Annexure-II
NOTIFICATION NO.26/2018
SCHEME AND SYLLABUS FOR RECRUITMENT TO THE POST OF
LECTURERS IN GOVERNMENT DEGREE COLLEGES IN A.P COLLEGIATE EDUCATION SERVICE

PART-A: Written 'Examination (Objective Type)			
Papers	**No. of Questions**	**Duration (Minutes)**	**Maximum Marks**
Paper-1: General Studies & Mental Ability (Degree Standard)	150	150	150
Paper-2: Concerned Subject (One only) (PG Standard)	150	150	300
PART-B: Interview (Oral Test)			50
		TOTAL	**500**
NEGATIVE MARKS: As per G.O.Ms. No.235, Finance (HR-I, Plg & Policy) Dept., Dt. 06/12/2016, for each wrong answer will be penalized with 1/3rd of the marks prescribed for the question.			

NB: The Candidates have to choose one of the following subjects relevant to the PG Degree for writing Paper-2:

1. English	2. Telugu	3. Hindi
4. Urdu	5. Oriya	6. Commerce
7. Economics	8. History	9. Political Science
10. Mathematics	11. Physics	12. Chemistry
13. Botany	14. Zoology	15. Statistics
16. Bio-technology	17. Microbiology	18. Computer Applications
19. Computer Science	20. Geology	

SYLLABUS
PAPER-1
GENERAL STUDIES & MENTAL ABILITY

1. Events of national and international importance.
2. Current affairs- international, national and regional.
3. General Science and it applications to the day to day life Contemporary developments in Science & Technology and information Technology
4. Social- economic and political history of modern India with emphasis on Andhra Pradesh.
5. Indian polity and governance: constitutional issues, public policy, reforms and e-governance initiatives with specific reference to Andhra Pradesh.
6. Economic development in India since independence with emphasis on Andhra Pradesh.
7. Physical geography of Indian sub-continent and Andhra Pradesh.
8. Disaster management: vulnerability profile, prevention and mitigation strategies,
   Application of Remote Sensing and GIS in the assessment of Disaster.
9. Sustainable Development and Environmental Protection
10. Logical reasoning, analytical ability and data interpretation.
11. Data Analysis:
    a) Tabulation of data
    b) Visual representation of data
    c) Basic data analysis (Summary Statistics such as mean, median, mode, variance and coefficient of variation) and Interpretation
12. Bifurcation of Andhra Pradesh and its Administrative, Economic, Social, Cultural, Political, and Legal implications/problems.

PAPER-2-SUBJECT

1. ENGLISH

I. Movements and Concepts

Renaissance, Metaphysical poetry, Neo-classicism, Romanticism, Rise of the novel, Modernism, Postmodernism, Colonialism, Postcolonialsim, Diaspora, Psychoanalytical criticism, Myth and archetype, Feminism, Structuralism, Poststructuralism, Deconstruction.

II. Writers and Texts

1)	William Shakespeare	*Hamlet*, *Tempest*
2)	John Milton	*Paradise Lost*-Book 1 and 9
3)	William Wordsworth	"Immortality Ode", *Tintern Abbey*
4)	John Keats	"Ode to a Nightingale", "To Autumn"
5)	Robert Browning	"My Last Duchess", "The Last Ride Together"
6)	**Charles Dickens**	**David Copperfield**
7)	**TS Eliot**	**"The Waste Land", Murder in the Cathedral**
8)	**GB Shaw**	**Saint Joan**
9)	**Virginia Woolf**	**"A Room of One's Own"**
10)	**Samuel Beckett**	**Waiting for Godot**
11)	**William Golding**	**Lord of the Flies**
12)	**Robert Frost**	**"Home Burial", "The Road Not Taken"**
13)	**Eugene O'Neill**	**The Hairy Ape**
14)	**Toni Morrison**	**Beloved**
15)	**Mulk Raj Anand**	**Untouchable**
16)	**AK Ramanujan**	"Love Poem for a Wife", "Small-Scale Reflections on a Great House"
17)	**Girish Karnad**	**Hayavadana**
18)	**Salman Rushdie**	**Midnight's Children**
19)	**Chinua Achebe**	**Things Fall Apart**
20)	**Margaret Atwood**	**Edible Woman**
21)	**AD Hope**	**"Australia", "Crossing the Frontier"**
22)	**Bessie Head**	*A Question of Power*

III. English Language Teaching

1) ELT in India: (History and status of English in India; English as Second Language, English as Foreign Language, and Ensglish as Global Language).
2) Methods and Approaches: (Grammar Translation method, Direct method, Audio-Lingual method; Structural approach, Communicative language teaching)
3) Teaching of Language Skills: (Teaching of Listening, Speaking, Reading, and Writing Skills; Teaching of Grammar and Functional English; Teaching of Vocabulary; Classroom techniques; Use of authentic materials)
4) Testing and Evaluation: (Principles, Types, Objectives of testing and evaluation)
5) Phonetics and Phonology; Syntax and Structure.

2. TELUGU

తెలుగు

1. (ఎ) సంప్రదాయ సాహిత్యకవుల అధ్యయనం – కాలం – రచనలు

నన్నయ, తిక్కన, ఎర్రన, శివకవులు (నన్నెచోడుడు, మల్లికార్జున పండితారాధ్యుడు, పాల్కురికి సోమనాథుడు), నాచనసోమన – భాస్కర రామాయణ కవులు, రంగనాథ రామాయణ కవి – శ్రీనాథుడు – పోతన – పిల్లలమర్రి పినవీరభద్రుడు – గౌరన – జక్కన – అనంతామాత్యుడు – కొరవి గోపరాజు – నంది మల్లన, ఘంట సింగన –అష్టదిగ్గజ కవులు – తాళ్ళపాక కవులు – శ్రీకృష్ణదేవరాయలు – పొన్నగంటి తెలగన్న – చేమకూర వెంకటకవి – తంజావూరు రాజకవులు – కవయిత్రులు – కూచిమంచి తిమ్మకవి – జగ్గకవి.

(బి) వేమన తాత్త్వికత – సమకాలిక పరిశీలన, దృక్పథం – సమాజంపై వేమన కవిత్వ ప్రభావం.

2. సాహిత్య ధోరణుల అధ్యయనం – యుగప్రభావం – రూపాలు – మొదలైనవి. ఇతిహాసం – పురాణం ప్రబంధం – శతకం – సంకీర్తన సాహిత్యం – చారిత్రక కావ్యం – సంప్రదాయ, ఆధునిక గద్య రచనలు – నవల – కథానిక – వ్యాసం – ఏకాంకిక మొదలైనవి – వాదాలు (దళిత, హేతు, స్త్రీ, ప్రాంతీయ)

3. జానపద విజ్ఞానం – గేయాలు – కథాగేయాలు – గద్యాఖ్యానాలు – (పురాణగాథలు – ఇతిహ్యాలు– కథలు), సామెతలు – పొడుపుకథలు – జానపద కళలు – (వీధి నాటకాలు, యక్షగానాలు, బొమ్మలాటలు, పగటివేషాలు, చిందు, గంగ జాతర కళారూపాలు.

4. ఆధునిక కవుల అధ్యయనం – ఆధునిక ధోరణులు వారి రచనలు – గురజాడ – రాయప్రోలు – వీరేశలింగం – చిలకమర్తి – పానుగంటి – విశ్వనాథ – దేవులపల్లి – బసవరాజు – పింగళి – కాటూరి – దువ్వూరి – పుట్టపర్తి – శ్రీశ్రీ – ప్రసిద్ధ ఆధునిక కవులు – భావ అభ్యుదయ – దిగంబర.

5. తెలుగు వ్యాకరణ, ఛందస్సు అధ్యయనం :

వ్యాకరణం – బాల వ్యాకరణం (సంజ్ఞ, సంధి, క్రియా, తత్సమ, ఆచ్చిక ప్రకరణాలు)
ప్రౌఢ వ్యాకరణ (సంజ్ఞ, సంధి, కారక, శబ్ద వాక్య పరిచ్ఛేదాలు)

ఛందస్సు – వృత్తాలు, జాతులు, ఉపజాతులు
(ఉత్పలమాల, చంపకమాల, శార్దూలం, మత్తేభం, ద్విపద, తరువోజ, సీసం, కందం, స్రగ్ధర, పంచచామరం)

అలంకారాలు – అర్థాలంకారాలు, శబ్దాలంకారాలు

6. తెలుగు భాషా చరిత్ర పరిణామం – (ప్రాఙ్నన్నయ యుగం నుండి నేటి వరకు)– ద్రావిడ భాషా కుటుంబాలలో తెలుగు స్థానం – భౌగోళిక విభజన – మాండలికాలు.

7. భాషా విజ్ఞాన అధ్యయనం – భాషా శాస్త్రం, అర్థ విపరిణామం – ఆధునిక కాలం : శాసన భాష నుండి సాహిత్య భాష వరకు (వ్యావహారిక భాషా ఉద్యమం వంటివి)

8. తెలుగు సాహిత్య పరిణామం – (ప్రాఙ్నన్నయ యుగం నుండి నేటి వరకు)

9. సౌందర్య, సాహిత్య విమర్శ అధ్యయనం (ప్రాక్, పశ్చిమ) ఆధునిక తెలుగు సాహిత్య విమర్శ.

10. సంస్కృత వ్యాకరణం, కావ్యాలు – సంస్కృత వ్యాకరణం ప్రాథమిక విజ్ఞానం, సామాన్య ప్రామాణిక గద్య, పద్య పాఠ్యాంశాలు – హితోపదేశం, కాళిదాసుని కృతులు, సంస్కృత పంచకావ్యాల పరిచయం.

3. HINDI

HINDI

हिन्दी भाषा और उसका विकास

इकाई-1

हिन्दी की ऐतिहासिक पृष्ठभूमि : प्राचीन भारतीय आर्यभाषाएँ – वैदिक तथा लौकिक संस्कृत और उनकी विशेषताएँ। मध्यकालीन भारतीय आर्यभाषाएँ – पालि; प्राकृत – शौरसेनी, अर्धमागधी, मागधी, अपभ्रंश और उनकी विशेषताएँ। आधुनिक भारतीय आर्यभाषाएँ और उनका वर्गीकरण। देवनागरी लिपि: विकास, विशेषताएँ और मानकीकरण।

इकाई-2

हिन्दी का भौगोलिक विस्तार: हिन्दी की उपभाषाएँ, पश्चिमी हिन्दी, पूर्वी हिन्दी, विशेषताएँ।

इकाई 3

हिन्दी का भाषिक स्वरूप : हिन्दी की स्वनिम व्यवस्था – खंड्य, खंड्येतर। हिन्दी शब्द रचना – उपसर्ग, प्रत्यय, समास। रूपरचना – लिंग, वचन, और कारक – व्यवस्था के संदर्भ में हिंदी के संज्ञा, सर्वनाम, विशेषण और क्रियारूपा। हिन्दी वाक्य रचना: पदक्रम और अन्विति।

इकाई 4

हिन्दी के विविध रूप: संपर्क भाषा, राष्ट्रभाषा, राजभाषा के रूप में हिन्दी, माध्यम-भाषा, संचार-भाषा; हिन्दी की सांविधानिक स्थिति। हिन्दी प्रसार के आंदोलन, प्रमुख व्यक्तियों तथा संस्थाओं का योगदान।

इकाई-5

हिन्दी साहित्य का इतिहास

हिन्दी साहित्य का इतिहास- दर्शन, हिन्दी साहित्य के इतिहास-लेखन की पद्धतियाँ। हिन्दी साहित्य के प्रमुख इतिहास ग्रंथ, हिन्दी के प्रमुख साहित्यिक केन्द्र, संस्थाएँ एवं पत्र-पत्रिकाएँ, हिन्दी साहित्य के इतिहास का काल विभाजन और नामकरण

आदिकाल: हिन्दी साहित्य का आरम्भ कब और कैसे ? रासो साहित्य आदिकालीन हिन्दी का जैन साहित्य, सिद्ध और नाथ साहित्य, अमीर खुसरों की हिन्दी कविता, विद्यापति और उनकी पदावली, आरम्भिक गद्य तथा लौकिक साहित्य।

इकाई 6

मध्यकाल

भक्ति आन्दोलन के उदय के सामाजिक-सांस्कृतिक कारण, प्रमुख निर्गुण एवं सगुण संप्रदाय, वैष्णव भक्ति की सामाजिक- सांस्कृतिक पृष्ठभूमि, आलवार सन्त, पुमुख संप्रदाय और आचार्य, भक्ति आन्दोलन का अखिल भारतीय स्वरूप और उसका अन्त:प्रादेशिक वैशिष्ट्य।

हिन्दी सन्त काव्य : सन्त काव्य का वैचारिक आधार, प्रमुख निर्गुण संत कवि कबीर, नानक, दादू, रैदास, संत काव्य की प्रमुख विशेषताएँ, भारतीय धर्म साधना में संत कवियों का स्थान।

हिन्दी सूफी काव्य: सूफी काव्य का वैचारिक आधार, हिन्दी के प्रमुख सूफी कवि और काव्य – मुल्ला दाऊद(चन्दायन), कुतुबन (मृगावती), मंझन (मधुमालती), मालिक मुहम्मद जायसी (पद्मावत), सूफी प्रेमाख्यानकों का स्वरूप, हिन्दी सूफी काव्य की प्रमुख विशेषताएँ।

हिन्दी कृष्ण काव्य : विविध संप्रदाय, वल्लभ संप्रदाय, अष्टछाप, प्रमुख कृष्ण भक्त कवि और काव्य, सूरदास (सूरसागर), नंददास (रास पंचाध्यायी), भ्रमरगीत परंपरा, गीति परंपरा और हिन्दी कृष्ण काव्य – मीरा और रसखान।

हिन्दी राम काव्य विविध संप्रदाय, राम भक्ति शाखा के कवि और काव्य, तुलसीदास की प्रमुख कृतियाँ, काव्य रूप और उनका महत्व।

रीति काल: सामाजिक-सांस्कृतिक परिप्रेक्ष्य, रीतिकाव्य के मूल स्त्रोत, रीतिकाल की प्रमुख प्रवृत्तियाँ, रीतिकालीन कवियों का आचार्यत्व, रीतिमुक्त काव्यधारा, रीतिकाल के प्रमुख कवि: केशवदास, मतिराम, भूषण, बिहारीलाल, देव, घनानन्द और पद्माकर, रीतिकाव्य में लोकजीवन।

इकाई 7

आधुनिक काल: हिन्दी गद्य का उद्भव और विकास। भारतेन्दु पूर्व हिन्दी गद्य, 1857 की राज्य क्रान्ति और सांस्कृतिक पुनर्जागरण, भारतेन्दु और उनका मण्डल, 19वीं शताब्दी के उत्तरार्द्ध की हिन्दी पत्रकारिता।

द्विवेदी युग: महावीर प्रसाद द्विवेदी और उनका युग, हिन्दी नवजागरण और सरस्वती, मैथिलीशरण गुप्त और राष्ट्रीय काव्यधारा, राष्ट्रीय काव्यधारा के प्रमुख कवि, स्वच्छन्दतावाद और उसके प्रमुख कवि।

छायावाद और उसके बाद: छायावदी काव्य की प्रमुख विशेषताएँ, छायावाद के प्रमुख कवि: प्रसाद, निराला, पंत, और महादेवी, उत्तर छायावादी काव्य और उसके प्रमुख कवि, प्रगतिशील काव्य और उसके प्रमुख कवि, प्रयोगवाद और नई कविता, नई कविता के कवि, समकालीन कविता, समकालीन साहित्यिक पत्रकारिता।

इकाई 8

हिन्दी साहित्य की गद्य विधाएँ

हिन्दी उपन्यास: प्रेमचंद पूर्व उपन्यास, प्रेमचंद और उनका युग, प्रेमचंद के परवर्ती प्रमुख उपन्यासकार: जैनेन्द्र, अज्ञेय, हजारी प्रसाद द्विवेदी, यशपाल, अमृतलाल नागर, फणीश्वरनाथ रेणु, भीष्म साहनी, कृष्ण सोबती, निर्मल वर्मा, नरेश मेहता, श्रीलाल शुक्ल, राही मासूम राजा, रंगेय राघव, मन्नू भण्डारी।

हिन्दी कहानी: बीसवीं सदी की हिन्दी कहानी और प्रमुख कहानी आन्दोलन।

हिन्दी नाटक: हिन्दी नाटक और रंगमंच, विकास के चरण और प्रमुख नाट्यकृतियाँ: अंधेर नगरी, चंद्रगुप्त, अंधायुग, आधे-अधूरे, आठवां सर्ग, हिन्दी एकांकी।

हिन्दी निबंध: हिन्दी निबंध के प्रकार और प्रमुख निबंधकार – रामचन्द्र शुक्ल, हजारीप्रसाद द्विवेदी, कुबेरनाथ राय, विद्यानिवास मिश्र, हरिशंकर परसाई।

हिन्दी आलोचना: हिन्दी आलोचना का विकास और प्रमुख आलोचक: रामचन्द्र शुक्ल, नंददुलारे वाजपेयी, हजारी प्रसाद द्विवेदी, रामविलास शर्मा, डॉ.नगेन्द्र, डॉ. नामवर सिंह, विजयदेव नारायण साही। हिन्दी की अन्य गद्य विधाएँ : रेखाचित्र, संस्मरण, यात्रा-साहित्य, आत्मकथा, जीवनी और रिपोर्ताज।

इकाई 9

काव्य शास्त्र और आलोचना:

काव्य के लक्षण: शब्दार्थौ सहितौ काव्यम् (भामह), तद्दोषौ शब्दार्थौ सगुणावनलंकृती पुन: क्वापि (मम्मट), वाक्यं रसात्मकं काव्यम् (विश्वनाथ), रमणीयार्थ-प्रतिपादक: शब्द: काव्यम् (पण्डितराज जगन्नाथ), काव्य की आत्मा।

विविध संप्रदाय, प्रमुख सिद्धांत-रस, अलंकार, रीति,ध्वनि, वक्रोक्ति और औचित्य।

रस का स्वरूप और साधारणीकरण।

सहृदय की अवधारणा।

हिन्दी आलोचना – रामचन्द्र शुक्ल और उनके आलोचनात्मक प्रतिमान।

शुक्लोत्तर समीक्षा और समीक्षक – हजारी प्रसाद द्विवेदी, नन्ददुलारे वाजपेयी, डॉ. रामविलास शर्मा, डॉ. नामवर सिंह, विजयदेव नारायण साही, समकालीन आलोचना।

प्लेटो और अरस्तू का अनुकरण सिद्धांत तथा अरस्तू का विरेचन सिद्धांत।

वर्डसवर्त का काव्य- भाषा सिद्धांत।

कालरिज कल्पना और फैन्टसी।

आई.ए.रिचर्डस – मूल्य सिद्धांत तथा काव्य भाषा सिद्धांत

टी.एस. इलिएट – निर्वेयक्तिकता का सिद्धांत, वस्तुनिष्ठ सह-सम्बन्धी, परंपरा की अवधारणा।

रुसो – रूपवाद, नयी समीक्षा।

संरचनावाद, उत्तर संरचनावाद, आध्निकता, उत्तर आधुनिकता, विखण्डनवाद।

इकाई 10

कबीर – हजारी प्रसाद द्विवेदी – दोहा – पद सं 160-209

जायसी ग्रंथावली – सं रामचन्द्र शुक्ल – नागमती वियोग खण्ड

सूरदास – भ्रमरगीत – सार – सं रामचन्द्र शुक्ल 21 से 70 तक

तुलसीदास – उत्तरकाण्ड, रामचरितमानस – गीता प्रेस, गोरखपुर

प्रसाद – कामायनी – श्रद्धा, इड़ा सर्ग

निराला – राम की शक्ति पूजा, कुकुरमुत्ता

अज्ञेय – असाध्यवीणा, नदी के द्वीप

मुक्तिबोध – अंधेरे में।

प्रेमचंद – गोदान

अज्ञेय – शेखर एक जीवनी, भाग-1

प्रसाद – चन्द्रगुप्त

मोहन राकेश – आधे-अधूरे

इकाई 11

प्रयोजनमूलक हिन्दी

प्रयोजनमूलक हिन्दी : अर्थ, परिभाषा और क्षेत्र, ज्ञान प्रधान, सूचनात्मक और रचनात्मक साहित्य में प्रयुक्त भाषा भेद, हिन्दी का क्षेत्रीय, राष्ट्रीय एवं अंतर्राष्ट्रीय संदर्भ

हिन्दी भाषा-नियोजन एवं भाषा प्रबंधन

भारतीय बहुभाषिकता और हिन्दी, हिन्दी की व्यापक संकल्पना

प्रयुक्ति का अर्थ और प्रकार

प्रयोजनमूलक हिन्दी की विविध प्रयुक्तियाँ

प्रमुख प्रयुक्ति क्षेत्र – वैज्ञानिक, तकनीकी, कार्यालयीं, व्यवसायिक आदि

इन क्षेत्रों से संबंधित विशिष्ठ अभिव्यक्तियों एवं पारिभाषिक शब्दावली का सामान्य परिचय

प्रयोजनमूलक हिन्दी और अनुवाद

इकाई 12

हिन्दी में कंप्यूटर की सुविधाएँ

शब्द संसाधन, हिन्दी साफटावेर , हिन्दी में कंप्यूटर अनुप्रयोग और मशीनी अनुवाद

इकाई 13

भारतीय साहित्य

भारतीय साहित्य का स्वरूप

भारतीय साहित्य के अध्ययन की समस्याएँ

भारतीय साहित्य का इतिहास और हिन्दी साहित्य के विकास में भारतीय साहित्य की भूमिका

इकाई 14

तेलुगु भाषा और साहित्य का इतिहास

तेलुगु भाषा का उद्भव और विकास

मध्ययुगीन तेलुगु साहित्य की मुख्य प्रवृत्तियाँ और प्रमुख रचनाकार

तेलुगु शैव और संत-साहित्य, राम काव्य, कृष्ण भक्ति काव्य, अष्ट दिग्गज कवि, दक्षिणांध्र युग-साहित्य, तेलुगु साहित्य का आधुनिक काल- आधुनिक तेलुगु कविता: भाव कविता-अभ्युदय कविता-दिगंबर कविता-तेलुगु कविता की अद्यतन प्रवृत्तियाँ-तेलुगु गद्य का विकास-उपन्यास-कहानी-नाटक-निबंध और अन्य गद्य विधाएँ- प्रतिनिधि रचनकार

इकाई 15

पत्रकारिता और मीड़िया-लेखन

हिन्दी पत्रकारिता का इतिहास

हिन्दी में समाचार लेखन कला

संपादकीय लेखन शीर्षक की संरचना, लीड, इंट्रो

पृष्ट-सज्जा

साक्षात्कार

मीड़िया-लेखन

विभिन्न जनसंचार माध्यमों का स्वरूप, मुद्रण, श्रव्य, दृश्य, इंटरनेट

मौखिक भाषा की प्रकृति, समाचार-लेखन एवं वाचन।

दृश्य माध्यमों में भाषा की प्रकृति।

4. URDU

The Syllabus covers all important topics related to Urdu Language and Literature. It deals with the Origin & Development of Urdu Language, Deccan Urdu Literature. Evolution & Development of different Forms of Literature, both in Prose and Poetry with reference to the works of prominent writers and poets, Literature Movements and Criticism.

The Syllabus is detailed as follows :

1. ORIGIN & DEVELOPMENT OF URDU LANGUAGE

Three different periods of Indo-Aryan Language. Maghribi Hindi Aur Uski Boliyan,Khadi Boli Ka Irteqa. Urdu ke Aaghaz Ke Barey Mein Mukhtalif Nazariyat.

2. DECCANIYAT :

a) Bahmani Daur : Fakhruddin Nizami (Kadamrao Padamrao).
b) Adilshahi Daur : Nusrati (Gulshan-e-Ishq)
c) Qutubshahi Daur : Mohammaed Quli Qutub Shah (Deewas-e- Mohammed Quli QutubShah), Mulla Wajhi (Sabras & Qutub Mushtari), Ghawwasi (Saiful Mulook-o-Badeeuj Jamaal), Ibne Nishati (Phool Ban)

3. DEVELOPMENT OF DIFFERENT FORMS OF LITERATURE :

a) POETRY :

i. GHAZAL : (Tareef, Tareekh aur Tanqeed) The following Poets: Mir, Dard, Atish,Ghalib,Momin, Iqbal, Hasrat, Fani, Jigar, Firaq, Nasir Kazmi.

ii. QASEEDA: (Tareef, Tareekh aur Tanqeed) The following poets : Sauda and Zauq.

iii. MARSIYA: (Tareef, Tareekh aur Tanqeed). The following poets: Mir Anees and Mirza Daber.

iv. RUBAYEE: (Tareef, Tareekh aur Tanqeed) The following Poets: Anees, Akbar, Amjad and Josh.

v. MASNAVI: (Tareef, Tareekh aur Tanqeed) Masnavi Sehrul Bayaan (Mir Hasan), Gulzar-e-Naseem (Daya Shanker Naseem), Zehr-e-Ishq (Nawab Mirza Shauq).

vi. NAZM : (Tareef, Tareekh aur Tanqeed) (Paband Nazm, Nazm-e-Murra, Azad Nazm, Sonnet, Triolet, Haiku and Mahiya) ; Nazeer, Hali, Akbar, Chakbast, Iqbal, Josh, Akhtarul Imaan, Sardar Jafari, Noon Meem Rashid, Meeraji, Farhat Kaifi and Aziz Tamannayee.

b) PROSE :

i. DASTAN : (Tareef, Tareekh aur Tanqeed) : Bagh-o-Bahar, Fasana-e-Ajayeb.

ii. NOVEL : (Tareef, Tareekh aur Tanqueed) Fasana-e-Azad (Ratan Nath Sharshar) Taubatun Nusooh (Deputy Nazeer Ahamed) Umrao Jan Ada (Mirza Hadi Ruswa) Gowdan (Prem Chand) Ek Chadar Maili si (Rajender Singh Bedi), Tedhi Lakeer (Ismath Chugtayee), Aiwane Ghazal (Jeelani Bano).

iii. AFSANA : (Tareef, Tareekh aur Tanqeed) Premchand (Najaat), Manto (Tobatek Singh), Krishen Chander (Mahalakshmi ka Pul), Quratul Ayen Hyder (Nazaara Darmiyan Hai).

iv. DRAMA : (Tareef, Tareekh aur Tanqeed) : Amaanat (Indra Sabha). Agha Hashr Kashmiri (Said-e-Hawas), Imtiyaz Ali Taj (Anarkali), Habeeb Tanweer (Agra Bazaar), Mohammed Hasan (Zahaak).

v. INSHAIYA : (Tareef, Tareekh aur Tanqeed) Khaja Hasan Nizami (Sipara-e-Dil), Rasheed Ahmed Siddiqui (Ashufta Bayani Meri) Patras Bukhari (Mazameen-e-Patras).

vi. KHUTOOT : (Tareef, Tareekh aur Tanqeed) Ghalib (Urdu-e-Mualla), Moulana Azad (Ghubar-e-Khatir).

vii. SAWANEH NIGARI : (Tareef, Tareekh aur Tanqeed) : Yadgaar-e-Ghalib, Nazeer Ahmed Ki Kahani Kuch Unki Kuch Meri Zabani.

4. LITERARY CRITICISM : (Tareef aur Tareekh)

i. Tazkeron Mein Tanqeedi Nuqoosh : Nikatush-Shoara, Gulshan-e-Bekhar, Aab-e-Hayat.
ii. Hali ke Tanqeedi Nazariyat : Muqaddama-e-Sher-o-Shairi.
iii. Mukhtalif Tanqeedi Dabistaan (Unki Tareef aur Tareekh) : Taassurati Tanqeed, Jamaliyati Tanqeed, Nafsiyati Tanqeed, Marxi Tanqeed aur Saakhtiyati Tanqeed.
iv. Mumtaz Naqideen : Hali, Shibli, Niyaz Fatehpuri, Waheeduddin Salim, Firaq, Ehtesham Hussain, Kalimuddin Ahmed, Aale-Ahmed Suroor, Mughni Tabassum.

5. DIFFERENT LITERARY MOVEMENTS : (Their Contribution)

Fort William College, Delhi College, St. George College, Dabistane Dilli Dabistane Lucknow, Aligarh Tahreek, Jamia Osmania and Darut Tarjuma, Taraqqi Pasand Tahreek, Halqa-e-Arbaab-e-Zauq, Jadeediyat.

6. URDU JOURNALISM, TRANSLATION & MASS – MEDIA, Print and Electronic.

5. ORIYA

ORIYA

ଓଡ଼ିଆ ପାଠ୍ୟକ୍ରମ

'କ' ବିଭାଗ

(ଓଡ଼ିଆ ଭାଷା ସମ୍ବନ୍ଧୀୟ)

ପ୍ରତ୍ୟେକ ବିଭାଗରୁ ପାଞ୍ଚଗୋଟି ପ୍ରଶ୍ନ ଦିଆଯିବ ।

* ଓଡ଼ିଆ ଭାଷାର ଉତ୍ପତ୍ତି ଓ କ୍ରମ ବିକାଶ
* ଓଡ଼ିଆ ଭାଷାର ଉପରେ ଇଂରେଜୀ, ଯାବନିକ ଓ ଦ୍ରାବିଡ ଭାଷାର ପ୍ରଭାବ
* କୃଦନ୍ତ ଓ ତଦ୍ଧିତ
* କାରକ ଓ ବିଭକ୍ତି
* ସମାସ ଓ ସମୋଚ୍ଚାରିତ ଶବ୍ଦ
* ସନ୍ଧି
* ଓଡ଼ିଆ ଶବ୍ଦ ଭଣ୍ଡାର
* ଧ୍ୱନି ପରିବର୍ତ୍ତନ କାରଣ
* ଓଡ଼ିଆ ସୁଭାଷଣ

'ଖ' ବିଭାଗ

(ଓଡ଼ିଆ ସାହିତ୍ୟ ସମ୍ବନ୍ଧୀୟ)

[*]ଚିହ୍ନିତ ପ୍ରତ୍ୟେକ ବିଭାଗରୁ ଦଶଗୋଟି ପ୍ରଶ୍ନ ଦିଆଯିବ ।

* ଚର୍ଯ୍ୟା ଗୀତିକା
* ସାରଳା ସାହିତ୍ୟ
* ଓଡ଼ିଆ ପୁରାଣ ଓ ସନ୍ଥ ସାହିତ୍ୟ
* ଓଡ଼ିଆ ରୀତି ସାହିତ୍ୟ
* ଚଉତିଶା, କୋଇଲି ଓ ଓଡ଼ିଆ ପଦାବଳୀ ସାହିତ୍ୟ
* ଉନବିଂଶ ଶତକ ଓଡ଼ିଆ ସାହିତ୍ୟ (ଗଦ୍ୟ ସାହିତ୍ୟ, ପଦ୍ୟ ସାହିତ୍ୟ ଓ ସାହିତ୍ୟ ପତ୍ରିକା)
* ସତ୍ୟବାଦୀ ସାହିତ୍ୟ
* ସବୁଜ ସାହିତ୍ୟ ଓ ପ୍ରଗତିଶୀଳ ଓଡିଆ ସାହିତ୍ୟ
* ସ୍ୱାଧୀନତା ପରବର୍ତ୍ତୀ ଓଡ଼ିଆ ଗଦ୍ୟ ସାହିତ୍ୟ (ଗଳ୍ପ, ଉପନ୍ୟାସ, ପ୍ରବନ୍ଧ)
* ସ୍ୱାଧୀନତା ପରବର୍ତ୍ତୀ ଓଡ଼ିଆ କବିତା

6. COMMERCE

Financial management : Meaning, nature, objectives and scope of financial management. Capital budgeting, process, techniques. Sources of finance. Cost of capital – cost of various sources of finance. Leverages – operating and financial leverages. Capital structure theories. Dividend decisions Working .capital management- cash, receivables and inventory management.

Financial and management accounting : Techniques of analysis of financial statements – comparative and common size statements, trend analysis and ratio analysis. Funds flow and cash flow analyses. Marginal costing and decision making.

Managerial economics : Meaning, nature and scope of managerial economics. Demand analysis. Production and cost analysis. Market structure – perfect and imperfect markets.

Business environment : Meaning and components of business environment. Industrial policies 1956, and 1991. Liberalization, privatization and globalization. WTO.

Marketing management : Meaning, concepts, nature, and scope of marketing management – Marketing environment. Consumer behavior and market segmentation. Product, Price, Promotion and Channel management.

Human resources management : HR functions. HR planning – job analysis, recruitment and job evaluation, Training and development methods. Performance appraisal methods. Trade unions and collective bargaining.

Quantitative techniques: Sampling and sampling methods. Probability and probability distributions – Hypothesis testing. Parametric tests (Z, t-tests, and ANOVA) and non-parametric tests (Chi-square test).

IT and e-commerce : E-Commerce business models – Internet and web technologies. E-payment methods – e-cash, e-cheques, credit cards, smart cards, and debit cards.

7.ECONOMICS

1. Microeconomic Analysis

Demand analysis – Marshallian, Hicksian and Revealed preference approaches; axiomatic approach Theory of Production and Costs Pricing and output under different forms of market structure; collusive and non-collusive oligopolies. Factor Pricing analysis. Elements of General Equilibrium analysis and new welfare economics.

2. Macroeconomic Analysis

National income accounting – basic concepts. methods of estimation. Determination of output and employment – Classical approach, Keynesian approach. Real balance effect – Patinkin and Pigou. Theories of inflation. Phillips Curve analysis. Business cycles – Models of Samuelson, Hicks and Kaldor. IS-LM Analysis - Relative roles of monetary and fiscal policies. Mundell-Fleming open economy model. Rational expectations; new classical / tenets.

3. Development and Growth

Development and Growth – Role of institutions.

Theories of growth and development – Models of growth of Joan Robinson and Kaldor; Technical Progress – Hicks, Harrod and learning by doing, production function approach to the determinants of growth ; Endogenous growth : role of education, research and knowledge – explanation of cross country differentials in economic development and growth.

Theories of development – Classical, Marx, Schumpeter and structural analysis of development – Imperfect market paradigm, Lewis model of development, Ranis-Fei model, Dependency theory of development.

Factors in economic development – natural resources, population, capital, human resource development – Measurement of development – Conventional, HDI and Quality of Life indices.

Trade and development – trade as engine of growth, two-gap analysis, Prebisch, Singer and Myrdal views; gains from trade and LDCs.

4. Money and Banking

Definition and functions of money; empirical definition of money – monetary aggregates; monetarism; demand for money – Fisher, Cambridge, Keynesian, Friedman, Baumol and Tobin; supply of money – determinants; money multiplier. Role and functions of Central bank; NBFIs; instruments of monetary control; stabilization polices; monetary and interest rate targetting.

Social responsibility of banks; banking sector reforms, Basel I and II; deregulation, competition and efficiency; NPAs. Specialized financial and investment institutions.

5. Public Finance

Role of government in a mixed economy – allocation, distribution and stabilization. Private, public and merit goods. Theories of Social choice. Theories of taxation, types, incidence and effects. Theories of public expenditure – effects on savings, investment and growth Burden of public debt; Wagner and Peacock – Wiseman hypotheses. Union Finance – Trends in Revenue and Expenditure of the Government of India. State Finance – Trends in Revenue and Expenditure of the State Governments. Public Debt – Effects and Burden and Management of public debt. Government Budget – Forms of Budgeting, Zero based budgeting, Different Budget deficits. Fiscal Federalism – Horizontal and vertical imbalances; methods of fiscal adjustment.

6. International Trade and Finance

Theories of International Trade : Empirical verification and relevance. International Trade under Imperfect competition. Terms of Trade and Economic Growth – Secular Deterioration of Terms of Trade Hypothesis – a critical review. Equilibrium / disequilibrium in Balance of Payment – Traditional, Absorption and monetary approaches to adjustment in Balance of Payments. Impact of Tariffs on Partial and general equilibrium analysis; Political economy of Non-Tariff Barriers. Theory of regionalism at Global level – Trade blocks – SAARC and ASEAN. Trade Policy and Reforms in India. Optimum currency areas – Euro - ERM

7. Indian Economy :

Basic features of Indian economy; growth and structural changes – composition and trends in National Income.

Demography – Demographic features; demographic transition and demographic dividend; rural urban migration and rural urban divide.

Planning : Objectives and strategies of planning; and achievements of programmes for poverty alleviation and regional imbalances.

Agriculture : Land reforms and New Green Revolution – Role of technology; regional disparities in Indian agriculture; Pricing Policy; Food subsidy and Public distribution system.

Industry : Industrial growth and Productivity – New industrial policy; Privatisation, Disinvestment – FDI and role of MNCs. SMEs and industrial development.

Public Finance : Composition and growth of public expenditure and debt; Fiscal reforms and rationalization of subsidies; Centre – State financial relations.

WTO and its impact on Indian economy; Energy and Environment: Energy Security; Environmental Policy of Government of India, Rationale of Social Forestry.

8. **QUANTITATIVE METHODS** :

a. **Statistical Methods**

Measures of Central tendency, dispersion, skewness and kurtosis

Fundamentals of probability – Binomial, Poisson and Normal distributions. Simple correlation and regression analysis

Statistical inferences – Applications, sampling distributions (t, Chi-square and F tests), Sampling of attributes, testing of hypothesis Index numbers and time series analysis Sampling and census methods, types of sampling and errors.

b. Econometric Methods :

i) Single Equation Linear Model :

Assumption and properties of OLS

Multiple Regression Model – Estimation and Interpretation

Multi-collinearity, auto-correlation and heteroscedasticity – Causes, detection, consequences and remedy.

Dummy variables, distributed lags – need, limitations and interpretation

Applications in economics.

ii) Simultaneous Equation Models :

Structural and reduced forms, Endogenous and exogenous variables, Identification problems and conditions.

Single equation methods of estimations – two stage least squares, indirect least squares, and least variance ratio.

c. Time Series Models

Auto-regressive (AR), moving average (MA) and mixed processes (ARMA, ARIMA)

Concepts of unit root, integration and cointegration, random walks.

d. Mathematical Methods

i) Principles of optimization : maxima and minima of functions of a single variable.

ii) Basic concepts of Game Theory – Two-person, Zero-sum Game, Pure and Mixed strategy, Saddle point solution, Linear programming and input output analysis.

8.HISTORY

Ancient India :

1. Pre and protohistoric background – Stone ages and Chalcolithic cultures.
2. Harappan Civilization – Exten, major cities, characteristic features, social and economic conditions, script, religious practices, causes for the decline.
3. Iron Age – Aryan migration – Second urbanization.
4. Vedic Age : Importance literature, Political, Social and economic conditions in the early and later vedic age.
5. India in the 6th century B.C. : Political, Social and economic conditions, Rise and spread of Jainism and Buddhism.
6. Mauryan Age: Political history of the Mauryans, Ashoka, Mauryan Administration, social and economic conditions, decline of the Mauryan empire.
7. The Satavahanas: Political history, administration, contribution to the culture.
8. Gupta Period: Political history, administration, social and economic conditions, growth of culture, decline of the empire.
9. India in the 7th century A.D.: Harsha Vardhana, Pallavas and Chalukyas, Rashtrakutas their political history and their contribution to culture.

Medieval India :

10. India between 650 and 1200 A.D. – Political, social and economic conditions, Chola administration and culture.
11. Age of the Delhi Sultanate: (1206-1526), Political history, Military and Administrative organisation, changes in society and economy, Bhakti movement.
12. The Vijayanagar Empire: Origin, History, Krishnadevaraya, social and economic conditions, contribution to art and architecture, decline.
13. Mughal Age (1556-1707) : Political history, Akbar, Administration, Social and economic conditions, culture, decline of the Mauryan empire, Marattas and Shivaji.

Modern India (1757-1947):

14. Historical forces and factors which led to the establishment of the British power in India – Early resistance to the British power in India – Hyder Ali, Tippu Sultan, causes for their failure.

15. Evolution of British paramountacy in India : Policies of Wellesley and Dalhousie – Economic policies of the British.
16. Socio-religious reform movements – Rajaram Mohan Roy, Dayananda Saraswathi and others – Educational policies of the British and their impact on Indian society.
17. Revolt of 1857 : Causes, results, significance.
18. Rise and growth of the Indian National Movement: Birth of the Indian National Congress, the national movement from 1885 to 1905; movement from 1905 to 1920. Role of Tilak and Annie Besant: The movement from 1920 to 1947 ; Emergence of Gandhi; Non-cooperation movement, Salt Satyagraha and the Quit India Movement.
    Freedom movement in Andhra Pradesh with special reference to the role of Alluri Sitarama Raju and Tanguturi Prakasam, Revolt against the nizam's rule in Telangana.

Modern World:

19. Industrial Revolution – Significance and results.
20. American War of Independence – course, results, significance.
21. French Revolution – course, effects, significance.
22. National liberation movements in Italy and Germany in the 19th century – Mazzini, Cavour, Garibaldi, Bismarck.
23. World War-I – Causes and effects.
24. The Russian Revolution of 1917 – Causes, results and importance.
25. The World between the two world wars – Nazism in Germany, Fascism in Italy, Turkey under Mustafa Kamal Pasha.
26. Developments in China 1911-1949 – Nationalist Revolution of 1911 – Communist Revolution of 1948.
27. World War-II – Causes and effects.

9. Political Science

I Political Science – Basic Concepts

1. Political Science - Nature and Scope – Inter disciplinary Character.
2. Key Concepts - State, Sovereignty, Power, Nation.
3. Political Ideas - Rights, Liberty, Equality, Law and Justice.
4. Democracy - Meaning and Theories of Democracy, Electoral System.
5. Forms of Government - Unitary and Federal, Parliamentary and Presidential.

II Political Theory

1. Political Theory- Nature, Concerns, Resurgence and its decline.
2. Political Ideologies - Liberalism, Neoliberalism, Marxism, Socialism and Fascism.
3. Role of Ideology and end of Ideology.
4. Nationalism and Internationalism.
5. Theories of Development.

III Political Thought

1. Greek Political Thought - Plato and Aristotle.
2. Medieval Political Thought - Aquinas and St. Augustine.
3. Modern Political Thought - Machiavelli and Bodin.
4. Contractual Political Thought - Hobbes, Locke and Rousseau.
5. Indian Political Thought - Manu, Kautilya, Gandhi, Phule and Ambedkar

IV Comparative Politics

1. Comparative Politics - Nature, Scope and Approaches.
2. Constitutionalism - Western and Non- Western.
3. Organs of Government - Legislature, Executive and Judiciary.
4. Party Systems and Pressure Groups.
5. Power, Authority and legitimacy.

V Political Sociology

1. Political Socialisation and Political Culture
2. Political Development and Political Modernisation.
3. Political Elite and Theories.
4. Political Communication - Changing Role of Media.
5. Political Stratification - Caste, Class and Gender.

VI Indian Government and Politics

1. Nationalist Movement and Making of the Constitution.
2. Salient Features and Ideological foundations of Indian Constitution.
3. Federalism and Centre – State Relations.
4. Union Executive , Legislature and Judiciary – President, Prime Minister, Council of Ministers, Loksabha and Rajyasabha, Supreme Court and Judicial Review.
5. Contemporary Socio- Political Movements – Peasant, Dalit, Backward, Envinormental, Regional and Sub- Regional Movements.

VII State and Local Governments

1. Frame work for the study of State Politics.
2. State Executive & Legislature : Governor, Chief Minister and State Legislature
3. Panchayati Raj : Genesis and Development – Structure and

functions, 73rd Amendment of India constitution

4. Urban Local Government : Structure and functions, 74th Amendment of Indian constitution
5. Regional Inequalities – Demand for Autonomy and statehood.

VIII Public Administration

1. Emergence of Public Administration as a discipline – Nature, Scope and importance of Public Administration.
2. Theories and principles of organization.
3. Human Resources Management and Bureaucracy.
4. Leadership and Decision-making.
5. Good Governance – problem of corruption – Right to Information – Need for Lokpal.

IX Public Policy and Political Analysis

1. Public Policy – Nature, Scope and Importance – Public Policy as a Policy Science.
2. Theories of Public Policy – Group theory, Incrementalism, Elite theory, Decision-making theory.
3. Policy making Institutions – Legislature, Executive and Judiciary – Planning Commission
4. Policy Process - Role of Media, Political Parties and Pressure Groups.
5. Policy Evaluation.

X International Relations

1. Approaches to the study of International Relations.
2. Elements of National Power.
3. Basic Issues – Disarmament, Arms control, Diplomacy, Cold war, War and conflict Resolution.
4. UNO : Aims, objectives, structure and its changing role in the contemporary world.
5. Indian Foreign Policy – Non-Alignment, Relations with neighbors and security concerns and Globalization.

10.MATHEMATICS

I. Real Analysis

Finite, countable and uncountable sets – Real Number system R – infimum and supremum of a subset of R – Bolzano – Weierstrass theorem.

Sequences, convergence, limit superior and limit inferior of sequences, sub sequences, Heine Borel Theorem.

Infinite series – Tests of convergence.

Continuity and uniform continuity of real valued functions of real variable. Monotonic functions and functions of bounded variation.

Differentiability and mean value theorems.

Riemann integrability.

Sequences and Series of functions.

II. Metric Spaces

Metric spaces – completeness, compactness and connectedness – continuity and uniform continuity of functions from one metric space into another.

Topological spaces – base and subbase – continuous function.

III. Elementary Number

Primes and composite numbers – Fundamental Theorem of arithmetic – divisibility – congruences – Fermat's theorem – Wilson's Theorem – Euler's Ø - function.

IV. Group Theory

Groups, subgroups, normal subgroups – quotient groups – homomorphisms and isomorphism theorems – permutation groups, cyclic groups, Cayley's theorem. Sylow's theorems and their applications.

V. Ring Theory

Rings, integral domains, fields – subrings and ideals – Quotient rings – homomorphisms – Prime ideals and maximal ideals – polynomial rings – Irreducibility of polynomials – Euclidean domains and principal ideal domains.

VI. Vector Spaces

Vector Spaces, Subspaces – Linear dependence and independence of vectors – basis and dimension – Quotient spaces – Inner product spaces – Orthonormal basis – Gram – Schmidt process.

VII. Matrix Theory

Linear transformations – Rank and nullity – change of bases.

Matrix of a linear transformation – singular and non-singular matrices – Inverse of matrix – Eigenvalues and eigenvectors of matrix and of linear transformation – Cayley – Hamilton's theorem.

VIII. Complex Analysis

Algebra of complex numbers – the complex plane – Complex functions and their Analyticity – Cauchy-Riemann equations – Mobius transformations.

Power Series.

Complex Integration – Cauchy's theorem – Morera's Theorem – Cauchy's integral formula – Liouville's theorem – Maximum modules principle – Schwarz's lemma – Taylor's series – Laurents series.

Calculus of residues and evaluation of integrals.

IX. Ordinary Differential Equation

Ordinary Differential Equation (ODE) of first order and first degree – Different methods of solving them – Exact Differential equations and integrating factors.

ODE of first order and higher degree – equations solvable for p, x and y – Clairaut's equations – Singular Solutions.

Linear differential equations with constant coefficients and variable coefficients – variation of parameters.

X. Partial Differential Equations

Formation of differential equations (PDE) – Lagrange and Charpit methods for solving first order – PDE's – Cauchy problem for first order PDE's Classification of second order PDE's – General solution of higher order PDE's with constant coefficients.

11.PHYSICS

PART-A

I. Mathematical Methods of Physics

Dimensional analysis. Vector algebra and vector calculus. Linear algebra, matrices, Cayley-Hamilton Theorem. Eigenvalues and eigenvectors. Linear ordinary differential equations of first & second order, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms. Elements of complex analysis, analytic functions; Taylor & Laurent series; poles, residues and evaluation of integrals. Elementary probability theory, random variables, binomial, Poisson and normal distributions. Central limit theorem.

Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least squares fitting, Linear and non-linear curve fitting and Chi-Square Test.

II. Classical Mechanics

Newton's laws. Dynamical systems, Phase space dynamics, stability analysis. Central force motions. Two body Collisions – scattering in laboratory and Centre of mass frames. Rigid body dynamics-moment of inertia tensor. Non-inertial frames and pseudoforces. Variational principle. Generalized coordinates. Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates. Periodic motion: small oscillations, normal modes. Special theory of relativity-Lorentz transformations, relativistic kinematics and mass-energy equivalence.

III. Electromagnetic Theory

Electrostatics : Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics : Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; boundary conditions on the fields at interfaces. Scalar and vector potentials, gauge invariance. Electromagnetic waves in free space. Dielectrics and conductors. Reflection and refraction, polarization, Fresnel's law, interference, coherence, and diffraction. Dynamics of charged particles in static and uniform electromagnetic fields. Charged particles in inhomogeneous fields.

IV. Quantum Mechanics

Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Tunneling through a barrier. Wave-function in coordinate and momentum representations. Commutators and Heisenberg uncertainty principle. Dirac notation for state vectors. Motion in a central potential : orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen aom. Stern-Gerlach experiment. Time-independent perturbation theory and applications. Variational method. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection.

V. Thermodynamics and Statistical Physics

Laws of thermodynamics and their significance. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase space, micro-and macro-states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Bose and Fermi gases. Principle of detailed balance. Blackbody radiation and Planck's distribution law.

VI. Electronics

Semiconductors devices (diodes, junctions, transistors, field effect devices, homo- and hetero-junction devices), device structure, device characteristics, frequency dependence and applications. Opto-electronic devices (solar cells, photo-detectors, LEDs). Operational amplifiers and their applications. Digital techniques and applications (Logic circuits, registers, counters and comparators). A/D and D/A converters. Microprocessor microcontroller basics. Fundamentals of communication electronics, modulation techniques.

VII. Atomic & Molecular Physics

Quantum states of an electron in an atom. Electron spin. Spectrum of helium and alkali atom. Relativistic corrections for energy levels of hydrogen atom, hyperfine structure and isotopic shift, width of spectrum lines, LS & JJ couplings. Zeeman, Paschen-Bach & Stark effects. Electron spin resonance. Nuclear magnetic resonance, chemical shift. Frank-Condon principle. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers : spontaneous and stimulated emission, Einstein A & B coefficients. Optical pumping, population inversion, rate equation. Modes of resonators and coherence length.

VIII. Condensed Matter Physics

Bravais lattices. Reciprocal lattice. Diffraction and the structure factor. Bonding of solids. Elastic properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Response and relaxation phenomena. Drude model of electrical and

thermal conductivity. Hall effect and thermoelectric power. Electron motion in a periodic potential, band theory of solids : metals, insulators and semiconductors. Superconductivity : type-I and type-II superconductors. Josephson junctions. Superfluidity. Defects and dislocations. Ordered phases of matter : translational and orientational order, kinds of liquid crystalline order. Quasi crystals.

IX. Nuclear and Particle Physics

Basic nuclear properties ; size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model. Nature of the nuclear force, form of nucleon-nucleon potential, charge-independence and charge-symmetry of nuclear forces. Deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitations. Elementary ideas of alpha, beta and gamma decays and their selection rules. Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.

PART-B

I. Mathematical Methods of Physics

Green's function. Partial differential equations (Laplace, wave and heat equations in two and three dimensions). Elements of computational techniques : root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods. Tensors. Introductory group theory.

II. Classical Mechanics

Basic concepts of dynamical systems, Poisson brackets and canonical transformations. Symmetry, invariance and Noether's theorem. Hamilton-Jacobi theory.

III. Electromagnetic Theory

Dispersion relations in plasma. Lorentz invariance of Maxwell's equation. Transmission lines and wave guides. Radiation- from moving charges and dipoles and retarded potentials.

IV. Quantum Mechanics

Spin-orbit coupling, fine structure. WKB approximation. Elementary theory of scattering : phase shifts, partial waves, Born approximation. Relativistic quantum mechanics : Klein-Gordon and Dirac equations. Semi-classical theory of radiation.

V. Thermodynamics and Statistical Physics

First- and second-order phase transitions. Diamagnetism, paramagnetism, and ferromagnetism. Ising model. Bose-Einstein condensation. Diffusion equation. Random walk and Bronian motion. Introduction to nonequilibrium processes.

VI. Condensed Matter Physics

Electron spin resonance, Nuclear magnetic resonance, chemical shift and applications. X-ray diffraction technique, scanning electron micrscopy and transimission electron microscopy.

VII. Nuclear and Particle Physics

Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics.

12.CHEMISTRY

INORGANIC CHEMISTRY

1. Atomic structure and chemical bonding – structure and bonding in homo and hetero nuclear molecules. Applications of VSEPR, Valence Bond and Molecular orbital theories in explaining the structures of simple molecules.
2. Transition elements and coordination compounds – physical and chemical characteristics of transition elements – Bonding theories – crystal field theory – crystal field splitting patterns in various geometries. Calculation of CFSE – Jahn-Teller effect – Application of MO theory to octahedral and square planar complexes – Electronic spectra of complexes – Russell Saunders coupling – term symbols – spectra of octahedral and tetrahedral complexes – charge transfer spectra – magnetic properties of complex compounds.
3. Metal - ligand equilibria in solution – step wise and overall stability constants – factors affecting the stability of metal complexes – Pearson's theory of hard and soft acids and bases (HSAB) – Chelate effect.
4. Reaction mechanisms in complexes – Inert and level complexes – Ligand substitution reactions of octahedral complexes – Acid hydrolysis, base hydrolysis – conjugate base mechanism – Anation reactions – substitution reactions of square planar complexes – Trans effect – Electron transfer reactions – Inner and outer sphere mechanisms.
5. Metal complexes - EAN rule – structure and bonding of metal carbonyls of Mn, Fe, Co and Ni – Metal nitrosyls – structure and bonding.
6. Cages and ring compounds – preparation, structure and reactions of boranes and carboranes – Boron-nitrogen and Sulfur-nitrogen cyclic compounds.
7. Metal clusters – factors favoring M-M bonds – Structure and bonding in $Re_2Cl_8^{2-}$ $Mo_6Cl_8^{4+}$, $Nb_6X_{12}^{2+}$, Re_3Cl_9 and $Re_3Cl_{12}^{3-}$.
8. Bio-inorganic chemistry – metal complexes as oxygen carriers – hemoglobin and myoglobin – oxygen transport – non heme proteins – hemerythrin and hemocyanin.
9. Analytical chemistry – chromatography – general principles involved in separations by paper, thin layer and column chromatography – GC and HPLC.

Physical Chemistry

1. Thermodynamics

Brief review of concepts of I and II laws of thermodynamics. Concept of entropy. Entropy as a state function. Calculation of entropy changes in various processes. Entropy changes in an ideal gas. Entropy changes on mixing of ideal gases. Entropy as a function of V and T. Entropy as a function of P and T. Entropy change in isolated systems- Clausius inequality. Entropy change as criterion for spontaneity and equilibrium.

Third law of thermodynamics. Evaluation of absolute entropies from heat capacity data for solids, liquids and gases. Standard entropies and entropy changes of chemical reactions. Helmholtz and Gibbs free energies (A and G). A and G as a criteria for equilibrium and spontaneity. Physical significance of A and G. Driving force for chemical reactions- relative signs of ΔH and ΔS.

Thermodynamic relations. Gibbs equations. Maxwell relations. Temperature dependence of G. Gibbs- Helmholtz equation. Pressure dependence of G.

Chemical potential: Gibbs equations for non-equilibrium systems. Material equilibrium. Phase equilibium. Clapeyron equation and Clausius-Clapeyron equation .

Conditions for equilibrium in a closed system. Chemical potential of ideal gases. Ideal-gas reaction equlibrium-derivation of equilibrium constant. Temperature dependence of equilibrium constant-the van't Hoff equation.

Solutions: Specifiying the Solution composition. Partial molar poperties-significance. Relation between solution volume and partial molar volume. Measurement of partial molar volumes- slope and intercept methods. The chemical potential. Variation of chemical potential with T and P. Gibbs-Duhem equation-derivation and significance

Ideal solutions. Thermodynamic properties of ideal solutions. Mixing quantities. Vapour pressure-Raoult's law. Thermodynamic properties of ideally dilute solutions. Vapour pressure-Henry's law.

Nonideal systems. Concept of fugacity, fugacity coefficeient. Determination of fugacity. Non ideal solutions. Activities and activity coefficients. Standard-state conventions for non ideal solutions. Determination of activity coefficients from vapour pressure measurements. Activity coefficients of nonvolatile solutes using Gibbs-Duhem equation.

Multicomponent phase equilibrium: Vapour pressure lowering, freezing point depression and boiling point elevation

2. Statistical Thermodynamics

Concepts of distribution and probability. Estimation of probability and the most probable distribution. Systems composed of noninteracting particles. Derivation of Boltzmann distribution law.

The molecular partition function. Systems composed of interacting particles. The concept of ensemble and canonical ensemble. Canonical partition function and its relation to molecular partition function. The factorization of molecular partition function – translational, rotational, vibrational and electronic partition functions. Derivation of expressions for translational, rotational (diatomic) and vibrational partition functions. Relationship between partition functions and thermodynamic functions.

The relationship between partition functions and thermodynamic functions. Specific heats of solids – Einstein equation of heat capacity of solids – derivation. Explanation of heat capacity at very low and very high temperatures – Dulong and Petits Law. Debye theory.

The entropy of a monoatomic ideal gas. The Sackur-Tetrode equation- derivation. Mean translational and vibrational energies.

3. Electrochemistry

Electrochemical Cells : Derivation of Nernst equation – problems. Chemical and concentration cells (with and without transference). Liquid junction potential – derivation of the expression for LJP – its determination and elimination**.** Applications of EMF measurements : Solubility product, potentiometric titrations, determination of transport numbers, equilibrium constant measurements.

Decomposition potential and its significance. Electrode polarization – its causes and elimination. Concentration overpotential.

Concept of activity and activity coefficients in electrolytic solutions. The mean ionic activity coefficient. Debye-Huckel theory of electrolytic solutions. Debye-Huckel limiting law (derivation not required). Calculation of mean ionic activity coefficient. Limitations of Debye-Huckel theory. Extended Debye-Huckel law.

Theory of electrolytic conductance. Derivation of Debye-Huckel-Onsager equation – its validity and limitations.

Concept of ion association – Bjerrum theory of ion association (elementary treatment) - ion association constant – Debye-Huckel-Bjerrum equation.

4.QUANTUM CHEMISTRY

Black body radiation-Planck's concept of quantization-Planck's equation, average energy of an oscillator (derivation not required). Wave particle duality and uncertain principle-significance of these for microscopic entities. Emergence of quantum mechanics. Wave mechanics and Schroedinger wave equation.

Operator**s**-operator algebra. Commutation of operators, linear operators.Complex functions. Hermitian operators. Operators ∇ and ∇^2 . Eigenfunctions and eigenvalues. Degeneracy. Linear combination of eigenfunctions of an operator. Well behaved functions. Normalized and orthogonal functions.

Postulates of quantum mechanics. Physical interpretation of wave function. Observables and operators. Measurability of operators. Average values of observables. The time dependent Schrodinger equation. Separation of variables and the time-independent Schrodinger equation..

Theorems of quantum mechanics. Real nature of the eigen values of a Hermitian operator-significance. Orthogonal nature of the eigen values of a Hermitian operator-significance of orthogonality. Expansion of a function in terms of eigenvalues. Eigen functions of commuting operators-significance. Simultaneous measurement of properties and the uncertainty principle.

Particle in a box- one dimensional and three dimensional. Plots of ψ and ψ^2-discussion. Degeneracy of energy levels. Comparison of classical and quantum mechanical particles. Calculations using wave functions of the particle in a box-orthoganality, measurability of energy, position and momentum, average values and probabilities. Application to the spectra of conjugated molecules.

Cartesian, Polar and spherical polar coordinates and their interrelations

Schrodinger equation for the hydrogen atom- separation into three equations. Hydrogen like wave functions. Radial and angular functions. Quantum numbers n, l and m and their importance. The radial distribution functions. Hydrogen like orbitals and their representation. Polar plots, contour plots and boundary diagrams.

Many electron systems. Approximate methods. The variation method-variation theorem and its proof. Trial variation function and variation integral. Examples of variational calculations. Paricle in a box. Construction of trial function by the method of linear combinations. Variation parameters. Secular equations and secular determinant..

Bonding in molecules. Molecular orbital theory-basic ideas. Construction of MOs by LCAO , H_2^+ ion. The variationan integral for H_2^+ ion. Detailed calculation of Wave functions and energies for the bonding and antibonding MOs. Physical picture of bonding and antibonding wave functions. Energy diagram. The MO and VB wave functions for H_2 molecule and their comparision

5.Chemical Kinetics

Theories of reaction rates : Collision theory, steric factor. Tranition state theory. Reaction coordinate, activated complex and the transition state. Thermodynamic formulation of

transition state theory. Unimolecular reactions and Lindamann's theory.
Complex reactions- Opposing reactions, parallel reactions and consecutive reactions(all first order type). Chain reactions-general characteristics, steady state treatment. Example- H_2-Br_2 reaction. Derivation of rate law.
Effect of structure on reactivity- Linear free energy relationships. Hammett and Taft equations-substituent(σ and σ^*) and reaction constant (ρ and ρ^*)with examples.
Factors affecting reaction rates in solution. Diffusion controlledr eactions. Influence of dielectric constant and ionic strength on ion-ion, ion-dipole and dipole-dipole reactions. Primary and secondary salt effects. Kinetic isotope effects: Primary and secondary isotope effects. Solvent isotope effects.

Enzyme catalysis: Chemical catalysis and enzyme catalysis – distinction – energy considerations and rate accelerations – examples.

Michaelis-Menten mechanisms of enzyme catalyzed reactions involving one and two intermediates. Steady-sate approximation. Derivation of kinetic equations. Evaluation of kinetic parameters. Enzyme-substrate complex: Fischer's lock and key and Koshland's induced fit hypotheses. Specificity of enzyme-catalyzed reactions. Discussion of the various types of forces involved in the formation of E-S complex. pH dependence of enzyme-catalyzed reactions – the kinetics and the equations involved.

6. Photochemistry
Electronic transitions in molecules. The Franck Condon principle. Electronically excited molecules- singlet and triplet states. Radiative life times of excited states-theoretical treatment. Measured lifetimes. Quantum yield and its determination. Actinomety-ferrioxalate and uranyl oxalate actinometers-problems.
Derivation of fluorescence and phosphorescence quantum yields. E-type delayed fluorescence- evaluation of triplet energy splitting(ΔE_{ST}). Photophysical processes-photophysical kinetics of unimolecular reactions. Calculation of rate constants of various photophysical processes-problems, State diagrams
Photochemical primary processes. Types of photochemical reactions- electron transfer, photodissociation, addition, abstraction, oxidation and isomerization reactions with examples. Effect of light intensity on the rates of photochemical reactions. Photosensitization. Quenching-Stern Volmer equation. Experimental set up of a photochemical reaction. Introduction to fast reactions- Principle of flash photolysis
7. Solid state chemistry
Magnetic properties of solids- classification of magnetic materials, Magnetic susceptibility, Langevin diamagnetism, Weiss theory of para magnetism
Electronic properties of metals, insulators and semi conductors: Electronic structure of solids, Band theory, band structure of metals, insulators and semiconductors. Electrons, holes and Excitons. The temperature dependence of conductivity of extrinsic semi conductors. Photo conductivity and photovoltaic effect-p-n junctions.
Superconductivity. Occurrence of superconductivity. Destruction of superconductivity by magnetic fields-Meisner effect. Types of superconductors. Theories of super conductivity- BCS theory.

ORGANIC CHEMISTRY

1. IUPAC nomenclature of organic molecules including structural, positional, functional, regio- and stereoisomers.

2. Molecular representations: Wedge, Fischer, Newman and Saw-horse formulae, their description and interconversions. Stereoisomers-classification-configuration –R,S-nomenclature-Criteria for Chirality. Axially chiral allenes, spiranes, alkylidene cycloalkanes, chiral biaryls, atropisomerism. Planar chiral ansa compounds and trans- cyclooctene. Helically chiral compounds, Determination of absolute configuration by chemical correlation methods. Determination of configuration in E,Z-nomenclature: Spectral and Chemical methods of configuration determination of E,Z isomers. Determination of configuration in aldoximes and ketoximes.

3. Nature of Bonding in Organic Molecules and Aromaticity, Delocalized chemical bonding-conjugation, cross conjugation, resonance, hyperconjugation, tautomerism, Huckle's rule and the concept of aromaticity, aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, metallocenes- Ferrocene, Azulenes, Fulvenes, Annulenes, anti-aromaticity, pseudo-aromaticity, homo-aromaticity.

4. Reactive intermediates and Molecular rearrangements. Reactive Intermediates: Generation, detection, structure, stability and reactions of carbocations, carbanions, carbenes, nitrenes and free radicals. Molecular rearrangements: Definition and classification. Molecular rearrangements involving 1) electron deficient carbon: Wagner- Meerwein, Pinacol-Pinacolone, Allylic and Wolf rearrangement. 2) Electron deficient Nitrogen: Hofmann, Lossen, Curtius, Schmidt and Beckmann rearrangements 3) electron deficient Oxygen: Baeyer-Villiger oxidation. 4) Base catalyzed rearrangements: Benzilic acid, Favourski, Transannular, Sommlett-Hauser and Smiles rearrangement

5. Organic Reaction mechanism-I Electrophilic addition to carbon-carbon double bond: Stereoselective addition to carbon-carbon double bond; *anti* addition- Bromination and epoxidation followed by ring opening. *Syn* addition of OsO_4 and $KMnO_4$. Hydroboration.

Michael reaction. Elimination reactions E2, E1, E1CB mechanisms. Orientation and stereoselectivity in E2 eliminations. Pyrolytic *syn* elimination and a-elimination, elimination Vs substitution. Determination of reaction mechanism: Energy profiles of addition and elimination reactions, transition states, product isolation and structure of intermediates, use of isotopes, chemical trapping, crossover experiments.

6. Importance of heterocyclic compounds as drugs. Nomenclature of heterocyclic systems based on ring size, number and nature of hetero atoms. Synthesis and reactivity of pyrrole, furan, thiophene, pyridine, indole, benzofuran, benzothiophene, quinoline, isoquinoline.

7. Alkaloids and terpenoids- Importance of natural products as drugs. Isolation of natural products by steam distillation, solvent extraction and chemical methods. Structure determination and synthesis of papaverine, nicotine and quinine-General methods in the structure determination of terpenes. Isoprene rule, structure determination and synthesis of a-terpeniol and camphor.

8. Organic Photochemistry, Photochemical energy, Frank-Condon principles, Jablonski diagram, singlet and triplet states, dissipation of photochemical energy, photosensitization, quenching, quantum efficiency and quantum yield. Photochemistry of carbonyl compounds - $n\rightarrow\pi^*$ and $\pi\rightarrow\pi^*$ transitions. Norrish type-I and Norrish type-II cleavages. Paterno-Buchi reactions, Photoreduction, photochemistry of enones - hydrogen abstraction, rearrangements of α,β- unsaturated ketones and cyclohexadienones, photochemistry of *p*-benzoquinones. Dienes - photochemistry of 1,3-butadienes, (2+2) additions leading to cage structures, photochemistry of cyclohexadienes, photochemistry of aromatic compounds, exicited state of benzene and its 1,2-, 1,4- additions

9. Pericyclic Reactions Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3 butadiene, 1,3,5 hexatriene and allyl system. Classification of pericyclic reactions. Woodward - Hoffmann correlation diagrams. FMO and PMO (Mobius Huckel) approaches. Electrocyclic reactions-Conrotatory and disrotatory. 4n, 4n+2 and allyl systems. Cycloadditions-antarafacial and suprafacial additions, 4n and 4n+2 systems, 2+2 addition of ketene, 1,3 dipolar cycloadditions Sigmatropic rearrangements - Suprafacial and antarafacial shifts of H, Sigmatropic shifts involving carbon moieties, 3,3 and 5,5 sigmatropic rearrangements.

10. Structure determination of organic compounds by UV IR, NMR an Mass Various electronic transitions, Beer-Lambert's law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl Compounds, dienes, conjugated polyenes, Effect of hydrogen bonding and solvent effects-NMR**-**Shielding mechanism, mechanism of measurement, chemical shift values, chemical exchange, complex spin-spin interaction, ^{13}C NMR spectroscopy, chemical shift-Mass spectral fragmentation of organic compounds, common functional groups, molecular-ion peak, metastable peak,

13.BOTANY

CELL AND MOLECULAR BIOLOGY OF PLANTS

Cell Wall : Structure and functions, biogenesis, growth.

Plasma membrane : Structure, models and functions : Sites for ATPases, Ion carriers, Channels and pumps, Receptors.

Plasmodesmata : Structure, Role in movement of molecules and macromolecules, Comparison with gap junctions.

Chloroplast : Structure, genome organization, gene expression, RNA editing, nucleo-chloroplastic interactions.

Mithochondria : Structure, genome organization, Biogenesis.

Plant Vacuoles : Tonoplast membrane, ATPases, transporters, as storage organelle.

Nucleus : Structure, nuclear pores, nucleosome organization, DNA structure : A, B and Z forms, replication, damage and repair, transcription, Plant promoters and transcription factors, splicing mRNA transport, nucleolus, rRNA biosynthesis.

Ribosomes : Structure, site of protein synthesis, mechanism of translation, initiation, elongation and termination; structure and role of tRNA.

Protein sorting : Targeting of proteins to organelles.

Cell shape and motility : The cytoskeleton; organization and role of microtubules and microfilaments; motor movements; implications in flagellar and other movements.

Cell cycle and apoptosis : Control mechanisms; role of cyclins and cyclin dependent kinases; retinoblastoma and E2F proteins; cytokinesis and cell plate formation; mechanisms of

programmed cell death.

Other cellular organelles : Structure and functions of microbodies, Golgi apparatus, lysosomes, endo plasmic reticulum.

Techniques in cell biology : Immuno techniques; in situ hybridization, FISH, GISH; confocal microscopy.

CYTOLOGY, GENETICS AND CYTOGENETICS

Chromatin organization : Chromosome structure and Packaging of DNA, molecular organization of centromere and telomere; nucleolus and ribosomal RNA genes ; euchromatin and heterochromatin ; karyotype analysis ; banding patterns ; specialized types of chromosomes ; polytene, lampbrush, B-chromosomes and sex chromosomes ; molecular basis of chromosome pairing.

Structural and numerical alterations in chromosomes : Duplication, deficiency, inversion and translocation ; autopolyploids ; allopolyploids ; evolution of major crop plants.

Genetics of prokaryotes and eukaryotic organelles : genetic recombination in phage ; genetic transformation, conjugation and transduction in bacteria ; genetics of mitochondria and chloroplasts cytoplasmic male sterility.

Gene structure and expression : Genetic fine structure ; cis – trans test ; Benzer's experiment; introns and their significance ; RNA splicing ; regulation of gene expression in prokaryotes and eukaryotes.

Genetic recombination and genetic mapping : Recombination ; independent assortment and crossing over ; molecular mechanism of recombination ; role of RecA and RecBCD enzymes ; site-specific recombination ; chromosome mapping, linkage groups, genetic markers, construction molecular maps.

Mutations : Spontaneous and induced mutations ; physical and chemical mutagens ; molecular basis of gene mutations ; transposable elements in prokaryotes and eukaryotes ; mutations induced transposons ; site-directed mutagenesis ; DNA damage and repair mechanisms.

Plant Breeding : Principles and methods of plant breeding ; Marker assisted breeding.

Biostatistics : Mean, Variance, Standard deviation, Standard error, Student't' test, chi-square and ANOVA.

Molecular cytogenetic : Nuclear DNA content; C-value paradox; cot curve and its significance; restriction mapping – concept and techniques ; multigene families and their evolution.

BIOLOGY AND DIVERSITY OF LOWEER PLANTS : CRYPTOGAMS

Microbiological techniques : Pure culture, enrichment and anaerobic culture.

Importance of microorganisms : Microbes in medicine, agriculture and environment.

Microbial growth : Nutritional requirements of microorganisms and methods to measure growth.

Microbial Ecology : Genetrification ; phosphorous solubilization ; nitrogen fixation

Phycology : Thallus organization ; cell ultra structure ; reproduction (vegetative, sexual, asexual) ; criteria for classification of algae : pigments, reserve food, flagella ; classification, salient features of Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta ; algal blooms, algal biofertilizers ; algae as food, feed and uses in industry.

Mycology : General characters of fungi ; substrate relationship in fungi ; cell ultrastructure ; unicellular and multicellular organization ; cell wall composition ; nutrition (saprobic, biotropic, symbiotic) ; reproduction (vegetative, asexual, sexual) ; heterothallism ; heterokaryosis parasexuality ; Molecular aspects in classification.

General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina ; fungi in industry, medicine and as food ; fungal diseases in plants and humans ; Mycorrhizae ; fungi as biocontrol agents.

Bryophyta : Morphology, structure, reproduction and life history ; distribution ; classification, general account of Marchantiales, Junger maniales, Anthoceratales, Sphagnales, Funariales and Polytrcales ; economic and ecological importance.

Pteridophyta : Morphology, anatomy and reproduction ; classification ; evolution of stele ; heterospory and origin of seed habit; general account of fossil pteriodophyta ; introduction to Psilo psida, Lycopsida, Sphenopsida and Pteropsida.

TAXONOMY AND DIVERSITY OF SEED PLANTS

Introduction and classification of Gymnosperms

Structure and reproduction in Cycadales, Ginkgoales, Coniferales, Ephedrales, Welwitschiales and Gnetales.

The species concept : Taxonomic hierarchy, species, genus, family and other categories ; principles used in assessing relationship, delimitation of taxa and attribution of rank.

Salient features of the International Code of Botanical nomenclature.

Taxonomic tools : Herbarium ; floras ; histological, cytological, phytochemical, serological, biochemical and molecular techniques ; computers and GIS.

Systems of angiosperm classification : Phenetic versus phylogenetic systems ; cladistics in taxonomy ; relative merits and demerits of major systems of classification.

Concepts of phytogeography : Endemism, hotspots; plant explorations; invasions and introductions.

PLANT PHYSIOLOGY AND METABOLISM

Energy flow : Principles of thermodynamics, free energy and chemical potential, redox reactions, structure and functions of ATP.

Fundamentals of enzymology : General aspects, allosteric mechanism, regulatory and active sites, isoenzymes, kinetics of enzymatic catalysis, Michaelis – Menton equation and its significance.

Membrane transport and translocation of water and solutes : Plant water relations, mechanism of water transport through xylem, passive and active solute transport, membrane transport proteins.

Signal transduction : Receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium calmodulin cascade, diversity in protein kinases and phosphatases.

Photochemistry and photosynthesis : Photosynthetic pigments and light harvesting complexes, photo oxidation of water, mechanisms of electron and proton transport, carbon assimilation – the Calvin cycle, photorespiration and its significance, the C_4 cycle, the CAM pathway, biosynthesis of starch and sucrose.

Respiration and lipid metabolism : Glycolysis, the TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternative oxidase system, structure and function of lipids, fatty acid biosynthesis, synthesis of membrane lipids, structural lipids and storage lipids and their catabolism.

Nitrogen fixation and metabolism : Biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation.

Photobiology : Photochromes and cryptochromes, photophysiology of light –induce responses, cellular localization.

Plant growth regulators and elicitors : Physiological effects and mechanism of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, polymines, jasmonic acid and

salicyclic acid.

The flowering process : Photoperiodism, endogenous clock and its regulation, floral induction and development – genetic and molecular analysis, role of vernalization.

Stress physiology : Plant responses to biotic and abiotic stress; mechanisms of biotic and abiotic stress tolerance, HR and SAR, water deficit and drought resistance, salinity stress, metal toxicity, freezing and heat stress, oxidative stress.

Coping with biotic stress : Chemical control, Biological control, IPM

PLANT DEVELOPMENT AND REPRODUCTION

Shoot development : Organization of the shoot apical meristem (SAM); control of cell division and cell to cell communication; control of tissue differentiation especially xylem and phloem ; secretory ducts and laticifers.

Phyllotaxy and leaf differentiation

Root development : Organization of root apical meristem (RAM); cell fates and lineages; vascular tissue differentiation; homeotic muntants in Arabidopsis and Antirrhinum, sex determination.

Male gametophyte: Structure of anthers; microsporogenesis, role of tapetum; pollen development and gene expression; male sterility; sperm dimorphism and hybrid seed production; pollen germination, pollen tube growth and guidance ; pollen storage ; pollen allergy, pollen embryos.

Female gametophyte: Ovule development; megasporogenesis; organization of the embryo sac, structure of the embryo sac cells.

Pollination, pollen – pistil interaction and fertilization : Floral characteristics, pollination mechanisms and vectors; self-incompatibility; double fertilization.

Seed development and fruit growth: Endosperm development during early, maturation and desiccation stages; embryogenesis, cell lineages during late embryo development; storage proteins of endosperm and embryo; polyembryony; apomixes; embryo culture; fruit maturation.

Dormancy: Seed dormancy; overcoming seed dormancy; bud dormancy.

Senescence and programmed cell death (PCD): Types of cell death, PCD in the life cycle of plants, metabolic changes associated with senescence and its regulation; influence of hormones and environmental factors on senescence.

PLANT ECOLOGY

Climate, soil and vegetation patterns of the world: Life zones; major biomes and major vegetation and sol types of the world.

Vegetation organization: Concepts of community and continuum ; analysis of communities(analytical and synthetic characters)

Ecological succession: Hydrosere and xerosere.

Ecosystem organization: Structure and functions; primary production (methods of measurement, global pattern, controlling factors); energy dynamics (trophic organization, energy flow Pathways, ecological efficiencies); litter fall and decomposition (mechanism, substrate quality land climatic factors); global biogeochemical cycles of C,N,P and S; mineral cycles (pathways, processes, budgets) in terrestrial and aquatic ecosystems.

Biological diversity: Concept and levels; role of biodiversity in ecosystem functions and stability ; speciation and extinction; IUCN categories of threat; distribution and global patterns, terrestrial biodiversity hot spots; inventory.

Air, water and soil pollution: Kinds, sources, quality parameters; effects on plants ecosystems.

Climate change: Green house gases (CO_2, CH_4, N_2O, CFCs: sources, trends and role); ozone

layer and ozone hole ; consequences of climate change (CO_2 fertilization, global warming, sea level rise, UV radiation).

Ecosystem stability : Concept (resistance and resilience); ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems ; ecology of plant invasion ; environmental impact assessment ; ecosystem restoration.

Ecological management : Concepts; sustainable development; sustainability indicators.

PLANT RESOURCE UTILIZATION AND CONSERVATION

Plant Biodiversity and sustainable development

Origin, evolution, botany, cultivation and uses of (i) Food forage and fodder crops (ii) fibre crops (iii) medicinal and aromatic plants and (iv) vegetable oil-yielding crops. Ethnobotany

Important fire-wood and timber – yielding plants and non-wood forest products (NWFPs) such as bamboos, rattans, raw materials for paper-making, gums, tannins, dyes, resins and fruits.

Green revolution : Benefits and adverse consequences.

Plants used as avenue trees for shade, pollution control and aesthetics.

Principles of conservation; extinctions; environmental status of plants based on International Union for Conservation of Nature.

Strategies for conservation – in situ conservation : International efforts and Indian initiatives ; protected areas in India – sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs for conservation of wild biodiversity.

Strategies for conservation – ex situ conservation : Principles and practices; botanical gardens, field gene banks, seed banks, in vitro repositories, cryobanks; general account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR) and the Department of Biotechnology (DBT) for conservation, non-formal conservation efforts.

BIOTECHNOLOGY AND GENETIC ENGINEERING OF PLANTS AND MICROBES

Plant Biotechnology – Principles, scope and applications.

Plant cell and tissue culture : General introduction, scope, cellular differentiation, and totipotency.

Organogenesis and adventives embryogenesis : Morphogenesis; somatic embryogenesis.

Somatic hybridization : Protoplast isolation, fusion and culture.

Applications of plant tissue culture : Clonal propagation, artificial seed, production of hybrids and soma clones, production of secondary metabolites / natural products, cryopreservation and germplasm storage.

Recombinant DNA technology : Gene cloning principles and techniques, genomic / c DNA libraries, vectors, DNA synthesis and sequencing, polymerase chain reaction, DNA fingerprinting and DNA markers.

Genetic engineering of plants : Transgenic plants, Methods of gene transfer – *Agrobacterium* – medicated and microprojectile, chloroplast transformation, intellectual property rights, ecological risks and ethical concerns.

Microbial genetic manipulation : Bacterial transformation, selection of recombinants and transformants, genetic improvement of industrial microbes.

Genomics and proteomics : High throughput sequencing, genome projects, bioinformatics, functional genomics, microarrays.

14.ZOOLOGY

General Concepts :

1. Levels of structural organization :
   Unicellular, colonial and multicellular forms. Prokaryotic and Eukaryotic cells. Levels of organization of tissues, organs & systems.
2. Acoelomata, Pseudocoelomata, Coelomata, Proterostomia and Dueterostornia.
3. Concepts of species and hierarchical taxa, biological nomenclature, classical methods of taxonomy of animals.

Non-Chordata :

1. General characteristics and classification of invertebrates up to class level.
2. Protozoa: Locomotion, Nutrition and Reproduction in protozoa, Protozoan diseases of man.
3. Porifera: Canal system in porifera, skeleton in porifera, Reproduction in sponges.
4. Coelenterata : Polymorphism, Metagenesis, coral formation,Etenophora.
5. Hemlinths: Common Helminthic parasites of Man – *Taenia solium, Schistosoma sp., Ascaris, Ancylostoma, Oxyuris, Loa, Trichinella, Strongyloides* – their life cycles. Parasitism and parasitic adaptations.
6. Annelida: Excretory system, Coelom formation, coelom and coelomoducts.
7. Arthropoda: Mouthparts of Insects, useful and harmful insects, Metamorphosis in insects. Apiculture and sericulture in India, crustacean larvae.
8. Mollusca: Respiritation, Torsion and De-torsion, pearl formation and Pearl industry.
9. Echinodermata: Echinoderm larvae, Water vascular system.

CHORDATA :

1. General Characters and classification of chordates upto class, Origin of Chordates, phylogeny and affinities of Hemichordata, Retrogressive metamorphosis.
2. Vertebrate integument and derivatives, Comparative account of Digestive, Respiratory,Circulatory, Excretory and Reproductive systems of Vertebrates.
3. Pisciculture in India, Common edible fishes of Andhra Pradesh.
4. Origin and evolution of Amphibia, Paedogenesis, Neotony.
5. Important Snakes of India, Dinosaurs.
6. Flight adaptations and Migration in birds. Archeopteryx, Poultry in India.
7. Adaptive radiation and Dentition in Mammals.

CELL BIOLOGY :

1. Prokaryotic and Eukaryotic cell, Plasma Membrane-Ultrastructure, Permeability, intercellular communication, Endocytosis, Exocytosis, Phagocytosis, Active transport, membrane pumps.
2. Structure & function of Intracellular organelles – Nucleus, Mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, Cell wall, Cytoskeleton and its role in motility.
3. Organization of genes and chromosomes - Operon, unique and repetitive DNA, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.
4 Cell division and cell cycle - Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.
5. DNA replication, repair and recombination - Unit of replication, replication origin and replication fork, Recombinant technology, Transgenic and cloned animals, DNA damage and repair mechanisms.
6. Protein synthesis - initiation, elongation and termination of Genetic code.
7. Regulation of gene expression - Lac operon, Lambda operan.

GENETICS :

1. Mendel's law of inheritance - Critical review and Linkage.
2. Gene mapping methods : Linkage-complete and Incomplete linkage; Linkage maps, Recombination, mapping with molecular markers, somatic cell hybrids.
3. Crossing over : Types (Somatic or mitotic crossing over and Germinal or meiotic crossing over), theories about the mechanism of crossing over, tetrad analysis, and cytological detection of crossing over.
4. Mutations : Types (Spontaneous and Induced), causes and detection, mutant types (lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants), Molecular basis of mutations.
5. Chromosomal aberrations (deletion, duplication, inversion and translocation, ploidy and their genetic implications); Autosomal abnormalities (Down's syndrome, Trisomy-13, -18);

Sex anamolies (Turner's syndrome, Klinefelter's syndrome, Hermaphroditism).
6. Human genetics : Human karyotyping, Genetic disorders due to mutant genes (Huntington's chorea), Inborn errors of metabolism-Pheynylketonuria, alkaptonuria, Sickle cell anemia.

SYSTEM AND CELL PHYSIOLOGY :

1. Blood and circulation - Blood corpuscles, haemopoiesis, plasma function, blood groups, haemoglobin, haemostasis.
2. Cardiovascular System : Neurogenic, myogenic hearts, cardiac cycle, heart as a pump, neural and chemical regulation of all above.
3. Respiratory system - Transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.
4. Nervous system - Neurons, action potential, Conduction of nerve impulse, synapse, Neurotransmitters.
5. Muscle : Ultraa structure and mechanism of muscle contraction.
6. Sense organs – Eye, Ear.
7. Excretory system - Comparative physiology of excretion, urine formation, micturition.
8. Osmaregulation – Osmoregulation in fishes, Hormonal control of osmoregulation.
9. Digestive system - Digestion, absorption, assimilation and egestion.
10. Endocrinology and reproduction - Endocrine glands, basic mechanism of hormone action, hormones and diseases, reproduction in mammals.
11. Chemical bonds (Covalent, Hydrogen and Ionic bonds, Van der waals interactions).
12. Outline classification of organic compounds (carbohydrates, proteins and lipids).
13. Order of protein structure, primary, secondary, tertiary and quaternary; Ramachandran plot.
14. Glycolysis, TCA cycle and their Biomedical importance. Pentose phosphate pathway, Gluconeogenesis. Redox Potentials, Mitochondrial electron transport system, Oxidative phosphorylation.

EVOLUTION :

1. Origin of life - Modern concepts, theories of Evolution.
2. Isolation, Speciation, Natural Selection.
3. Hardy weinberg' Law.
4. Population Genetics (Gene pool, Gene frequency), Genetic drift and convergent evolution, Adaptive radiation.
5. Evolution of Man.
6. Zoogeographical realms of the world.

DEVELOPMENTAL BIOLOGY :

1. Speamatogenesis, oogenesis.
2. Fertilization, cleavage, gastrulation formation of germ layers, parthenogenesis.
3. Embryogenesis in vertebrates.
4. Formation and function of foetal membranes.
5. Types of Placenta.
6. Regualtion, genetic control of development.
7. Development of Frog and chick.

HISTOLOGY :

1. Histology of Mammalian tissues and organs - Epithelial, connective, blood, bone, cartilage, skin, stomach, intestine, liver, pancreas, kidney, Testis and Ovary.

ECOLOGY :

1. Concept of Ecosystem.
2. Biogeochemical cycles (Carbon, Nitrogen and Phosphorous).

3. Influence of environmental factors on animals, energy flow in Ecosystem, food chains, food web and trophic levels.
4. Community and population ecology. Ecological succession.
5. Environmental pollution-Air, water, land, noise, radioactive, thermal and visual, effects of pollution on ecosystem, prevention of pollution.
6. Wildlife in India-conservation, Chipko movement.
7. Biodiversity-Economic significance, conservation, hot spots of India.

IMMUNOLOGY :

1. Cells of the immune system : Lymphoid cells, Mononuclear cells, granulocytic cells, Mast cells.
2. Organs of the immune system - primary and secondary lymphoid organs, lymphatic system.
3. Antigens: Antigenic determinants or epitopes, immunogenicity, Haptens.
4. Innate (Non-specific immunity): Anatomical barriers, phagocytosis, NK cells, interferon.
5. Humoral immunity: Immunoglobulins (fine structure of immunoglobulins and immunoglobulin classes); the complement system, Classical and alternate pathway, inflammation.
6. Cell mediated immunity : Mechanism of cell mediated immunity; Brief account on Antigen presentation, Major histocompatability complex.
7. Antigen-Antibody interactions : Affinity, Avidity, Cross-reactivity, precipitation reactions, and Agglutination reactions and ELISA.
8. Brief account on immunological Hypersensitivity disorders :

   a) Tolerance and Autoimmunity
   b) Transplantation.
   c) Immunodeficiency diseases - HIV.
   d) Immunization (Active and passive immunity).

15.STATISTICS

Probability Theory :

- Random experiment, Random event, Sample Space, Classes of sets, fields, sigma-fields, minimal sigma-fields, Borel sigma fields in R, Measure, Lebesque mesure, Lebesque-Stieltjes measures, Measurable functions, Borel function, induced sigma field, Probability Measure, Basic Properties of a Measure, conditional probability and Bayes Theorem. Caratheodory extension theorem (Statement only), measurable function, random variables, distribution function and its properties, expectation, statements and applications of monotone convergence theorem, Foatou's lemma, dominated convergence theorem.
- Expectations of functions of rv's, conditional expectation and conditional variance, their applications. Characteristic function of a random variable and its properties. Inversion theorem, uniqueness theorem (Functions which cannot be Characteristic functions). Levy's continuity theorem (Statement only). Chebychev, Markov, Cauchy-Schwartz, Jenson, Liapunov, Holder's and Minkowsky's inequalities.
- Sequence of Random variables, convergence in Probability, convergence in distribution, almost sure convergence, convergence in quadratic mean and their interrelationships, Slutskey's theorem, Borel-Cantelli lemma Borel 0-1 law, Kolm ogorov 0-1 law (Glevenko – Cantelli Lemma Statement only).
- Law of large numbers, Weak law of large numbers, Bernoulli and Khintchen's WLLN's, Kolomogorov Inequality, Kolmogorov SLLN for independent random variables and statement only for i.i.d. case and their applications, statements of three series theorem. Central Limit theorem : Demoviere – Laplace CLT, Lindberg-Levy CLT, Liapounou' CLT, Statement of Lindberg-Feller CLT, simple applications.
- Introduction to stochastic processes; classification of stochastic process according to state-space and time-domain. Finite and countable state Markov chains; time-homogeneity; Chapman-Kolmogorov equations; marginal distribution and finite – dimensional distribution; classification of states of a Markov chain – recurrent, positive recurrent, null-recurrent and transient states.

Distribution Theory

- Standard discrete and continuous univariate distributions : Binomial, geometric, Poisson, Negative Binomial, Hyper-geometric, Uniform, Triangular, beta, exponential, gama, Weibull, Normal, Lognormal, and Cauchy distributions and their properties. Joint, Marginal and conditional pmf's and pdf's.
- Families of Distributions : Power series distributions, Exponential families of distributions. Functions of Random variables and their distributions (including transformation of rv's). Bivariate Normal, Bivariate Exponential (Marshall and Olkins form), Compounding distributions using Binomial and Poisson. Truncated (Binomial, Poisson, Normal and Lognormal) and mixture distributions – Definition and examples.
- Sampling Distributions of sample mean and variance, independence of X and s^2. Central and Non-central $\chi 2$, t and F distributions. Order statistics Joint and marginal distributions of order statistics and Distribution of Range. Distributions of order statistics from rectangular, exponential and normal distributions. Empirical distribution function.
- Multinomial distribution. Multivariate normal, bi-variate as a particular case, moments, c.f., conditional and marginal distributions. Distributions of correlation coefficient, partial and multiple correlations, and inter relationships. Dimension reduction method : PCA, FA, Canonical Correlations an MDS. Discriminent analysis and cluster Analysis.
- Distributions of quadratic forms under normality and related distribution theory.

Statistical Inference :

- Point Estimation : Point Estimation Vs. Interval Estimation, Advantages, Sampling distribution, Likelihood function, exponential family of distribution. Desirable properties of a good estimator : Unbiasedness, consistency, efficiency and sufficiency – examples. Neyman factorization theorem (Proof in the discrete case only), examples. UMVU estimation, Rao-Blackwell theorem, Fisher Information, Cramer-Rao inequality and Bhattacharya bounds. Completeness and Lehmann-Scheffe theorem. Median and modal unbiased estimation.
- Methods of estimation : method of moments and maximum likelihood method, examples. Properties of MLE. Consistency and asymptotic normality of the consistent solutions of likelihood equations. Definition of CAN and BAN, estimation and their properties, examples. Interval

estimation, confidence level CI using pivots and shortest length CI. Confidence intervals for the parameters for Normal, Exponential, Binomial and Poisson Distributions.

- Fundamental notions of hypothesis testing-Statistical hypothesis, statistical test, Critical region, types of errors, test function, randomized and non-randomized tests, level of significance, power function, Most powerful test, Neyman –Pearson fundamental lemma. MLR families and Uniformly most powerful tests for one parameter exponential families.
- Concepts of consistency, unbiased and invariance of tests. Likelihood Ratio tests, statement of the asymptotic properties of LR statistics with applications (including homogeneity of means and variances). Relation between confidence interval estimation and testing of hypothesis. Concept of robustness in estimation and testing with example.
- Concept of sequential estimation, sequential estimation of a normal population. Notions of sequential versus fixed sample size techniques. Wald's sequential probability Ratio test (SPRT) procedure for testing simple null hypothesis against simple alternative. Termination property of SPRT. SPRT procedures for Binomial, Poisson, Normal and Exponential distributions and associate OC and ASN functions. Statement of optimality of SPRT.
- Concepts of loss, risk and decision functions, admissible and optimal decision functions, Estimation and testing viewed as decision problems.

- **Nonparametric methods :** Nonparametric methods for one-sample problems based on sign test, Wilcoxon signed Rank test, run test and Kolmogorov – Smirnov test.
- Two sample problems based on sign test, Wilcoxon signed rank test for paired comparisons, Wilcoxon Mann-Whitney test, Kolmogorov – Smirnov Test, (Expectations and variance of above test statistics, except for Kolmogorov – Smirnov tests, Statements about their exact and asymptotic distributions), Wald-Wolfowitz Runs test and Normal scores test.
- Chi-Square test of goodness of fit and independence in contingency tables. Tests for independence based on Spearman's rank correlation and Kendall's Tau. Ansari-Bradley test for two sample dispersions. Kruskal – Wallis test for one-way layour (K-samples). Friedman test for two-way layout (randomised block).
- Asymptotic Relative Efficiently (ARE) and Pitman's theorem. ARE of one sample, paired sample and two sample locations tests.

Sampling Techniques

- Non – Sampling errors : Sources and treatment of non-sampling errors. Non – sampling bias and variance.
- SRSWR / WOR, Stratified random sampling and Systematic Sampling.
- Unequal probability Sampling : ppswr / wor methods (including Lahiri's scheme) and related estimators of a finite population mean. Horowitz – Thompson, Hansen – Horowitz and Yates and Grundy estimators for population mean / total and their variances.
- Ratio Method Estimation: Concept of ratio estimators, Ratio estimators in SRS, their bias, variance / MSE. Ratio estimator in Stratified random sampling – Separate and combined estimators, their variances / MSE.
- Regression method of estimation : Concept, Regression estimators in SRS with pre-assigned value of regression coefficient (Difference Estimator) and estimated value of regression coefficient, their bias, variance / MSE, Regression estimators in Stratified Random sampling – Separate and combined regression estimators, their variance / MSE.
- Cluster Sampling : Cluster sampling with clusters of equal sizes, estimator of mean per unit, its variance in terms of intracluster correlation, and determination of optimum sample and cluster sizes for a given cost. Cluster sampling with clusters of unequal sizes, estimator – population mean its variance / MSE.
- Sub sampling (Two – Stage only) : Equal first stage units – Estimator of population mean, variance / MSE, estimator of variance. Determination of optimal sample size for a given cost. Unequal first stage units – estimator of the population mean and its variance / MSE.

Design of Experiments

- Formulation of a linear model through examples. Estimability of a linear parametric function. Gauss-Markov linear model, BLUE for linear functions of parameters, relationship between BLUE's and linear Zero-functions. Gauss-Markov theorem.
- Simple linear regression, examining the regression equation, Lack of fit and pure error. Analysis of Multiple regression models. Estimation and testing of regression parameters, sub-hypothesis. Introduction of residuals, overall plot, time sequence plot, plot against Yi, Predictor variables $\mathbf{X_{ij}}$,

Serial correlation among the residual outliers. The use of dummy variables in multiple regression, Polynomial regressions – use of orthogonal polynomials. Derivation of Multiple and Partial correlations, tests of hypothesis on correlation parameters.

- Analysis of Covariance : One-way and Two-way classifications. Factorial experiments : Estimation of Main effects, interaction and analysis of 2^k, factorial experiment in general with particular reference to k = 2, 3 and 4 and 3^2 factorial experiment. Multiple Comparisons : Fishers least significance difference (LSD) and Duncan's Multiple Range test (DMR test).
- Total and Partial Confounding in case of 2^3, 2^4 and 3^2 factorial designs. Concept of balanced partial confounding. Fractional replications of factorial designs : One half replications of 2^3 and 2^4 factorial designs, one-quarter replications of 2^5 and 2^6 factorial designs. Resolutions of a design. Split – Plot design.
- Youdin design, intra block analysis. **B.I.B.D., P.B.I.B.D.,** their analysis, estimation of parameters, testing of hypothesis.

16.BIOTECHNOLOGY

CELL BIOLOGY: Diversity of cell size and shape. Cell theory, microscopic techniques for study of cells. Sub-cellular fractionation and criteria of functional integrity. Cellular organelles-Plasma membrane, cell wall, Mitochondria, Chloroplast, Nucleus and other organelles and their organization, structure and functions. Cell motility-cilla, flagella of eukaryotes. Transport of nutrients, ions and macromolecules across membranes. Liposomes, drug delivery systems, cellular energy transactions-role of mitochondria and chloroplast. Molecular assemblies like membranes; structure and functional aspects. Ribosome's, extra cellular matrix. Cell cycle – Overview of eukaryotic cell cycle, regulation of cell cycle by cell growth and extra cellular signals. Cell cycle check points. Regulators of cell cycle progression – MPF, cyclins and cyclin-dependent kinases. Cell death and proliferation – Apoptosis: definition, differences between apoptosis and necrosis and mechanism. Cancer: Types and Classification, Development and Properties of Cancer cells. Somatic mutations in cancer cells. Biotic and abiotic stress in plants. Signal transduction: types of receptors, second messengers (calcium, phoshoinositides and Nitric oxide). Meiosis, Gametogenesis, fertilization and Development of chick embryo.

BIOMOLECULES AND ANALYTICAL TECHNIQUES: - Chemical foundations of Biology water, pH, pK, acids, bases, buffers, weak bonds, covalent bonds. Principles of thermodynamics. Classification, structure and functions of carbohydrates, amino acids, proteins, nucleic acids and lipids. Chromatography Methods; partition, ion exchange, and affinity methods, criteria for purity, proteins and nucleic acids sequencing methods, Hormones, vitamins and minerals.

Analytical techniques: Principle, instrumentation and applications of VIS/UV, IR, NMR, LASER Raman Spectroscopy MASS Spectroscopy, Fluorescence Spectroscopy, Differential colorimetry, X-ray Crystallography, Ultra centrifugation, Electron Cryomicroscopy and Scanning Tunneling microscopy. Methods of cell study; confocal microscopy, Flowcytometry and FACS (fluorescence activated cell sorter) and atomic force microscopy. Radiochemical methods; Stable and radioactive isotopes, measurement of radioactivity by Liquid scintillation counting, GM counters and autoradiography. Specific activity and precursor-product relationship. Tracer studies and Effect of radiation on cells.

MOLECULAR BIOLOGY: - DNA Structure, replication, repair and recombination, Transcripition, regulation and post transcriptional modifications in Prokaryotes and Eukaryotes. Transcriptional and post-transcriptional gene silencing. Translation and regulation in Prokaryotes and eukaryotes, co-translation and post-translational modifications of proteins. Protein Localization-Synthesis of secretory and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes, Biology of Cancer-Oncogenes and Tumour Suppressor genes, Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins.

Antisense oligonucelotides, molecular targets of drug action and Ribozyme Technology. Homologous Recombination-Holliday model gene targeting, gene disruption, FLP/FRT and Cre/Lox recombination RecA and other recombinases. Molecular Mapping of Genome, Genes, mutation and mutagenesis, site directed mutagenesis and Human genome project, Transposons

BIOSTATISTICS: - Frequency distribution, Distribution of data bionomial, poission and normal. Measures of central tendency-mean, median, mode and standard deviation-probability distribution-regression-correlation- Analysis of variance-tests of significance- T-test, F-test, Chi-square test.

MICROBIOLOGY: - Discovery of the microbial world; Distinguishing features of prokaryotes and eukaryotes; general role of microorganisms in transformation of organic matter and in the causation of diseases; Microbial taxonomy; Classification, Nomenclature and new approaches to microbial taxonomy; Pure culture techniques; sterilization methods; Principles of microbial nutrition and composition of culture media; culture enrichment techniques; Growth and its mathematical expression; synchronized cultures, Culture collection and maintenance of cultures; Purple and green bacteria Ricketsias; Chlamydia and Mycoplasma. Archea; Viruses: structure and replication of viruses; DNA viruses and RNA viruses; Viroids and Prions; Viruse and their Genetic System; Bacteriophages; RNA phages; Retroviruses, Biomass and Bioenergy.

IMMUNOLOGY:- Phylogeny of immune System; Innate and acquired immunity; Hematopoietic and differentiation, cells and organs of the immune system; Lymphocyte trafficking; Antigencity and super antigens; Immunoglobulin types, structure and function, Antigen-antibody interactions; Blood groups, Cell migration and Homing, Immunoglobulin and gene organization. Major histocompatibility complex, BCR and TCR and generation of diversity; Complement system, Antigen processing and presentation, generation of humeral and cell mediated immune responses; Activation of B-and T- lymphocytes, Cytokines and their role in immune regulation; Cell mediated cytotoxic, Hypersensitivity, Autoimmunity, Transplantation, Tumor Immunology, AIDS and other Immunodeficiency; Hybridoma Technology, Psychoneuro-immunology,

Single chain antibodies, theories of antibody diversity, Vaccines – Concept of immunization, routes of vaccination. Types of vaccines – Whole organism (attenuated and inactivated) and component vaccines (synthetic peptides, DNA vaccines, recombinant vaccines, subunit vaccines, conjugate vaccines. Vaccine delivery systems.

BIOPROCESS ENGINEERING:- Fermentation-types of fermentors and bioreactor design, cell concentration and stirring. Filtration, methods of cell disruption. Downstream processing, industrial applications of bioprocess. Synchronized and continuous culturing. Industrial production of glutamic acid, citric acid, ethanol, penicillin and riboflavin. Purification and crystallization of products.

ENZYME TECHNOLOGY:- Discovery classifications and nomenclature of enzymes. Techniques of enzymes isolation and assay, Intracellular localization of enzymes, Isoenzymes, Multienzyme complexes and multifunctional enzymes Physico-chemical characterization of enzymes, Enzymes kinetics, kinetic of enzymes of inhibition. Allosterism, Enzyme memory and mnemonic enzymes, Various techniques used for the immobilization of enzymes and their applications in Biotechnology. Purification of enzymes and their applications, Single cell proteins. Industrial application of enzyme, applications in biosensors.

ENVIRONMENTAL BIOTECHNOLOGY:- Ecological balance, resiliency of ecosystem and sustainable development, environmental pollution and global problems, water, air, soil pollution and their impacts on environment and biotechnological approaches for management, waste

water treatment: aerobic and anaerobic processes, bioremediation of contaminated soils and waste land, biotechnological treatment for industrial effluents and solid wastes. GM microbes

GENETIC ENGINEERING:- Discovery, properties and application of Restriction enzymes, Cloning and expression vectors, Purification of plasmids, genomic DNA and mRNA. Genomic and cDNA Library construction and screening of recombinants by hybridization methods, Reporter assays, protein engineering- site directed mutagenesis, adding disulfide bonds – changing asparagines to other amino acids modification of metal cofactor requirements. Increasing of specific activity Stability to thermal and salinity conditions, Phage Display library and yeast two hybrid system. Gene transfer methods Tagging, Role of gene tagging analysis; Gene Therapy, Gene silencing methods, Biochips.

BIOINFORMATICS-:- Biological databases, ORF finding, EST analysis, gene identification, microsatellite repeat patterns, Blast all flavours, Mutation matrix, global Vs local alignments, Dot plots, PAM and BLOSUM matrices, Multiple sequence modeling, alignments dendrograms, phylograms, protein structure prediction methods, molecular modeling, Primer design, QSAR, Drug designing

PLANT BIOTECHNOLOGY:- Selection of explants, micro and macro Propagation techniques in plant tissue culture suspension culture, single cell. Anther, pollen and ovary culture for production of haploid plants. Cryopreservation for germplasm conservation. Plant Transformation technology, Transgene stability and gene silencing. Application of plant Transformation for productivity and performance. Metabolic Engineering and Industrial products: Plant secondary metabolites, industrial enzymes, biodegradable plastics, therapeutic proteins, antibodies, edible vaccines. Molecular marker assisted selection and Breeding: RFLP maps, RAPD markers, STS, microsatellites, SCAR (sequence characterized amplified regions), SSCP (single stand conformational polymorphism), AFLP, GM Crops

ANIMAL BIOTECHNOLOGY: - Animal cell culture technology, simple and complex growth media, cell culture techniques, primary and established cell lines. Biology and characterization of the cultured cells, measuring growth parameters, maintenance of cell culture, Measurement of viability and cytotoxicity, cell separation. Scaling–up of animal cell culture. Cell synchronization. Cell cloning and micromanipulation. Cell transformation. Stem cell cultures, embryonic stem cells and their applications. Cell culture based vaccines. Organ and histotypic cultures. Apoptosis, measurement of cell death. Biodegradation of Toxicants, Diagnostic aids, organ perfusion studies., GM animals.

Principles and preparation of DNA and RNA probes and their applications: Study and expression of cloned genes in prokaryotes and eukaryotic systems. Microbial production of interferon, human growth hormone, insulin in *E.coli*. Genetic Engineering – Social and moral implications, national and international guidelines/regulations. Biotechnology patents and safeguarding human health.

17.MICROBIOLOGY

General Microbiology and Microbial Physiology

History of Microbiology. Contributions of Scientists. Types, applications and importance of microscopy. Structure of microbial cells. Methods of sterilization: Physical methods –chemical methods and their application. Pure culture techniques. Preservation methods and Maintenance of Microbial cultures. Microbiological media and cultivation of microorganisms. Mcrobial identification methods. Principles of bacterial taxonomy and classification. Microbial growth curve. Measurement of Growth. Synchronous cultures – methods of synchronous culturing. Continuous culturing methods, factors effecting growth. Phenomenon of bacterial sporulation.

Cell and Molecular Biology, Virology

DNA structure, types and replication, Structure and types of RNA. Transcription and translation. Concept of ribozyme. Genetic code and Wobble hypothesis, Gene regulation. Cloning and expression vectors. Construction and screening of genomic and cDNA libraries. Types of mutagens, molecular basis and analysis of mutations, site directed mutagenesis. DNA damage and repair mechanisms. Recombination in bacteria by Transformation, Conjugation, Transduction. Transposable elements. Cell cycle and programmed cell death. Signal transduction, Protein folding & roles of Molecular chaperones.

Structure of viruses. Cultivation of viruses. Structure, genetics and Replication of Bacteriophages (Lytic and Lysogenic cycle), Plant Virus (TMV), Animal/human viruses (eg. Influenza virus, HIV and Adeno virus). Viral Interference and Interferons. Biochips. DNA markers: RFLP, Micro/mini satellites, SNPS, RAPDs and AFLP. Finger printing. DNA sequencing. Expression of recombinant proteins Protein-protein and protein-DNA interaction. Applications of recombinant DNA technology and Gene therapy.

Biochemistry and Techniques

pH and its biological relevance. Redox potentials, Electron transport, oxidative phosphorylation. Microbial respiration and fermentation. Classification, properties and chemical structure of carbohydrates and lipids. Classification, Properties and structure of amino acids and proteins. Biosynthesis and degradation of amino acids and proteins. Metabolism of carbohydrates and lipids – glycolytic pathways, TCA cycle, gluconeogenesis, glycogenesis. Biosynthesis of triacyl-glycerols and oxidation of fatty acids. Enzymes - nomenclature, classification, methods for determination of enzyme activity. Enzyme kinetics - Michelis-Menton kinetics. Optical methods - colourimetry and spectrophotometry, fluorimetry, optical rotation, Circular dichroism, NMR, ESR spectroscopy, X-ray diffraction, types of mass spectrometry. Chromatographic techniques , diffusion, dialysis, cell disruption methods, centrifugation techniques, electrophoreses and blotting techniques. Radio isotopes – detection and measurement.

Immunology

Components of immune system, Clonal selection theory. Antigen and antibody structure. Major Histocompatibility Complex (MHC) and transplantation. Antigen and antibody reactions. Immune response to infectious diseases. Hybridoma technology. Hypersensitivity, Tumor immunology, Immunological tolerance and immuno-suppression. Immune deficiency diseases. Immunotherapy of infectious diseases. Vaccines and Immunization.

Biostatistics: Variations and frequency distributions, measures of central tendency and dispersion, standard deviation, standard error, elements of probability, correlation and linear regression. Normal curve test, 't' test, 'F' test, 'Z'-test, ANOVA, Chi-square test, and confidence intervals. Experimental designs using statistical tools.

Bioinformatics: Basics of computers, Disk operating systems (DOS), Windows, MS office, information networking. Databases, Sequence and structure analysis of DNA and Proteins. Primer design. Protein engineering and drug designing. Tools and packages of networking.

Industrial Microbiology

Exploitation of microbes and industrial products. Types of fermentations, Detection and assay of fermentation products. Scale up of fermentations, Product recovery methods, Strain development strategies. Immobilization methods. Fermentative production of Ethanol , beer, wine, Antibiotics, citric acid, Vitamin B12, Glutamic acid and microbial enzymes. Steroid Biotransformations – Principles of vaccine production. Microbial biopesticides, Microbial products from genetically modified (cloned) organisms eg. Insulin. QA, QC, GLP, GMP, Patents & IPR

Medical Microbiology

Principles of Medical Microbiology, Normal flora of human body. Properties of pathogenic microorganisms. Bacterial, viral, fungal and parasitic infectious diseases (air born, water born, food born, insect born and zoonotic infections). Principles of diagnostic microbiology. Systematic Medical Microbiology - β-Haemolytic streptococci, *Mycobacterium tuberculosis, Neisseria gonorrhoea, E.coli, Salmonella typhi. Staphylococcus aureus, Clostridiuym tetani, Pseudomonas,* HIV, Polio, Rabies and Amoebiasis, Malaria and Trichomoniasis and Fungal diseases. Medical diagnostics.

Mode of action of important drugs – Cell wall inhibitors (Betalactum – eg. Penicillin), membrane inhibitors (polymyxins), macromolecular synthesis inhibitors (streptomycin), Antifungal antibiotics (nystatin). Drug resistance. Antiviral agents. Microbiological assays.

Food, Environment and Agriculture Microbiology.

Dairy Microbiology. microbiological examination of fresh and canned foods. Fermented foods, spoilage of foods and food preservation methods. Current and future implications concerning food safety, hazards and risks. Microbes and animal interactions – Rumen Microbiology, termite microbial communities. Probiotics, Prebiotics and their significance in human beings and animals. Microorganisms in air, water and soil and their importance. Microbial diversity in the environment. Microbial mineralization and C, N, S, P and Fe cycles. Soil humus formation. Rhizosphere, mycorhiza and phyllosphere. Microbial degradation of carbonaceous materials in soil. Biology and biochemistry of Nitrogen fixation. Biofertilizers, Biopesticides, Persistance and degradation of pesticides, herbicides, fungicides and insecticides. Sewage treatment and bioremediateion.

18.Computer Applications
19.Computer Science

1. **Mathematical Foundations:**
   Mathematical Logic – Propositional Logic, First Order Logic; Probability: Conditional Probability, Mean, Median, Mode and Standard deviation; Random Variables; Distributions - Uniform, Normal, Exponential, Poisson, Binomial. Set Theory and Algebra: Sets, Relations, Functions, Groups, Partial Orders, Lattices, Boolean Algebra. Combinatorics: Permutations, Combinations, Counting, Summation, Generating Functions, Recurrence Relations.
2. **Programming:**
   Programming in C, C++ and Java: Object Oriented Programming Concepts including Classes; Polymorphism; Inheritance and Programming in C, C++ and Java.
3. **Data and File Structures:**
   Data structure – Definition, Arrays, stacks, queues, linked lists, trees, graphs, priority queues and heaps.
   File Structures - Fields, records and files, Sequential, direct, index-sequential and relative files, Hashing, inverted lists and multi-lists B trees and B+ trees.
4. **Design and Analysis of Algorithms:**
   Asymptotic notation, Notations of Space and Time complexities, Worst and Average case analysis; Design: Greedy Approach, Dynamic Programming, Divide and Conquer; Tree and Graph traversals, connected components, spanning trees, shortest paths; Hashing, Sorting, Searching. Asymptotic analysis (best, worst and average cases) of time and space, upper and lower bounds.
5. **Computer Organization:**
   Machine instructions and addressing modes, Main Memory Organization, CPU Organization, I/O Organization, Micro-programmed Control, Cache Memory, Secondary Storage.
6. **Operating Systems and Unix:**
   Processes, Threads, Inter-process communication, Concurrency, Synchronization, Deadlock, CPU scheduling, Memory management and virtual memory, File systems, I/O systems, Protection and security.
   Unix System - File system, process management, bourne shell, Shell variables, command line programming.
   Filters and Commands - Pr, head, tail, cut, paste, sort, uniq, tr, join, etc., grep, egrep, fgrep, etc., sed, awk, etc.
   System Calls (like) - Creat, open, close, read, write, iseek, link, unlink, stat, fstat, umask, chmod, exec, fork, wait, system.
7. **Relational Database Design and SQL**
   E R diagrams and their transformation to relational design, normalization - 1NF, 2NF, 3NF, BCNF and 4NF, Limitations of 4NF and BCNF.
   SQL - Data Definition language (DDL), Data Manipulation Language (DML), Data Control language (DCL) commands. Database objects like-Views, indexes, sequences, synonyms, data dictionary.
   Transaction Management, concurrency control and system recovery.
8. **Software Engineering:**
   Software Characteristics, Software Process Models, Analysis, Design, Coding, Testing, and Software Quality Assurance, Software Metrics
9. **Computer Graphics:**
   Line Drawing, Graphic Primitives and Polygons, 2D Transformations, Windowing and Clipping, 3-D Graphics, Curves and Surfaces.
10. **Computer Networks:**
    ISO/OSI stack, LAN technologies, (Ethernet and Token ring), Flow and error control techniques, Routing algorithms, Congestion control, TCP/UDP and Sockets, IP (v4), Application layer protocols (icmp, dns, smtp, pop, ftp, http).

11. **Data Warehousing and Mining:** Data Warehousing Concepts and Architectures, OLAP, Data Pre-processing, Data Cube Technology, Data mining Functionalities, Primitives, Data Characterization, Association Mining, Classification and regression, Clustering and Outlier Analysis.
12. **Web Technologies:**
    HTML, XML, Basic Concepts of Client Server computing, Static, Dynamic and Active Web pages, Client and Server Side Scripting.
13. **E Commerce and Security:**
    Electronic Commerce - Framework, Media Convergence of Applications, Consumer Applications, Organisation Applications.
    Electronic Payment Systems - Digital Token, Smart Cards, Credit Cards, Risks in Electronic Payment System, Designing Electronic Payment Systems.
    Electronic Data Interchange (EDI) - Concepts, Applications, (Legal, Security and Privacy) issues, EDI and Electronic Commerce, Standardization and EDI, EDI Software Implementation, EDI Envelope for Message Transport, Internet-Based EDI.
    Cryptography - Fundamentals of Cryptology, Cipher Methods, Cryptographic Algorithms, Cryptographic Tools, Protocols for Secure Communication, Attacks on Crypto systems. Security Technologies – Firewalls, Intrusion Detection and Prevention Systems, VPNs.
14. **Theory of Computation and Compiler Design:**
    Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Undecidability. Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environments, Intermediate and target code generation, Basics of code optimization.
15. **Cryptography and Network Security**:
    Data Encryption and Decryption, Symmetric Key algorithms like DES, IDEA and AES, Public Key Cryptography, RSA algorithm, Digital Signatures & Authentication, Firewalls and VPN.
16. **Artificial Intelligence:**
    AI Approach to problem solving, State Space Search, Problem Characteristics, Production System Model, Breadth First and Depth First Search, Heuristic Search Techniques, Predicate Logic and Resolution for Theorem Proving, Knowledge representation using Rules, Frames, Semantic Nets, Script, and CD Diagrams, Uncertain reasoning Techniques, TMS, Linear and Nonlinear Planning.

20.GEOLOGY

1. Geomorphology and Remote Sensing

Basic principles, weathering and soils, mass wasting, influence of climate on processes. Concept of erosion cycles. Geomorphology of fluvial tracts, arid zones, coastal regions, karst landscapes and glaciated ranges. Applications of Geomorphology in mineral prospecting, civil engineering, hydrology and environmental studies, topographical maps and geomorphology of India.

Concepts and principles of aerial photography and photogrammetry Satellite Remote Sensing. Fundamentals of Digital Image Processing. Use of Remote Sensing in landforms, landuse, and structural mapping, Hydrogeological studies and mineral exploration. Geographic Information System (GIS) – principles and applications.

2.Structural geology and Geotectonics

Principles of geological mapping and map reading, projection diagrams, stress-strain relationship of elastic, plastic and viscous materials. Behavior of minerals and rocks under deformation conditions. Structural analysis of folds, cleavages, lineation's, joints, and faults. Superposed deformation. Mechanism of folding and faulting. Unconformities and basement cover relations. Structural behavior of igneous rocks, diapirs and salt domes. Fundamentals of petrofabric analysis.

Earth and solar system. Planetary evolution of earth and its internal structure. Heterogeneity of the earth's crust. Major tectonic features of the oceanic and continental crust. Continental drift-geological, geophysical and other evidences, mechanics, objections and present status. Gravity and magnetic anamolies at mid oceanic ridges, deep sea trenches, continental shield areas and mountain chains. Paleomagnetism, seafloor spreading and plate tectonics, Island arcs, oceanic islands and volcanic arcs, isostacy, orogeny, epeirogeny, geosynclines, and seismic belts of the earth. Seismicity and plate movements. Geodynamics of
the Indian plate.

3.Stratigraphy

Nomenclature and the modern stratigraphic code. Radio isotopes and measuring geological time. Geological time scale, stratigraphic procedures of correlation of unfossiliferous rocks. Precambrian stratigraphy of India. Stratigraphy of the Paleozoic and Mesozoic and Cenozoic formations of India. Gondwana system and gondwana land, and origin of Himalaya and evolution of Siwalik basin, Deccan volcanic. Quaternary stratigraphy, rock record, paleoclimates and paleogeography.

4. Paleontology

Fossil records, morphology and time ranges fossil groups. Evolutionary changes in Mollusks and mammals in geological time. Principles of evolution. Use of species and genera of foraminifera and echinodermata in biostratigraphic correlation. Siwalik vertebrate fauna and flora, different microfossil groups and their distribution in India.

5. Crystallography and Mineralogy

Physical, chemical and crystallographic characteristic of common rock forming mineral group. Silicate structures. Common minerals of igneous and metamorphic rocks. Minerals of the carbonate, phosphate, sulphide, halide and oxide groups.

Optical properties of common rock forming silicate minerals, uniaxial and biaxial minerals. Extinction, plechroism, birefringence of mineral and their relation with mineral composition. Twinned crystals and dispersion of optic axis and crystallographic axis.

6. Igneous and Metamorphic petrology

Forms, textures, and structures of igneous rocks, silicate melt equilibria, binary and ternary phase diagrams, Petrology and geotectonic evolution of granites, basalts, andesites and alkaline rocks. Petrology of gabbros, kimberlites, anorthosites and carbonatites. Origin and evolution of magmas.

Textures and structures of metamorphic rocks. Regional and contact metamorphism of pelitic and impure calcareous rocks. Mineral assemblages and P/T condition.

Characteristics of different grades and facies of metamorphism, Metasomatism and granitization, magmatites. Plate tectonics and metamorphic zones. Paired metamorphic belts.

7. Sedimentology

Provenance and digenesis of sediments, Sedimentary textures. Framework matrix and cement of terrigenous sediments. Definition, measurement and interpretation of grain size. Elements of hydraulics, primary structure, paleocurrent analysis. Biogenic and chemical sedimentary structures. Sedimentary environment and facies. Facies modeling for marine, non marine and mixed sediments. Tectonics and sedimentation. Classification and definition of sedimentary basins, sedimentary basins of India. Cycle sediments. Seismic and sequence stratigraphy. Purpose and scope of basin analysis. Structure contours and isopach maps.

8. Geochemistry

Earth in relation to the solar system and universe, cosmic abundance of elements. Composition of the planets and meteorites. Structure and composition of earth and distribution of elements. Trace elements. Elementary crystal chemistry and thermodynamics. Introduction to isotope geochemistry. Geochemistry of hydrosphere, biosphere and atmosphere. Geochemical cycle and principles of geochemical prospecting. Origin of elements.

9. Environmental geology

Concepts and principles. Natural hazards, preventive/precautionary measures-floods, landsides, earthquakes, rivers and coastal erosion. Impact assessment of anthropogenic activities such as urbanization, open-cast mining and quarrying, river-valley projects, disposal of industrial radioactive waste. Excess withdrawl of groundwater, use of fertilizers, dumping of ores, mine waste and flyash. Organic and inorganic contamination of groundwater and their remedial measures. Soil degradation and remedial methods. Environmental protection-legislative measures in India. Factors for groundwater subsidence.

10.Indian mineral deposits and mineral economics

Occurrence and distribution of metalliferous deposits-base metals, iron, manganese, alluminium, platinum, chromium, nickel, gold, silver, molybdenum. Indian deposits of non metals-mica, asbestos, barite, gypsum, apatite and beryl. Phosphrite, placer and rare earth mineral deposits. Gemstones, raw materials used for refractories, abrasives, glass, fertilizers, paints, ceramics and cement industries.

Stragetic, critical and essential minerals. Indias status in mineral production. Change in pattern of mineral consumption, National Mineral Policy. Mineral concession rules, Marine mineral resources and law of sea. Conservation and substitution of minerals.

11. Ore genesis

Ore deposits and ore minerals. Magmatic processes of mineralization, porphyry, skarn, and hydrothermal mineralization. Fluid inclusion studies and paragenesis. Mineralization associated with – i. ultramafic, mafic and acid rocks, ii. Greenstone belts, iii. Komatites, anorthosites and kimberlites, iv, Submarine volcanism-volcanogenic deposits. Magma-related mineralization through geological time. Stratiform and stratabound ores. Syngenetic deposits, residual and mechanical concentration processes, supergene sulphide and oxide enrichments.

12. Mineral exploration

Methods of surface and subsurface exploration, prospecting for economic minerals and fuels-drilling, sampling, and assaying. Geophysical techniques – gravity, electrical, magnetic, air borne, and seismic. Instrumental techniques of detection and measurement of radio activity. Radio active methods for prospecting and assaying of mineral deposits. Geomorphological and remote sensing techniques. Geobotanical and geochemical methods. Bore hole logging and survey for deviation.

13. Fuels

Definition, origin of coal, stratigraphy of coal measures. Fundamentals of coal petrology, peat, lignite, bituminous and anthracite. Industrial application of coal. Indian coal deposits.

Origin, accumulation, migration and entrapment of natural hydrocarbons. Characters of reservoir rocks. Structural, stratigraphic and mixed traps. Geographical and geological distribution of petroliferous basins of India. Gas hydrates and Coal Bed Methane occurrences.

Mineralogy and geochemistry of radioactive minerals. Distribution of radio active minerals in India. Radio active methods in petroleum exploration-well logging techniques. Nuclear waste disposal-geological constraints.

14. Engineering geology

Mechanical properties of rocks and soils. Geological investigations for river-valley projects-dams and reservoirs; tunnels-type, methods and problems. Bridges-types and foundation problems. Shoreline engineering, landslides, classification, causes, prevention and rehabilitation. Earthquake resistant structures. Problems of groundwater in engineering projects. Geotechnical case studies of major projects in India.

15. Hydrogeology

Origin of water-meteoric, juvenile, and connate. Hydrological cycle-evaporation, precipitation, runoff. Hydrographs, water table contour maps. Rock properties affecting groundwater. Types of aquifers. Porosity, permeability, specific yield and retention, hydraulic conductivity, trasmitssivity, storage and storage coefficient.

Well hydraulics, general flow equations, study of unidirectional flow, radial flow to a well, unsteady radial flow in a confined and unconfined aquifer. Water level fluctuation and causative factors. Methods of pumping tests and analyses, evaluation of aquifer parameters. Artificial recharge of groundwater. Groundwater legislation. Sustainability criteria and managing renewable and non-renewable groundwater resources.

Groundwater quality-sources of salinity, estimation of major elements, interpretation of chemical analyses. Groundwater pollution, arsenic and fluoride problems. Groundwater quality maps of India. Quality criteria for groundwater use. Salt water intrusion in coastal aquifers and remedial methods.

Surface geophysical methods-seismic, gravity, geoelectrical and magnetic. Subsurface geophysical methods-well logging for delineation of aquifers and estimation of water quality.