MAHARSHI DAYANAND SARASWATI UNIVERSITY,
AJMER

पाठ्यक्रम

SYLLABUS

SCHEME OF EXAMINATION AND
COURSES OF STUDY

FACULTY OF SCIENCE

B.Sc. BIOTECHNOLOGY

B.Sc. Previous Examination
B.Sc. Final Examination

ALKA PUBLICATIONS
Purani Mandi, Ajmer

NOTICE

1. Change in Statutes/Ordinances/Rules/ Regulations Syllabus and Books may, from time to time, be made by amendment or remaking, and a candidate shall, except in so far as the University determines otherwise comply with any change that applies to years he has not completed at the time of change. **The decision taken by the Academic Council shall be final.**

सूचना

1. समय–समय पर संशोधन या पुन: निर्माण कर परिनियमों/ अध्यादेशों/नियमों / विनियमों / पाठ्यक्रमों व पुस्तकों में परिवर्तन किया जा सकता है, तथा किसी भी परिवर्तन को छात्र को मानना होगा बशर्ते कि विश्वविद्यालय ने अन्यथा प्रकार से उनको छूट न दी हो और छात्र ने उस परिवर्तन के पूर्व वर्ष पाठ्यक्रम को पूरा न किया हो। विद्या परिषद द्वारा लिये गये निर्णय अन्तिम होंगे।

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अनिवार्य विषय

B.A. Part - I / B.Sc. Part - I / B.Com. Part I

गाँधी जीवन और दर्शन

(Life and Philosophy of Gandhi)

उद्देश्य

1. विद्यार्थियों को महात्मा मोहनदास करमचंद गाँधी के जीवन तथा उनके दर्शन के बारे में जानकारी
2. गाँधीजी के विचारों का विश्लेषण
3. राजनीतिक, सामाजिक, धार्मिक, आर्थिक, सांस्कृतिक एवं पर्यावरण के संदर्भ में गाँधी जी के विचारों को जानना

Objectives

1. To apprise students with Gandhian Life and his philosophy
2. To analyze Gandhian thoughts
3. To know Gandhian views on politics, Society, Religion, Economics, Calture and Environment

परीक्षा योजना

1. यह परीक्षा वार्षिक होगी एवं एक ही प्रश्न पत्र होगा।
2. यह प्रश्न पत्र 100 अंकों का होगा जिसमें पाँच इकाईयाँ होंगी। प्रत्येक इकाई से 10 बहुविकल्पी प्रश्न पूछे जायेंगे।
3. प्रत्येक प्रश्न के दो अंक होंगे।
4. छात्र न्यूनतम 36 या अधिक अंक प्राप्त करने पर उत्तीर्ण होंगे।
5. परीक्षा **OMR sheet** आधारित होगी।
6. तीन वर्ष (अधिस्नातक पाठ्यक्रम की अवधि) में यह प्रश्न पत्र उत्तीर्ण करना अनिवार्य होगा।
7. विश्वविद्यालय के सभी संकायों के लिए सत्र 2019–20 से यह प्रश्न पत्र अनिवार्य होगा।

Scheme of Examination

1. Examination will be held annually based on one question paper.
2. Maximum marks for the question paper will be 100 which will have five units. Ten multiple choice questions will be asked from each unit.
3. Each question will carry 2 marks.
4. Minumum passing marks will be 36 to declare pass.
5. Examination will be OMR sheet based.
6. It is essential for a student to pass this paper within a period of three years (peroid of degree program).
7. This paper will be compulsory for students of all the faculties of the University from session 2019-20.

इकाई 1. गाँधी जी का जीवन परिचय गाँधी जी के जीवन की प्रेरक घटनाएँ

Unit-1. Life of Gandhi Ji. Inspirational events in the life of Gandhi.

इकाई 2. गाँधी जी के राजनैतिक विचार - राजनैतिक धर्म एवं राजनीति में सत्य अहिंसा एवं सत्याग्रह के प्रयोग

Unit-2. Gandhian political thoughts- Political religion and use of truth, non-violence and satyagrah in politics

इकाई 3. गाँधीजी का आर्थिक विचार - ग्रामीण विकास, खादी एवं ग्रामोद्योग, न्यासवादिता का सिद्धांत

Unit-3. Economic thought of Gandhi - Rural development, Khati and rural industry, Principal of Trusteeship

इकाई 4. भारतीय जीवन मूल्य एवं गाँधी दर्शन,

Unit-4. Indian Life Values and Gandhian philosophy

इकाई 5. गाँधी जी का सामाजिक विचार, समाजोत्थान के कार्य, महिला सशक्तिकरण, बुनियादी शिक्षा एवं सामाजिक समरसता, अस्पृश्यता, रूढ़िवादिता का निवारण, नागरिक कर्तव्य, स्वच्छता, पर्यावरण एवं स्वावलंबन

Unit-5. Gandhian Social Thought, Works of social upliftment, women empowerment, basic education and social homogeneity, untouchability, solutions to fanaticism, civil duties, cleanliness, environment and self dependency.

Suggested Readings

1. M.K. Gandhi - My experiment with truth, Pub. Bombay sarvodya mandal, Mumbai
2. M.K. Gandhi - Hind Swaraj. Pub. Rajpal and Sons, Delhi
3. Naresh Dadhich - Gandhi Chintan. Pub. Rawat Publications, Jaipur
4. Dhirendra Mohan Datta – Philosophy of Mahatma Gandhi. Pub. Madison, The University of Winsconsin Press.

□□□

B.Sc. Biotechnology

The course covers how life began on earth (Cosmogenesis & Evolution), what are the molecules of Life (Biochemistry, Molecular Biology), what is the structure of life (Cytology & Developmental Biology), how life continues (Principles of Genetics. Molecular Biology) how is it maintained (Comparative physiology. Biophysics), how does it respond to the environment (Ecology & Environmental Biotechnology)- how organisms interact with each other (the offense & defence), how mathematics helps biology (elementary mathematics & Biostatistics), what aids we need to study organisms (Biophysics, Biotechniques). how life may be manipulated (Genetic Engineering), what organisms offer us and how they might be turned into factories (Microbial, Plant, Animal resources & technology, Fermentation Technology).

Scheme of Examination

There are 6 theory papers per year dedicated to biotechnology and allied sciences each carrying maximum 50 marks in biotechnology. The paper will consist of Part-A (15 marks - 10 questions each carrying 1-5 marks); Part - B (15 marks - 5 questions each 50 marks each carrying 3 marks); Part C (20 marks - 3 questions max. 400 words carrying 7 + 7 + 6 = 20 marks) Each year there will be a combined practical examination of 200 marks. Along with these 6 papers even. year, regular 3 papers of Chemistry being run in B.Sc. Botany, Zoology, Chemistry group shall be essential for all students opting for B.Sc. Biotechnology course.

A combined practical examination (Maximum 150 marks with break up as below) shall be conducted at the end of each year.

a. **Experimental work** (Max. marks 100, 10 hrs. duration, to be completed in two days) shall be performed by each candidate as per the question paper set on the basis of prescribed course of practical* each year as mentioned in the syllabus (*concerned department depending upon the facilities available with them can modify syllabus up to a maximum of 10%).

b. **Date wise, signed record** (maximum 30 marks) of the experiments conducted by each student throughout the academic session shall be placed by him/her before the examining panel on the day of practical examination.

c Viva voce 20 marks.

The number of paper and the maximum marks for each paper together with the minimum marks required for a pass are shown against each subject below. It will be necessary for a candidate to pass in the *theory* as well as the practical part of subject/paper separately. First division will be awarded at >60% marks and second division at >48% marks of the aggregate marks obtained in all the three parts of B.Sc. Biotechnology. All the rest shall be declared to have passed the examination, if they obtain minimum passing marks in each subject as mentioned. No division shall be awarded at Part I and Part II.

S. No	Subject of the paper	Number of paper	Max Marks	Min Pass Marks	Duration
Compulsory papers					
1	Samanva Hindi or General English or Elementary Hindi or History of Indian Civilization		100	36	3 hr
2	~~Environmental Studies~~		~~100~~	~~36~~	~~3 hr~~
B.Sc. Part I					
C1	Inorganic chemistry	Chem I	50	18	3 hr
C2	Organic chemistry	Chem II	50	18	3 hr
C3	Physical chemistry	Chem III	50	18	3 hr
C4	Practicals	Chem IV	75	27	5 hr
B1	Cosmogenesis and evolution	BBT I	50	18	3 hr
B2	Biochemistry	BBT II	50	18	3 hr
B3	Biophysics & Biotechniques I	BBT III	50	18	3 hr
B4	Cytology & Developmental Biology	BBT IV	50	18	3 hr
B5	Principles of Genetics	BBT V	50	18	3 hr
B6	Microbial resources & technology	BBT VI	50	18	3 hr
B7	Combined practical	BBT VII	150	54	10 hr
B.Sc. Part II					
C5	Inorganic chemistry	Chem V	50	18	3 hr
C6	Organic chemistry	Chem VI	50	18	3 hr
C7	Physical chemistry	Chem VII	50	18	3 hr
C8	Practicals	Chem VIII	75	27	5 hr
B8	Comparative physiology	BBT VIII	50	18	3 hr
B9	Molecular Biology	BBT IX	50	18	3 hr
B10	Plant resources & technology	BBT X	50	18	3 hr
B11	Biophysics & Biotechniques II	BBT XI	50	18	3 hr
B12	Eicology & Environmental Biotechnology	BBT XII	50	18	3 hr
B13	Cellular interactions	BHT XIII	50	18	3 hr
B14	Combined Practical	BBT XIV	150	54	10 hr

2, life and Philosophy of Gandhi

Compulsory Paper
Environmental Studies 100 36 3h

B.Sc Part III					
C9	Inorganic chemistry	Chem IX	50	18	3 hr
C10	Organic chemistry	Chem X	50	18	3 hr
C11	Physical chemistry	Chem XI	50	18	3 hr
C12	Practicals	Chem XII	75	27	5 hr
B15	Animal resources & technology	BBT XV	50	18	3 hr
B16	Genetic Engineering	BBT XVI	50	18	3 hr
B17	Elementary mathematics & Biostatistics	BBT XVII	50	18	3 hr
B18	Fermentation technology	BBT VIII	50	18	3 hr
B19	Biotech enterprises and socioeconomic issues	BBT IX	50	18	3 hr
B20	Emerging technologies	BBT XX	50	18	3 hr
B21	Combined Practicals	BBT XXI	150	54	10 hr

Compulsory Paper
~~Life and Philosophy of Gandhi~~ 100 36

1. सामान्य हिन्दी

समय 3 घंटे | उत्तीर्णांक : 36 | पूर्णांक : 100

निर्देश: इस प्रश्न-पत्र के प्राप्तांक श्रेणी निर्धारण में सम्मिलित नहीं किये जायेंगे।

अंक योजना-

(अ भाग)

गद्य एवं पद्य संकलन की विविध विधाएँ क्रमश: (25 + 25 = 50 अंक)

1. एक प्रश्न व्याख्याओं से संबंधित क्रमश: (10 + 10 = 20 अंक)
2. दो परिचयात्मक प्रश्न पाठ्य पुस्तकों से (15 + 15 = 30 अंक)

(ब भाग)

1. शब्द शुद्धि -5 अंक
2. वाक्य शुद्धि -5 अंक
3. पारिभाषिक शब्दावली (अंग्रेजी शब्दों के हिन्दी समानार्थक शब्द) -5 अंक
4. संक्षेपण -5 अंक
5. पल्लवन -5 अंक
6. वाक्यांश के लिए सार्थक शब्द -5 अंक
7. प्रारूप -5 अंक
8. शब्द युग्म: अर्थ-भेद -5 अंक
9. निबन्ध -10 अंक

गद्य–संकलन

1. ग्रामोत्थान- नानाजी देशमुख, दीनदयाल शोध संस्थान चित्रकूट
2. पर्यावरण और सनातन दृष्टि छगन मेहता, संक्रान्ति और सनातनता, संकलन से वागदेवी प्रकाशन बीकानेर
3. ठिठुरता हुआ गणतंत्र (व्यंग्य)- हरिशंकर परसाई, तिरछी रेखाएँ, वाणी प्रकाशन दिल्ली
4. लछमा (रेखाचित्र) महादेवी वर्मा, अतीत के चल चित्र वाणी प्रकाशन, नई दिल्ली
5. अग्नि की उड़ान (परिच्छेद 16) ए.पी.जे.अब्दुल कलाम प्रभात प्रकाशन, नई दिल्ली
6. भेड़ाघाट: मार्बल रॉक्सौर धुआँधार - अमृत लाल वेगड़ अमृतस्य नर्मदा ग्रंथ, मध्यप्रदेश अकादमी, भोपाल, मध्यप्रदेश
7. आवाज का नीलाम (एकांकी) धर्मवीर भारती गद्य-प्रभा-डॉ. नवल किशोर पंचशील प्रकाशन, जयपुर
8. सावचेती विजयदान देथा , आउटलुक पत्रिका 03.10.2005
9. हिन्दी भाषा और उसकी विरासत -डॉ विद्यानिवास मिश्र, हिन्दी साहित्य का पुनरावलोकन विद्या निवास मिश्र, प्रभा प्रकाशन, दिल्ली
10. सुसंग-कुसंग-सीताराम महर्षि, कृष्ण कुटीर, रतनगढ़, चुरू (राज.)
11. ये हैं प्रोफेसर शशांक-डॉ. विष्णुकान्त शास्त्री -'स्मरण को पाथेय बनने दो संग्रह, लोक भारती, इलाहाबाद (उ. प्र.)
12. तुलसी के काव्य में 'कुराज' और 'सुराज'- प्रो. सूर्य प्रसाद दीक्षित साहित्यिक डी 54, निराला, नगर लखनऊ (उ. प्र.)

पद्य – संकलन

1. गंगावतरण, भारतेन्दु हरिश्चन्द्र 'भारतेन्दु समग्र' संपादक, हेमंत शर्मा हिन्दी प्रकाशन संस्थान, वाराणसी (उ. प्र.)
2. गोवर्धन धारण, हरिऔध 'प्रिय प्रवास' महाकाव्य हिन्दी साहित्य कुटीर, वाराणसी(उ. प्र.)
3. भारत वन्दना मैथिलीशरण गुप्त 'मंगल-घट' काव्य ग्रंथ साहित्य (नीलाम्बर परिधान)सदन चिरगाँव, झाँसी (उ. प्र.)
4. समर शेष है रामधारी सिंह दिनकर 'परशुराम की प्रतीक्षा' ग्रंथ से, राजपाल एण्ड संस, दिल्ली
5. वीरों का कैसा हो वसन्त, सुभद्रा कुमारी चौहान 'सुभद्रा कुमारी चौहान' सम्पादक: सुधा चौहान साहित्य अकादमी, नई दिल्ली
6. चल पड़े जिधर दो डग, सोहन लाल द्विवेदी 'राष्ट्रीय गीत संग्रह' साहित्य अकादमी, नई दिल्ली
7. श्रम दयाकृष्ण विजय 'श्रम-धरा' अर्चना प्रकाशन, अजमेर
8. भारती की साधना इन्दुशेखर तत्पुरूष 'हमारा दृष्टि कोण स्मारिका' 70/75 मानसरोवर जयपुर (राज.)

1. GENERAL ENGLISH

Duration: 3 Hours **Min Pass Marks 36** **M.M. 100**

Objectives: This is Essentially a Language Based Course. It aims at making students read English prose with a view to enlarging their comprehension of the language and encouraging them to develop reading habits. It also aims at giving them basic skills in grammar widening their vocabulary. The Question paper will consist of 100 multiple choice questions of 1 mark each (OMR sheet system)

1. **Comprehension and Vocabulary**
   - A. Questions based on content from the prescribed text 15
   - B. Questions based on a passage from the prescribed text to test the candidate's comprehension and vocabulary. 20
   - C. Questions based on an unseen passage to test the candidate's comprehension and vocabulary. 15

   (There will be text of essays and short stories between 100 and 120 pages in length. The text book prescribed is "Language Through Literature" (OUP, NEW DELHI)
2. **Grammar**
   - A. Prepositions 5 marks
   - B. Direct & Indirect Speech 5 marks
   - C. Active-Passive Voice 5 marks
   - D. Joining Sentences 5 marks
   - E. Elements of a sentence 5 marks
   - F. Transformation of Sentences 5 marks
   - G Modals 5 marks
   - H. Tense Usage 5 marks
   - I. Determiners 5 marks
   - J. Common errors in English 5 marks

Books recommended

1. A.J. Thomson and A.V. Martinet : A practical English Grammar (Oxford Paper Back)
2. S. Pit Corder : Intermediate English Practice Book (Orient Longman)
3. Bhaskaran and Hordburgh : Strengthen Your English (OUP 1973)
4. T.I.H. Smith Pearce : The English Errors of Indian Students (OUP)
5. I.K. Sharma and V.D. Singh : A Practical Course of English (Ramesh Book Depot, Jaipur)

1. प्रारम्भिक हिन्दी

(ELEMENTARY HINDI)

(सामान्य हिन्दी के स्थान पर केवल अहिन्दी भाषी क्षेत्रों से आए हुए विद्यार्थियों के लिए)

उत्तीर्णांक: 36 अवधि 3 घण्टे पूर्णांक : 100

अंकों का विभाजन-

1. पुस्तकों पर आधारित	50 अंक
2. व्याकरण से संबंधित	20 अंक
3. रचना से संबंधित	
क. लोकोक्तियाँ तथा मुहावरे आदि	10 अंक
ख. पत्र लेखन अथवा निबंध	20 अंक

पाठ्यक्रम :

1. अध्ययनार्थ पाठ्य पुस्तकें : क. निबंध-संग्रह , ख. कहानी संग्रह
2. व्याकरण : शब्द विचार, वाक्य विन्यास, वाक्य खण्ड, पद-क्रम का ज्ञान तथा इसमें होने वाली सामान्य त्रुटियों का ज्ञान।
3. रचना :

क. मुहावरों तथा लोकोक्तियों का प्रयोग, काव्य में समान दिखाने वाले शब्दों का अर्थ-भेद और उनका वाक्यों में प्रयोग

ख. पत्र लेखन, अथवा सरल निबन्ध।

पाठ्य पुस्तकें :

क. निबन्ध संग्रह

सुगम हिन्दी गद्य (सम्पादक) सूरज भान, राजपाल एण्ड सन्स, दिल्ली

ख. गल्पदशिका 2, 7 एवं 8 पाठों को छोड़कर

सं. एम. एल. गर्ग एवं कमला भटनाकर, कालेज बुक डिपो, जयपुर

ग. व्याकरण एवं रचना-

सुबोध व्याकरण एवं रचना- सं. श्री व्यथित हृदय संशोधन कर्त्ता- डॉ. अम्बाप्रसाद सुमन, श्री राम मेहरा एण्ड कम्पनी, आगरा।

OR

HISTORY OF INDIAN CIVILISATION

(in lieu of compulsory subject of General Hindi and Foreign Students)

Scheme of Examination

Min. Pass Marks 36 Duration: 3 hrs M.M. 100

There will be following three parts in the question paper of this subject.

Part A **Marks – 20**

Note : Part A will contain 10 question in all. candidate are required to attempt all question in 20 words each. All questions carry equal marks.

Part B **Marks – 20**

Part B will contain 05 question having one internal choice. Candidate are required to attempt five questions 50 words each. All questions carry equal marks.

Part C **Marks – 60**

Part C will cantain 05 questions in all. Candidate are required to attempt 03 questions in 400 words each. All questions carry equal marks.

HISTORY OF INDIAN CIVILISATION

Part 'A'

Outline of Historical Development : Indus Valley and the Aryans. Rise of Territorial States, Rise of Empires-Mauryas, Gupta, Kushan & Vardhana.

Part B'

Emergence and Impact of Islam, the Rajput and Akbar. The British Impact. The National Movement Tilak, Gandhi and Nehru.

Part 'C'

Social Life and Cultural Heritage : Family, Caste, Education, Buddhism and Jainism, Bhakti Movement, Literary and Art Heritage. Epics, Kalidas. Tulsidas, Tagore, Sanchi Ajanta Temple Architeture, Mughal Architecture Rajput and Mughal Painting.

3. COMPULSORY PAPER OF ENVIRONMENTAL STUDIES

Compulsory in II year for all streams at undergraduate level

Scheme of examination

Time 3 hrs Pass Marks 36 Max. Marks 100

Theory

Theory paper will contain nine questions. The students are required to attempt

five question in all including question no.1 which will be compulsory.

Q1 short answer type. Ten question of two marks each (compulsory) 10×2 = 20 marks

Q2 to Q9 essay type question of 20 marks each (attempt any four)

The students are required to visit some field or sites mentioned in the syllabus under the guidance of a teacher. The teacher shall certify that the student have visited the site and should further inform their respective principal in writing regarding the same.

Note:

1. The marks secured in this paper shall not be counted in awarding the division to a candidate.
2. The candidate have to clear compulsory paper in three chances
3. Non appearing or absent in the examination of compulsory paper will be counted a chance.

CORE MODULE SYLLABUS FOR ENVIRONMENTAL STUDIES FOR UNDERGRADUATE COURSES OF ALL BRANCHES OF HIGHER EDUCATION

Unit 1: The Multidisciplinary nature of environmental studies

Definition , scope and importance

Need for public awareness.

Unit 2: Natural Resources:

Renewable and non-renewable resources:

- Natural resources and associated problems.
  a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.
  b) Water resources: Use and over-utilization of surface and groundwater, floods, drought, conflicts over water, dams-benefits and problems.
  c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
  d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
  e) Energy resources: Growing energy needs, renewable and nonrenewable energy sources, use of alternate energy sources. Case studies.

  f) Land resources: Land as a resource, Land degradation, man induced Landslides, soil erosion and desertification.
- Role of an individual in conservation of natural resources.
- Equitable use of resources for sustainable lifestyles.

Unit 3: Ecosystems

- Concept of an ecosystem.
- Structure and function of an ecosystem.
- Producers, consumers and decomposers.
- Energy flow in the ecosystem
- 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)

Unit 4: Biodiversity and its conservation

- Introduction – Definition: genetic, species and ecosystem diversity.
- Biogeographical classification of India
- 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 5: Environmental Pollution

Definition

- Causes, effects and control measures of:-

a. Air pollution b. Water pollution c. Soil pollution
d. Marine pollution e. Noise pollution f. Thermal pollution
g. Nuclear hazards

- Solid waste Management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution
- Pollution case studies.
- Disaster management: floods, earthquake, cyclone and landslides.

Unit 6: Social Issues and the Environment

- From Unsustainable to Sustainable development
- Urban problems related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rehabilitation of people; its problems and concerns. Case Studies.
- Environmental ethics: Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.
- Wasteland reclamation.
- Consumerism and waste products.
- Environmental Protection Act.
- Air (Prevention and Control of Pollution) Act.
- Water (Prevention and Control of Pollution) Act.
- Wilde life Protection Act.
- Forest Conservation Act.
- Issues involved in enforcement of environmental legislation.
- Public Awareness.

Unit 7: Human Population and the Environment

- Population growth, variation among nations.
- Population explosion- Family Welfare Programme.
- Environment and Human health.
- Human Rights.
- Value Education.
- HIV/AIDS.
- Women and Child Welfare.
- Role of Information Technology in Environment and human health.
- Case Studies.

Unit 8: Field Work

- Visit to a local area to document environmental assets- river / forest / grasslands / hill/ mountain.
- Visit to local polluted site- Urban /Rural / Industrial /Agricultural.
- Study of common plants, insects, birds.
- Study of simple ecosystems- pond, river, hill slope, etc.

स्नातक अनिवार्य विषय : पर्यावरण विज्ञान

इकाई प्रथम

पर्यावरण अध्ययन की बहुआयामी प्रकृति,परिभाषा एवं महत्व जन जागृति की आवश्यकता

इकाई द्वितीय : प्राकृतिक संसाधन

नवीनीकरण एवं अनवीनीकरण संसाधन : प्राकृतिक संसाधन एवं उससे संबंधित समस्याएं

1. वन संसाधन : उपयोग एवं अतिशोषण, वनोन्मूलन केस अध्ययन, टिम्बर निष्कर्षण, खनन एवं उनके वनों एवं जनजातियों पर प्रभाव
2. जलसंसाधन : सतही एवं भूजल का उपयोग एवं अतिउपभोग, बाढ़, सूखा, जल विवाद, बांधों की समस्याएं एवं लाभ
3. खनिज संसाधन : उपयोग एवं अतिशोषण, खनिज संसाधन के उपयोग एवं निष्कर्ष के पर्यावरणीय प्रभाव, केस अध्ययन
4. खाद्य संसाधन : विश्व खाद्य समस्याएं कृषि एवं अतिचारण के कारण होने वाले परिवर्तन, आधुनिक कृषि के प्रभाव, उर्वरक एवं पीड़कनाशक जनित समस्याएं, जलाक्रान्ति, लवणीयता, केस अध्ययन।
5. ऊर्जा संसाधन : बढ़ती हुई ऊर्जा आवश्यकताएं, नवीनीकरण एवं अवनीनीकरण ऊर्जा संसाधन, ऊर्जा संसाधनों का वैकल्पिक उपयोग केस अध्ययन।
6. भूसंसाधन : भूमि एक संसाधन, भूअपघटन, मानवजनित भूस्खलन मृदा अपरदन एवं मरूस्थलीकरण, प्रकृतिक संसाधनों के संरक्षण में व्यक्तिक भूमिका सतत् जीवनचर्या के लिए संसाधनों का उपयुक्त उपयोग।

इकाई तृतीय : पारिस्थितिकी तंत्र

- पारिस्थितिकी तंत्र की अवधारणा
- पारिस्थितिकी तंत्र की संरचना एवं कार्यप्रणाली

- उत्पादक, उपभोक्ता, अपघटक
- पारिस्थितिकी तंत्र में ऊर्जा प्रवाह
- पारिस्थितिकी अनुक्रमण
- खाद्य श्रृंखला, खाद्यजाल एवं पारिस्थितिकी स्तूप
- परिचय, प्रकार, विशेषताएं, गुण, संरचना एवं कार्यप्रणाली
  अ) वन पारिस्थितिकी तंत्र
  ब) घास के मैदान पारिस्थितिकी तंत्र
  स. मरूस्थल पारिस्थितिकी तंत्र
  द. जलीय पारिस्थितिकी तंत्र (तालाब, धारा, झील, नदियां, समुद्र)

इकाई चतुर्थ : जैव विविधता एवं संरक्षण

- परिचय – परिभाषा : जीनीय, प्रजातीय एवं पारिस्थितिकी विविधता
- भारत का जैवभौगोलिक वर्गीकरण
- जैवविविधता का महत्व, उपभोगीय उपयोगिता, उत्पादकीय उपयोगिता, सामाजिक, नैतिक सौन्दर्य बोध एवं वैकल्पिक मूल्य
- वैश्विक, राष्ट्रीय एवं स्थानिक स्तर पर जैव विविधता
- भारत : एक मैगाविविधता राष्ट्र
- जैवविविधता के तप्तस्थल
- जैवविविधता के खतरे : आवासक्षय, वन्यप्राणियों का शिकार, मानव–वन्यप्राणियों के बीच विरोधाभास
- भारत की विलुप्तप्राय एंव स्थानिक प्रजातियां
- जैव विविधता का संरक्षण : स्व स्थानीय एवं पूर्व स्थानी संरक्षण

इकाई पंचम : पर्यावरणीय प्रदूषण

- परिभाषा, कारण, प्रभाव एवं नियंत्रण उपाय
  a) वायु प्रदूषण b) जल प्रदूषण c) मृदा प्रदूषण
  d) समुद्री प्रदूषण e) ध्वनि प्रदूषण f) तापीय प्रदूषण
  g) नाभीकीय खतरे
- ठोस अपशिष्ट प्रबंधन : शहरी एवं औद्योगिक अपशिष्ट के कारण प्रभाव एवं नियंत्रण उपाय

- प्रदूषण निवारण में व्यक्तिगत भूमिका
- प्रदूषण केस अध्ययन
- आपदा प्रबंधन : बाढ़, भूकम्प, चक्रवात एवं भूस्खलन

इकाई षष्ठम : सामाजिक मुद्दे एवं पर्यावरण

- असतत से सतत् विकास
- उर्जा से संबंधित शहरी समस्याएं
- जल संरक्षण, वर्ष जल संचयन, जल प्रवाह प्रबंधन
- लोगों का पुर्नवास एवं पुनः नियोजन
- समस्याएं एवं चिन्ताएं केस अध्ययन
- पर्यावरण नीति, मुद्दे एवं संभव समाधान
- जलवायु परिवर्तन, वैश्विक तापवृद्धि, अम्लवर्षा, ओजोनपरत क्षरण
- परमाणु दुर्घटनाएं एवं पूर्णाहुति, केस अध्ययन
- बंजर भूमि उद्धार
- उपभोक्तावाद एवं अपशिष्ट उत्पाद
- पर्यावरण निवारण नियम
- वायु निवारण (निवारण एवं नियंत्रण) प्रदूषण नियम
- जल (निवारण एवं नियंत्रण) प्रदूषण नियम
- वन्य जीव संरक्षण नियम
- वन संरक्षण नियम
- पर्यावरण कानूनों के प्रवर्तन में शामिल मृद्दे
- जन जागरूकता

इकाई सप्तम : मानव जनसंख्या एवं पर्यावरण

- जनसंख्या वृद्धि, राष्ट्रो के बीच भिन्नता
- जनसंख्या विस्फोट, परिवार कल्याण योजना
- पर्यावरण एवं मानव स्वास्थ्य – मानव अधिकार
- मौलिक शिक्षा
- एच.आई.वी./एड्स

- महिला एवं शिशु कल्याण
- पर्यावरण एवं मानव स्वास्थ्य में सूचना एवं प्रोद्योगिकी की भूमिका
- केस अध्ययन (घटनात्मक / उदाहरणात्मक अध्ययन)

इकाई अष्टम् : स्थानीय क्षेत्रों की यात्रा

- पर्यावरण दस्तावेजों के लिये नदी / वन / घास के मैदान, पहाड़ी, पहाड़
- स्थानीय दूषित क्षेत्रों की यात्रा -- शहरी / ग्रामीण / औद्योगिक / कृषि
- स्थानीय पेड़ों, कीड़ों एवं पक्षियों का अध्ययन
- सरल पारिस्थितिकी तंत्र का अध्ययन — तालाब, नदी, पहाड़ी तलहटी

B.Sc. Part I Examination

C1 - I INORGANIC CHEMISTRY

Hours : Three **Max. Marks : 50**

Unit-I

A. Atomic Structure

Idea of de Broglie matter waves. Heisenberg uncertainty principle, atomic orbitals, Schrodinger wave equation, significance of ψ and ψ^2, quantum numbers, radial and angular wave functions and probability distribution curves, shapes of s, p, d orbitals. Aufbau and Pauli exclusion principles, Hund's multiplicity rule. Electronic configuration of the elements, effective nuclear charge.

B. Chemical Bonding

Covalent Bond – Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions. Valence shell electron pair repulsion (VSEPR) theory to NH_3, H_3O^+, SF_4, ClF_3, ICl^-_2, and H_2O, MO theory, homonuclear and heteronuclear (CO and NO) diatomic molecules, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

Unit-II

A. Periodic Properties

Atomic and ionic radii, ionization energy, electron affinity and electronegativity- definition, methods of determination and trends in periodic table, applications in predicting and explaining the chemical behaviour.

B. s-Block Elements

Comparative study, diagonal relationships, salient features of hydrides, solvation and complexation tendencies including their function in biosystems, and introduction to alklys and aryls.

C. p-Block Elements

Comparative study (including diagonal relationship) of groups 13-17 elements, compounds like hydrides, oxides and halides of groups 13-16, hydrides of boron-diborane and higher boranes, borazine, properties borohydrides.

Unit- III

A. Ionic Solids- Ionic structures, radius ratio and coordination number, limitation of radius ratio rule, lattice defects, semiconductors, lattice energy and Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule. Metallic bond- free electron, valence bond and band theories.

B. Weak Interactions- Hydrogen bonding, van der Waals forces.

C. Fullerenes, carbides, flurocarbons, silicates (Structural principle), tetrasulphur tetranitride, basic properties of halogens, interhalogens and polyhalides.

D. Chemistry of Noble Gases

Chemical properties of the noble gases, chemistry of xenon, structure and bonding in xenon compounds.

C 2 –II ORGANIC CHEMISTRY

Hours: Three Max. Marks:50

UNIT-I

A. Structure and Bonding

Hybridization, bond lengths and bond angles, bond energy, localized and delocalized chemical bond, van der Waals interactions, inclusion compounds, clatherates, charge transfer complexes, resonance, hyperconjugation, aromaticity, inductive and field effects, hydrogen bonding.

B. Mechanism of Organic Reactions

Curved arrow notation, drawing electron movements with arrows, half-headed and double headed arrows, homolytic and heterolytic bond breaking. Types of reagents-electrophiles and nucleophiles. Types of organic reactions. Energy considerations. Reactive intermediates-carbocations, carbanions, free radicals, carbenes, arynes and nitrenes (with example). Assigning formal charges on intermediates and other ionic species.

C. Stereochemistry of Organic Compounds

Concept of isomerism. Types of isomerism. Optical isomerism-elements of symmetry, molecular chirality, enatiomers, stereogenic centre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogenic centres, diastereomers, threo and erythro diastereomers, meso compounds, resolution of enantiomers, inversion, retention and racemization.

Relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature.

Geometric isomerism- determination of configuration of geometric isomers, E & Z system of nomenclature, geometric isomerism in oximes

and alicyclic compounds.
Conformational isomerism- conformational analysis of ethane and n-butane; conformations of cyclohexane, axial and equatorial bonds, conformation of mono substituted cyclohexane derivatives. Newman projection and Sawhorse formulae, Fischer and flying wedge formulae. Difference between configuration and conformation.

UNIT-II

A. Alkanes and Cycloalkanes

IUPAC nomenclature of branched and unbranched alkanes, the alkyl group, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation (withspecial reference to Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids), physical properties and chemical reactions of alkanes.
Mechanism of free radical halogenation of alkanes: orientation, reactivity and selectivity Cycloalkanes- nomenclature, methods of formation, chemical reactions, Baeyer's strain theory and its limitations. Ring strain in small rings(cyclopropane and cyclobutane), theory of strainless rings. The case of cyclopropane ring: banana bonds.

B.Alkenes

Nomenclature of alkenes, methods of formation, mechanism of dehydration of alcohols and dehydrohalogenation of alkyl halides. regioselectivity in alcohol dehydration. The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes-mechanisms involved in hydrogenation, electrophilic and free radical additions. Markownikoff's rule, hydroboration-oxidation, oxymercuration-reduction. Epoxidation, ozonolysis, hydration hydroxylation and oxidation with $KMnO_4$. Polymerization of alkenes. Substitution at the allylic and vinylic positions of alkenes. Industrial applications of ethylene and propene.

C. Cycloalkenes, Dienes and Alkynes

Methods of formation, conformation and chemical reactions of cycloalkenes.
Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes.
Structure of allenes and butadiene, methods of formation, polymerization. Chemical reactions-1,2 and 1,4 additions, Diels-Alder reaction.
Nomenclature, structure and bonding in alkynes. Methods of formation. Chemical reactions of alkynes, acidity of alkynes. Mechanism of electrophilic and nucleophilic addition reactions. hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization.

UNIT-III

A. Arenes and aromaticity

Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: molecular formula and Kekule structure. Stability and carbon- carbon bond lengths of benzene, resonance structure, MO picture.

Aromaticity: the Huckle rule, aromatic ions.

B. Aromatic electrophilic substitution- general pattern of the mechanism, role of σ and π Complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction. Energy profile diagrams. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction.

C. Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.

D. Alkyl and Aryl Halides

Nomenclature and classes of alkyl halides, Methods of formation, chemical reaction. Mechanisms of nucleophilic substitution reactions of alkyl halides, S_N2 and S_N1 reactions with energy profile diagrams.
Polyhalogen compounds: chloroform, carbon tetrachloride.
Methods of formation of aryl halides, nuclear and side chain reactions. The addition elimination and the elimination-addition mechanisms of nucleophilic aromatic substitution reactions.
Relative reactivities of alkyl halides vs allyl, vinyl and aryl halides. Synthesis and uses of DDT and BHC.

C3 –III PHYSICAL CHEMISTRY

Hours: Three Max. Marks:50

UNIT-I

A. Mathematical Concepts and Computers

(a) Mathematical Concepts
Logarithmic relations, curve sketching, linear graphs and calculation of slopes, differentiation of functions like k_x, e^x, x^n, sin x, log x; maxima and minima, partial differentiation and reciprocity relations. Intergration of some useful/ relevant functions; permutations and combinations. Factorials. Probability

(b) Computers
General introduction to computers, different components of a computer, hardware and software, input-output devices; binary numbers and arithmetic; introduction to computer language. Programming, operating systems.

B. Colloidal State

Definition of colloids, classification of colloids.
Solids in liquids (sols): properties- kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number.
Liquids in liquids (emulsions): types of emulsions, preparation, Emulsifier.
Liquids in solids (gels): classification, preparation and properties, inhibition, general applications of colloids.

UNIT-II

A. Gaseous States

Postulates of kinetic theory of gases, deviation from ideal behavior, van der Waals' equation of state.

Critical Phenomena:PV isotherms of real gases, continuity of states. the isotherms of van der Waals equation, relationship between critical constant and van der Waals constants. the law of corresponding states, reduced equation of state.

Molecular velocities: Root mean square, average and most probable velocities. Qualitative discussion of the Maxwell's distribution of molecular velocities. collision number, mean free path and collision diameter. Liquification of gases (based on Joule-Thomson effect.)

B. Liquid State

Intermolecular forces, structure of liquids (a qualitative description)Structural differences between solids, liquids and gases.

Liquids crystals: Difference between liquid crystal, solid and liquid. Classification, structure of nematic and cholestric phases. Thermography and seven segment cell.

UNIT-III

A. Solid State

Definition of space lattice, unit cell.

Laws of crystallography-(i)Law of constancy of interfacial angles (ii) Law of rationality of indices (iii) Law of symmetry. Symmetry elements in crystals.

X-ray diffraction by crystals. Derivation of Bragg equation. Determination of crystal structure of NaCl, KCl and CsCl (.Lauc's method and powder method).

Catalysis. Characteristics of catalyzed reactions. classification of catalysis, miscellaneous examples.

B. Solutions, Dilute Solutions and Colligative Properties

Ideal and non-ideal solutions, methods of expressing concentration of solutions. activity and activity coefficient.

Dilute solution. colligative properties, Raoult's law, relative lowering of vapour pressure. molecular weight determination. Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression in freezing point. Experimental methods for determining various colligative properties.

Abnormal molar mass, degree of dissociation and association of solutes.

C4 –IV

PRACTICALS

Time : 5 Hours Max.Marks:75

1. **Inorganic Chemistry**

Semi-micro Analysis- separation and identification of four ions, cation analysis from Groups I, II, III, IV, V and VI, anion analysis including interfering radicals.

2. **Organic Chemistry**

(A) Laboratory Techniques.(Any Three)

(a) Calibration of Thermometer
80-82° (Naphthalene),113.5-114°(Acetanilide).
132.5-133° (urea), 100° (Distilled Water)

(b) Determination of Melting Point
(Naphthalene),80-82° ,Benzoic acid 121.5-122°
Urea 132.5-133°, Succinic acid 184.5-185°
Cinnamic acid 132.5-133°,Salicyclic acid 154.5-158°
Acetanilide 113.5-114° m-Dinitrobenzene 90°
p-Dichlorobenzene 52° Aspirin 135°

(c) Determination of boiling points
Ethanol 78°, Cyclohexane 81.4°, Toluene 110.6° Benzene 80°

(d) Mixed melting points
Urea-Cinnamic acid mixture of various compositions (1:4, 1:1, 4:1)

(e) Distillation
Simple distillation of ethanol-water mixture using water condenser
Distillation of nitrobenzene and aniline using air condenser

(f) Crystallization
Concept of induction of crystallization
Phthalic acid from hot water (using fluted filter paper and stemless funnel)
Acetanilide from boiling ethanol
Benzoic acid from water

(g) Decolorisation and crystallization using charcoal
Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration. Crystallization and decolorisation of impure naphthalene (100 g of naphthalene mixed with 0.3 g if Congo Red using 1 g decolorising carbon) from ethanol.

(h) Sublimation (Simple and Vacuum)
Camphor, Naphthalene, Phthalic acid and Succinic Acid.

(B) Qualitative Analysis

Detection of extra elements (N,S and halogens) and functional groups (phenolic, carboxylic, carbonyl, esters, carbohydrates, amines, amides, nitro and anilide) in simple organic compounds.

3. PHYSICAL CHEMISTRY (ANY FIVE)

1. To determine the specific reaction rate of the hydrolysis of methyl acetate/ ethyl acetate catalyzed by hydrogen ions at room temperature.
2. To study the effect of acid strength on the hydrolysis of an ester.
3. To compare the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of ethyl acetate.
4. To study kinetically the reaction rate of decomposition of iodide by H_2O_2.
5. To study the distribution of iodine between water and CCl_4
6. To study the distribution of benzoic acid between benzene and water.
7. To prepare arsenious sulphide sol and compare the precipitating power of mono-,bi- and trivalent anions.

8. To determine the percentage composition of a given mixture (non' interacting systems) by viscosity method.
9. To determine the viscosity of amyl alcohol in water at different concentrations and calculate the excess viscosity of these solutions.
10. To determine the percentage composition of a given binary mixture by surface tension method (acetone & ethyl methyl ketone).

Scheme of Practical Examination

Inorganic Chemistry-

A mixture containing four radicals including one inferring radical will be provided to each candidate for analysis.

Organic Chemistry-

(A) At least one laboratory technique is to be performed by the candidate out of three

(B) Detection of elements and functional group of any two simple organic compound should be analysed by the candidate.

Physical Chemistry:

Out of five, one experiment should be performed by the candidate.

Distribution of Marks:

1. Inorganic Radicals -24 (6 Marks each) No negative marking.
2. (A) Lab Technique - 10
   (B) Qualitative Analysis- 12
3. Physical- 14
4. Viva- 10
5. Record- 5

B1. Cosmogenesis and evolution

Section A

Current perspectives of cosmogenesis. Wave particle dualism and particle physics revolution. Determinism and uncertainty principle. The concept of gravity, space and time.

The Big Bang. Condensation of primordial soup, Matter and anti matter, Grand Unification Theory, Fundamental particles, Quarks, Plasma, Theory of strings and Superstrings, Vibrating universe, Theory of inflation.

Section B

Models of self organization, Pattern and network, dissipative structures. Eigen's hypercycles, Autopoiesis. Requirements of life and living structures. Living beings as dissipative structures and nonequilibrium thermodynamics. Simplest possible mechanisms to yield energy, replicate information and contain the constituents.

Selection and Genetic drift. Molecular chronometers. Molecular methods to study evolution. Strategies of life: Variation and its mechanisms, redundancy,

Section C

Theory of endosymbiogenesis, sexual selection, mate selection, kin selection. Coevolution. Concept of niche and evolution of biodiversity, r- and K- selection theory, Fisher's theory of the evolution of mimicry, Theory of balanced polymorphism. Theory of allopatric speciation. Theory of phyletic

gradualism, Theory of speciation in diploid species.

Books:

Fritzof Capra. 1996. Web of Life. Harper Collins Pub., London.

Lewis, Ralph W. 1980. Evolution: A system of theories. Prespectives in Biology & Medicine. (Summer) 551-572.

Guth, Alan H. 1997 : The Inflationary Universe. The quest fo a new theory of cosmic origins. Helix Books, Perseus Books, Massachusettes.

Eigen Manfred. 1971. Molecular self organization and the early stages of evolution. Quarterly Rev. Biophysics. 4.149.

Margullis Linn & Dorian Sagan. 1995. What is life? Simon & Schuster, New York.

B2. Biochemistry

Section A

Composition of living matter: Water and its properties. Buffers. Solutions. Ionic equilibrium, pH, pK values. Handersen-Hasselbatch equation. Cell chemistry, constituents and their functions.

Amino acids: Structure and properties. Proteins their types with examples. Enzymes, mechanism of action, classification, Michaelis Menten equation. Regulation of enzymes: Allosteric, uncompetitive, Competitive, Non competitive.

Section B

Carbohydrates: Structure, function, classification of different types of carbohydrates with examples. Aldoses and ketoses. Haworth projection. Epimers, Isomers and Mucopolysaccharides.

Lipids: Structure function and classification. Triglycerides, waxes, phospholipids, polar and non polar lipids. Cholesterol. Sphingolipids, Cerebrolipids. Comparative account of types of lipids characteristic to plants, animals and microbial systems. Structure of cell membranes.

Section C

Nucleic acids: Structure of nucleotides, nucleosides. Types of Nucleic acids, their functions, structure in prokaryotes and eukaryotes. Structure of DNA. Types of DNA conformations. Packaging of DNA into nucleosomes. Heterochromatin, euchromatin, Repetitive DNA, palindromes, concept of the gene. Introns and exons.

Vitamins and hormones, their types and functions.

B3. Biophysics & Biotechniques I

Section A

Thermodynamics: Warming, Cooling, Conduction, Heat capacity and specific heat, Latent heat, First law of thermodynamics. Temperature scales. Coefficient of thermal expansion. Perspiration, heat regulation in warm and cold blooded animals. Pressure Cooker. Metabolic rate and body size. Goose pimples. Bergamann's law. Second and third law of thermodynamics. Information: definition, unit, DNA as information molecule. Flow of energy through biosphere. Entropy, Enthalpy and bonding energy, phosphorylation. Does life violate the second law? Entropy and Probability, Nonequilibrium thermodynamics. Isolated Systems, Closed Systems near Equilibrium. Closed

Systems Far from Equilibrium. Stochastic Processes. Markovian and Gaussian Processes. Brownian Motion. Random walk.

Section B

Strategies of energy production in the cell. Redox reactions. coupled reactions and group transfer. ATP production. Transport. Free energy and spontaneity of reaction. G, G°. G' and equilibrium. Mass and energy balance in metabolism. Metabolic heat generation. Fourier's law of heat conduction and analogy with momentum transfer. Convection and concept of heat transfer coefficient.

Asepsis and observation techniques: Principles of asepsis. Principles and techniques of sterilization. disinfection and antisepsis.

Section C

Cultivation of microorganisms. Constructing nutrient media (Ingredients. Types). Environmental factors affecting growth of microorganisms. Isolation (Enrichment. selection. bait technique. isolating single spores). purification techniques, maintenance and preservation of cells. Methods of cell disruption. Physical and chemical methods.

Methods of separation. Filtration techniques. Angular momentum. moment of inertia. Centrifugal and centripetal forces. Why one feels dizzy on a Merry-Go-Round. Centrifugation. Principles. types and applications. Chromatography and Electrophoresis: Principles types and applications.

Books:

Physics (1988). Machlup. Wiley International Edition. John Wiley and Sons, New York

B4. Cytology and developmental biology

Section A

Discovery of the cell. Cell Theory. Cell composition. Cell constitutents. Biogenic elements. Periodic table and biogenic elements. Properties of water and carbon that help sustenance of life. Eukaryotic and prokaryotic cells. Plant and animal cells. Cell inclusions. Advantages of compartmentalization. Membrane systems not bound by unit membrane (Mesosomes. Thylakoids, Chlorosomes. Magnetosomes. Carboxysomes). Cytoskeletal structures (Microvilli. microtubules) and cell inclusions (storage bodies. pyrenoids. oil droplets, sulfur particles. volution granules).

Section B

Diversity of cell types and their differences. Archaebacterial cells. Eubacterial cells. Cell envelopes. Their types and distribution. Cell walls: structure and function. Cell membranes. Structure. function and models. Protein mosaic and lipid raft model. Translocation through membranes. Gates and thoroughfares. Excretion and uptake. Membranes as sites for energy generation and photo entrapment systems.

Cell appendages and surface architecture (Flagella, cilia, pili, capsule, sheath). Cell organelles. their structure and function: Endoplasmic reticulum, Golgi bodies, Mitochondria. Chloroplast, Ribososmes, Lysosomes,

Peroxisomes, Nucleus, Vacuoles. Cell cycle. Cell differentiation in prokaryotes (endospores, exospores, cysts, akinetes, heterocysts, asexual spores) and its need. Vegetative propagation. Somatic division. Asexual reproduction. Diversity of spores in algae. fungi, protozoa) and comparison of their structure and genesis. Reproductive division. Sexual reproduction. Spores (in algae, fungi, protozoa), their structure and genesis. Cell senescence and apoptosis.

Section C

Tissues, their types, structure and function. Comparative histology of plants and animals. Growth and differentiation. Organs and organ systems. Vascular system in plants. Common features of Digestive, Excretory, Circulatory, Respiratory, Muscular, Skeletal, Nervous and sensory system in animals and evolution of complexity.

Embryology of plants and animals. Placentation in mammals, Embryonic stem cells, Biology of aging. Developmental biology morphogenesis, organogenesis. Developmental biology: neuroendocrine regulations, reproductive system, estrous and menstrual cycle. Gametogenesis, cleavage, differentiation, organogenesis.

B5. Principles of Genetics

Section A

Mendelian principles: Principle of segregation, monoclonal crosses, dominance, codominance, semidominance, lethal genes. Principle of independent assortment: dihybrid ratios, trihybrid ratios, gene interactions, epistasis, multiple alleles. Meiosis and Mendel's principles.

Sex determination and linkage: Mechanisms of sex determination: Simple mechanisms, One or a few genes, identification of sex chromosomes, XX-XY mechanism. Y chromosome and sex determination in mammals

Section B

Balanced concept of sex determination in *Drosophila*, haploidy and sex determination in hymenoptera, Mosaics and gynandromorphs, environmental factors in sex determination, sex differentiation, sex influenced dominance, sex limited gene expression, sex linked inheritance.

Principles of linkage: Crossing over, cytological basis of crossing over, chromdsome mapping by two factor crosses, interference. ordered tetrad data, somatic cell hybridization. Molecular mechanism of crossing over, gene conversion.

Section C

Classical versus molecular concept of the gene. Cis-trans complementation, deletion mapping, one gene-one band in *Drosophila* salivary gland chromosomes. Genes within genes.

Population Genetics: Behavioral genetics, Hardy-Weinberg frequencies. inbreeding. calculating F from pedigrees. outbreeding and assorted mating, genetic equilibrium. chemotaxis. inheritance and learning in bees. *Drosophila*: behavioural genetics. genetic and environmental interactions in dogs.

B6. Microbial resources & technology

Section A

Classification of microorganisms. Haeckel's three kingdom and Whittaker's five kingdom concepts. Three domain concept of Carl Woese. Archaebacteria and eubacteria. Classification and economic importance of algae, fungi, lichen and protozoa up to class level. Thallus organization and importance. Gram positive and Gram negative bacteria. Biology and importance of methanogens, actinomycetes, fermentative bacteria, rhizobiaceae, cyanobacteria and yeasts.

Section B

Nutritional classification of bacteria. Functional diversity of bacteria (oxygenic and anoxygenic photosynthesis, fermentations, anaerobic respiration, diazotrophy, nitrification, denitrification, methylotrophy, methanogenesis, hydrogen production and uptake, sulfur oxidation and reduction). Economic importance of bacteria.

Section C

Economic importance of protozoa and algae. Features and life history of *Amoeba, Paramecium, Euglena, Volvox, Oedogonium, Coleochaete, Vaucheria, Ectocarpus, Sargassum, Polysiphonia.*

Features and life history of *Pythium, Phytophthora, Mucor, Sacccharomyces, Eurotium, Chaetomium, Peziza, Puccinia, Agaricus, Phomes, Cercospora, Colletotrichum.*

Acellular living entities (Viruses, virusoids, viroids, prions). Structure, multiplication and important diseases caused by them in man, plants, cattle, hogs, poults, fishes.

B7. Combined Practical

Biochemistry

1. Numerical exercises on normality, molarity, molality, percent solution, ppm, ppb solutions.
2. Measurement of pH.
3. Preparing buffer. Preparation of phosphate buffer and calculation of pH using Handerson Hasselbach equation
4. Estimation of intra and extracellular protein by Lowry's method.
5. Estimation of total carbohydrates by anthrone method
6. Phytochemical tests of the following: Glucose, starch, proteins, fats, tannins, ascorbic acid and anthocyanin.
7. Soxhlet separation of oils from seeds and its gravimetric estimation
8. Estimation of DNA content
9. Estimation of RNA content
10. Using a centrifuge, determine minimum time that will be required to settle algal/blood cells.

Microbiology

1. Parts of a microscope. Handling. Precautions.
2. Obtaining Koehler illumination.
3. Types and use of different bright filed microscopes. 1. Dissection microscope, 2. Stereo microscope and 3. Inverted microscope.
4. Calibration of a micrometer and micrometry of cells.
5. Microscopic enumeration of cells using

a. Drop method and
b. Cell Counters (Neubauer chamber/ Hemocytometer/ Sedgwick Rafter cells)

6. Numerical exercises on determination of volume of a cell counter.
7. Simple staining of yeast/ molds
8. Identifying different types of spores of fungi- conidiospores, ascospores, bacsidiospores, uredospores, telcutospores, pycnidiospores)
9. Differentiating akinetes, heterocysts and vegetative cells in cyanobacteria
10. Microscopic identification of 5 representatives showing various thallus organizations, each of algae, fungi and cyanobacteria
11. Microscopic identification of 5 types of protozoans.
12. Differential staining: Gram staining bacteria
13. Ubiquity of microorganisms

Cell biology & developmental biology

1. Endospore staining in bacteria
2. Sectioning, staining and observation of leaf, stem and root of monocot and dicot plants.
3. Histological slides of cleavage, blastula, gastrula, nerula and tail bud stages.
4. Study sex combs and giant chromosomes of salivary glands of *Chironomous* or *Drosophila*
5. Mitotic and meiotic studies in yeast/ onion root tips/ flower buds/ grasshopper testes/salivary glands of *Drosophila*
6. Demonstration of sexual reproduction in algae and protozoa by permanent slides.
7. Differentiating viable and nonviable cells by fluorescence microscopy

***In vitro* Culture**

1. Methods of sterilization: Wet heat, dry heat and filter sterilization. Sterilizing glassware.
2. Determining efficacy of aseptic techniques
3. Methods of disinfection: Physical and chemical, and their efficacy
4. Need, use and cleaning of laminar flow.
5. Preparation of stocks of inorganic compounds for culture media.
6. Preparing culture medium, its sterilization and pouring the plates, preparing tubes (Liquid, slants, stabs).
7. Selective cultivation of fungi, actinomycetes, bacteria and studies on their micro and macromorphological features.
8. Dual culture method for Protozoa. Cultivating Paramecium.
9. Cultivation of virus in chick embryo.

B.Sc. Part II examination

C5 - I INORGANIC CHEMISTRY

Time:3 Hours **Max. Marks:50**

Unit I

A. Chemistry of Elements of First Transition Series

Characteristic properties of d-block elements.

Properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry.

B. Chemistry of Elements of Second and Third Transition series

General characteristics, comparative treatment with their 3d-analogues in respect of ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry.

Unit II

A. Coordination Compounds

Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes.

B. Chemistry of Lanthanide Elements

Electronic structure, oxidation states and ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds.

C. Chemistry of Actinides

General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between the later actinides and the later lanthanides.

Unit III

A. Oxidation and Reduction

Use of redox potential data-analysis of redox cycle, redox stability in water-Frost, Latimer and Pourbaix diagrams. Principles involved in the extraction of the elements.

B. Acids and Bases

Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concepts of acids and bases.

C. Non-aqueous Solvents

Physical properties of a solvent, types of solvents and their general characteristics reactions in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2

C6 - ORGANIC CHEMISTRY

Time:3 Hours **Max. Marks:50**

Unit I

A. Electromagnetic Spectrum: Absorption Spectra

Ultraviolet (UV) absorption spectroscopy- absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome, bathchoromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones. Infrared (IR) absorption spectroscopy-molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorption of various functional groups and interpretation of IR spectra of simple organic compounds.

B. Ethers and Epoxides

Nomenclature of ethers and methods of their formation, physical properties. Chemical reactions-cleavage and autoxidation, Ziesel's method.

Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Unit II

A. Alcohols

Classification and nomenclature.

Monohydric alcohols-nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding, Acidic nature. Reactions of alcohols.

Dihydric alcohols-nomenclature, methods of formation ,chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement.

Trihydric alcohols- nomenclature and methods of formation, chemical reactions of glycerol.

B. Phenols

Nomenclature, structure and bonding. Preparation of phenols, physical properties and acidic character. Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion. Reactions of phenols-electrophilic aromatic substitution, acylation and carboxylation. Mechanisms of Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Hauben-Hoecsch reaction, Lederer-Manasse reaction and Reimeer-Tiemann reaction.

C. Carboxylic Acids

Nomenclature, structure and bonding, physical properties, acidity of carboxylic acids, effects of substituents on acid strength. Preparation of carboxylic acids. Reactions of carboxylic acids. Hell-Volhard-Zelinsky reaction. Synthesis of acid chlorides, esters and amides. Reduction of carboxylic acids. Mechanism of decarboxylation.

Methods of formation and chemical reactions of halo acids.Hydroxy acids: malic, tartaric and citric acids.

Methods of formation and chemical reactions of unsaturated monocarboxylic acids.

Dicarboxylic acids: methods of formation and effect of heat and dehydrating agents.

D. Carboxylic Acid Derivatives

Structure and nomenclature of acid chlorides, esters, amides (urea) and

acid anhydrides. Relative stability of acyl derivatives. Physical properties. interconversion of acid derivatives by nucleophilic acyl substituion.
Preparation of carboxylic acid derivatives. chemical reactions. Mechanisms of esterfication and hydrolysis (acidic and basic).

Unit III

A. Aldehydes and Ketones

Nomenclature and structure of carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, synthesis of aldehydes and ketones using 1,3-dithianes, synthesis of ketones from nitriles and from carboxylic acid. Physical properties.

Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Witting reaction, Mannich reaction.

Use of acetals as protecting group. Oxidation of aldehydes, Baeyer-villiger oxidation of ketones, Cannizzaro reaction, MPV, Clemmensen, Wolff-kishner, $LiAlH_4$ and $NaBH_4$ reductions. Halogenation of enolizable ketones.

An introduction to α,β unsaturated aldehydes and ketones.

B. Organic Compounds of Nitrogen

Preparation of nitroalkanes and nitroarenes. Chemical reactions of nitroalkanes.

Mechanisms of nucleophilic substitution in nitroarenes and their reductions in acidic, neutral and alkaline media. Picric acid. Halonitroarenes: reactivity. Structure and nomenclature of amines, physical properties. Stereochemistry of amines. Separation of a mixture of primary, secondary and teritary amines. Structural features effecting basicity of amines. Amines salts as phase-transfer catalysts. Preparation of alkyl and aryl amines(reduction of nitro compounds. nitriles).reductive amination of aldehydic and ketonic compounds. Gabriel-phthalimide reaction. Hofmann bromamide reaction.

Reaction of amines. electrophilic aromatic substitution in aryl amines. reaction of amines with nitrous acid. Synthetic transformation of aryl diazonium salts. azo coupling.

C7 - PHYSICAL CHEMISTRY

Time:3 Hours **Max. Marks:50**

Unit I

A. Thermodynamics-I

Definition of thermodynamic terms: system, surroundings etc. Types of systems, intensive and extensive properties. State and path functions and their differentials. Thermodynamic process. Concept of heat and work.

First Law of Thermodynamics: Statement, definition of internal energy and enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Joule's law-Joule-Thomson coefficient and inversion temperature. Calculation of w,q, dU, & dH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process

Thermochemistry: standard state, standard enthalpy of formation-Hess's

Law of heat summation and its applications. Heat of reaction at constant pressure and at constant volume. Enthalpy of neutralization. Bond dissociation energy and its calculation from therno-chemical data. temperature dependence of enthalpy, Kirchhoff's equation.

B. Thermodynamics-II

Second law of thermodynamics: need for the law, different statements of the law. Carnot cycle and its efficiency, Carnot theorem. Thermodynamic scale of temperature.

Concept of entropy: entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change. Clausius inequality, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

Third law of thermodynamics: Nernst heat theorem, statement and concept of residual entropy. evaluation of absolute entropy from heat capacity data. Gibbs and Helmholtz functions; Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change. Variation of G with A with P, V and T.

Unit II

A. Chemical Equilibrium

Equilibrium constant and free energy. Thermodynamic derivation of law of mass action. Le Chatelier's principle.

Reaction isotherm and reaction isochore- Clapeyron equation and Clausisus- Clapeyron equation, applications.

B. Phase Equilibrium

Statement and meaning of the terms- phase, component and degree of freedom, thermodynamic derivation of Gibbs phase rule, phase equilibria of one component system- water, CO_2 and S systems.

Phase equilibria of two component system- solid-liquid equilibria, simple cutectic-Bi-Cd, Pb-Ag systems, desilverisation of lead.

Solid solutions- compound formation with congruent melting point (Mg-Zn) and incongruent melting point, ($NaCl-H_2O$), ($FeCl_3-H_2O$) and ($CuSO_4-H_2O$)system. Freezing mixtures, acetone-dry ice.

Liquid-liquid mixtures- ideal liquid mixtures, Raoult's and Henry's law. Non-ideal system-azeotropes- $HCl-H_2O$ and ethanol – water systems.

Partially miscible liquids- Phenol-water, trimethylamine, nicotine-water systems.

Lower and upper consolute temperature. Effect of impurity on consolute temperature.

Immiscible liquids, steam distillation.

Nernst distribution law-thermodynamic derivation, applications.

C. pH

Definition of pH and pK_a determination of pH using hydrogen, quinhydrone and glass electrodes. by potentiometric methods.

Buffers-mechanism of buffer action, Henderson-Hazel equation. Hydrolysis of salts.

Corrosion-types. theories and methods of combating it.

Unit III

A. Electrochemistry-I

Electrical transport-conduction in metals and in electrolyte solutions. specific conductance and equivalent conductance. measurement of equivalent conductance. variation of equivalent and specific conductance with dilution.

Migration of ions and Kohlrausch law. Arrehenius theory of electrolyte dissociation and its limitations. weak and strong electrolytes. Ostwald's dilution law its uses and limitations.

Debye-Huckel-Onsagar's equation for strong electrolytes (elementary treatment only).

Transport number. definition and determination by Hittorf method and moving boundary method.

Applications of conductivity measurements: determination of degree of dissociation. determination of K_a of acids. determination of solubility product of a sparingly soluble salt. conductometric titrations.

B. Electrochemistry-II

Types of reversible electrodes-gas-metal ion. metal-insoluble salt-anion and redox electrodes. Electrode reactions. Nernst equation. derivation of cell E.M.F. and single electrode potential. standard hydrogen electrode- reference electrodes-standard electrode potential. sign conventions. electrochemical series and its significance.

Electrolytic and Galvanic cells-reversible and irreversible cells. conventional representation of electrochemical cells.

EMF of a cell and its measurements. Computation of cell EMF. Calculation of thermodynamic quantities of cell reactions(ΔG ΔH, and K), polarization. over potential and hydrogen over voltage.

Concentration cell with and without transport. liquid junction potential. application of concentration cells. valency of ions. solubility product and activity coefficient. potentiometric titrations.

C8 : PRACTICALS

Time:6 Hours **Max. Marks:75**

Inorganic Chemistry

(A) Calibration of fractional weights. pipettes and burettes. Preparation of standard solutions. Dilution 0.1 M to 0.001 M solutions.

(B) Quantitative Analysis

Volumetric Analysis (Any Four)

(i) Determination of acetic acid in commercial vinegar using NaOH.
(ii) Determination of alkali content-antacid tablet using HCl.
(iii) Estimation of calcium content in chalk as calcium oxalate by permanganometry.
(iv) Estimation of hardness of water by EDTA.
(v) Estimation of ferrous and ferric dichromate method.

(vi) Estimation of copper using thiosulphate.

(C) Gravimetric Analysis.

(i) Analysis of Cu as CuSCN
(ii) Ni as Ni-dimethylglyoxime.

Organic Chemistry

(A) Chromatography (Any Four)

(i) Separation . R_f values and identification of organic compounds.
(ii) Preparation and separation of 2,4-dinitrophenylhydrozone of acetone,2-butanone. hexan-2- and 3-one using toluene and light petroleum (40:60:).
(iii) Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5)
(iv) Separation of a mixture of phenylalanine and glycine. Alanine and aspartic acid. Leucine and glutamic acid. Spray reagent-ninhydrin.
(v) Separation of a mixture of D,L-alanine, glycine and L-Leucine using n-butanol:acetic acid: water(4:1:5). spray reagent-ninhydrin.
(vi) Separation of monosachharides- a mixture of D-galactose and D-fructose using n-butanol: acetone : water (4:5:1) spray reagent-aniline hydrogen phthalate.

(B) Qualitative Analysis

Identification of an organic compound through the functional group analysis, determination of melting point and preparation of suitable derivatives.

Physical Chemistry (Any Four)

1. Determination of the transition temperature of the given substance by thermometric/dialometric method (e.g.$MnCl_2,4H_2O$,$SrBr_2$ $2H_2O$).
2. To study the effect of a solute(e.g. NaCl, succinic acid) on the critical solution temperature of two partially miscible liquids (e.g. phenol-water system) and to determine the concentration of that solute in the given phenol-water system.
3. To construct the phase diagram of two component (e.g. diphenylamine-benzophenone) system by cooling curve method.
4. To determine the solubility of benzoic acid at different temperatures and to determine ΔH of the dissolution process.
5. To determine the enthalpy of neutralization of a weak acid/weak base versus strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
6. To determine the enthalpy of solution of solid calcium chloride and calculate the lattice energy of calcium chloride from its enthalpy data using Born Haber cycle.

Scheme of Examination (B.Sc. Part- II)

	Max. Marks75
Inorganic	
A- Calibration & Preparation of solution	-05
B- One Exercise	-10
C- One Exercise	-10
Organic	
A- One Exercise	-10

B-One Organic Compound	-10
Physical	
One experiment is to be performed	-20
Viva	-05
Record	-05

B8. Comparative physiology

Section A

Comparative account of the mechanisms of food uptake in animals. Digestion of food. Uptake of the nutrients by plant, animals and microorganisms. Transport of nutrients across the cell membrane for energy, structure and storage. Concept of exoenzymes and endo enzymes, bound and soluble enzymes.

Section B

Metabolism: Integration of catabolism and anabolism. Secondary metabolism, regulation of metabolic pathways, compartmentalization of metabolic pathways in microorganisms and higher organisms.

Photosynthesis. Diversity of Phototrophs. Chloroplast structure. Pigments involved in photosynthesis chlorophylls, carotenoids, xanthophylls, phycobillins. Light and dark reaction. C3 and C4 pathways. Comparison of photosynthetic systems of plants and bacteria, Photorespiration.

Section C

Respiration: Glycolytic pathway. Citric acid cycle, glyoxylate cycle. Pentose phosphate pathway, their significance, energetics and enzymology.

Electron transport chain, phosphorylation and ATP production. Anaerobic respiration, Fermentation. A comparative account of respiratory processes of microorganisms, plants and animals.

B9. Molecular Biology

Section A

DNA as the genetic material. Hershey & Chase experiment. Conrat and Senger's experiment. Structure of DNA, Watson & Crick's Model, Types of DNA, Meselsen & Stahl's experiment, DNA replication, genome complexity, packaging of DNA into chromosomes. Euchromatin, heterochromatin, repetitive DNA, DNA denaturation and renaturation. Genetic information content- C-value paradox and reassociation kinetics. Genetic code, Steps of protein synthesis and their details. Structure and types of RNA and their functions

Section B

Transcription of RNA in prokaryotes and eukaryotes: Steps in transcription. Maturation and processing of RNA.

Translation: Comparison between prokaryotic and eukaryotic translation. Post translational processing of proteins.

Genetic recombination. Molecular aspects of recombination. Homologous and heterologous recombination. Holliday Model. Gene expression and organization in mitochondrion and chloroplast.

Section C

Regulation of expression in prokaryotes and eukaryotes. Operon concept.

Inducible and repressible operons. Negative and positive regulation. Details of lac and tryp operon.

Gene control of development in *Drosophila*, hormonal control of gene expression. regulation of alternate pathways of transcript splicing. regulation of complex circuits of gene expression in eukaryotes.

B10. Plant resources & Technology

Section A

Basic features of anatomy of cryptogams and phenerogamis. Diversity of forms of seeds, fruits, flowers, leaves, stems and roots.

Classification of plants upto family level. Vegetative and floral characteristics and economic importance of cucurbitaceae, Fabaceae, Cruciferae and Poaceae (Graminae). Pteridophytes with specific reference to *Azolla*.

Section B

Forest products: *Tectona, Delbergia, Tecomella*. Medicinal plants: *Cinchona, Withania*. Pharmacological and ethnobotanical traditional medicines. Characterization and formulation of crude drugs in Ayurvedic system. Plant sources of homeopathic medicines. Fuel crops: Jojoba, *Euphorbia antisyphilitica, Calotropis procera* Characteristics, cultivation and extraction of oil. Edible and poisonous fungi. Cultivation of different types of mushrooms

Section C

In situ and *ex situ* methods of conservation of phytodiversity. *In vitro* methods in plant tissue culture. Nutrient media. Use of growth regulators. *In Vitro* fertilization. Ovary and ovule culture. Micropropagation (clonal propagation), organ culture- anther, embryo, endosperm culture and their applications. Organogenesis and somatic embryogenesis-techniques and applications.

Protoplast culture- Isolation, regeneration, viability test, somatic hybridization, methods of protoplast fusion. Practical application of somatic hybridization and cybridisation. Somaclonal variations and their significance. *In vitro* production of secondary metabolites- techniques and significance. Plant cell suspension culture to produce saffron and capsicin.

B11. Biophysics & Biotechniques II

Section A

Electromagnetic radiations: Light rays, refraction, Snell's law. Image by spherical surface, Diffraction, Interference, Single slit, many slit and 2-D gratings, resolving power of a grating, dispersion of a grating, Polarization, Frequency and wavelength, colour, spectrum.

Observing cells and microorganisms: Principles of microscopy. Electromagnetic radiations, magnification, numerical aperture, resolving power. chromatic aberrations. Devlopment of microscopes from simple bright field to electron microscopes. Types of microscopy, principles and uses: Visible light (Dark and bright field), Fluorescence microscopy. UV and Electron based microscopy techniques. Stereo and Inverted microscopes and their uses. Transmission, Scanning and Scanning Tunneling Microscopes.

Section B

Photons. LASER. Momentum of radiation. Compton effect and X-rays. Bragg's law. Project seafarer. microwave ovens. Black-body radiation and spectrum. Photons from a light bulb. Signal to noise ratio. Photomultiplier. Solar battery. Laser surgery (photocoagulation). Structure factor expression. electron density equation. The Planck's hypothesis. wave-particle duality. matter waves and de Broglie hypothesis. Principles of Spectroscopy. Energy levels. excitation. absorption. electronic. vibrational. rotational spectra. Types of spectroscopy and their uses.

Density and specific gravity. Archimedes' principle. Pressure and Buoyant force. Units of pressure. Sphygmomanometer. Gas laws. ideal gas. Avogadro's laws. Pressure. altitude and autoclaving and pressure cooking. Fluid flow. Bernoulli's principle. Viscosity and Poiseuille's law. Units of viscosity, Stoke's law. Reynold's number. Osmosis.,Waves. Surface tension.

Section C

Radioactivity. radioactive nuclei. Physical and biological half life, handling and standardization of a- and b-emitting isotopes. Uranium. Radium-the Curie and Plutonium. Thorium. Radioactive series. Nuclear systematics. Nuclear fission,

Breeder reactors, ecological fall outs. Biological applications. Radiolabelling. Diagnosis (Radioimmunoassay) Tracers. GM and Scintillation Counters. Therapy (Neutron activation, therapy), Radiation dose (Roentgen. Rad and Rem) and safety. Uses in molecular biology. Shielding and other precautions. Radiocarbon dating. Tritium dating.

Books:Physics (1988), Machlup, Wiley International Edition. John Wiley and Sons, New York

B12. Ecology & Environmental biotechnology

Section A

Basic principles of ecology. Ecosystem, population. community, succession, ecological pyramids, trophic levels. food chains, food webs, guild, productivity. Abiotic-biotic factors and their interactions. Leibig's law of minimum and Shelford's law of tolerance. Combined concept of limiting factors. Biotic – biotic interactions Adaptations: hydrophytes. halophiles. xerophiles.

Biodiversity. Measures of biodiversity and their limitations. Concept of niche and evolution of biodiversity. Information and stability of a system. Biogeochemical cycles of water. carbon. nitrogen and phosphorus.

Section B

Environmental Issues: Ozone hole, Global warming. El Nino, pollution. eutrophication. Biology in warning systems for environmental disturbance-Ecological indicators. biomarkers.

Liquid. solid (degradable. nondegradable. xenobiotic) and gaseous wastes. Bioremediation. Wastewater treatment. Oxidation ponds and activated sludge process. Solid waste treatment for degradable wastes. Anaerobic treatment. composting and vermiculture. Flue gas treatment strategies.

Section C

Resources: Renewable and non renewable. Green technologies. Fuels and their alternatives. Biofertilizers v/s fertilizers, pesticides v/s biopesticides, plastics v/s bioplastics, surfactants v/s biosurfactants, polymers (gums, adhesives, lubricants) v/s biopolymers. Production technology of *Rhizobium*, cyanobacterial biofertilizers and *Bacillus thuringiensis*. Ore leaching (biomining). Biofuels: biodiesel, petrocrops, gasohol, biogas, hydrogen production.

B13. Cellular Interactions

Section A

Semiochemicals: Allomones, Kairomones. Pheromones. Hormones, Allarmones. Allelochemicals. Antibiosis, antibiotics, bacteriocins. Cell-cell recognition and adhesion. Signal transduction in cells: Electrical signals, messangers and receptors.

Defense in microorganisms: Against other microorganisms, heavy metals, DNA damage and higher organisms.

Section B

Plant defenses : unfavourable environment, hormonal regulation, drought survival. air pollution, heavy metals. infection. signaling molecules in defense. Defense in invertebrates: internal defense in molluscs, arthropods. interactions in defense.

Defense in non mammalian vertebrates: cells and tissues of immune system in fish and birds, antigen recognition, B-lymphocytes, its structure and function. Effect of temperature, stress on fish immunity.

Section C

Mammalian defense: physicochemical barriers. Immunology. Passive, active and acquired immunity. Humoral and cell mediated immunity. Cells and organs of immune responses and their functions. Antigens Factors affecting antigenicity. Antibodies, their structure and types. Production of antibodies. Complement system. Hypersensitivity and allergic reactions.

Immunodiagnostics in Typhoid, Syphilis, Typhus fever and HIV. RIA & ELISA. Vaccines, history, types and their production strategies. Vaccines available and vaccination schedules for children. Importance of cold chain and precautions in vaccinations.

Books: Counotte A., Leach C.K., van Dam-Mieras, M.C.E. (eds) 1993. Defense mechanisms. Biotechnology by Open Learning (BIOTOL) series. Butterworth Heinemann. Oxford.

B14. Combined practical

Physiology

1. Internal anatomy of cockroach (dissection). ruminants and men (models).
2. Demonstration of plasmolyisis using *Roheo discolor* leaves/red blood cells
3. Demonstration of osmosis by potato osmoscope
4. Estimation of chlorophyll by hot methanol extraction method

5. Estimation of photosynthetic rate using light and dark bottle method
7. Estimation of respiratory rate by Warburg method
8. Demonstration of catalase activity and peroxidase
9. Demonstration of exoenzyme activities- cellulases and amylases.
10. Demonstration of fermentation by yeast.

Molecular Biology

1. Extraction, estimation and purification of protein from animal/microbial source by salt precipitation and organic solvent method.
2. Seperation of proteins by polyacrylamide gel electrophoresis
3. Demonstration of DNA transfer by transformation and conjugation in bacteria by teaching kits.
4. Extraction of DNA from plant/animal/microbial cells.
5. Restriction digestion of DNA followed by agarose gel electrophoresis and gel documentation
6. Isolation of plasmid DNA from *Escherichia coli*

Plant resources & Technology

1. Preparation of plant tissue culture medium: MS, Nitsche and White's media.
2. Production of callus and suspension culture
3. Isolation of plant protoplasts.
4. Plant production through tissue culture (shoot tip and nodal culture)
5. Anther culture
6. Preparation of synthetic seeds

Biotechniques

1. Mechanical methods of cell disruption of animal/plant cells
2. Chemical methods of cell disruption of Gram negative bacteria
3. Ultrasonication to break cells of Gram positive bacteria
4. Methods of concentrating thermolabile solutions: rotary evaporator, lyophilizer.
5. Paper chromatographic separation of pigments
6. Phytochemical tests of the following: Glucose, starch, proteins, fats, tannins, ascorbic acid and anthocyanin.
7. TLC of sugars/amino acids
8. Demonstration of Beer and Lambert's law
9. Determining l_{max} of a coloured solution

Ecology & Environmental Biotechnology

1. Calculate diversity index of a community of plants/algae
2. Oligodynamic effect of metals on bacterial populations
3. Microscopic and macroscopic differentiation of root nodules and root galls.
4. Observing mycorrhiza.
5. Demonstration of antibiotic activity of *Penicillium* or any other organism
6. Determination of pollution in water/food using *Escherichia coli* as indicator.
7. Determination of Blood groups
8. Demonstration of precipitin test

9. Demonstration of ELISA

B.Sc. Part III examination w.e.f -

C9 - INORGANIC CHEMISTRY

Time : 3 Hours **Max. Marks:50**

Unit-I

(a) Metal-ligand Bonding in Transition Metal Complexes

Limitations of valence bond theory, an elementary idea of crystal-field theory, crystal field splitting in octahedral , tetrahedral and square planar complexes, factors affecting the crystal-field parameters.

(b) Thermodynamic and Kinetic Aspect of Metal Complexes

A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes.

Unit-II

(a) Magnetic Properties of Transition Metal Complexes

Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula. L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.

(b) Electronic Spectra of Transition Metal Complexes

Types of electronic transition, selection rules of d-d transitions, spectroscopic ground state, spectrochemical series. Orgel-energy level diagram for d^1 and d^9 states, discussion of the electronic spectrum of $[Ti(H_2O)_6]^{3+}$ complex ion.

Unit-III

Organometallic Chemistry

Definition, nomenclature and classification of organometallic compounds. Preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti, a brief account of metal-ethylenic complexes and homogeneous hydrogenation, mononuclear carbonyls and the nature of bonding in metal carbonyls.

Unit-IV

Bioinorganic Chemistry

Essential and trace elements in biological processes, metallporphyrins with special reference to haemoglobin and myoglobin. Biological role of alkali and alkaline earth metal ions with special reference to Ca^{2+}. Nitrogen fixation.

Unit-V

(a) Hard and Soft Acids and Bases(HSAB)

Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.

(b) Silicones and Phosphazenes

Silicones and phosphazenes as examples of organic polymers, nature of bonding in triphosphazenes.

C10 - ORGANIC CHEMISTRY

Time : 3 Hours **Max. Marks:50**

UNIT-I

Spectroscopy

Nuclear Magnetic resonance (NMR) spectroscopy.

Proton magnetic resonance(^{1}H NMR) spectroscopy, nuclear shielding and dishielding chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2,-tribromoethane, ethyl acetate, toluene and acetophenone. Problems pertaining to the structure elucidation of simple organic compounds using UV, IR and PMR spectroscopic techniques.

UNIT-II

(a) Organometallic Compounds

Organomagnesium compounds: the Grignard reagents-formation, structure and chemical reaction.

Organozinc compounds:formation and chemical reactions.

Organolithium compounds: formation and chemical reactions.

(b) Fats, Oil and Detergents

Natural fats, edible and industrial oils of vegetable origin, common fatty acids, glycerides, hydrogenation of unsaturated oils. Saponification value, iodine value, acid value. Soaps, synthetic detergents, alkyl and aryl sulphonates.

UNIT-III

Organic Synthesis via Enolates

Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate.

Alkylation of 1,3-dithianes. Alkylation and acylation of enamines.

UNIT-IV

(a) Carbohydrates

Classification and nomenclature. Monosaccharides, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Erithro and threo diastereomers. Conversion of glucose into mannose. Formation of glycosides, ethers and esters, Determination of ring size of monosaccharides. Cyclic structure of D(+)- glucose. Mechanism of mutarotation. Structure or ribose and deoxyribose.

An introduction to disaccharides(maltose, sucrose and lactose) and polysaccharides(starch and cellulose) without involving structure determination.

(b) Amino Acids, Peptides, Proteins and Nucleic Acids

Classification, structure and stereochemistry of amino acids. Acid base behavior, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids.

Structure and nomenclature of peptides and proteins. Classification of proteins. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins, level of protein structure. Proteins denaturation/ renaturation.

Nucleic acids: introduction, Constitution of nucleic acids. Ribnonucleosides and ribonucleotides. The double helical structure of DNA.

UNIT-V

(a) Synthetic Polymers

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization. Polyesters, polyamides, phenol formaldehyde resins, urea formaldehyde resins, epoxy resins and polyurethanes.

Natural and synthetic rubbers.

(b) Synthetic Dyes

Colour and constitution (electronic concept). Classification of dyes. Chemistry and synthesis of Methyl orange, Congo red, malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and indigo.

C11 - PHYSICAL CHEMISTRY

Time : 3 Hours **Max. Marks:50**

UNIT-I

Elementary Quantum Mechanics

Black-body radiation, Planck's radiation law, photoelectric effect, heat capacity of solids, Bohr's model of hydrogen atom (no derivation) and its defects, Compton effect.

De Brogile hypothesis, the Heisenberg's uncertainty principle, Sinusoidal wave equation, Hamiltonian operator, Schrodinger wave equation and its importance, physical interpretation of the wave function, postulates, of quantum mechanics, particle in a one dimensional box.

Schrodinger wave equation for H-atom, separation into three equations (without derivation), quantum numbers and their importance, hydrogen like wave functions, radial wave functions, angular wave functions.

UNIT-II

Molecular orbital theory basic ideas- criteria for forming M.O from A.O, construction of M.O's by LCAO-H_2^+ ion, calculation of energy levels from wave functions, physical picture of bonding and antibonding wave functions, concept of σ, σ^*,π, π^* orbitals and their characteristics. Hybrid orbitals-sp, sp^2, sp^3- calculation of coefficients of A.O.'s used in these hybrid orbitals.

Introduction to valence bond model of H_2, comparison of M.O. and V.B. models.

UNIT-III

Spectroscopy

Introduction : electromagnetic radiation, regions of the spectrum, basic features of different spectrometers, statement of the Born-Oppenheimer

approximation, degrees of freedom.

Rotational Spectrum

Diatomic molecules, Energy levels of a rigid rotor (semi-classical principles), selection rules, spectral intensity, distribution using population distribution (Maxwell-Boltzmann distribution) determination of bond length, qualitative description of non-rigid rotor, isotope effect.

Vibrational Spectrum

Infrared spectrum: Energy levels of simple harmonic oscillator, selection rules, pure vibrational spectrum, intensity, determination of force constant and qualitative relation of force constant and bond energies, effect of anharmonic motion and isotope on the spectrum, idea of vibrational frequencies of different functional groups.

Raman Spectrum concept of polarizability, pure rotational and pure vibrational Raman Spectra of diatomic molecules, selection rules.

UNIT-IV

(A) Electronic Spectrum

Concept of potential energy curves for bonding and antibonding molecular orbitals, qualitative description of selection rules and Frank-Condon principle.

Qualitative description of σ, π- and n M.O., their energy levels and the respective transitions.

(B) Photochemistry

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grothus-Drapper law, Stark-Einstein law, Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluroscence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions- energy transfer processes (simple examples)

UNIT-V

Solutions, Dilute Solutions and Colligative Properties

Ideal and non-ideal solutions, methods of expressing concentration of solutions, activity and activity coefficient.

Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure, molecular weight determination. Osmosis, law of osmotic pressure and its measurement, determination of molecular weight from osmotic pressure. Elevation of boiling point and depression in freezing point. Experimental methods for determining various colligative properties.

Abnormal molar mass, degree of dissociation and association of solutes.

C12 - PRACTICALS

Time: 6 Hours **Max. Marks: 75**

(A) Instrumentation

Colorimetry

(a) Job's method (b) Mole-ratio method

Adulteration- Food stuffs.

Effluent analysis, water analysis.

OR

Solvent Extraction: Separation and estimation of Mg(II) and Fe(II)

Ion Exchange Method: Separation and estimation of Mg(II) and Zn(II).

(B) Synthesis of (Any six)

(a) Sodium trioxalato ferrate (III), $Na_3[Fe(C_2O_4)_3]$

(b) Ni-DMG complex, $[Ni(DMG)_2]$

(c) Copper tetrammine complex $[Cu(NH_3)_4]SO_4$.

(d) Cis-and trans-bisoxalato diaqua chromate (III) ion.

(e) m-dinitrbenzene

(f) p-nitroacetanilide

(g) p-bromoacetanilide

(h) 2,4,6- tribromophenol

(i) Methyl orange

(j) Methyl red

(k) Benzoic Acid

(l) Aniline

(m) m-nitroaniline

(C) Organic Qualitative Analysis

Analysis of an organic mixture containing two solid components using water, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives.

(D) Laboratory Techniques

Steam Distillation

Naphthalene from its suspension in water

Clove Oil from cloves

Separation of o-and-p-nitrophenols

OR

Column Chromatography

Separation of fluorescene and methylene blue

Separation of leaf pigments from spinach leaves

Resolution of racemic mixture of (±) mandelic acid

OR

Stereochemical Study of Organic Compounds via Models

(i) R and S configuration of optical isomers.

(ii) E,Z configuration of geometrical isomers.

(iii) Conformational analysis of cyclohexane and substituted cyclohexanes.

(E) PHYSICAL CHEMISTRY (ANY SIX)

1. To determine the strength of the given acid conductometrically using standard alkali solution.
2. To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.
3. To study the saponification of ethyl acetate conductometrically
4. To determine the ionisation constant of a weak acid conductometrically.
5. To titrate potentiometrically the given ferrous ammonium sulphate solution using $KMnO_4/K_2Cr_2O_7$ as titrant and calculate the redox potential of Fe^{++}/

Fe^{+++} system on the hydrogen scale.

6. To verify law of refraction of mixtures (e.g. of glycerol and water) using Abbe's refractometer.
7. To determine the specific rotation of a given optically active compound
8. Determination of molecular weight of a non-violatile solute by Rast method/ Backmann freezing point method.
9. Determination of the apparent degree of dissociation of an electrolyte (e.g. NaCl) in aqueous solution at different concentrations by ebullioscopy.
10. To verify Beer-Lambert law for $KMnO_4/K_2Cr_2O_7$ and determine the concentration of the given solution of the substance.

Books Suggested (Laboratory Courses)

1. Vogel's Qualitative Inorganic analysis, revised, Svehla, Orient Longman.
2. Vogel's Textbook of quantitative Inorganic Analysis (revised), J. Bassett, R.C. Denney, G.H. Heffery and J Mendham, ELBS.
3. Standard Methods of Chemical Analysis, W.W. Scott, The Technical Press.
4. Experimenal inorganic Chemistry, W.G Palmer, Cambridge.
5. Handbook of Preparative Inorganic Chemistry, Vol, I & II Brauer, Academic Press.
6. Inorganic Syntheisis, McGraw Hill.
7. Experimental Organic Chemistry Vol. I&II, P.R. Singh, D.S. Gupta and K.S. Bajpai, Tata McGraw Hill.
8. Laboratory Manual in Organic Chemistry, R.K. Babsal, Wiley Eastern.
9. Vogel's Textbook of Practical Organic Chemistry, B.S.. Furniss, A.J. Hannaford, V. Rogers, P.W.G Smith and A.R. Tatchell, ELBS.
10. Experiments in General Chemistry, C.N.R. Rao and U.C. Agarwal,East-West press.
11. Experiments in Physical Chemistry, R.C. Das and B. Behra, Tata McGraw hill.
12. Advanced Practical Physical Chemistry, Vol.I-Physical, J.B. Yadav, Goel Publishing House.
13. Advanced Experimental Chemistry, Vol.I-Physical, J.N. Gurtu and R.Kapoor, S Chand & Co.
14. Selected Experiments in Physical Chemistry, N.G Mukherjee . J.N. Ghose & Sons.
15. Experiments in Physical Chemistry, J.C. Ghosh, Bharati Bhavan.

SCHEME OF EXAMINATION (B.SC. III)

Time: 6 Hours Max. Marks:75

A) Instrumentation(One Exercise)	15
B) Synthesis	15
C) Organic Qualitiative Analysis	10
D) Laboratory Techniques (one Exercise)	05
E) One physical experiment is to be performed	20
Viva	05
Record	

B15. Animal resources and Technology

Unit I. Chordates and non chordates. General characters of all phyla upto orders with examples emphasizing their biodiversity, economic importance and conservation measures where required. Classification, habits, habitat and features of obelia, sycon, fasciola, taenia, nereis, hirudinaria, palaemon.

Unit II. Classification, habits, habitat and features of Pila, lamellidens, asterias, herdmania, branchiostoma, peteromyzon, myxine. Biology of insecta. Morphology, Anatomy, life history and importance of Lepidoptera, Hemiptera, Isoptera, Orthoptera and Hymenoptera.

Unit III. Sericulture, Apiculture, Lac culture. Aquaculture – pisciculture, prawn and pearl culture, Vermiculture

Unit IV. Scope of animal tissue culture. Natural media- plasma clot, biological fluids, tissue extracts. Importance of serum. Chemically defined media. Primary culture- Cell lines, cloning disaggregation of tissue, isolation of tissue, enzymatic disaggregation and mechanical disaggregation.

Unit V. Secondary culture- transformed animal cells and continuous cell lines. Stem cells and their cultivation. Importance of stem cell cultivation and ethical issues involved. Production and application of monoclonal antibodies and vaccines.

B16. Genetic Engineering

Unit I: Mutations: molecular mechanism of mutations, Types of mutations (insertions, deletions, frame shift, cryptic), spontaneous and induced mutations, chemical mutagenesis with examples, Ames test, site directed mutagenesis, mobile genetic elements: Insertion elements, transposons, maize elements, Ty elements in yeast, copia elements PCR and its use in genetic engineering.

Unit II : Concept of cloning. Restriction enzymes their types and properties, properties of a Cloning vehicles, plasmids as cloning vectors, viruses (phage lambda and mu) as cloning vectors, insertion of a DNA molecule into a vector, expression of cloned genes, recombinant selection and screening, genomic and cDNA libraries.

Unit III : Gene transfer mechanisms in bacteria: principles and application of transformation, conjugation and transduction, applications of microbial genetic engineering in biotechnology

Unit IV : Gene transfer mechanisms in plants. Techniques of transformation. *Agrobacterium* mediated and physical methods (microprojectile and electroporation). Applications of transgenic plants. Edible vaccines from plants.

Unit V : Gene transfer mechanisms in animals: Transfection of animal cell lines. HAT selection. Selectable markers and transplantation of cultured cells. Expression of cloned proteins in animal cells- expression vector, over production. T-cell cloning.

B17. Elementary Mathematics & Biostatistics

Unit I. The language of mathematics. Priority rules of operators, The signs, Functions, Constants, variables and parameters, Dimensional analysis, plotting graphs. Exponents and Logarithms: Integer powers, Fractional exponents, Addition and subtraction of exponents, Logarithms, Common logarithms, Exponential decay, Logarithms as a method of scaling, Products of equilibrium constants, Logarithms of dimensional quantities, Redox potentials, Dependence of redox potentials on pH. Permutations and combinations, factorials.

Unit II. Differential Calculus: Co-ordinate geometry, Slope of a curve, Rapid differentiation, Derivatives of sums and products, Derivative of a function, Derivative of a ratio, Higher derivatives, Notation, Maxima and minima, terminology, points of inflexion, Sketching curves.

Unit III. Integral calculus: Increase in area, definite and indefinite integrals, simple integrals, differential equations, numerical integration: evaluating the area under curve. Solving equations: linear equations in one unknown, rearranging equations, simultaneous linear equations, determinants, quadratic equations, graphical solution of equations, Newton's method, approximate methods. Partial differentiation: Its meaning, exact and inexact differentials.

Unit IV. Necessity of statistics. Data, population, Errors and sampling, Descriptive and inferential statistics. Frequency distribution (Binomial, Poisson and Normal), tabulation, graphical presentation. Accuracy, precision, methods of their expression, errors, their classification, detection and correction of determinate and indeterminate errors, Normal laws of distribution of errors.

Unit V. Measures of central tendency and dispersion. Concepts and problems of probability. Probability of errors. Correlation, regression. Least squares fitting and its application to Michaelis-Menten equation. Hypothesis testing: tests of significance- chi square, t-test.

Books: Cornish-Bowden, Athel. 1981. Basic mathematics for biochemists. Chapman & Hall, London.

B18. Fermentation Technology

Unit I. Growth and its requirements (environmental and nutritional). Factors affecting growth. Growth kinetics. Synchronous non synchronous, continous and batch cultivation. Types of industrial bioprocesses (aerobic, anaerobic and light based processes, solid state and submerged fermentation).

Unit II. Design and parts of a fermenter (photobioreactor). Types of fermenters. Stirred tank, membrane reactors and continuous flow reactors. Maintenance of asepsis, pH, gaseous environment and temperature in a fermenter.

Unit III. Upstream and downstream processes. Examples of fermentations involving biomass production. Production of single cell protein and single cell oil, *Spirulina*. Separation and harvesting the desired product. Immobilization

of cells and enzymes and its advantages. Bioprocesses involving extra cellular liberation of biomolecules. Production of Alcoholic beverages, penicillin, amylase. separation and harvesting of desired product.

Unit IV. Bioprocesses involving intracellular production of biomolecules. Production of polyhydroxyalkanoates. Separation and harvesting of desired product.

Unit V. Fermented foods: Yoghurt, buttermilk. idli, dosa and cheese. Strategies to reduce cost of production. Techniques to improve yield of the desired product (Strain improvement and other strategies).

B19. Biotech enterprises and socioeconomic issues

Unit I. Draft paper Biodiversity – Ministry of Environment & Forests and Draft paper Biotechnology-Department of Biotechnology. National Nanotechnology Initiative.

Unit II. Entrepreneurship in biotechnology. Funding agencies. Concepts and advantages of Biotechnological Parks and incubators. Prospecting and preparing a project report. Market survey. and decision making. Estimating the budget. Non recurring and recurring costs. Long and short term capital for the enterprise. Registering the firm with department of industries. Clearance from the department of environment, fire safety.

Unit III. Globalization: Concept and issues, International treaties affecting national policies related to biotechnology. Patents. Copy rights. Trade marks. Choice of IPR. Role of WTO. General Agreement of Trade and Tariffs (GATT). Trade related IPRs (TRIPS). Legal issues concerning biotechnology.

Unit IV. Biohazards. Biosafety guidelines and regulations. Biological contaminants. Biowaste disposal. Release of Genetically Engineered Microorganisms in environment, its fate and fears. Ethical issues in biotechnology. Genetically modified crops (BT crops) and environmental and ethical issues.

Unit V. Biological warfare. Gene banks. Importance of type cultures. Cryopreservation methods. Plant cell banks, pollen banks, blood banks, sperm banks, microbial germplasm collections and international regulations.

B20. Emerging technologies

Unit I : Bioinformatics Concept, scope and application. Biological databases. Database searches. BLAST and its relatives.

Unit II: Genomics. Concept, scope and application. Human Genome project. Functional genomics. DNA Microarrays.

Unit III. Proteomics. Concept, scope and applications. Protein classification, enzyme nomenclature. Families and superfamilies. Tools: 2-D electrophoresis, MALDI Mass spectrometry. Protein microarrays. Concept of metabolomics.

Unit IV: Nanotechnology and Nanobiotechnology. Concept, Scope (nanotubes, nanometals, nanoreactors, nanocomposites, nanocrystals) and application. Concept of nanotribology, nanoelectronics. MEMS.

Unit V: Biomimetics: Concept, scope and applications. Biomaterials and their scope in health and medicine. Trends in medical biotechnology: Genetic diseases and gene therapy. Bone marrow transplantation, artificial skin, molecular methods in diagnostics. Forensic medicine: identifying criminals using DNA fingerprinting.

B21. Combined Practical

Animal resources & technology

1. Cultivation of *Daphnia*.
2. Microscopic identification of crustaceans: *Daphnia, Cerodaphnia*.
3. Earthworms used in vermiculture

Genetic Engineering

1. Barr bodies in buccal smears
2. Karyotype analysis in man and onion.
3. Producing auxotrophic mutants of *Escherichia coli* by chemical mutagens
4. Transfection of bacterial cells using plasmid/phage vector.

Biostatistics

Numerical exercises on precision, accuracy, randomization in experiments, tests of significance on experiments conducted earlier or being conducted.

Fermentation Technology

1. Preparing serial dilutions to count bacteria.
2. Determining growth rate of any bacteria.
3. Demonstration of diauxy in bacteria to demonstrate lac operon activity.
4. Immobilization of cells (algal/yeast cells)
5. Immobilization of enzyme (invertase may be obtained from yeast cells and observed for glucose production)
6. Production of citric acid by *Aspergillus* and its estimation.
7. Prospecting amylase producing microorganisms.
8. Preparation of yoghurt and wine
9. Estimation of alcohol by specific gravity method.

Biotech Enterprises and socioeconomic issues

1. Preparing a project report to begin a biotechnology based enterprise
2. Preparing a report on the biosafety and environmental safety practices being followed by any institution and pointing out deficiencies.

Emerging technologies

1. Elementary knowledge of biological databases. Submitting sequences on databases in public domain and practicing homology calculations.
2. Observation of slides of genetic diseases in man (Down, Turner and other syndromes) and comments on them.

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