (2013). Economically Important Medicinal Plants, Campus Book International. 1st edition.
- Arya, P.S. (2000). Spice Crops of India, Kalyani Publishers.

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SEMESTER – VI

MJC-10 (T): Plant Systematics

Course Objective

The aim of this course is to acquaint the students with the systematic arrangement of plants based on their characteristics and different systems of plant classification. Students will acquire knowledge of botanical nomenclature as per ICBN. Tools and techniques of herbarium preparation will be taught.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1:** Identify and classify the local flora
- CO2:** Know about the rules of ICBN
- CO3:** Awareness of different systems of Plant Classification
- CO4:** Preparation of herbarium and its importance

MJC-10 (T) Plant Systematics (Theory: 3 credits)		
Unit	Topics to be covered	No. of Lectures
1	Systematics, Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary) Botanical nomenclature: Idea about important rules of plant nomenclature as per ICBN	12
2	Classification of plants as proposed by Bentham & Hooker and Hutchinson	08
3	Floral characteristics and economic importance of following families: Ranunculaceae, Asclepiadaceae, Apocynaceae, Amaranthaceae, Euphorbiaceae, Lamiaceae, Cyperaceae and Poaceae	10
4	Phylogeny of Angiosperms: Terms and concepts of primitive and advanced, homology and analogy, origin & evolution of angiosperms, methods of illustrating evolutionary relationship (phylogenetic tree, cladogram)	10
TOTAL		40

Suggested Readings:

1. Singh, G. (2012). Plant Systematics: Theory and Practice, Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
2. Jeffrey, C. (1982). An Introduction to Plant Taxonomy, Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach, Sinauer Associates Inc., U.S.A. 2nd edition.
4. Radford, A.E. (1986). Fundamentals of Plant Systematics, Harper and Row, New York.
5. Sharma, O.P. (2016). Plant Taxonomy, McGraw Hill Education Pvt. Ltd. 2nd edition.
6. Sambamurthy, A.V.S.S. (2005). Taxonomy of angiosperms, I.K. International Pvt. Ltd. 1st edition.

MJC-10 (P)	Plant Systematics (Practical: 1 credit)	No. of Classes
Practical : 1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Ranunculaceae, Lamiaceae, Apocynaceae, Amaranthaceae, Asclepiadaceae, Euphorbiaceae and Cyperaceae 2. Preparation of Herbarium sheets (to be submitted in the record book)		40

SEMESTER – VI

MJC-11 (T): Reproductive Biology of Angiosperms

Course Objective

Students will be able to comprehend complete details about the structures, and development of embryo at different stages including gametogenesis, fertilization, etc. Students will be able to understand detailed characteristics of anther and pollen biology, ovule, endosperm, apomixis and polyembryony.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Know about the sporogenesis and gametogenesis.
- CO2: Understand structure and functions of anther wall and pollen wall, pollen biology.
- CO3: Learn detailed study of double fertilization, endosperm and embryo.
- CO4: Comprehend the causes of polyembryony and apomixes.

MJC-11 (T) Reproductive Biology of Angiosperms (Theory: 3 credits)		
Unit	Topics to be covered	No. of Lectures
1	Anther: Structure and functions of anther wall, microsporogenesis and microgametogenesis; Palynology and scope (a brief account); Pollen viability, germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia	10
2	Ovule: Structure and Types; Special structures—endothelium, obturator, aril, caruncle and hypostase; Female Gametophyte (Types of Embryo sacs) and megagametogenesis (details of <i>Polygonum</i> type); Organization and ultrastructure of mature embryo sac; Double fertilization Endosperm: Types, development and its morphological natures	16
3	Embryo: General pattern of development of dicot and monocot embryo	08
4	Apomixis & Polyembryony – Definition, types and applications	06
TOTAL		40

Suggested Readings :

1. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House, Delhi. 5th edition.
2. Shivanna, K.R. (2003). Pollen Biology and Biotechnology, Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V. (2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. I (1984). Embryology of Angiosperms, Springer-Verlag, Netherlands.
5. Johri, B.N. Ambegaokar, K.B., Srivastava, P.S. (2015). Comparative Embryology of Angiosperms, Vol. 1 & 2. Springer. 1st edition.

MJC-11 (P)	Reproductive Biology of Angiosperms (Practical: 2 credits)	No. of Classes
Practical : 1. Photographs/slides of pollen grains of families: Malvaceae, Liliaceae, Asteraceae and Poaceae 2. Study of anther, ovule, double fertilization, endosperm and embryo through slide/photographs/ppt 3. Models of the above topics to be submitted by the students		40

SEMESTER – VI**MJC-12(T): Plant Physiology****Course Objective**

The course aims at making students realize how plants function, namely the importance of water, minerals, hormones, and light in plant growth and development; understand water transport mechanisms in xylem and translocation of solute in the phloem.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Understand Water relation of plants with respect to various physiological processes
 CO2: Know about the mineral nutrition
 CO3: Understand dormancy and germination in plants; learn about types and roles of phytohormones

MJC-12 (T)		Plant Physiology (Theory: 3 credits)
Unit	Topics to be covered	No. of Lectures
1	Plant water relationship: Imbibition, diffusion and osmosis; Water Potential and its components; Active and passive absorption and transport of water and solutes; Ascent of sap; Transpiration and factors affecting transpiration, mechanism of stomatal movement and factors controlling it Transport of organic substances: Path and mechanism of translocation	12
2	Mineral nutrition: Macro and micronutrients and their role in plant nutrition; nutrient uptake and transport mechanisms. role of carriers	06
3	Phytohormones: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Absciscic acid and Ethylene	12
4	Physiology of flowering: Photoperiodism and vernalization; Plant movements, plant growth	10
TOTAL		40

Suggested Readings :

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology, John Wiley and Sons. U. S.A. 4th edition.
3. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual, Narosa Publishing House, New Delhi.
4. Jain V. K. (2014). Fundamentals of Plant Physiology, S. Chand & Company Ltd. 16th Revised edition
5. Verma V. (2016). Plant Physiology, Athena Academic. 2nd edition.
6. Mazumdar, B.C. (2005). Photoperiodism and Vernalization in Plants, Daya Publishing House. 1st edition.
7. Mukherji, S., Gosh, A.K. (1996). Plant Physiology, New Central Book Agency (P) Ltd. 1st edition.

MJC-12 (P)	Plant Physiology (Practical: 2 credits)	No. of Classes
Practical : 1. Determination of the rate of transpiration by using Farmer's and Ganong's Potometer 2. Determination of the amount of water absorbed and transpired by a plant, using T/A apparatus 3. Study of different types of stomata 4. To compare the rate of imbibition of oily and starchy seeds 5. Study of effect of sugar concentrations on leaf cell by plasmolytic method Demonstration experiments 1. Bell jar experiment 2. Wilmott's bubbler method 3. Demonstration of osmosis using potato		40















SEMESTER – VI

MIC-7 (T): Plant Ecology and Phytogeography

Course Objective

This course is designed to develop in depth knowledge of the core concepts and principles of ecology and phytogeography. Students will acquire information about soil properties, types of pollution and biogeochemical cycles. Students will also get to understand the importance of conservation of biodiversity, and important climatic events like global warming and ozone hole.

Course Outcomes

After the completion of the course, the student will have to:

- CO1:** Knowledge of plant communities and ecological adaptations in plants
- CO2:** Knowledge about the succession and soils on the basis of physical, chemical and biological components
- CO3:** Know about the types of pollution and their control measures
- CO4:** Knowledge about the types and control of pollution, phyto-geographical regions of India

MIC-7 Plant Ecology and Phytogeography (Theory: 3 credits)		
Unit	Topics to be covered	No. of Lectures
1	Environment, Ecology, Biosphere, Biome, habitat, niche; Adaptation of hydrophytes and xerophytes Biotic interactions: Beneficial and harmful interactions (symbiosis, commensalism, amensalism, herbivory, predation, parasitism)	6
2	Community ecology: Concept of ecological amplitude; Characters: analytical and synthetic; Dynamics: succession (Hydrosere and Xerosere) Ecosystem: Structure and function of ecosystem, food chains and webs, Principles and models of energy flow, ecological pyramids	10
3	Soil: Origin, Formation, Composition (Physical, Chemical and Biological) Soil profile and importance	4
4	Biogeochemical cycles: Gaseous cycles Environmental pollution: Air pollution, water pollution, noise pollution, radioactive pollution and their control measures, global Warming and Ozone hole Phytogeography: Major vegetational belts of India	10
TOTAL		30

Suggested Readings:

1. Odum, E.P. (2005). Fundamentals of ecology, Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2. Singh, J.S., Singh, S.P., Gupta, S. (2006). Ecology Environment and Resource Conservation, Anamaya Publications, New Delhi, India.
3. Sharma, P.D. (2010). Ecology and Environment, Rastogi Publications, Meerut, India. 8th edition.
4. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach, Oxford University Press. U.S.A.
5. Dash, M.C., Dash, S.P. (2009). Fundamentals of Ecology, Tata McGraw Hill. 3rd edition.
6. Shukla, R.S., Chandel, P.S. (2010). A text book of Plant Ecology, S. Chand & Company Pvt. Ltd. 2nd edition.

SEMESTER – VI

MIC-8 (T): Plant Systematics

Course Objective

The aim of this course is to acquaint the students with the systematic arrangement of plants based on their characteristics and different systems of plant classification. Students will acquire knowledge of botanical nomenclature as per ICBN. Tools and techniques of herbarium preparation will be taught.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Identify and classify the local flora
- CO2: Know about the rules of ICBN
- CO3: Awareness of Plant Classification
- CO4: Preparation of herbarium and its importance

MIC-8 Plant Systematics (Theory: 2 credits)		
Unit	Topics to be covered	No. of Lectures
1	Systematics, Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary) Botanical nomenclature: Idea about important rules of plant nomenclature as per ICBN	08
2	Classification of plants as proposed by Bentham & Hooker	03
3	Floral characteristics and economic importance of following families: Ranunculaceae, Apocynaceae, Euphorbiaceae and Cyperaceae	10
	TOTAL	48

Suggested Readings :

1. Singh, G. (2012). Plant Systematics: Theory and Practice, Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
2. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach, Sinauer Associates Inc., U.S.A. 2nd edition.
3. Radford, A.E. (1986). Fundamentals of Plant Systematics, Harper and Row, New York.
4. Sharma, O.P. (2016). Plant Taxonomy, McGraw Hill Education Pvt. Ltd. 2nd edition.
5. Sambamurthy, A.V.S.S. (2005). Taxonomy of angiosperms, I.K. International Pvt. Ltd. 1st edition.

MIC-8 Plant Systematics (Practical: 1 credit)		No. of classes
Practical : 1. Study of vegetative and floral characters of the above families. 2. Preparation of Herbarium sheets (to be submitted in the record book)		20

SEMESTER – VII

MJC-13: Plant Metabolism

Course Objective

Students will have a comprehensive study of different pathways of carbon assimilation including their biochemistry and molecular details. To gain the knowledge of physiological and biochemical processes in the plant system especially its photosynthetic and respiratory pathways. Biological nitrogen fixation in legumes and non-leguminous plants will be taught.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1:** Understand the anabolic and catabolic pathways of metabolism
- CO2:** Recognize the importance of carbon assimilation in photorespiration
- CO3:** Understand ATP synthesis in respiration
- CO4:** Interpret the biological nitrogen fixation

MJC-13 Plant Metabolism (Theory: 5 credits)		
Unit	Topics to be covered	No. of Lectures
1	Concept of metabolism, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and isozymes)	06
2	Photosynthesis: photosynthetic apparatus, pigments, photochemical reactions, electron transport pathways in chloroplast membranes, photophosphorylation, Calvin Cycle, Crassulacean Acid Metabolism, Hatch & Slack pathway; Photorespiration	14
3	Respiration: Glycolysis, TCA Cycle; oxidative phosphorylation, Pentose Phosphate Pathway, Respiratory quotient	12
4	Biological nitrogen fixation (examples of legumes and non-legumes)	08
	TOTAL	40

Suggested Readings :

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology, John Wiley and Sons. U. S.A. 4th edition.
2. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development, Sinauer Associates Inc. USA. 6th edition.
4. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual, Narosa Publishing House, New Delhi.
5. Jain V. K. (2014). Fundamentals of Plant Physiology, S. Chand & Company Ltd. 16th Revised edition.
6. Verma V. (2016). Plant Physiology, Athena Academic. 2nd edition.
7. Harborne, J.B. (1973). Phytochemical Methods, John Wiley & Sons. New York.
8. Pathak, V.N., Khatri, N.K., Pathak, M. (2012). Fundamental of Plant Physiology, Agribios. 5th edition.

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SEMESTER – VII

MJC-14: Research Methodology of Faculty of Science

SEMESTER – VII

MJC-15 (T): Recombinant DNA technology and Plant Biotechnology

Course Objective

The objective of the course is to give students new knowledge and widening of the knowledge acquired in other courses by handling of classical and modern plant biotechnology processes, including tissue culture for healthy plants, plants with improved characteristics. This course explores the use of biotechnology to both generate genetic variation in plants and to understand how factors at the cellular level contribute to the expression of genotypes and hence to phenotypic variation. Understanding of biotechnological processes such as recombinant DNA technology and its applicative value in pharmaceuticals, food industry (transgenic crops), agriculture etc This knowledge is central to our ability to modify plant responses and properties for global food security and commercial gains in biotechnology and agriculture.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Have knowledge about the core enzymes involved in Recombinant DNA Technology
- CO2: Have knowledge about the different steps of Recombinant DNA Technology
- CO3: Understand the principle and basic protocols for Plant Tissue Culture and its application
- CO4: Know about the role of rDNA and Plant Biotechnology as well as biosafety concerns of GMO

MJC-15 (T) Recombinant DNA technology and Plant Biotechnology (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	rDNA technology: History; Major enzymes used: Restriction enzymes-types and cleavage pattern; DNA ligase- types and ligation process. Steps of Genetic engineering: Selection of cloning vectors- Plasmids (natural, pBR322), Phages, cosmid.	10
2	Passenger DNA: Different strategies used for isolation/synthesis of gene; Construction of genomic and cDNA libraries Construction of rDNA: Different strategies for construction of rDNA. Methods of DNA transfer in suitable host: electroporation, microinjection, particle gun method. Selection strategies: Different methods for selection of clone (antibiotic resistant markers, colony hybridization, immune-screening) Expression of foreign gene	12
3	Plant Tissue Culture: Basic aspect, totipotency, organogenesis, embryogenesis (somatic and zygotic), Role of plant tissue culture in growth, development and differentiation, anther culture and their applications micro-propagation Germplasm conservation, Cryopreservation	10
4	Application of Recombinant DNA technology: In medicine (Humulin) and Agriculture (Bt-cotton, Flavr Savr tomato, Golden rice). Biosafety concerns on GMO	08
TOTAL		40

Suggested Readings :

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice, Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA, ASM Press, Washington.
3. Singh, B.D. (2012). Biotechnology : Expanding Horizons, Kalyani Publishers, 4th edition.
4. Dubey R.C. (2006). A text book of Biotechnology, S. Chand & Company Pvt. Ltd. 4th edition.

MJC-14 (P)	Recombinant DNA technology and Plant Biotechnology (Practical: 2 credits)	No. of Classes
1. (a) Preparation of MS medium (b) Demonstration of <i>in vitro</i> sterilization and inoculation methods using leaf and nodal explants of tobacco, <i>Datura</i> , <i>Brassica</i> etc. 2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs 3. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs 4. Isolation of genomic DNA from cauliflower 4. Models on the above mentioned topics to be submitted by the students	40	

SEMESTER – VII**MIC-9 (T): Plant Physiology****Course Objective**

The course aims at making students realize how plants function, namely the importance of water, minerals, hormones, and light in plant growth and development; understand transport mechanisms and translocation in the phloem.

Course Outcomes

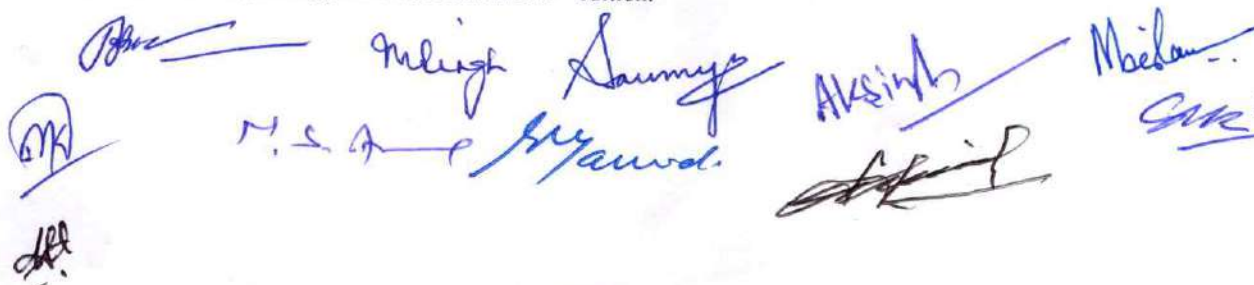
After the completion of the course, the student will be able to:

- CO1: Understand Water relation of plants with respect to various physiological processes
CO2: Know about the mineral nutrition
CO3: Learn about types and roles of phytohormones

MIC-9 Plant Physiology (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Plant water relationship: Imbibition, diffusion and osmosis; Water Potential and its components; Active and passive absorption and transport of water and solutes; Ascent of sap; Transpiration and factors affecting transpiration, Transport of organic substances	20
2	Mineral nutrition: Macro and micronutrients and their role in plant nutrition	06
3	Phytohormones: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins and Cytokinin	14
	TOTAL	40

Suggested Readings :

1. Taiz, L., Zeiger, E., Møller, I.M. and Murphy, A (2015). Plant Physiology and Development, Sinauer Associates Inc. USA. 6th edition.
2. Bajracharya D. (1999). Experiments in Plant Physiology-A Laboratory Manual, Narosa Publishing House, New Delhi.
3. Jain V. K. (2014). Fundamentals of Plant Physiology, S. Chand & Company Ltd. 16th Revised edition
4. Verma V. (2016). Plant Physiology, Athena Academic. 2nd edition.



SEMESTER – VIII
MJC-16: Horticultural Practices and Post-Harvest Technology

Course Objective

The course will let the students understand the basic scope and importance of horticulture and gain in-depth knowledge of various fruits, vegetables and ornamental plants. This course is also designed to facilitate the students to know the basic concept of post-harvest technology.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Understand the scope and importance of horticulture
 CO2: Obtain knowledge of different fruits, vegetables and ornamental plants.
 CO3: Know the basics of horticulture practices for fruits, vegetables and ornamental plants
 CO4: Understand the importance of Post-harvest technology.

MJC-16 Horticultural Practices and Post-Harvest Technology (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Introduction: Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Urban horticulture and ecotourism.	02
2	Ornamental plants: Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, poppies, tuberose, cacti and succulents] Fruit and vegetable crops: Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetables and fruits; Identification of some fruits and vegetables (citrus, banana, mango, chillies and cucurbits).	10
3	Horticultural techniques: Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.	10
4	Landscaping and garden design: Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices. Floriculture: Cut flowers, bonsai, commerce (market demand and supply); Importance of flower shows and exhibitions.	08
5	Post-harvest technology: Importance of post harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing losses during storage and transportation; Food irradiation - advantages and disadvantages; food safety. Disease control and management: Field and post-harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices.	10
TOTAL		40

Suggested Readings:

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.

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SEMESTER – VIII

MIC-10: Horticultural Practices

Course Objective

The course will let the students understand the basic scope and importance of horticulture and gain in-depth knowledge of various fruits, vegetables and ornamental plants.

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Understand the scope and importance of horticulture
- CO2: Obtain knowledge of different fruits, vegetables and ornamental plants.
- CO3: Know the basics of horticulture practices for fruits, vegetables and ornamental plants
- CO4: Understand the importance of Post-harvest technology.

MIC-10 Horticultural Practices (Theory: 4 credits)		
Unit	Topics to be covered	No. of Lectures
1	Introduction: Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Urban horticulture and ecotourism.	08
2	Ornamental plants: Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, carnations, cacti and succulents] Fruit and vegetable crops: Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identification of some fruits and vegetable varieties banana, mango, chillies and cucurbits).	16
3	Horticultural techniques: Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Propagation Methods: asexual (grafting, cutting, layering, budding)	16
	TOTAL	40

Suggested Readings :

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA

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RP1: Project/Dissertation (12 Credits)

Course Outcomes

After the completion of the course, the student will be able to:

- CO1: Acquire special/advanced knowledge through a project work with an advisory support of a teacher/faculty member
- CO2: Apply knowledge involving / analyzing /exploring a real life situation / difficult problem
- CO3: Practical work in the field and laboratory experiments will enhance skills in handling scientific instruments
- CO4: Enhance presentation (writing and oral) skills

RP-1	Project/Dissertation (12 Credits)
Dissertation or project work as one Discipline Specific Elective paper (12 credits) in 8th Semester.	
Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his/her own with an advisory support by a teacher/ faculty member is called dissertation/project.	
Project work/Dissertation is considered as a special course involving application of knowledge involving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 12 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper	

Component of CIA (For theory and Practical):

(i) One mid-semester written test (1x15) =	15 marks
(ii) Seminar/Quiz/Presentation/Assignment =	10 marks
(iii) Attendance and Conduct=	05 marks
Total=	30 marks

The question paper pattern of ESE shall consist of three parts-

Part A- Compulsory-consisting of object type/multiple choice type each carrying two marks-
10x2= 20 marks

Part B- Short answer Type- Four questions to be answered out of six questions each carrying five marks-
04x5=20 marks

Part C- Long Answer Type- Three questions to be answered out of Five questions each carrying ten marks-
03x10=30

[Signatures]
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Mishra ...
AK Singh ...
Gill ...
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