ACADEMY OF SCIENTIFIC AND INNOVATIVE RESEARCH

SYLLABUS

OF

INTER-DISCIPLINARY / CROSS-DISCIPLINARY COURSES

FOR

PhD PROGRAM

(*A part of the August 2020 Revised Course Structure*)

Academy of Scientific and Innovative Research

CSIR-HRDC Campus, Sector-19, Ghaziabad, U P., India

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

Revision of course curriculum from several perspectives (including updation to state of art knowledge & others) is a dynamic process restructuring for the contemporary needs and expectations w.r.t. courses of study for an academic program. This dynamic process is driven by growing needs and contemporary advancements in respective fields.

Academy of scientific & Innovative Research (AcSIR) aims to train and create quality human resource with positive attitude towards learning, leading to specialization in Ph.D. curricular education. An endeavour to revise the AcSIR Ph.D. study course syllabus has been done basically to provide opportunities to extend as well as deepen their knowledge, understanding, develop competencies & skills. It also emphasizes in the structure of teaching, learning and course duration so that it is optimum to earliest entry of students to their lab research phase of the program.

The academic programme in each of the five faculties in which AcSIR offers Ph.D. degrees is administered by a Board of Studies (BoS). The core courses have syllabi that are designed by the faculties in those areas, who have pursued research and taught these courses. Besides this, in order to get the most out of the expertise of the faculty members and their research experience in learning by students, some flexibility is given to the instructors in each course so that they can introduce a few special topics of their choice, making the course unique. Advanced courses are normally given by the faculty members in their own area of expertise. Each AcSIR Academic Centre has its area of specialization and expertise.

General Objectives of the course is that after successfully going through it, students will be able to understand the methods and techniques, developing knowledge and competencies, to be helpful in their research plans ahead in his/her selected field of research. Also, to support the students to understand the nature of problems faced during the Ph.D. period, develop suitable interdisciplinary scientific methods through some innovative remedies and learn to solve them.

Identical titles with identical contents listed across the faculty of Studies were pruned and only one is listed under the most relevant faculty with course serial no.

Course Requirements
For Completion of PhD Program

Minimum credits required to be successfully completed: 18 credits

Distribution of the 18 credits:

- Course 1: Total credits: 6 (consisting of two courses as under)
  - Research Methodology: 4 credits
  - Research Publication and Ethics: 2 credits
- Course 2: Total credits: 2 (consisting of one or two courses)
  - Inter-disciplinary/ Cross-disciplinary Course: 2 credits (either two courses of 1 credit each OR one course of 2 credits, to be opted from the list of offered courses)
- Course 3: Total credits: 6 (consisting of two or three courses)
  - Advanced Course: 6 credits (either two courses of 3 credit each OR three courses of 2 credits each, to be opted from the list of offered courses within Institute; restrictions of exclusion may apply when opted across Institutes)
- Course 4: Total credits: 4
  - Societal Program: Problem Understanding and Analysis: 4 credits (Group activity of upto five Team members from within Institute or across Institutes), no restriction of Faculty of Study, discipline of an AcSIR student.

How to read Course Codes:

Every Inter-disciplinary / Cross-disciplinary Course in AcSIR has a unique course code. A code can be understood as under:

AcSIR- 01- XX- 001

Two numbers identify AcSIR centres code:

Code	Lab Name
1	CBRI, Roorkee
2	IGIB, New Delhi
3	CCMB, Hyderabad
4	CDRI, Lucknow
5	CECRI, Karaikudi
6	CEERI, Pilani
8	CFTRI, Mysuru
9	CGCRI, Kolkata
10	CIMAP, Lucknow
11	CLRI, Chennai
12	CMERI, Durgapur
14	CRRI, New Delhi
15	CSIO, Chandigarh
16	CSMCRI, Bhavnagar
17	IICB, Kolkata
18	IICT, Hyderabad
19	IIP, Dehradun
20	IMTECH, Chandigarh
22	IITR, Lucknow
24	NAL, Bengaluru
25	NBRI, Lucknow
26	NCL, Pune
27	NEERI, Nagpur
28	NGRI, Hyderabad
29	NIO, Goa
30	NISTADS, New Delhi
31	NML, Jamshedpur
32	NPL, New Delhi
33	IHBT, Palampur
35	AMPRI, Bhopal
36	IMMT, Bhubaneswar
37	IIIM, Jammu
38	NEIST, Jorhat
39	NIIST, Trivendrum
41	SERC, Chennai
42	NISCAIR, New Delhi
43	CIMFR, Dhanbad
44	URDIP, Pune
45	4PI, Bengaluru
61	PHFI-IIPH-Delhi
62	PHFI-IIPH-Hyderabad
63	LVPEI, Hyderabad
64	BSIP, Lucknow
65	NIMR, New Delhi
66	IASST, Guwahati

Two letter shows course type i.e. XX can be:

RM: for Research Methodology

RP: for Research Publication and Ethics

ID: for Inter-disciplinary/ cross-disciplinary Learning

AD: for Advanced

SP: for Societal Program

A serial number for course to distinguish

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Inter-disciplinary / Cross-disciplinary Courses and Syllabus

Course contents

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01	CSIR-CBRI	2	Inter-disciplinary / Cross-disciplinary

Course Code	Course Title
AcSIR-01-ID-001	Building Construction for Science Students
AcSIR-01-ID-002	Building Science
AcSIR-01-ID-003	Chemistry for Engineers
AcSIR-01-ID-004	Computers for Research Students
AcSIR-01-ID-005	Economics for Scientists & Engineers
AcSIR-01-ID-006	Geology for Engineers
AcSIR-01-ID-007	Mathematics for Chemical Sciences
AcSIR-01-ID-008	Physics for Engineers

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AcSIR Academic Centre Code: 01

CSIR-Central Building Research Institute	**CSIR-CBRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Building Construction for Science Students**	**Course Code**	**Credits**
		AcSIR-01-ID-001	**1**

Introduction to Building Construction, Buildings, Purposes, Types and Theory of Building Systems and Architectural Components, Building Materials, Lime, Cement, Aggregates, Bricks, Stones, Timber, Metals, Concrete, Asphalt, Bitumen, Insulating Materials, Materials for Doors and Windows, Paints. Construction Foundations, Masonry Structure, RCC Construction, Precast and prefabricated Construction, Pre-engineered structures, Lintels, Staircases, Doors and Windows, Roofing Materials, Damp Proof, Roofing and Flooring, Estimation and Costing, Curing, Form Work, Scaffolding, Underpinning.

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AcSIR Academic Centre Code: 01

CSIR-Central Building Research Institute **CSIR-CBRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Building Science	Course Code	Credits
		AcSIR-01-ID-002	1

Climatology, Introduction to Climate classification, Thermal comfort and indices, Orientation of buildings, Bioclimatic design principles, Heat Transmission through Building Sections, Introduction to principles of heat transmission, Thermal performance of building sections, Thermal Performance Index, Calculation of Thermal Transmittance of walling and roofing assemblies, Ventilation and Lighting, Natural ventilation requirements in buildings, Daylighting and illumination requirements in buildings, Integration of daylight with artificial lighting, Glazing systems.

References:

1. Handbook on Functional Requirements of Buildings (Other than Industrial Buildings) SP: 41 (S&T) -1987, Bureau of Indian Standards.
2. Passive Building Design. A Handbook of Natural Climatic Control. N.K.Bansal, Gerd Hauser and Gemot Minke. Elsevier Science B.V. 1994.
3. The Climatic Data Handbook, Tata Mc Gravv Hill Pub. Co Ltd. 1 993. Shanma I.C.
4. Climate Responsive Architecture- A Design Handbook for Energy Efficient Buildings, Tata Mc Gravv Hill Pub. Co Ltd. 1993. Arvind Krishnan et al.
5. National Building Code, 2016.
6. Energy Conservation Building Code , 2017 & 201 8

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AcSIR Academic Centre Code: 01

CSIR-Central Building Research Institute	**CSIR-CBRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Chemistry for Engineers	Course Code	Credits
		AcSIR-01-ID-003	1

Solutions, Colloids, Nano-particles Solutions, Methods of expressing concentration of a solution: Molarity, Molality, Normality, Mole fraction and Percentage Mass; True solution and Colloidal solution, Types of colloids: Lyophilic and Lyophobic colloids, Tyndall effect, Brownian movement, Electrophoresis and Coagulation, Purification of water, Cleansing action of soap; Nano-Particles, Importance of Nano-particles and Application in Construction sector. Materials chemistry: Polymers-classification with examples, polymerization-addition, condensation and copolymerization; Plastics: Thermoplastics and thermosetting plastics, Compounding of plastics, Preparation, properties and applications of Polyvinylchloride, Teflon, Bakelite and Nylon-6,6, Rubbers: Natural rubber its process and vulcanization; Elastomers: Buna-S and Thiokol rubber; Cement: Composition of Portland cement, setting and hardening of Portland cement; Composite materials- Theory and applications. Corrosion and its control: Corrosion, Types of Corrosion, Theories of corrosion, Factors influencing the rate of corrosion, Control of Environment, Alloying, Surface coatings, Metal coatings, Electroplating, Galvanization and Tinning, Inorganic coating, Cathodic Protection, Sacrificial Anode Method and Impressed Voltage Method, Paint, Components of Paints and their functions, Varnish, Special Paints, Luminescent Paints, Fire Retardant Paints.

References:
1. P. C. Jain & Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company, 15th Edition, 2015.
2. Shasi Chawla, "Text Book of Engineering Chemistry", Dhanpat Rai Publishing Company, New Delhi, 2017.
3. S.S . Para & S. S. Umre, "A Text Book of Engineering Chemistry", S. Chand, 2004.

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CSIR-Central Building Research Institute	CSIR-CBRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Computers for Research Students	Course Code	Credits
		AcSIR-01-ID-004	1

Introduction of Computer and their components; Introduction of Python Programming, Application of software such as Matlab, Excel and SPSS for Data analysis. Writing of programs in Matlab; Use of macros in Excel and Writing of macros, Use of Statistical, Tools of Excel and Matlab for curve fitting.

References:

a. Fundamentals of computers by BALAGURUSAMY, McGraw Hill
b. Programming and Problem Solving with Python by Ashok Namdev Kamthane and Amit Ashok Kamthane, McGraw Hill
c. MATLAB for Beginners: A Gentle Approach, Peter Issa Kattan

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AcSIR Academic Centre Code: 01

CSIR-Central Building Research Institute **CSIR-CBRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Economics for Scientists & Engineers	Course Code	Credits
		AcSIR-01-ID-005	1

Introduction of Engineering Economics and Demand Analysis: Various Definition of Economics, Nature of Economics problem, relation between science, engineering, technology & economics, Meaning of demand, law of demand, elasticity of demand, practical importance & applications of the concept of elasticity of demand.
Meaning of production and factor of production: Land, Labour, Capital, Entrepreneur & organizations, their characteristics, law of variable proportion, return to scale.
Cost Analysis: Introduction, Types of Costs, Cost-Output Relationship, Cost Function, Cost-Output Relationships in the Short Run, and Cost-Output Relationships in the Long Run, Short run and long run, Break-Even Analysis, Production functions: laws of variable proportions, law of returns, Economies of scale: Internal and external.
Corporate Social responsibility: Meaning, Importance
Business Ethics: Meaning, Importance.

References:
Principles of Management by Tripathy and Reddy
Modern micro economic theory - H.L. Ahuja, S.Chand.
Engineering economics - Sullivan, Wicks, Koelling - Pearsons.
Modern Economic Theory, By Dr. K. K. Dewett & M. H. Navalur, S. Chand Publications

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AcSIR Academic Centre Code: 01

CSIR-Central Building Research Institute CSIR-CBRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Geology for Engineers	Course Code	Credits
		AcSIR-01-ID-006	1

Rocks and Minerals, Geological structure: faults, folds, shear zones; Plate tectonics and himalayan geology, Geological investigation and mapping; Rock mass classification, Geohydrology, Geological hazards: landslides, earthquake, tsunami; Geology in civil infrastructure engineering geophysics, Application of geophysical methods for geo-hazard studies, Non-invasive geophysical methods for engineering problems, Geophysical survey: Electrical, Seismic and electromagnetic, Geophysical site investigation techniques.

References:

1. Engineering Geology ((2013) by Subinoy Gangopadhay, Oxford University Press
2. Fundamentals of Engineering Geology(2006) by F.G. Bell, Elsevier Publication
3. Ground Water (1987) by HM Ragunath, New Age International Limited
4. Principles of Engineering Geology (1976), Attewell, P.B., Farmer, I.W., Springer
5, Applied Geophysics (1990)Telford W.M., Geldart L.P., Sheriff R.E., Cambridge University Press, Cambridge pp760.

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AcSIR Academic Centre Code: 01

CSIR-Central Building Research Institute	**CSIR-CBRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Mathematics for Chemical Sciences**	**Course Code**	**Credits**
		AcSIR-01-ID-007	**1**

Rounding, Significant figures and decimal places, Equations and functions, graphs. Powers: Negative powers, Special cases, Rules for power, roots, solving systems of equations, Rearranging equations, order of rearrangements, rearraning with power and roots, vectors theory of probability, curve fitting.
Exponentials: Exponentials function, graphs, algebraic rules for exponentials,
Logarithms: Iinverses of exponentials, logarithms to the base 10, logarithms to the base, laws of logarithms, converting b/w logarithms to different base, rearranging exponential and logarithms.

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CSIR-Central Building Research Institute	CSIR-CBRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Physics for Engineers	AcSIR-01-ID-008	1

Introduction to building heat Transfer- Steady state calculations, Steady state heat flow and temperature distribution in a multilayer wall with no internal heat sources, Surface resistances, Definition of the U-value, Two-dimensional heat conduction, Energy Efficiency and Indoor Climate - Indoor air quality monitoring and control mechanism, air flow, lighting, ventilation, water management, gas management, sensor technology, Internet of Things approach, building controller and features.
Acoustics: Sound control in buildings, standardized measuring methods, acoustics of membrane building components, environmental noise control, acoustic measurement and analysis methods.
Hygrothermics: moisture and thermal control - current scenario and future prospects and control strategy.

References:

1 . Handbook on Functional Requirements of Buildings (Other than Industrial Buildings)
SP: 41 (S&T) -1987, Bureau of Indian Standards.
2. Passive Building Design. A Handbook of Natural Climatic Control. N.K. Bansal, Gerd Hauser and Gemot Minke. Elsevier Science B.V. 1994.
3. The Climatic Data Handbook, Tata Mc Graw Hill Pub. Co Ltd. 1993. Sharma I.C.
4. Building Physics - Heat, Air and Moisture: Fundamentals and Engineering Methods with Examples and Exercises - Author(s): Hugo Hens,
5. Applied Building Physics: Boundary Conditions, Building Performance and Material Properties Author(s):Hugo Hens,
6. National Building Code, 2016.
7. Energy Conservation Building Code , 2017 & 2018

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02	CSIR-IGIB	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-02-ID-001	Chemistry for Biologists
AcSIR-02-ID-002	Computer Applications and Bioinformatics
AcSIR-02-ID-003	Disease Mechanisms: Integration of Metabolic and Cellular Signaling
AcSIR-02-ID-004	Lipid, Membranes, and Beyond
AcSIR-02-ID-005	Microbes and Environment
AcSIR-02-ID-006	Protein Structure and Function
AcSIR-02-ID-007	Proteomics and Metabolomics
AcSIR-02-ID-008	Tools & Techniques for Biologists

AcSIR Academic Centre Code: 02

CSIR-Institute of Genomics and Integrative Biology CSIR-IGIB

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:		Course Code	Credits
	Chemistry for Biologists	AcSIR-02-ID-001	1

Atoms to building blocks of biology (atoms, molecules, chemical bonds), Forces in biology (different types of interactions, such as hydrophobic, Vander Waals), Energetics of biology (thermodynamics), Key concepts for enzymology: Nucleophiles, water, Asymmetry and chirality in biomolecules, Chemical tools in biology (spectroscopy)

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AcSIR Academic Centre Code: 02

CSIR-Institute of Genomics and Integrative Biology	**CSIR-IGIB**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Computer Applications and Bioinformatics	**AcSIR-02-ID-002**	**1**

Bioinformatics databases and integrative extraction of information and compilation, sequence alignments, multiple sequence alignments and phylogenetic analysis, Introduction to R, a programming and environment language for statistical computation and graphics, Reading and writing files, lists, data frames and S4 objects, Random sampling, statistical tests and visualization

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AcSIR Academic Centre Code: 02

CSIR-Institute of Genomics and Integrative Biology | CSIR-IGIB

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Disease Mechanisms: Integration of Metabolic and Cellular Signaling	Course Code	Credits
		AcSIR-02-ID-003	1

Focus of the course: How physiological changes are routed through metabolic and cellular pathways and how perturbations can lead to diseased states topics: Compartmentalization principles in the cell, design principles of electron transport in conjunction with metabolism, mitochondrial dynamics, calcium dynamics and cross-talk, ER quality control, lipid storage and degradation, transcriptional control of metabolism, metabolic cross-talk during infection, inflammation and metabolism.

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AcSIR Academic Centre Code: 02

CSIR-Institute of Genomics and Integrative Biology CSIR-IGIB

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Lipid, Membranes, and Beyond	Course Code	Credits
		AcSIR-02-ID-004	1

Chemical and biophysical properties of different lipid classes, lipid compartmentalization, lipid trafficking, specialization of functions with lipid-protein interactions, lipid secondary messengers, lipid diversity and methods

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AcSIR Academic Centre Code: 02

CSIR-Institute of Genomics and Integrative Biology **CSIR-IGIB**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Microbes and Environment	Course Code	Credits
		AcSIR-02-ID-005	1

Survival strategies of bacterial pathogens, signalling mechanisms in bacteria, transport systems in microbes, bacterial secretions systems, virulence factors of pathogenic bacteria, microbial communities in nature, role of quorom sensing in populations and their dynamics.

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AcSIR Academic Centre Code: 02

CSIR-Institute of Genomics and Integrative Biology **CSIR-IGIB**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Protein Structure and Function	**AcSIR-02-ID-006**	**1**

Amino acid to proteins, sequence-folding relationship (Ramachandran plot, basics of secondary structure), structure and conformation, dynamic regulation of protein function, techniques and challenges.

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AcSIR Academic Centre Code: 02

CSIR-Institute of Genomics and Integrative Biology CSIR-IGIB

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Proteomics and Metabolomics	Course Code	Credits
		AcSIR-02-ID-007	1

The course will focus on mass spectrometry based investigations of proteomes and metabolomes. It will cover basic principles of identification, quantitative label free and labelbased methods, multiple reaction monitoring.

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AcSIR Academic Centre Code: 02

CSIR-Institute of Genomics and Integrative Biology — CSIR-IGIB

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Tools & Techniques for Biologists	Course Code	Credits
		AcSIR-02-ID-008	1

Genomics: Next Gen sequencing platforms and their applications, Microscopy: Spectral resolution, spatial resolution, Epifluorescence, confocal, super-resolution microscopy, electron microscopy

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Course Code	Course Title
AcSIR-03-ID-001	Biology of Macromolecules
AcSIR-03-ID-002	Chemistry for Biologists
AcSIR-03-ID-003	Computer Applications & Informatics for Biologists
AcSIR-03-ID-004	Self Organizations in Biology
AcSIR-03-ID-005	Tools & Techniques for Biology

AcSIR Academic Centre Code: 03

CSIR-Centre for Cellular and Molecular Biology	CSIR-CCMB

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title: Biology of Macromolecules	Course Code	Credits
	AcSIR-03-ID-001	

Introduction to biological macromolecules: Need for (polymeric macromolecules for living cell. Information content (general ideas on Shannon's information theory), Non-covalent forces (electrostatic, hydrophobic, hydrogen bonding etc.), Properties of water in relation to macro molecular conformation. Problem of protein folding: Introduction to protein folding, Levinthal's paradox and necessity for folding pathways, discussion on folding pathways (framework, hydrophobic collapse, nucleation-condensation-propagation, zigzag puzzle models and experimental evidence in support and against for these), Current view of protein folding, Folding surface and funnel. Assisted protein folding: Need for assistance in protein folding in vivo, Differences between in vitro and in vivo folding, Discovery of molecular chaperone, classification of chaperone and brief description of functions of GroEL, Methods for investigating protein folding: Fluorescence and Circular Dichroism, Basic principles and applications, Structure-Function relationship: Why structure? Different methods of structure determination, Retrieving, visualizing and Understanding macromolecular structures, Correlation between structure and function. Protein Architecture: Organization of Protein Structure, Supersecondary structural elements, Ramachandran Plot, Structure determination by X ray crystallography, Globular proteins, Identification of folds and Classification, Some examples of structures revealing biological insights, Complexity of Biological Processes, Induced Fit vs conformational selection, NMR and X-ray structures: Similarity and differences, Some examples by NMR, basic principles of NMR, Chemical shift, 15N, 1H HSQC, Folding-unfolding by HSQC, 3D NMR, Basic backbone assignment experiments, NOEs., Structure Calculation by NMR, Some examples of NMR structures, in cell NMR, solid state NMR, membrane proteins, ligand: Protein interaction, conformational exchange, SAR by NMR, Protein dynamics, Nucleic acids structures, various structural forms of nucleic acids, base pairing (WC and nonWC), DNA double helix, A B and Z-form of DNA, RNA structures, Riboswitches, mRNA structure, conformations of RNA, few examples. Macromolecular interactions: Simple and complex equilibria, General description of ligand binding (the essentials and thermodynamics), Simple equilibrium binding (stoichiometric titration, equilibrium binding/dissociation constants Complex equilibrium binding (classical modes of analysis: Scatchard plot, Klotz Plot and Hill Plot, cooperativity, MWC and KNF model for cooperative binding), Protein-Protein and protein ligand interactions: Experimental exposures, Microcalorimetry (ITC), Microcalorimetry

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AcSIR Academic Centre Code: 03

CSIR-Centre for Cellular and Molecular Biology	CSIR-CCMB

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Chemistry for Biologists	Course Code	Credits
		AcSIR-03-ID-002	1

Chemical Bonding: Structure of atoms, Bond Formation, Valence Shell Electron Pair Repulsion (VSEPR) Theory, Hybridization of Orbitals, Geometry of Molecules. Chemical Structure of Biological Molecules: Nucleic Acids, Lipids / Fatty Acids, Complex Carbohydrates, Proteins. Chemical Equilibrium: Concept of mole / Concentration, Law of Mass Action, Factors affecting Equilibrium, Buffer, Thermodynamics. Chemical Kinetics: Rate of Reaction, Order of Reaction, Integrated Rate Law, Complex Reactions (Parallel, Consecutive, etc), Effects of Temperature on Reaction Rate, Enzyme Kinetics (Michaelis Menton Equation), Lineweaver Burk Equation. Inhibition

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AcSIR Academic Centre Code: 03

CSIR-Centre for Cellular and Molecular Biology	CSIR-CCMB

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Computer Applications & Informatics for Biologists	Course Code	Credits
		AcSIR-03-ID-003	

Text-based searching of databases; examples of biological questions that can be addressed using text-based searches, Sequence-based search of databases; the alignment problem; BLAST algorithm; interpretation of BLAST results, Multiple sequence alignment algorithms; using Clustalw and interpreting the results; using the output of multiple alignment for motif discovery, phylogeny, Various methods, distance-based and alignment-based, for doing phylogeny; bootstrapping; obtaining consensus trees, Introduction to NGS analysis: de novo assembly of genomes and transcriptomes; analysis of re-sequencing data for genomes and transcriptomes, Introduction to Galaxy suite of tools for various analyses, Protein sequence and structure databases, Secondary and tertiary structure prediction, Fold and motif identification, Structure-function inference, Programming in Python

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AcSIR Academic Centre Code: 03

CSIR-Centre for Cellular and Molecular Biology	**CSIR-CCMB**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:		Course Code	Credits
	Self Organizations in Biology	**AcSIR-03-ID-004**	

Biomembranes: basic facts - why are they needed?, Biomembranes from an evolutionary perspective, A few milestones in membrane research, What is so unique about membrane organization?, Early diffusion measurements and the evolution of the fluid mosaic model, Membrane lipid structures and diversity What holds the membrane together: the hydrophobic effect, Role of membrane lipids in membrane function, Manifestations of diverse types of anisotropy in biomembranes, Membrane dynamics (rotation & lateral) and diffusion, Cellular timescales: what is the suitable timescale for membrane events?, How to monitor membrane dynamics: spectroscopic (fluorescence, ESR) - dynamics and spectral line widths, Why fluorescence? fluorescence probes and GFP, Quantitative fluorescence microscopy: FRAP & FCS (approaching dynamics with few molecules), Phase transition in membranes: fluorescence anisotropy and DSC, Phase transition and cholesterol: dual role of cholesterol in membrane order, Homeoviscous adaptation: model and complex organisms, Cellular signaling and dynamics – are they correlated?, Lipid-protein interactions: annular and nonannular lipids: a few lipids matter – it is all about weak interactions, Crowding in membranes and its consequences, Hydrophobic mismatch: when the tails matter, Membrane proteins – what is the problem in getting their structures?, GPCRs: membrane proteins that act as drug targets & signaling hubs, Lessons learnt from GPCR structures: the story of bound cholesterol, Membrane domains: platforms for organization, A hint of curvature: are all the curves in the right places?, Lipid structures: Primacy of membranes in biology, chemistry, distribution, crystal structure of lipids, Lipid phase transitions: Biological role of phase transitions, fusion, Emergent properties of lipids: Long range order, heterogeneity and membrane shape control

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 03

CSIR-Centre for Cellular and Molecular Biology CSIR-CCMB

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Tools & Techniques for Biology	Course Code	Credits
		AcSIR-03-ID-005	

Introduction to commonly used instruments in biological research, SOPs for using instruments, Hands-on demonstration of operation of various instruments. Mass Spectrometry: Introduction and history, Aims, strategies and challenges in mass spectrometry, Basic MS principles, Sample preparation in mass spectrometry, MS instrumentation – ionization sources (MALDI, ESI etc.), Fragmentation techniques/spectra/ions with emphasis on proteins & peptides, Basics of data analysis, Basics of modern proteomics, Proteomics technologies, The proteomics work flow Basic of separation sciences: Protein and peptides, 2D-electrophoresis, Tandem MS configurations and introduction to ion fragmentation, MALDI-TOF mass spectrometry (detail), Identifying unknown proteins by peptide mass fingerprinting de novo sequencing of peptides from fragment ion spectra obtained by tandem MS, Identification of post-translational modifications from tandem MS data, Analysis of full length proteins (Top-down proteomics), MALDI imaging, Analysis of other biomolecules by MS (e.g. nucleic acids, carbohydrates, lipids, metabolites), Proteomics technologies, Experimental designs, Sample preparation for proteomics and protein MS, Dealing with complex samples – protein and peptide separation technologies, Coupling liquid chromatography and MS (LC-MS, Different types of proteomic experiments and experimental setups, Practical considerations for designing proteomic experiments, Immunoprecipitation and enrichment strategy etc., Combining MS and tandem MS for protein identification/quantification, Quantitative and qualitative proteomics by mass spectrometry, Quantitative MS – Absolute and relative quantification of using stable isotope labelling (SILAC, iTRAQ etc.), Label-free approaches to quantification of proteins, Practical problems - how to see a spectrum (with examples)?, Instrumentation - analyzers (Ion-trap, Quadruple, OrbiTrap etc.), Instrumentation - basic designs of LTQ, Velos, Q-exactive etc., Data analysis - search algorithms and statistics, practical considerations, Global and targeted proteomics. Genome Engineering: Genetic Manipulations - Transgenic and locus specific manipulation tools in bacteria and yeast and vertebrate systems. Gene transfers techniques, electroporation, microinjection, nucleofection etc., DNA manipulation tools - Recombineering (plasmids and BACs), Overlap extension PCR for site directed mutagenesis, Gateway system, Golden gate cloning, site-specific recombinase and Gibson Assembly. Concepts, tools designing and applications. (Will be regularly updated with the new developments in the field.), Genome editing tools - Zinc Finger Nuclease, TALENS and CRISPRs in Prokaryotic and Eukaryotic model systems - concepts, tools and designing. (Will be regularly updated with the new developments in the field)

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

04	CSIR-CDRI	2	Inter-disciplinary / Cross-disciplinary

Course Code	Course Title
AcSIR-04-ID-001	An Intro to Drug Discovery & Development: Holistic View of Drug Discovery Research
AcSIR-04-ID-002	Bio techniques & Instrumentation
AcSIR-04-ID-003	Bioinformatics
AcSIR-04-ID-004	Biology for Chemists
AcSIR-04-ID-005	Chemical Biology
AcSIR-04-ID-006	Chemistry for Biologists
AcSIR-04-ID-007	Homeostasis and Feedback in Biological Systems

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 04

CSIR-Central Drug Research Institute	CSIR-CDRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	An Intro to Drug Discovery & Development: Holistic View of Drug Discovery Research	Course Code	Credits
		AcSIR-04-ID-001	1

Physiology-based (Phenotype) approach to drug discovery, Target-based approach to drug discovery "Me Too" drugs, New chemical entities, Generics, Pro-drugs, Orphan drugs, Sources of chemical libraries for screening/selection of molecules, natural products/privileged, structures, Drug ability and Characteristics of hit/lead, Structure Activity Relationship (SAR),Repositioning/repurposing of known drugs, Introduction to proteomics and genomics Target discovery/validation, Assay Development: In Vitro/Cell-based/In vivo, Biologics Toxicity/PK studies/ Formulation IND/NDA Clinical trials Phase I/II/III.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 04

CSIR-Central Drug Research Institute	**CSIR-CDRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Bio techniques & Instrumentation**	**Course Code**	**Credits**
		AcSIR-04-ID-002	**1**

Immuno-techniques: ELISA, Immuno-fluorescence, immuno-histochemistry, immuno-precipitation, ChIP, etc. Automation in Drug Discovery: High-Content and High-Throughput Screening, High resolution microscopy Transmission and Scanning, Electron Microscopy and Laser Scanning Confocal Microscopy. Gene Expression Analyses DNA Microarray and Proteomics, Radiation biology: Introduction to radiation biology, Scintillation counting, Autoradiography. Instrumentation: Centrifugation, Transmission Electron Microscope, Scanning Electron Microscope, Laser Scanning Confocal Microscope, High Content Screening System, MALDI-MS.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 04

CSIR-Central Drug Research Institute **CSIR-CDRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Bioinformatics	**AcSIR-04-ID-003**	**1**

Introduction to Bioinformatics: History of Bioinformatics, Genome sequencing projects, Human Genome Project, Applications of Bioinformatics. Introduction to databases, Type and kind of databases, Applications and limitations. Literature Search Databases, Nucleic acid and protein databases, Animal and plant databases, Ensembl Genome project TIGR database, Biotechnological databases, Motifs and Pattern Databases, Databases for species identification and classification, Structural databases. Database Retrieval and deposition systems. Web tools and resources for sequence analysis: Pairwise and multiple sequence Alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, Restriction map analysis, primer design, Gene prediction, Phylogenetic Tree, Protein structure prediction and visualization.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 04

CSIR-Central Drug Research Institute	**CSIR-CDRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Biology for Chemists**	**Course Code**	**Credits**
		AcSIR-04-ID-004	**1**

Basic Biology for Inter-disciplinary nature Chemical evolution to biological evolution, Cellular Components and their function, Overview of the flow of information from DNA to RNA to protein, Structure, function and composition of DNA, DNA Replication and Genetic inheritance, Transcription in Prokaryotes (bacteria) and Eukaryote RNA structure and function, Translation and post translational modifications, Enzyme biology: Kinetics, regulations and inhibition, Introduction to Chemical Biology, Click chemistry, Chemical genetics to re-shape biology.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 04

CSIR-Central Drug Research Institute	CSIR-CDRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Chemical Biology	Course Code	Credits
		AcSIR-04-ID-005	1

Chemistry and life: Science at the Interface Chemistry-Biology, Introduction to Chemical Biology : This lecture will provide a survey of major topics, technologies, and themes in Chemical Biology,RNA interference: Including lectures on RNAi biological applications, siRNA- A tool in chemical biology and designing and synthesizing siRNAs, Click Chemistry applications in Chemical Biology, Fluorescent probes and fluorescent sensors for studying the biology, Chemical Genetics: amelioration of biology through chemistry, Semi synthesis of proteins and Protein ligation, native chemical ligation, Unnatural amino acids as probes of protein structure and function.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 04

CSIR-Central Drug Research Institute	**CSIR-CDRI**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Chemistry for Biologists**	**Course Code**	**Credits**
		AcSIR-04-ID-006	**1**

Basic Chemistry for Inter-disciplinary nature Thermodynamics Solutions and Ions Chemical bonding and molecular structure Chemical Kinetics, Stereochemistry, Introduction to drug discovery (Medicinal chemistry approach), Drug target, discovery and development (forward and reverse approach

AcSIR Academic Centre Code: 04

CSIR-Central Drug Research Institute CSIR-CDRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Homeostasis and Feedback in Biological Systems	Course Code	Credits
		AcSIR-04-ID-007	1

Levels of organization: Molecular, Cellular and Tissue Physiology, Control and Regulation: Nervous and Endocrine Systems, Overview of physiological adaptation, Components of homeostasis & physiological feedback, Regulation of homeostasis and adaptive mechanisms of glucose, water, pressure & volume, mineral & ion, acid-base (include oxygen-CO2 regulation), temperature, Pathways affecting homeostasis, Physiological Applications: Reproductive System and contraception

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

05	CSIR-CECRI	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-05-ID-001	Bio Electrochemistry (Theory & Lab)
AcSIR-05-ID-002	Smart Materials for Devices (Theory & Lab)

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 05

CSIR-Central Electro Chemical Research Institute	CSIR-CECRI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Course Code	Credits
Bio Electrochemistry (Theory & Lab)	AcSIR-05-ID-001	2

Theory:

Origin of electrical potential of biomolecules, membrane potentials, electron transfer from biological molecule to electrodes, enzyme electrodes, electrochemical immunoassays, nucleic acid based biosensor, application of enzyme based micro electrodes for in vivo and in vitro electrochemical analysis, amperometric biosensors, Field effect transistor (FET) based biosensor, electrochemiluminesce in biosensors, miscellaneous techniques for biosensor application biofuel cells, bio corrosion,

Lab:

Potentiometry based ion selective electrode for intracellular applications, electrochemically coupled enzymatic reactions of modified electrodes for biosensor applications, redox mediated electrochemistry of biomolecules.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 05

CSIR-Central Electro Chemical Research Institute	CSIR-CECRI

Course 2 : Inter-disciplinary — Total Credits 2

Title:	Smart Materials for Devices (Theory & Lab)	Course Code	Credits
		AcSIR-05-ID-002	2

Smart Materials for Devices - Theory

Thermoelectric effect and thermoelectric devices Seebeck effect, Peltier effect, Thomson effect, Thermoelectric figure of merit, Applications.

Current research on thermoelectric materials Classical thermoelectric materials, Commercial materials: oxides, half-Heusler, Nanostructures, Complex materials.

Thermionic power conversion Richardson formula, Thermionic engines: vacuum, solid-state, Schottky barrier and diode, pn junction and diode.

Photovoltaic cells Solid-state thermionics, Solar cell basic principles, Efficiency: maximization, limiting factors, Types of PV cells, single junction and multi-junction.

Solar concentration and solar thermal technology, Solar hot water systems, Imaging and nonimaging optics, Tracking and nontracking systems, Methods for concentration: Trough, tower, dish, EM wave calculation of surface properties, Solar thermoelectric and applications of solar thermovoltaics, Selective surfaces, Solar thermophotonics, Solar thermoelectrics.

Smart Materials for Devices - Practical Module

Practical 1: Synthesis of size-selective novel metal nanoparticles (mainly Au and Ag)
Practical 2: Microwave assisted synthesis of Nanomatrials
Practical 3: Fabrication of Nanomaterials via Electrospinning techniques
Practical 4: Synthesis of metal Organosol by wet-chemical route
Practical 5: Hydrothermal synthesis of transition metal based Nanomaterials
Practical 6: Synthesis of magnetic Nanoparticles
Practical 7: DNA based nano-assemblies for device fabrication

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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06	CSIR-CEERI

2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-06-ID-001	Advanced Engineering Mathematics
AcSIR-06-ID-002	Foundation of Cyber Physical Systems
AcSIR-06-ID-003	Smart Sensors and Interface Electronics
AcSIR-06-ID-004	Microwaves: Devices and System Engineering
AcSIR-06-ID-005	Measurement and Characterization Techniques
AcSIR-06-ID-006	Modelling and Simulation
AcSIR-06-ID-007	Signal Processing and Machine Learning

AcSIR Academic Centre Code: 06

CSIR-Central Electronics Engineering Research Institute CSIR-CEERI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Advanced Engineering Mathematics	Course Code	Credits
		AcSIR-06-ID-001	3

Probability theory, stochastic processes, and statistical inference. Elements of real and complex analysis, and linear algebra. Partial Differential Equations and Applications, and Optimization, with an emphasis on application and implementation, Graph and Network.

Module 1: Ordinary Differential Equations (ODEs) (1 Credit)
First and higher order differential equations, Bernoulli equations, Euler-Cauchy equations, practical examples and modeling of differential equations Laplace transforms.
Module 2: Linear Algebra and Vector Calculus (1 Credit)
Linear algebra, eigenvalue and eigenvector, Symmetric, skew-Symmetric and orthogonal matrices, spectral theorem, self-adjoint and normal operator, diagonalization, matrix traingularization, singular-value decomposition and Taylor series, Fourier series, Gradient, divergence and curl, line, surface and volume integrals, Stokes's theorem.
Module 3: Optimization and Probability (1 Credit)
Basic concepts of optimization, Line searches, Gradient based methods, Global optimization methods; Data Representation, Probability, Permutations and Combinations, Random Variables, Probability Distributions, Mean and Variance of a Distribution, Normal Distribution.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 06

CSIR-Central Electronics Engineering Research Institute CSIR-CEERI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Foundation of Cyber Physical Systems	Course Code	Credits
		AcSIR-06-ID-002	3

Introduction to Cyber-Physical Systems, Modelling of physical processes; Differential Equations and domains. Choice and Control: Introduction to Hybrid Programming, Safety & contracts, Dynamical systems & dynamic axioms, Truth & proof, Control loops & invariants, Events & responses, Reactions & delays, Logical foundations & CPS, Hybrid systems & games, Winning strategies & regions, Distributed systems & hybrid systems. IOT and implementation of CPS systems. Application Examples – transportation system, mobile robot.

Module 1: Design (1 credit)

Literature survey
Modelling and Design of Cyber Physical Systems
Module 2: Simulation (1 credit)
Implementation of the design on software
Results and analysis
Module 3: Case Study (1 credit)
Conceptual design and simulation of a Cyber Physical System

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 06

CSIR-Central Electronics Engineering Research Institute	**CSIR-CEERI**

Course 2 : Inter-disciplinary / Cross-disciplinary | **Total Credits 2**

Title:	**Smart Sensors and Interface Electronics**	**Course Code**	**Credits**
		AcSIR-06-ID-003	**3**

Smart sensor fundamentals and Interface strategy. Feed-back system. Sensor transduction principles analysis and fabrication techniques. Development of Op-Amp based of Analog circuit building blocks and their application. Bias circuit architecture. Sensor non-linearity compensation techniques (offset, noise, temperature, drift). Introduction to data converters and converter architectural selection criteria based on different applications. PCB Design. Smart sensor case study with example.

Module 1: Foundation of smart sensors and systems
Introduction to smart sensors, interface electronics: using Application Integrated Circuits (ASICs) and commercially available ICs & discrete components. Classification of smart-sensors/actuators, their transduction and actuation mechanism, fabrication techniques and integration. Modelling and design of negative feedback system: Introduction to control system, stability in control systems, PID controllers and tuning, and case study.
Module 2: Fundamentals Analog Circuit Design and Interface Electronics
Fundamentals of analog circuit design: small-signal analysis of circuits, current Mirror (bias, source, sink),voltage reference, Op-amp (parameters, input stage architecture, IA), comparator design, filter design (passive, active), oscillator architectureand design followed by interface circuits design for various sensing mechanisms, viz.: resistive, capacitive, piezoelectric, and electromagnetic induction.
Module 3: ADCs and System Design
Selection of ADC architecture based on application and type of sensor: ADC Architectures and comparison, mathematical modelling front-end amplifier / circuits, example of any one application; DC- DC convertors, bias circuit architectures, noise analysis (based on type of sensor and circuit architecture); PCB design: PCB design guideline, ground bounce, de-coupling, parasitic impact.
Module 4: Case Study on Smart Sensors Design
Case study of smart sensor design using capacitive/piezo-resistive accelerometer from sensor interface to read out electronics.

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AcSIR Academic Centre Code: 06

CSIR-Central Electronics Engineering Research Institute | CSIR-CEERI

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Microwaves: Devices and System Engineering	AcSIR-06-ID-004	3

Introduction to microwaves systems and basic building blocks: active and passive components, transmission line and characterisation. Microwave passive devices: Operating principles, frequency, bandwidth, power handling capacity, losses, performance issues. Microwave amplifier and oscillator: Overview of semiconductor and vacuum based devices, their operating principle, and performance characteristic viz. output power, gain, stability, linearity; limitation and scopes. Mixer, detector, switches: characteristics, classification, and devices for system design. Microwave system design: Introduction to system design: basic architectures, selection of active and passive devices, design parameters, noise (thermal noise, flicker noise, noise figure, signal to noise ratio), linearity, inter component compatibility. Examples of microwave systems: RADAR, satellite communication system, 5G communication system, high power microwave systems.

Module 1: Introduction to microwave systems and basic building blocks (1 credit)
Active and passive components, transmission line and characterisation. Microwave passive devices: Operating principles, frequency, bandwidth, power handling capacity, losses, performance issues.
Module 2: Microwave amplifier and oscillator (1 credit)
Overview of semiconductor and vacuum based devices, their operating principle, and performance characteristic viz. output power, gain, stability, linearity; limitation and scopes. Mixer, detector, switches: characteristics, classification, and devices for system design
Module 3: Microwave system design (1 credit)
Introduction to system design: basic architectures, selection of active and passive devices, design parameters, noise (thermal noise, flicker noise, noise figure, signal to noise ratio), linearity, inter component compatibility. Examples of microwave systems: RADAR, satellite communication system, 5G communication system, high power microwave systems.

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AcSIR Academic Centre Code: 06

CSIR-Central Electronics Engineering Research Institute	**CSIR-CEERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Measurement and Characterization Techniques**	**Course Code**	**Credits**
		AcSIR-06-ID-005	**2**

Measurement and characterization – definition and concepts, Design of experiments - Components of Experimental Design, Design Guidelines, Design Process, One Factor Experiments, Multi-factor Experiments, Taguchi Methods; Measurement techniques for micro/nano scale; compensation techniques, reliability of the measurement system with fault analysis and diagnostic techniques. Design of measurement systems – case study: pressure, light, temperature, gas sensor systems and other examples.

Module 1: Design (1 credit)
Assignments /quiz/mid-term exam based on theoretical classes
Design of smart sensor or device.
Module 2: Case Study (1 credit)
Final combined theoretical exam from all focused area in CSIR-CEERI.

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AcSIR Academic Centre Code: 06

CSIR-Central Electronics Engineering Research Institute	**CSIR-CEERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Modelling and Simulation**	**Course Code**	**Credits**
		AcSIR-06-ID-006	**2**

Introduction to modelling and simulation: representation of space and time; Taxonomy of Models as Linear- Non-Linear, Continuous time- Discrete event, Static-Dynamic, Steady-Transient, stochastic-deterministic Models; How to represent a system with Model; Identifying the parameters of a model; Simulation of Dynamical systems and numerical integration as solution technique; Discrete Events Simulation, Characteristic of a queueing system, Simulation of single server queueing system, Monte Carlo simulation, Agent based models and AI applications, Case Studies.

Module 1: Introduction to modelling and simulation: Modeling and simulation basics, usage & significance, developing a simulation model & synthesizable model; Modeling methods

Taxonomy of Models: Linear-Non-Linear, Continuous time- Discrete time, Static and Dynamic, Steady-Transient, stochastic-deterministic Models

Module 2: Dynamical systems: Modelling Dynamical Systems, Time-Domain & Frequency-Domain Representations, Parametric Identification, Simulation of Dynamical System and numerical integration

Module 3: Queuing system: Queueing Theory, Queueing Networks, Characteristic of a queueing system, Simulation Techniques, simulation of single server queueing system

Monte Carlo Simulation and case studies: Monte Carlo, Quasi Monte Carlo and Chance Constrained Monte Carlo Simulation, Case studies: Agent based models and AI applications

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AcSIR Academic Centre Code: 06

CSIR-Central Electronics Engineering Research Institute	**CSIR-CEERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Signal Processing and Machine Learning**	**Course Code**	**Credits**
		AcSIR-06-ID-007	**3**

Introduction to the world of sensors and signals - speech image, video and other sensors. Representation of signals: Quantisation and sampling; Aliasing; Anti-aliasing. Finite and infinite impulse response filters (FIRs and IIRs); Poles, zeros and frequency response; Design of Digital Filters, FIRs and IIRs; Butterworth, Chebyshev filters. Application of filters. Transform Domain representation of signals, FFT, DCT, Haar Transform, DWT. Adaptive transforms (KLT/PCA). Feature extraction from familiar signals (audio, video), eigenfaces. Basics of pattern recognition, Linear Discriminant Analysis, Bayesian Classification; Discriminative modeling - neural networks and back propagation, support vector machine. Decision tress and Random forest Classifiers. Clustering and Clustering techniques. Generative modeling - Gaussian and mixture of Gaussian models, hidden Markov models.
Special Topic: Compressive Sensing

Module 1: 1 Credit
DSP Basics & LTI Systems
System Analysis
Module 2: 1 credit
Basics of Machine Learning
Dimensionality Reduction Techniques
Classification Techniques
Module 3 (1 Credit)
Clustering Techniques
Generative Models
Special Topics

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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Course Code	Course Title
AcSIR-08-ID-001	Application of Nano-Technology in Food Processing
AcSIR-08-ID-002	Biotechniques
AcSIR-08-ID-003	Biochemistry and Molecular Biology
AcSIR-08-ID-004	Bioinformatics
AcSIR-08-ID-005	Biology for Chemical Sciences
AcSIR-08-ID-006	Bioresource Management
AcSIR-08-ID-007	Chemistry for Interdisciplinary Sciences
AcSIR-08-ID-008	Green Chemistry
AcSIR-08-ID-009	Modelling and Simulation
AcSIR-08-ID-010	Physics for Engineering Sciences
AcSIR-08-ID-011	Postharvest Management and Processing
AcSIR-08-ID-012	Separation Sciences
AcSIR-08-ID-013	Spectroscopy

AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute	CSIR-CFTRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Application of Nano-Technology in Food Processing	Course Code	Credits
		AcSIR-08-ID-001	1

Introduction to nanostructured materials with thermodynamics and quantum mechanics for nano scale systems and engineering principles for nanotechnology. Fundamentals of food nanotechnology nanoencapsulation techniques, nanoemulsions, nanoparticles, nanodevices and nanosensors. Nanomaterials characterizationand imaging techniques.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute CSIR-CFTRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Biotechniques	Course Code	Credits
		AcSIR-08-ID-002	

Carbohydrates: isolation, purification, sample preparation and analytical techniques in carbohydrates research. Proteins: isolation, purification, sample preparation and analytical techniques in protein research. Lipids: isolation, purification, sample preparation and analytical techniques in lipid research. Nucleic acids: isolation, purification, sample preparation and analytical techniques in DNA and RNA research, real time PCR. Vitamins and Minerals: Sample preparation and analytical techniques. Animal studies & Cell culture techniques: Laboratory animal models, Dietary guidelines for animal studies, Principles of plant and animal cell culture, growth media, clean bench, primary cell lines, immortalized cells, Hybridoma technology, co-culture techniques. Immunological techniques: Antigenicity, immunogenicity, immunoprecipitation, dot blot technique, western immunoblotting, immunohistochemistry, immunofluorescence. Laboratory instruments in modern biology: Microscope - principle of microscopy, basic and advanced microscope and its applications. Centrifugation - principle of centrifugation, application of ultra-centrifugation in modern biology. Chromatography - principle of chromatography, types of chromatography (Ion exchange chromatography, affinity chromatography, gel filtration, GC, GC-MS, HPLC, LC-MS). Spectroscopy- Principles of spectroscopy, spectrophotometer, NMR, FTIR. Laboratory instruments in food technology: Dehydration instruments, evaporation instruments, other unit operations in food processing. Nanotechnology applications, Nano sensors.

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AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute	**CSIR-CFTRI**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Biochemistry and Molecular Biology**	**Course Code**	**Credits**
		AcSIR-08-ID-003	

Introduction to eukaryotic and prokaryotic cell, architecture and biochemistry of cells, cell division-mitosis, meiosis and cell cycle. Enzymes: An Introduction to Enzymes, Regulatory Enzymes, Enzyme Kinetics. Hormones: Types, structure, function. Mechanism of action and regulation of hormone action. Introduction to molecular biology. Molecular cloning tools and techniques, Cloning of genes and PCR techniques. Regulation of gene expression.

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AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute	CSIR-CFTRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Bioinformatics	Course Code	Credits
		AcSIR-08-ID-004	

Bioinformatics: Introduction, history and applications of bioinformatics; Genome sequencing projects - Human Genome; Databases – introduction, types, applications and limitations; Literature search databases - PUBMED, MEDLINE; Nucleic acid and protein databases - NCBI, EMBL, DDBJ, SWISS PROT, UNIPROT, etc.; Biotechnological databases - EST, STS, GSS, HTG, SNP, etc.; Animal and plant databases - Ensembl Genome project, TIGR database, Maize GDB, etc.; Motifs and Pattern Databases - PROSITE, Pfam, BLOCKS, PRINTS, etc.; Structural databases - PDB, PDBsum, NDB, SCOP, CATH etc.; Database Retrieval and deposition systems - SRS, Entrez, Bankit, Seqin, Webin, AutoDep, etc.; Web tools and resources for sequence analysis; Pair-wise and multiple sequence Alignment; Sequence similarity search; BLAST & FASTA; Pattern recognition; Motif and family prediction;, Restriction map analysis; Primer design; Gene prediction; Phylogenetic Tree; Protein structure prediction and visualization.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute **CSIR-CFTRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Biology for Chemical Sciences	**AcSIR-08-ID-005**	**1**

Carbohydrates and polysaccharides, Structure and functions of important derivatives of monosaccharides, Proteins and amino acids, structure function relation, Lipids, Alkaloids, Terpenoids and Steroids. Isolation and characterization of functional compounds, elucidation of structure-property relationships. Vitamins, enzymes and minerals.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute CSIR-CFTRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Bioresource Management	Course Code	Credits
		AcSIR-08-ID-006	1

Biomass and feedstock utilization, First generation biofuels, Second generation biofuels, Thermochemical conversion (Fischer-Tropsch), Concept of biorefinery, Biological waste water treatment, Algal technology, Dairy waste management, Food processing waste management, Marine waste processing, Life cycle assessment.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute	**CSIR-CFTRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Chemistry for Interdisciplinary Sciences	Course Code	Credits
		AcSIR-08-ID-007	

Basics of inorganic, organic, physical and biochemistry, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, structure function relation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

CSIR-Central Food Technological Research Institute	CSIR-CFTRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Green Chemistry	AcSIR-08-ID-008	1

Green chemistry concepts: Basic understanding, scope and interdisciplinary nature of green chemistry; Environmental factors; Carbon credit, Energy efficiency and atom economy, Catalysis and green chemistry, Alternate reaction media and reaction systems, ionic liquids, supercritical fluids, solvent-less chemistry.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute	CSIR-CFTRI

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Modelling and Simulation	Course Code	Credits
		AcSIR-08-ID-009	1

Models and modelling, Role of modelling in food science and technology, Kinetic modelling, Modelling heat and mass transfer, Empirical approaches, Applications of modelling, Computational approaches for simulation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

CSIR-Central Food Technological Research Institute	CSIR-CFTRI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Physics for Engineering Sciences	Course Code	Credits
		AcSIR-08-ID-010	1

Introduction, Water activity, rheology and geometric properties of materials
Equilibrium, S-L boundary surfaces, Adsorption equilibrium and models, Law and hygroscopicity, Models for aw measurement, Elastic properties, Young's, bulk and shear modulus, Concepts of rheology and Newtonian flow behavior, Non-Newtonian flows.
Interfacial phenomenon, Interfacial surface tension, Curved interfaces, Temperature and concentration dependency, Measurement of contact angle.
Permeability, Steady state diffusion in solids, Conductivity, conductance and resistance, Food packaging considerations, Molecular transport in permeation, Temperature dependency, Heat and electricity transport phenomenon.
Properties of materials: Thermal, Electrical, Magnetic and Electromagnetic, Optical, Acoustical.
On-line sensing: Control systems, Sensors types and applications, Weighing sensors, Density sensors, Metal sensors, Flow sensors, Refraction sensors, Chemosensors and biosensors.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute	CSIR-CFTRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Postharvest Management and Processing	AcSIR-08-ID-011	1

Handling of fresh produce, Degree of perishability of unprocessed foods; Causes of quality deterioration and spoilage of perishable foods; Objectives of food processing. Technological applications relating to low temperature and freezing preservation; Water activity, Hurdle technology and Intermediate moisture foods. Drying and dehydration. Methods of drying and their application to fruits & vegetables. Principles of canning and canning of fruits and vegetables. Fermentation, Smoking, and Pickling, Fruit juices and concentrates, Food Irradiation. Non-thermal processing.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute	CSIR-CFTRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Separation Sciences	Course Code	Credits
		AcSIR-08-ID-012	1

Resins and membranes for separations, Classification of membranes; electro membrane processes; Ion-exchange membranes and their applications, polymer electrolyte membrane and their applications, electrodialysis, ultrafiltration, pervaporation, membrane fouling, concentration polarization in membranes.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 08

CSIR-Central Food Technological Research Institute | CSIR-CFTRI

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Spectroscopy	AcSIR-08-ID-013	1

Mass spectroscopy, IR spectroscopy, Proton magnetic resonance spectroscopy, Structural Assignment by employing NMR techniques, Carbon-13 NMR spectroscopy, Introduction to COSY, HSQC, HMBC, NOESY, ROESY, Structural elucidation using 2D-NMR methods.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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09	CSIR-CGCRI	2	*Inter-disciplinary*

Course Code	Course Title
AcSIR-09-ID-005	Fibre Optics and Devices
AcSIR-09-ID-006	Introduction to Materials Engineering
AcSIR-09-ID-007	Transport Phenomenon in Materials Processing
AcSIR-09-ID-001	Introduction to Materials Chemistry
AcSIR-09-ID-002	Fundamentals of Glass
AcSIR-09-ID-003	Fundamentals of Ceramics
AcSIR-09-ID-004	Ceramic Science and Fundamentals of Process Engineering

AcSIR Academic Centre Code: 09

CSIR-Central Glass & Ceramic Research Institute **CSIR-CGCRI**

Course 2 : Inter-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Fibre Optics and Devices	**AcSIR-09-ID-005**	**2**

Types of optical fibers electromagnetic theory, nonlinear optical properties of fiber, fiber design and fabrication, fiber characterization optical fiber amplifier, fiber laser and' Raman laser, photosensitive fiber and fiber Bragg grating, microstructured fiber, polymer optical fiber, nonlinear fiber optics and mathematical simulations.
Modulation techniques, analogue and digital theory, multiplexing and demultiplexing of signal carrier, TDM and WDM for electronic and optical network, photonic switching, ITU-T recommendations and differenttelecom protocol.
Optical fiber components and devices. fiber coupler, attenuator, filters, fiber Bragg grating sensor, strain-stresstemperature sensing devices.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 09

CSIR-Central Glass & Ceramic Research Institute	**CSIR-CGCRI**

Course 2 : Inter-disciplinary	**Total Credits 2**

Title:	**Introduction to Materials Engineering**	**Course Code**	**Credits**
		AcSIR-09-ID-006	**2**

Atomic structure & bonding, structures of solids, thermodynamic principles of solid solution,phase diagrams, properties of materials, Metallic materials, Ceramic materials, Glass, Polymeric materials and Composite materials.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 09

CSIR-Central Glass & Ceramic Research Institute	**CSIR-CGCRI**

Course 2 : Inter-disciplinary **Total Credits 2**

Title:	**Transport Phenomenon in Materials Processing**	**Course Code**	**Credits**
		AcSIR-09-ID-007	**2**

Diffusion in solids, mass transfer in liquids, interphase mass transfer. Heat transport in solids, liquids and gases, thermal transport phenomena for glass and ceramic processing. Fluid dynamics of Newtonian and Non-Newtonian flows, rheology, concept of flow regimes, applications of momentum transport to material processing with special emphasis on glass and ceramics. Fundamental concepts of numerical simulation.

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AcSIR Academic Centre Code: 09

CSIR-Central Glass & Ceramic Research Institute **CSIR-CGCRI**

Course 2 : Inter-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Introduction to Materials Chemistry	**AcSIR-09-ID-001**	**2**

Module 1(credit 1): Atomic structure & bonding, Structures of solids
Module 2(credit 1): Diffusion in solids, Thermodynamic principles of solid solution, Phase diagrams

References:

Materials Science and Engineering by William D. Callister Jr. and David G. Rethwisch
Materials Science and Engineering by Raghavan V
Introduction to Materials Science for Engineers by James F. Shackelford,
The Science and Engineering of Materials by Donald R. Askeland, Pradeep P. Fulay, Wendelin J. Wright

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 09

CSIR-Central Glass & Ceramic Research Institute	**CSIR-CGCRI**

Course 2 : Inter-disciplinary **Total Credits 2**

Title:	**Fundamentals of Glass**	**Course Code**	**Credits**
		AcSIR-09-ID-002	**2**

Module-1: Introduction to Glass Science (1 Credit)
Definition of glass, Materials classification – position of glass: Principles of Glass Formation : Volume-temperature diagram, glass transition range, Structural and Kinetic theories of glass formation; Structure of glass: fundamental law and Elements of structural models, Structural models
for different types of oxide glasses. Glass Melting: Raw materials, batch composition; Viscosity of Glass forming melts: Concept of Viscoelasticity, Viscosity-temperature dependence, reference points, Dependence on composition and temperature, Method of measurements; Different types of specialty Glass: Fast ion conducting glass, laser glass, dosimeter glass, Photochromic glass, Photosensitive glass, opal glass, pH glass electrode, solder glass, semiconductor glass, Bioactive glass, metallic glass
Module-2: Properties of Glass (1 Credit)
Thermal properties of glass: Concept of thermal expansion, Specific heat and thermal conductivity, Dependence on composition and temperature
Physical and Optical Properties of Glass: Dependence of density on composition and temperature, calculation of density based on composition, surface tension and methods of measurement. molar volume calculation.
Electromagnetic spectrum and basics of optical properties of glass, Refractive index:
Dependence on composition and temperature, calculation based on composition, methods of measurement, dispersion,. Transparency: transmission spectrum
Mechanical Properties of Glass: Elastic properties: Elastic modulus, poison ration, dependence on composition and temperature, Fracture processes, fracture toughness, flexural strength, Hardness
Electrical Properties of Glass: Basics of electrical conductivity, dependence on composition and temperature, methods of measurement, ionic diffusion, glass electrolytes, Basics of dielectric properties of glass

Introduction to Glass Science and Technology, 2nd Edition, by J. E. Shelby, RSC Publication, UK, 2005
☐ Fundamentals of Ceramics, by Michel W. Barsoum, McGraw-Hill Companies Inc. New York, 1997
 Glass, Nature, Structure and properties by Horst Scholze, Springer-Verlag. New York, 1990
 Fundamentals of Inorganic glasses, by Arun K. Varshneya, Sanxon Glass Technologies Inc. New York, 2006
 Glass and the vitreous state, by J. Zarzycki, Cambridge Solid State Science Series, Cambridge, 1982
 Introduction to Modern Vibrational Spectroscopy, 1st Edition by Max Diem, Wiley Inter science, 1993
 Fourier transform Raman Spectroscopy from concept to Experiment, (Eds.) D. B. Chase and J. F. Rabolt, Academic Press Inc. USA, 1994
 Introductory Raman Spectroscopy (2nd Edition), John R. Ferraro, Kazuo Nakamoto, Chri s W. Brown, Academic Press Inc., USA, 2003
 Analytical Absorption spectroscopy, (Ed.) M. G. Mellon, John Wiley & Sons, USA, 1950

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 09

CSIR-Central Glass & Ceramic Research Institute **CSIR-CGCRI**

Course 2 : Inter-disciplinary **Total Credits 2**

Title:	Fundamentals of Ceramics	Course Code	Credits
		AcSIR-09-ID-003	2

Module 1: Introduction to ceramics (1 Credit)
1. Classification of ceramics and its applications
2. Ceramic raw materials and their properties
3. Mechanical processing of ceramic materials: classification, theory of grinding, principle of milling, milling efficiency, factors affecting grinding efficiency
4. Fabrication of ceramic articles
5. Sintering: types, mechanism, sintering stages, factors affecting solid state sintering
6. Drying: types, mechanism, factors affecting different stages of drying

Module 2: Properties of Ceramics: Credit 1
1. Thermal and thermo-mechanical properties:
Thermal expansion, thermal shock, high temperature strength of ceramics, creep
2. Optical properties of ceramics
3. Electrical and magnetic properties of ceramics Semiconducting ceramics
4. Bioceramic materials and its application
5. Nuclear ceramic materials and its application
6. “nano" effects in ceramics material.

1. Fundamentals of Ceramics, Michel W. Barsoum, McGraw-Hill Companies Inc. New York, 1997
2. Fine Ceramics, F.H. Norton, McGraw-Hill Inc
3. Ceramic Materials: Science and Engineering, C. Barry Carter and M. G. Norton, Springer
4. Materials Science and Engineering an Introduction, WillamD.Callister,Jr
5. Introduction to ceramics, Kingery, W.D., H.K. Bowen and D.R.Uhlmann

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 09

CSIR-Central Glass & Ceramic Research Institute **CSIR-CGCRI**

Course 2 : Inter-disciplinary **Total Credits 2**

Title: Ceramic Science and Fundamentals of Process Engineering	Course Code	Credits
	AcSIR-09-ID-004	2

Module -I (1 Credit):- Ceramic precursors / raw materials - its importance related to various ceramic processing, Classifications, Structure -property correlation for naturally occurring precursors, Synthetic precursors, Polymorphic transformation, Related numerical; Ceramic Powder packing - Working models of powder packing, packing of monosized spheres Packing of spheres of different / varying sizes, random packing, packing factor (PF) and packing density, Theoretical maximum packing density (PFmax), Packing density of mixed spheres of different sizes, hindered packing; Different methods of synthesis of ceramic powders - Conventional methods, mechanical comminuation, Basics of mixing and powder grinding though ball milling technique mechanochemical synthesis, solid state reaction synthesis; Science behind colloidal processing of ceramics -Development of surface charge on suspended particles, Electrical double layer and concept of zeta potential, Electrokinetic properties and suspension stability; Rheological properties of ceramic suspension - Newtonian behavior, Non-Newtonian behavior of ceramic suspension, Shear thinning (pseudoplastic) and shear thickening (dilatant) behavior, Bingham plasticity; Non-linear stress-strain behavior, Thixotrophy & Rheopexy

Module -II (1 Credit):-
Green Shape making in Ceramics- Stages in dry pressing, modes of dry pressing, various processing additives, Powder flow and die cavity filling mechanism, compaction behavior of the ceramic feed granules, mechanism of ejection and transfer, die wall effect, Brief introduction to cold & hot isostatic pressing, pressing defects and control; Plastic forming of ceramics – Elastic & anelastic behaviour in ceramics; plastic flow behavior in ceramics, Science behind the plastic forming of ceramics related to bulk body processing; Fundamentals of thermal processing of ceramic involving high temperature diffusion phenomena, fundamentals of high temperature calcination in air and controlled atmosphere; Mathematical Modeling related to sintering of ceramic - Viscous sintering, Reaction sintering & sintering of porous ceramics, Driving force of sintering and related derivations, Viscous and diffusional flow, Liquid Phase and Solid State Sintering (Grain Boundary Diffusion and Lattice Diffusion), Surface diffusion, Defect driven sintering, Coarsening in presence and absence of

☐ Fundamentals of Ceramic Powder Processing and Synthesis – Terry A. Ring,ISBN: 9780125889308, 9780080532196
 Ceramic Technology & Processing – Alan G. King, ISBN: 9780815514435, 9780815516330
 Fabrication and machining of ceramic composites — A review on current scenario, Published online: 16 Feb 2017, DoI:
https://doi.org/10.1080/10426914.2017.1279301
 Ceramic processing: An overview, Roy W. Rice, First published: April 1990, https://doi.org/10.1002/aic.690360402
 Ceramic Processing - M.N. Rahaman, ISBN: 1498716423, 9781498716420

10	CSIR-CIMAP	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-10-ID-001	Advances in Essential Oil Chemistry
AcSIR-10-ID-002	Advances in Extraction and Processing Technologies
AcSIR-10-ID-003	Advances in Phytochemistry
AcSIR-10-ID-004	Aromatic Chemistry of Important Plant Varieties
AcSIR-10-ID-005	Bioinformatics
AcSIR-10-ID-006	Biology of Inheritance
AcSIR-10-ID-007	Biology of Macromolecules
AcSIR-10-ID-008	Bioresources and Bioprospection
AcSIR-10-ID-009	Chemistry for Biologists
AcSIR-10-ID-010	Frontiers in Pharmaceutical Chemistry
AcSIR-10-ID-011	Fundamentals of Environmental Chemistry
AcSIR-10-ID-012	Introductory Plant Biology for Chemists
AcSIR-10-ID-013	Plant Molecular Genetics
AcSIR-10-ID-014	Plant Pathology, Microbiology and Nematology
AcSIR-10-ID-015	Plant-Environment Interaction

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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10	CSIR-CIMAP	2	Inter-disciplinary / Cross-disciplinary

Course Code	Course Title
AcSIR-10-ID-016	Precision Farming Using Geo-informatics Tools

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants **CSIR-CIMAP**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Advances in Essential Oil Chemistry	Course Code	Credits
		AcSIR-10-ID-001	1

Terpenoids, chemistry of essential oils, isoprene rule, classification of terpenes, structures of mono-, sesqui- and diterpenes, occurrence of terpenes and phenylpropanoids and their isolation/ distillation, preparation of concrete and absolute, phenylpropanoids C6-C3, physico-chemical parameters of essential oils: specific gravity, refractive index, optical rotation, solubility; Method development for quality separation of essential oils in one dimensional GC and GC-MS; analysis and fingerprint generation of commercially important plant Mentha as an example.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants	**CSIR-CIMAP**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:		Course Code	Credits
	Advances in Extraction and Processing Technologies	**AcSIR-10-ID-002**	**1**

Processing and value addition technologies of MAPs, Techniques of distillation, Extraction with volatile solvents, Modern extraction techniques : Supercritical fluid extraction, Hydro fluorocarbon extraction, Ultrasonication and microwave extraction, Fractional distillation of essential oils, Downstream processing technologies for isolation of phytomolecules, Liquid liquid extraction, Techniques for up scaling of natural products, Green Chemistry & extraction technologies.

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AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants	**CSIR-CIMAP**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Advances in Phytochemistry**	**Course Code**	**Credits**
		AcSIR-10-ID-003	**1**

Natural product chemistry and its importance in our life, Classification and chemotaxonomy of natural products, Recent advances in drugs from traditional plants; Plants secondary metabolites (PSM), Chemistry and elementary biosynthesis of steroids, terpenoids, carbohydrates, alkaloids.
Leads from plants such as antimicrobial, antifungal, anticancer, anti-malarial etc; medicinal plants.

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AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants CSIR-CIMAP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Aromatic Chemistry of Important Plant Varieties	Course Code	Credits
		AcSIR-10-ID-004	1

Chemistry of commercially important aromatic plants varieties: Essential oil profile of different varieties of Lemongrass (Cymbopogon flexuosus (Nees ex Steud.) W.Watson, Cymbopogon khasianus (Hack.) Stapf ex Bor, Cymbopogon pendulus Nees ex Steud., Cymbopogon khasianus × C. pendulus etc.), Java-Citronella (Cymbopogon winterianus Jowitt ex Bor), Palmarosa (Cymbopogon martini (Roxb.) W. Watson), Ocimum (Ocimum basilicum L., Ocimum tenuiflorum L., Ocimum gratissimum L., Ocimum africanum Lour. etc.), Rose-scented geranium (Pelargonium species), Clary sage (Salvia sclarea L.), Damask-rose (Rosa damascena Mill.), Lavender (Lavandula angustifolia Mill.), African-marigold (Tagetes minuta L.), Patchouli (Pogostemon cablin (Blanco) Benth.), Rosemary (Rosmarinus officinalis L.), Chamomile (Matricaria chamomilla L.), and Davana (Artemisia pallens Wall. ex DC.). Chemistry of some other commercially important essential oils: Orange, Lemon, Nagarmotha, Sandalwood, Sassafras, Cedarwood, Eucalyptus, Ajwain, Ginger, Cinnamon, Clove, Celery, Caraway, Cardamom, Angelica, Cumin, Frankincense, Coriander, Star-Anise, Mandarin, Litsea cubeba, lavandin, Nutmeg, Fennel, Dill seed, Tea tree, Bergamot oil, Ylang Ylang, Catnip, Calamus, lemon-balm, carrot seed, Gurjan balsam, Curry leaf, Neroli, Rosewood, Thyme, Oregano, Linaloe, Wintergreen, bitter almond and Parsley.

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AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants	CSIR-CIMAP

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Bioinformatics	AcSIR-10-ID-005	1

Introduction to Bioinformatics: History of Bioinformatics; Applications of Bioinformatics; Introduction to databases: Type and kind of databases, Applications and limitations; Literature Search Databases, Nucleic acid and protein databases, Animal and plant databases, Genome project databases, Biotechnological databases, Motifs and Pattern Databases, Databases for species identification and classification, Structural databases. Database retrieval and deposition systems. Web tools and resources for sequence analysis: Pair-wise and multiple sequence Alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, Restriction map analysis, Primer design, Gene prediction, Phylogenetic analysis and Tree, Protein structure prediction and visualization.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants	CSIR-CIMAP

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Biology of Inheritance	Course Code	Credits
		AcSIR-10-ID-006	1

Evolution, Mendel's Laws of Inheritance, Chromosome theory of inheritance, Codominance and incomplete dominance; pleiotropism, genotypic interactions, epistasis, mechanism of epistasis, Polygenes and polygenic inheritance. Cell cycle and cell division (Mitosis and Meiosis). Linkage and crossing over, FISH/GISH, coincidence and interference. Extra-nuclear inheritance: determining non-Mendelian Inheritance, maternal effects, cytoplasmic inheritance. Polyploidy, Chromosomal aberrations, Mutation. Nature and components of variation, heritability and genetic advance, self incompatibility and male sterility system, role of mutations and chromosome modifications, induction of polyploidy and its significance, Genetic consequences of self and cross fertilization, mating systems, apomixes.

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CSIR-Central Institute of Medicinal and Aromatic Plants	CSIR-CIMAP

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Course Code	Credits
Biology of Macromolecules	AcSIR-10-ID-007	1

Basic concept: Life forms from prokaryotes to eukaryotes, Molecules, building block, Basis of biological macromolecules constitution, water and buffer systems, nucleic acid, proteins, lipids and sugars. Structure and function of macromolecules, Structural mechanisms for biological processes, Anabolisms and catabolism of building blocks and macromolecules in prokaryotes and eukaryotes.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants	**CSIR-CIMAP**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Bioresources and Bioprospection**	**Course Code**	**Credits**
		AcSIR-10-ID-008	**1**

Bioresources and Bioprospection Biodiversity: principles, importance and characterization, Threats, conservation and gene banking, Remote sensing and GIS concepts and approaches, Classification of plant metabolites (primary & secondary), Classes of secondary metabolites (Alkaloids, Terpenoids, Phenylpropanoids), Bioprospection: principle, techniques and applications, Bioprospecting natural products.

Introduction to Pharmacognosy: Natural sources of drug, classification of drug, phyto-constituents of therapeutic value,

Drug evaluation: Botanical, physical, chemical and biological evaluation of drugs, Effect of climate, growth period on active constituents, methodologies for harvest and storage.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants CSIR-CIMAP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Chemistry for Biologists	Course Code	Credits
		AcSIR-10-ID-009	1

Basic chemistry for biologist: Acid-base equilibria (pH, buffer solutions, indicators, etc), redox reactions; Aliphatic and aromatic compounds; Bonding in organic compounds (electronic structure, bonding in methane, ethene, benzene and carbonyl compounds, electro negativity and bond polarity); Organic chemistry conventions (name and draw organic compounds); Isomerism in organic compounds (structural isomerism and stereoisomerism both geometric and optical); Organic acids and bases (acid strengths of carboxylic acids, phenols and alcohols, and the base strengths of primary amines); Building blocks of all matter-atom, element; compound and mixtures; Chemistry of Water; Chemistry of Water, Introduction to Organic Molecules Carbohydrates; Lipids; Proteins; Nucleic Acids; Vitamins and Minerals; Introductions to agrichemicals (Nutrient, pesticide) and allelochemicals.

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CSIR-Central Institute of Medicinal and Aromatic Plants CSIR-CIMAP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:		Course Code	Credits
	Frontiers in Pharmaceutical Chemistry	AcSIR-10-ID-010	1

Fundamentals of Medicinal chemistry: Drugs history, mechanism of drug action, drug discovery process, modern drug designing, Lead identification, lead optimization, Combinatorial chemistry, receptor theories, agonists and antagonists, Pharmacokinetics and pharmacodynamics, ADME, Lipinski's Rule, Rule of three, Fragment based drug discovery (FBDD), bioisosteres, Drug efficacy, half life of drug, soft drug design, therapeutic index, Drug testing and clinical phases; Chemistry and biology of some anticancer leads from plants: Camptothecin, Podophyllotoxin, Taxol, Combretastatin A4.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants CSIR-CIMAP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Fundamentals of Environmental Chemistry	Course Code	Credits
		AcSIR-10-ID-011	1

Fundamental principles of chemistry to gain an understanding of the source, fate, and reactivity of compounds in natural and polluted environments. Environmental implications of energy utilization and on the chemistry of the atmosphere, hydrosphere, and lithosphere. Effects on biota, Chemical, photochemical, photosensitized reactions in the atmosphere. Photochemical smog- mechanisms of smog formation. Effects of smog, thermal inversion. Global environmental concerns: Anthropogenic change in the atmosphere, Greenhouse gases and Global warming, Acid rain, Ozone layer destruction, Nuclear winter, El nino, Asian Brown Haze, pollution and treatment of water sources, and the effect of insecticide and herbicide residues. Organic carbon; organic carbon budget, natural polymers- cellulose and chitosans; Chemical modifications in natural polymers and their applications; Conversion of natural polymers to nano-composites and their industrial utilization.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants	**CSIR-CIMAP**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Introductory Plant Biology for Chemists**	**Course Code**	**Credits**
		AcSIR-10-ID-012	**1**

Plant kingdom and different plant forms, Plant evolution, Basics of plant taxonomy; morphology and cellular structure, plant development and reproductive biology; Economic botany; Principles and procedures of microtomy and advanced histological techniques.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants CSIR-CIMAP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Plant Molecular Genetics	AcSIR-10-ID-013	1

Basic concept of Genetic and Epigenetic regulations in Plant; Structure and organization of gene and chromatin, Forward and reverse genetics, Genetic interactions, Epigentic regulation, its types and mechanisms; Molecular regulation of plant growth, development and differentiation; Mechanisms of temporal and spatial gene regulation in organ and tissue initiation and patterning; Molecular regulation of stress response pathways and plant adaptation.

AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants	**CSIR-CIMAP**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Plant Pathology, Microbiology and Nematology**	**Course Code**	**Credits**
		AcSIR-10-ID-014	**1**

Principles of plant pathology; epidemiology of plant diseases; Plant Pathogens (Fungal, Bacterial Viruses and Phytoplasma) and Plant Parasitic Nematodes: characterization, classification and identification; plant disease diagnosis (Koch 's postulates); Preservation and maintenance of plant pathogens, Molecular Taxonomy and phylogenetics, DNA bar-coding and Microbial Diagnostics; Microbial diversity and Metagenomics; Plant growth promoting microbes and their characterization; Endophytic microbes; Microbial bio-inoculants; Biological Nitrogen fixation; Role of microbial technologies in agriculture.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants CSIR-CIMAP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Plant-Environment Interaction	Course Code	Credits
		AcSIR-10-ID-015	1

Introduction to environment: classification, components of environment, Ecology and ecosystems; Symbiotic relationships, Plant responses to abiotic & biotic stresses; Plant-soil interactions, Classification of agro climatic condition and soil types in India, MAPs suitability in various environmental conditions, Identification of abiotic and biotic stresses, Stress tolerance in plants

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 10

CSIR-Central Institute of Medicinal and Aromatic Plants **CSIR-CIMAP**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Precision Farming Using Geo-informatics Tools	**AcSIR-10-ID-016**	**1**

Precision agriculture: concepts and techniques, their issues and concerns for Indian agriculture especially focused on medicinal and aromatic crops; Remote sensing and Geo-informatics concepts, tool and techniques, their use in Precision Agriculture; Crop discrimination and yield monitoring; Global positioning system (GPS), components and its functions; Crop modeling concepts and principles, Various approaches for precision agriculture in MAPs.Introduction to GIS software, spatial data creation and editing, image processing software; Visual and digital interpretation of remote sensing images; Generation of spectral profiles of different objects; Supervised and unsupervised classification and acreage estimation; Crop stress (biotic/abiotic) monitoring using precision agriculture technology; Use of GPS for agricultural survey.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

11	CSIR-CLRI	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	**Course Title**
AcSIR-11-ID-001	Basic Chemistry
AcSIR-11-ID-002	Basic Mathematics for Biologists & Chemists
AcSIR-11-ID-003	Biomaterials
AcSIR-11-ID-004	Catalysis of Organic Chemistry
AcSIR-11-ID-005	Cell Signaling
AcSIR-11-ID-006	Combinatorial Chemistry
AcSIR-11-ID-007	Computer Aided Drug Discovery
AcSIR-11-ID-008	Environmental Chemistry for Interdisciplinary Science
AcSIR-11-ID-009	Introduction to Bioinformatics
AcSIR-11-ID-010	Introduction to Chemical Biology
AcSIR-11-ID-011	Introduction to Nanoscience and Nanotechnology
AcSIR-11-ID-012	Polymer Chemistry
AcSIR-11-ID-013	Sol-gel Chemistry

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute CSIR-CLRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Basic Chemistry	Course Code	Credits
		AcSIR-11-ID-001	1

Thermodynamics Solutions and Ions Chemical bonding and molecular structure Chemical Kinetics Stereochemistry Introduction to drug discovery (Medicinal chemistry approach) Drug target, discovery and development (forward and reverse approach)

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute	**CSIR-CLRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Basic Mathematics for Biologists & Chemists**	**Course Code**	**Credits**
		AcSIR-11-ID-002	**1**

Determinants and Matrices, Complex Variables, Vector analysis, Infinite Series, Special Functions, Differential Equations, Interpolation and Approximation, Numerical differentiation and Integration, Basic Linux, Introduction to Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/GnuplotAlgorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute CSIR-CLRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Biomaterials	Course Code	Credits
		AcSIR-11-ID-003	1

Physical properties of materials and their measurements Biomaterial tissue interaction Stabililisation of biomaterial Metals, Polymers and biodegradable polymers, Cell addition and colonization of surfaces Physico- chemical characterization of biomaterials, Surface characterization Design of composites and their application. Bioceramics, Tissue response to implants and biocompatibility Biosensor technologies.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute **CSIR-CLRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Catalysis of Organic Chemistry	**AcSIR-11-ID-004**	**1**

Homogeneous and heterogeneous catalysis, adsorption, diffusion, kinetics, equilibrium and rate expressions; Chiral catalysis, Surface Science in Catalysis, Catalytic Materials; Supports; Active Components, Classes of reactions and types of reactors; Catalyst preparation methods; Characterization of catalysts; Catalysis in super critical media; Brief introduction of organo and electro-catalysis; Structure-activity property-stability of catalysts, Catalysts in chemical industry, Catalysis in petroleum refining and petrochemicals; Catalysis in the utilization of renewable feed stocks and concepts of sustainable chemistry.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute	CSIR-CLRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Cell Signaling	AcSIR-11-ID-005	1

General principles of cell signaling, G Protein-Coupled Receptor (GPCR) Signaling, Growth Factor/ Receptor Tyrosine Kinases (RTKs) , Calcium and Cytokine signaling, Wnt signaling, JAK/STATs , Ras, Mitogen-Activated protein Kinase (MAPK) pathways Protein Kinases and Phosphatases, Ion channels

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute	**CSIR-CLRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Combinatorial Chemistry**	**Course Code**	**Credits**
		AcSIR-11-ID-006	**1**

Principles and techniques of combinatorial chemistry, Popular organic reactions in combinatorial chemistry. solid-phase organic synthesis, Solution-phase parallel synthesis, mixture-based compound libraries, principles of compound library design, natural product and natural product-like libraries, case studies of combinatorial chemistry in drug discovery.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute	CSIR-CLRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Computer Aided Drug Discovery	Course Code	Credits
		AcSIR-11-ID-007	1

Use of molecular modeling to Discover and Design of Drugs, Molecular modeling in drug discovery; computer representation of molecules, chemical databases and 2D substructure searching, 3D Database searching, Deriving and Using 3D pharmacophore, constrained systematic search, Ensemble distance geometry, Ensemble molecular dynamics and genetic algorithms, clique detection method for finding pharmacophore, maximum likelihood method, incorporating geometric futures in 3D pharmacophore. Molecular Docking; Various types of docking techniques, Scoring functions, Applications of database searching and docking, Molecular similarity and similarity searching, Molecular Descriptors, Quantitative structure- activitiy relationships, selecting compounds for QSAR analysis, various types of descriptors, Deriving QSAR equations, Cross validation, interpreting QSAR equation, Regression analysis, Partial Least squares, Principle component analysis, Molecular field Analysis, 2D-QSAR, 3DQSAR and muti-dimensional QSAR approaches. Structure based methods to identify lead compound, de novo ligand design

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute CSIR-CLRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Environmental Chemistry for Interdisciplinary Science	Course Code	Credits
		AcSIR-11-ID-008	1

Carbon Cycle; Nitrogen Cycle; Sulphur Cycle; CO formation in atmosphere; Organic Pollutants; Pollution from Combustion Systems; Coal Combustion; Photochemical Smog; Indoor Air Pollution; Ground and subsurface water contamination; Water pollution sources; Ground Water Pollution; Eutrophication; Acid Mine Drains; Pesticides and Fertilizers; Dying and Tanning; Chemical Degradation of wastes and Chemicals; Coagulation and flocculation; Photocatalytic degradation of pollutants; Supercritical water oxidation; Soil Water Characteristics; Soil & Pollution; Soil Pollution Management; Sewage Treatment; Solid Waste Management.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute	**CSIR-CLRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Introduction to Bioinformatics	**AcSIR-11-ID-009**	**1**

Introduction to Bioinformatics: History of Bioinformatics, Genome sequencing projects, Human Genome Project, Applications of Bioinformatics. Introduction to databases, Type and kind of databases, Applications and limitations. Literature Search Databases, Nucleic acid and protein databases, Animal and plant databases, Ensembl Genome project TIGR database, Biotechnological databases, Motifs and Pattern Databases, Databases for species identification and classification, Structural databases. Database Retrieval and deposition systems. Web tools and resources for sequence analysis: Pairwise and multiple sequence Alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, Restriction map analysis, primer design, Gene prediction, Phylogenetic Tree, Protein structure prediction and visualization.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute CSIR-CLRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Introduction to Chemical Biology	Course Code	Credits
		AcSIR-11-ID-010	1

Chemical biology/synthetic biology, Structure, function and chemistry of biological macromolecules including amino acids, proteins, nucleic acids and carbohydrates, Chemical kinetics and thermodynamics in biology, Chemical reactions and chemical diversity in Biology The Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Drugs from Nature, Drug interaction.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute	**CSIR-CLRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:		Course Code	Credits
	Introduction to Nanoscience and Nanotechnology	**AcSIR-11-ID-011**	**1**

General considerations, Introduction, definitions, consequences of size reduction, Properties: structural, thermodynamic, optical, electrical and magnetic properties, Methods of synthesis, Surface modifications, factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute **CSIR-CLRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Polymer Chemistry	**AcSIR-11-ID-012**	**1**

Techniques of polymerization, polymer characterization techniques, Stereochemistry of Polymers, polymer nano-architectures, random and block copolymers, Liquid Crystalline Polymers, Conducting Polymers, Nonlinear Polymers, Polymer Blends and Composites, polymer rheology, inorganic, bio and supramolecular polymers.and herbicide residues. Organic carbon; organic carbon budget, natural polymers- cellulose and chitosans; Chemical modifications in natural polymers and their applications; Conversion of natural polymers to nano-composites and their industrial utilization.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 11

CSIR-Central Leather Research Institute	CSIR-CLRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Sol-gel Chemistry	AcSIR-11-ID-013	1

Introduction, Hydrolysis and condensation reactions, Solution chemistry and physics of intermediates, Role of the anion on the hydrolysis and condensation reactions, Kinetics of Hydrolysis and Condensation, Non- Hydrolytic Sol-Gel Processing, Gelation, Ageing, Drying, Densification, Characterization, Chemistry of Sol- Gel Silicates, Solution chemistry of transition metal alkoxide precursors, Sol-gel synthesis and characterization of important materials, structure-property relationships.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

12	CSIR-CMERI	2	Inter-disciplinary / Cross-disciplinary

Course Code	Course Title
AcSIR-12-ID-001	Basic Chemistry for Interdisciplinary Science
AcSIR-12-ID-002	Basic Physics for Interdisciplinary Science
AcSIR-12-ID-003	Basics of Embedded Systems and Data Analytics
AcSIR-12-ID-004	Basics of Soft Computation
AcSIR-12-ID-005	Functional Ceramics
AcSIR-12-ID-006	Fundamentals of Electro-mechanical Systems
AcSIR-12-ID-007	Introduction to Mechatronics System
AcSIR-12-ID-008	Introduction to Nanoscience and Nanotechnology
AcSIR-12-ID-009	Mathematics for Engineers
AcSIR-12-ID-010	Mathematics for Engineering and Science
AcSIR-12-ID-011	Modern Magnetic Materials

AcSIR Academic Centre Code: 12

CSIR-Central Mechanical Engineering Research Institute **CSIR-CMERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Basic Chemistry for Interdisciplinary Science	Course Code	Credits
		AcSIR-12-ID-001	1

Basics of inorganic, organic, physical and biochemistry, momenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, acids and bases, atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general name reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 12

CSIR-Central Mechanical Engineering Research Institute	CSIR-CMERI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Basic Physics for Interdisciplinary Science	Course Code	Credits
		AcSIR-12-ID-002	1

Fundamentals of Dynamics, Elasticity, Thermodynamics, Kinetic Theory of Gases, Real Gases, Atomic structure, Molecular Spectra, Lasers, Basic Electromagnetism, Electromagnetic Waves, Crystal Structure, Elementary Lattice Dynamics, Magnetic and Electrical Properties of Materials, Particles and Waves, Basic Postulates of Quantum Mechanics, Schrödinger Wave Equation, Low-dimensional structures (Quantum well, quantum wire, quantum dot, quantum confinement); Confinement energy level, band-gap enhancement, absorption-emission spectra, blue shift, luminescence.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 12

CSIR-Central Mechanical Engineering Research Institute	**CSIR-CMERI**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Basics of Embedded Systems and Data Analytics**	**Course Code**	**Credits**
		AcSIR-12-ID-003	**1**

Introduction to embedded systems and computing, Microprocessor and micro controller, Jump, Loop and call, I/O port programming, Addressing modes, Arithmetic and logic instructions, Timer handling, Interrupt processing, ADC, DAC and sensor Interfacing, Working projects and examples.

Basics of Data analytics and data exploration, Software environment for data analytics, Data management and indexing, Basic syntax: Data types, operators, lists, factors, data frames. Data interfacing with different file formats, Infographical representation of big data, Regression, Ancova, Decision tree, etc.

AcSIR Academic Centre Code: 12

CSIR-Central Mechanical Engineering Research Institute	**CSIR-CMERI**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Basics of Soft Computation**	**Course Code**	**Credits**
		AcSIR-12-ID-004	**1**

Introduction to soft computing, Artificial neural networks (ANN), Supervised and unsupervised learning of ANN, Fuzzy logic and fuzzy inference systems. Evolutionary algorithms, Hybrid Systems.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 12

CSIR-Central Mechanical Engineering Research Institute | CSIR-CMERI

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Functional Ceramics	AcSIR-12-ID-005	1

Advanced Electronic Ceramics, high temperature ceramic super conductors, dielectric ceramics, microwave ceramics, low k materials, SOFC materials, solid-ionic conductors, phosphor materials, Impedance analysis, varistors, sensors, ceramic magnets, thermal shock resistance and super plastic ceramics.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 12

CSIR-Central Mechanical Engineering Research Institute	CSIR-CMERI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Fundamentals of Electro-mechanical Systems	Course Code	Credits
		AcSIR-12-ID-006	1

Introduction to electro-mechanical systems, Examples and applications, Sensors and actuators, Encoders, Resolvers, Servo drives, Power transmission components, Planetary and harmonic drives, Basic kinematic and dynamic analysis techniques and tools, motion controllers, Future Trends.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 12

CSIR-Central Mechanical Engineering Research Institute **CSIR-CMERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Introduction to Mechatronics System	Course Code	Credits
		AcSIR-12-ID-007	1

Overview: What is Mechatronics? Instrumentation and Control System.
Sensors and Transducers: Physical principles and Basic mechanisms in sensor systems, Performance characteristics, Different type of Sensors and Transducers based on principles – Position and Speed Measurement, Stress and Strain Measurement, Temperature Measurement, Vibration and Acceleration Measurement.

Actuators: Electromagnetic Principles, Motors –Electric, Hydraulics & Pneumatics.

Mathematical Modeling: State space representation, Model Linearization, Sate model from linear graphs, Bond graphs, Modeling Electromechanical Systems. Structures and Materials, Modeling of Mechanical Systems for Mechatronics Applications, Fluid Power, Using MATLAB SIMULINK for modeling and simulation Mechatronics systems; Interfacing & Virtual Instrumentation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 12

CSIR-Central Mechanical Engineering Research Institute	CSIR-CMERI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Introduction to Nanoscience and Nanotechnology	AcSIR-12-ID-008	1

General considerations, Introduction, Definitions, Consequences of Size reduction, Properties: Structural, thermodynamic, optical, electrical and magnetic properties.
Methods of synthesis, Surface modifications, Factors governing stability and assembly, Characterization and applications of nanomaterials.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 12	
CSIR-Central Mechanical Engineering Research Institute	**CSIR-CMERI**
Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	Mathematics for Engineers	Course Code	Credits
		AcSIR-12-ID-009	1

Matrices, solution methods for linear simultaneous equations, Eigenvalue problem.
Vector methods: Vector products, Vector differentiation, Vector operators. Vector integration. Application of vectors.
Differential equations: Linear ODEs of first and second orders, Applications. Laplace transformation methods.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 12

CSIR-Central Mechanical Engineering Research Institute **CSIR-CMERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Mathematics for Engineering and Science	**AcSIR-12-ID-010**	**1**

Linear Algebra: Linear independence, Orthogonality, Vector Spaces and their bases and dimensions, Gram-Schmidt method for orthogonal basis set, Orthogonal projections. Matrices, solution methods for linear simultaneous equations, Eigenvalue problem.

Vector Analysis : Vector differentiation, Applications, Vector operators: Grad, Div and Curl. Vector integration & related Integral Theorems, Applications. Cylindrical and Spherical Co-ordinate Systems.

Differential Equations: Linear ODEs of first and second orders, Linear second order equations, Applications. The Laplace Transform, Applications. Fourier Series and Applications. Partial differential equations of first and second orders. The Laplace and Wave Equations.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 12

CSIR-Central Mechanical Engineering Research Institute	CSIR-CMERI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Modern Magnetic Materials	Course Code	Credits
		AcSIR-12-ID-011	1

Types of magnetism, molecular field theory, measurement techniques, magneto resistance (AMR, GMR, CMR, TMR), hard and soft magnets, New magnetic materials, applications.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

14 CSIR-CRRI

2 *Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-14-ID-001	Admixture for Roads & Bridges
AcSIR-14-ID-002	Concrete Technology
AcSIR-14-ID-003	Highway Material Characterisation
AcSIR-14-ID-004	Introduction to Optimization Techniques
AcSIR-14-ID-005	Nano Technology for Infrastructures
AcSIR-14-ID-006	Principles of Pavement Design
AcSIR-14-ID-007	Strength of Materials
AcSIR-14-ID-008	Traffic Field Surveys

AcSIR Academic Centre Code: 14

CSIR-Central Road Research Institute	**CSIR-CRRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Admixture for Roads & Bridges**	**Course Code**	**Credits**
		AcSIR-14-ID-001	**1**

Supplementary Cementitious Materials (Fly ash, Silica Fume, Ground granulated blast furnace slag, Rice husk ash, Nano materials) ,Chemical Admixtures (Plasticizers, super plasticizers, accelerating admixtures, retarding, admixtures, air-entraining admixtures etc.) Corrosion inhibiting admixtures, Integral water proofing admixtures. Refining process of Asphalt binders, testing procedures, grading systems; additives and admixtures for Asphalt Concrete.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 14

CSIR-Central Road Research Institute	CSIR-CRRI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Concrete Technology	Course Code	Credits
		AcSIR-14-ID-002	1

Concrete - Characterisation of ingredients. Concrete mix design. Concrete science (mixing, Transportation, placing and curing of concrete). Properties of fresh and hardened concrete. New materials for concrete,

Quality control - Quality assurance of concrete. Durability of concrete.

Concrete technology- Sustainable construction.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 14

CSIR-Central Road Research Institute **CSIR-CRRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Highway Material Characterisation	Course Code	Credits
		AcSIR-14-ID-003	1

Nature, sources, and uses of bitumen, Production and classification of bitumen. Chemistry of bitumen, Physical and rheological properties of bitumen, Tests on bitumen, Classification and properties of mineral aggregates, test on aggregates, aggregate calculations, bitumen mix design. Materials for Concrete Road Construction: Introduction to material used in different layers of concrete pavement i.e. concrete fundamentals for rigid pavements, Aggregates for concrete road construction: Suitability of aggregate for application including aggregate derived from C&D debris;Water. Commonly used cements for the manufacturing of concrete. Hydration of cement. Materials beyond basic components of cement concrete i.e. special purpose materials such as mineral admixtures, chemical admixtures, Fibers. DLC and PQC layers: Importance, mix design and evaluation of DLC and PQC mixes.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 14

CSIR-Central Road Research Institute CSIR-CRRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Introduction to Optimization Techniques	Course Code	Credits
		AcSIR-14-ID-004	1

Different types of optimization problems, One dimensional optimization technique such as Golden Section method, Bisection Method and Newton Method.
Introduction to Linear Programming problems, Application and Model formulation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 14

CSIR-Central Road Research Institute CSIR-CRRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Nano Technology for Infrastructures	AcSIR-14-ID-005	1

Physics and Chemistry of Nano-materials, Materials Characterization Techniques, Nanotechnology for Construction Materials, Applications of Nanotechnology in Road Pavement, Smart Materials for Construction, Environmental Nanotechnology.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 14

CSIR-Central Road Research Institute CSIR-CRRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Principles of Pavement Design	Course Code	Credits
		AcSIR-14-ID-006	1

Road Pavements and pavement layers, Pavement material Characteristics, Stresses and Deflection strain in flexible pavements, Flexible pavement design and Rigid pavement design.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 14	
CSIR-Central Road Research Institute	**CSIR-CRRI**
Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	Course Code	Credits
Strength of Materials	**AcSIR-14-ID-007**	**1**

Stress, Strain, Modulus of Elasticity [Linear, Volumetric, Shear], Poisson's Ratio, Principle Stresses, Statically Determinate Structures, Bending Moment, Shear Force, Theory of Bending, Deflection of Beams, Statically Indeterminate Structures, Torsion of Shaft, Direct and Bending Stresses, Buckling of Columns, Fatigue, Evaluation of Material Properties i.e. Young's Modulus of Elasticity, Toughness Properties, Endurance Limit.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 14

CSIR-Central Road Research Institute CSIR-CRRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title: Traffic Field Surveys	Course Code	Credits
	AcSIR-14-ID-008	1

Speed, Journey Time and Delay Studies, Vehicle Volume Count Classification and Occupancy Survey, Origin- Destination Survey, Parking Survey, Household Survey, Spot Speed Survey, Pedestrian Survey, Freight Survey, Public Transport Passenger Survey and Staged Auto Survey, Intermediate Public Transport Survey and Road Inventory Survey, Saturation flow studies and testing of Road signs.

15	CSIR-CSIO	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-15-ID-001	Chemistry for Engineers
AcSIR-15-ID-002	Material Science for Engineers
AcSIR-15-ID-003	Mathematics for Engineers
AcSIR-15-ID-004	Nano-Photonics
AcSIR-15-ID-005	Optics for Engineers
AcSIR-15-ID-006	Physics for Engineers
AcSIR-15-ID-007	Physiology for Engineers

AcSIR Academic Centre Code: 15

CSIR-Central Scientific Instruments Organisation	CSIR-CSIO

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Chemistry for Engineers	Course Code	Credits
		AcSIR-15-ID-001	1

Introduction to chemistry, Periodic table, Chemical bonding, Formation of materials, Chemical compounds and chemical formulas, Acids and bases, Chemical equilibrium & thermodynamics, Kinetics and rate of chemical reactions.
Electrochemistry: Introduction to electrochemical systems, Redox reactions, Structure of electrochemical devices, Characterizing electrochemical devices based on standard reduction potentials, Applications of electrochemistry.
General instrumentation for chemistry: Brief introduction to measurement instruments, Brief introduction to characterization instruments, Physical characterization instrumentation, Chemical characterization instrumentation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 15

CSIR-Central Scientific Instruments Organisation	**CSIR-CSIO**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Material Science for Engineers**	**Course Code**	**Credits**
		AcSIR-15-ID-002	**1**

Materials science and engineering, Classification of engineering materials, Levels of structure, Structure-property relationships in materials, Geometry of crystals, Space lattices, Crystal structures, Crystallographic directions, Crystallographic planes, Linear and planar densities, Structure determination by X-Ray diffraction, Bragg law of X ray diffraction, Power method, Imperfections in solids, Mechanical properties of metals.

Phase diagrams: Phase rule, Single-component systems, Binary phase diagrams, Micro-structural changes during cooling, Lever rule, Iron–iron carbide (Fe–Fe3C) phase.

Failure: Fundamentals of fracture, Types of fracture, Theoretical fracture strength of brittle materials, Griffith theory of brittle fractures, Ductile fracture, Fracture toughness, Prevention of fractures, Fatigue, Creep.

Magnetic & dielectric materials: Diamagnetism and paramagnetism, Ferromagnetism, Anti-ferromagnetism and ferrimagnetism, Influence of temperature on magnetic behaviour, Domains and hysteresis, Magnetic anisotropy, Soft magnetic materials, Hard magnetic materials, Superconductivity, Polarization, Electric breakdown, Ferroelectric materials, Frequency dependence of dielectric constant, Dielectric strength, Dielectric materials.

AcSIR Academic Centre Code: 15

CSIR-Central Scientific Instruments Organisation **CSIR-CSIO**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Mathematics for Engineers	**AcSIR-15-ID-003**	**1**

Ordinary differential equations (ODEs): First order & second order, Partial differential equations (PDEs), Determinants and matrices, Probability, Bayes Theorem, Random variables, Continuous and discrete distribution function, Probability distribution function, Binomial distribution, Poisson distribution, Interpolation and extrapolation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 15

CSIR-Central Scientific Instruments Organisation **CSIR-CSIO**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Nano-Photonics	**AcSIR-15-ID-004**	**1**

Introduction, Theoretical foundation, Evanescent wave, Light-matter interaction on a nanometer scale, Localization of light.
Near-field optics: Nano-antenna, Nano-imaging, Behaviour of light at metal-dielectric interface, Theory of surface plasmon.
Nano-photonics in interdisciplinary field of research: Optical force, Gradient force and scattering force, Optical trapping and optical tweezing, Manipulating objects at submicron level, Plasmonics in sensing, Metamaterials and superlens.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 15

CSIR-Central Scientific Instruments Organisation CSIR-CSIO

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title: Optics for Engineers	Course Code	Credits
	AcSIR-15-ID-005	1

Concepts of geometrical and physical optics: Laws of refraction, reflection and dispersion; lens formula; scattering, diffraction, interference and polarization.
Principles of optical sources and detectors: Broadband light, LED, lasers; photoconductive, photovoltaic, photodiodes, CCD and CMOS.
Optical measurement and imaging techniques: Shadowgraphy, Schlieren, Interferometry, speckles, computer generated holograms and digital holography.
Applications of optical methods in displays, communication, precision engineering and metrology, thermal, vibration and shock wave studies, bio-imaging, and non-destructive testing.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 15

CSIR-Central Scientific Instruments Organisation **CSIR-CSIO**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Physics for Engineers	Course Code	Credits
		AcSIR-15-ID-006	1

Modern Physics: Black body radiation, Plank's law, Weins law and Rayleigh Jeans law, deBroglie hypothesis, photoelectric effect, Compton Effect Matter waves, Concept of Phase velocity, group velocity and particle velocity & their relations.
Quantum Mechanics: Heisenberg's uncertainity principle, Wave function, Properties and physical significance of wave function, Probability density and Normalization of wave function, time independent Schrodinger wave equation, Eigen values and Eigen vectors, Application of Schrodinger wave equation.
Lasers and Optical Fibers: Principle, Construction and working Lasers, CO2 laser and semiconductor Laser, Holography–Principle of Recording and reconstruction of images, Propagation mechanism in optical fibers, Angle of acceptance, Numerical aperture, Types of optical fibers and modes of propagation, Attenuation, its applications.
Crystal Structure: Space lattice, Bravais lattice–Unit cell, primitive cell, Lattice parameters, Crystal systems, Direction and planes in a crystal, Miller indices, Bragg's law, determination of inter – planar spacing, crytallite size using X–ray difractometer, Co-ordination number, Atomic packing factors, Polymarphism and Allotropy.
Physics of Nano Materials: Introduction to Nano Science, Density of states in 1D, 2D and 3D structures, Synthesis: Top–down and Bottom–up approach, Ball Milling and Sol–Gel methods, different carbon nanostructure material and synthesis methods.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 15

CSIR-Central Scientific Instruments Organisation	CSIR-CSIO

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Physiology for Engineers	Course Code	Credits
		AcSIR-15-ID-007	1

Cell and Tissue :Introduction to cell, multicellular organization, basic structure and organization of cell, cell organelles, tissue structure, types of tissue.
Cardiovascular system: Anatomy of cardiovascular system, cardiac muscle, electrical conduction in heart, brief introduction to ECG/ EKG, types of circulation, working of heart and cardiaccycle.
Respiratorysystem: Anatomy of respiratory system, gas exchange, physiologyofrespiration, spirometry, respiratory volumes and capacities.
Digestive system: Anatomy of digestive system, process of digestion, absorption and excretion, role of digestive enzymes and juices, heaptobiliary system.
Musculoskeletal system: Types of muscles, muscle contraction physiology, types of bones, bone macro and micro anatomy, bones in body, cartilage types, joints types, movement at joints, fracture types and healing.
Urinary system: Anatomy of renal system, working of the kidneys, process of urine concentration and bladder control, maintenance of acid-base balance.
Immune system: Types of immunity, Immune system components, antibodies, antigen, blood groups, detection of antigen/ antibody for disease diagnostics.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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Course Code	Course Title
AcSIR-16-ID-001	Asymmetric Catalysis
AcSIR-16-ID-002	Basic Biology and Chemical Biology for Chemists
AcSIR-16-ID-003	Biology for Engineers
AcSIR-16-ID-004	Bioprocess Technology for Biologists
AcSIR-16-ID-005	Chemical engineering for chemists
AcSIR-16-ID-006	Chemistry for Biologists
AcSIR-16-ID-007	Chemistry for Engineers
AcSIR-16-ID-008	Environmental Science and Technology
AcSIR-16-ID-009	Introduction to Bioinformatics
AcSIR-16-ID-010	Membrane Technologies
AcSIR-16-ID-011	Optical Sensors
AcSIR-16-ID-012	Physics for Chemists
AcSIR-16-ID-013	Risk Assessment and Hazard Management
AcSIR-16-ID-014	Water and Wastewater Treatment Technologies

AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute **CSIR-CSMCRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Asymmetric Catalysis	**AcSIR-16-ID-001**	**1**

Basics of asymmetric catalysis, Energetics of reaction, Factors affecting enantioselectivity, Kinetic and dynamic kinetic resolutions, Chiral Lewis and Brønsted acid catalysis, Bifunctional and cooperative catalysis, Counter-ion directed catalysis, Mechanistic studies of asymmetric catalysis: Non-linear effects and Autocatalysis, Asymmetric epoxidation and aziridination, Asymmetric hydrogenation, Asymmetric organocatalysis, Asymmetric aldol and Mannich reactions, Some important asymmetric reactions including asymmetric Diels-Alder reaction, Asymmetric cyclopropanation, Atroposelective biaryl synthesis, Catalysis by chiral-at-metal centers, Catalysis by short peptides (di-/tripeptides), Enzymatic catalysis applications of asymmetric catalysis in industrial preparation of drugs and APIs.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute CSIR-CSMCRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Basic Biology and Chemical Biology for Chemists	Course Code	Credits
		AcSIR-16-ID-002	1

Properties of cell and its building blocks; Structures of proteins and lipids; Cellular organic/inorganic cofactors; DNA replication, transcription, and translation; RNA structure and function; Mechanisms of DNA damage; Chou-Fasman rules; Ramachandran plots. Chemistry of Enzymes; Enzyme Catalysis; Consecutive, parallel and competitive reactions in biological systems; Thermodynamics, Alosteric effect in biology; Types of bonds, hydration and their specific contribution towards specific thermodynamic parameters, enthalpy or entropy; Scatchard analysis; Hill plot analysis. Healthcare diagnostics; Biomarkers of few lifestyle diseases; Biosensors; Development of probes for selected health issues; Protein misfolding and disease(s); Biopolymers; Prodrug; Measurement of drug release from prodrug polymers.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute | CSIR-CSMCRI

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Biology for Engineers	AcSIR-16-ID-003	1

Origin and evolution life; Basic concept of cells: composition, structure, Types: prokaryotes and eukaryotes; Bacteria: Types, microscopy and biofouling; Fermentation: design and application; Basic concept of biomolecules (nucleotides, DNA, RNA, amino acids, protein, and saccharides, lipids) and their biological function; Basic concept of metabolism: types and function; Basic concept of genetics, hereditary and physiology; Basic concept of Genetic Engineering; Computational Biology: In silico study, modelling, theory, algorithms, analysis, visualization, applications, and hands-on exercises.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute	**CSIR-CSMCRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Bioprocess Technology for Biologists**	**Course Code**	**Credits**
		AcSIR-16-ID-004	**1**

Introduction to Bioprocess Engineering; Isolation, screening and maintenance of industrially important microbes; Microbial growth kinetics; Strain improvement for desirable characteristics; Types of fermentation processes; Process technology for the production of alcohol (ethanol), acids (citric and acetic), antibiotics (penicillin and streptomycin), amino acids (lysine and glutamic acid), enzymes (proteases, amylases, lipases, cellulases) and single-cell proteins (SCPs); Techniques related to downstream processing and product recovery.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute **CSIR-CSMCRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Chemical engineering for chemists	**AcSIR-16-ID-005**	**1**

Introduction and basic concepts: Fundamentals. Kinetics, Thermodynamics and the reaction coordinate. Derivation of rate expressions. Ideal and non-ideal reactors. Gas-liquid mass transfer effects. Review of kinetics of homogeneous and heterogeneous chemical and biochemical reactions, Single and multiple reactions, Order & molecularity, Rate constant, Elementary and non elementary reactions, Reaction equilibrium, Equilibrium constant and equilibrium compositions. Reactor design: Design of single and multiple reactions in batch reactor, Plug flow reactor, Continuous stirrer tank reactor (C.S.T.R), and semi batch reactor, Packed bed reactors and fluidized bed reactors. Non isothermal reactor design: General design procedure, optimum temperature progression, adiabatic operation, non adiabatic operation, semi batch reactors.
Steady state and unsteady state operations in C.S.T.R and plug flow reactors, Stability of steady state, Linearized stability analysis, Reactor stability (with special reference to C.S.T.R), Chemical engineering for chemists parametric sensitivity and runaway behaviour, Optimization of chemical reactors. Non ideal flow: Residence time distribution of fluid in vessel, E, F & C curve, Mean residence time, Reactor modelling using RTD, Dispersion model, N Tanks in series model, micromixing and macromixing. Reactors: Fixed bed catalytic reactor, Single and multibed adiabatic reactors, Multitubular fixed bed reactor, Monolith reactors. Heterogeneous catalysis and catalytic reactors: Basic knowledge of chemical reaction ngineering, Introduction and basic concepts in heterogeneous catalysis, Classification of catalysts, Application of catalyst functionality concepts for control of reaction selectivity and kinetic models. Steps in catalytic reaction, Effect of heat and mass transfer on reaction rate and its role in heterogeneous catalysis, Diffusion in Porous Catalyst, Concept of effective diffusivity and thermal conductivity of porous catalysts, Thiele modulus and effectiveness factor, falsified kinetics, Mechanism and kinetics of heterogeneous reactions. Selection, Preparation and characterization of catalysts, Acid base catalysts, Supported metal catalysts and Zeolites, their Application, Promoter and inhibitors, Catalysts deactivation/poisoning, Various deactivation models. Catalysis reactors: Commercial reactors (fixed bed, fluidized bed, trickle bed, slurry etc.), Reactor modeling. Industrially important green catalysts and processes such as oxidation, Processing of petroleum and hydrocarbons, Synthesis gas and related process, Chemistry and engineering aspects of catalytic processes along with problems arising in industry.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute	CSIR-CSMCRI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Chemistry for Biologists	Course Code	Credits
		AcSIR-16-ID-006	1

Thermodynamics, Solutions and Ions, Chemical bonding and molecular structure, Chemical Kinetics, Stereochemistry, Introduction to drug discovery (Medicinal chemistry approach) Drug target, discovery and development (forward and reverse approach).

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute	**CSIR-CSMCRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Chemistry for Engineers**	**Course Code**	**Credits**
		AcSIR-16-ID-007	**1**

Fundamentals of Analytical Chemistry, Green Chemistry, Physical chemistry, organic chemistry, Industrial and engineering chemistry: Overview of Indian chemical industry, raw material and energy sources, role of catalysis, inorganic products, organic intermediates and final products, Polymers (e.g., polyethylene/ polypropylene), Manufacturing of inorganic acids, Chlor-alkali industry, Fertilizers, Industrial processes for ammonia, syngas and hydrogen, methanol, chemicals from oxo-synthesis, Organic chemicals based on methanol and ethanol (e.g., formaldehyde, acetaldehyde, acetic acid).

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute	**CSIR-CSMCRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Environmental Science and Technology	Course Code	Credits
		AcSIR-16-ID-008	1

Environmental Resources-Natural, Mineral, Food, Energy, Land & Biogeochemical cycles, Ecosystems & Biodiversity-Components, Trophic levels, Types, Values, Threats, Conservation, Environmental Pollution-Air, Water, Soil/Land, Marine, Noise & disasters, Social Issues & Environment-Sustainable development, Environmental ethics, Climate change, Wasteland reclamation, Public awareness, Human Population & Environment-Population growth & explosion, Human health, Human rights, Value education.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute	CSIR-CSMCRI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Course Code	Credits
Introduction to Bioinformatics	AcSIR-16-ID-009	1

Introduction to Bioinformatics – History of Bioinformatics, Sequencing projects: Applications of bioinformatics; Introduction to databases – Type and kind of databases (literature search, nucleic acids, proteins, animals & plants, biotechnological, motifs & patterns, species and structure), applications and limitations, Database retrieval and deposition systems, Web tools and resources with practical exposure.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute	CSIR-CSMCRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Membrane Technologies	Course Code	Credits
		AcSIR-16-ID-010	1

Classification of membranes, Principle of osmosis, Reverse Osmosis, Forward osmosis, Nanofiltration, Ultrafiltration, Microfiltration, Mass transport through membrane, Membrane element configurations, Spiral wound membrane systems, Basics of membrane system design, Concentrate management in Reverse Osmosis systems. Electro-membrane processes, Ion-exchange membranes and their applications, Electrodialysis and related processes, Polymer electrolyte membranes and their applications for fuel cell, Water electrolyzer for hydrogen production, Reverse electrodialysis for energy from concentration gradient.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute **CSIR-CSMCRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Optical Sensors	**AcSIR-16-ID-011**	**1**

Introduction to sensors, sensing and transduction elements, performance factors, measurement techniques, direct and indirect sensing methodologies, planar and fiber optic sensor formats, basics of fiber optics for optical sensing, sensor materials and films, sensor film preparation methods, tailoring of films for physical and chemical characteristics, study examples of optical sensors (for chemical, biological, healthcare, packaging applications), calibration and validation

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute **CSIR-CSMCRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Physics for Chemists	Course Code	Credits
		AcSIR-16-ID-012	1

Introduction to classical mechanics, Kinetic theory of gases, Transport phenomena, Elements of statistical physics, Thermodynamics, Black bodies, Limitations of classical physics and introduction to quantum physics, Basics of quantum physics and quantum mechanics, Electrostatics, Photoelectric effect and Compton effect, Physical optics, EM waves, LASER and x-rays, Polarization of light, Waves and acoustics.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute CSIR-CSMCRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Risk Assessment and Hazard Management	Course Code	Credits
		AcSIR-16-ID-013	1

Risk & Hazards-Types, Severity; Process Safety Management System and Occupational Hazards; Legal framework-Acts & Rules; Personal protective equipment; Tools for Hazard identification and risk assessment (HIRA); Hazard and Operability Study (HAZOP); Fire & Explosion-Terminologies, Types, Causes, Firefighting devices; Laboratory safety, MSDS; Risk evaluation and mitigation; Case studies of major accidents/disasters

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 16

CSIR-Central Salt and Marine Chemicals Research Institute	CSIR-CSMCRI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Water and Wastewater Treatment Technologies	Course Code	Credits
		AcSIR-16-ID-014	1

Basic elements of hydrological cycle, its scope and engineering perspective, Need of water resources projects, Hydrology and Ground Water, Water wells and artificial recharge, Rainfall-Runoff relationships and impact of land use changes, Introduction to waste processing and environmental management, Waste generation, its recycling and management, Point and non-point sources of water pollution, Concepts of physico-chemical analysis of water and wastewater, Toxicological characterization of effluents. Basics of desalination by solar thermal energy, Water treatment, Desalination technologies, Membrane and thermal desalination, Reverse Osmosis, Process design of Reverse Osmosis systems, Renewable energy powered desalination, Oil- water separation process, Wastewater treatment technologies, Advanced wastewater treatment technologies, Biological wastewater treatment, Phytoremediation technologies for wastewater treatment, Constructed wetland technologies for wastewater treatment.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

17	CSIR-IICB	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-17-ID-001	Basic Biology
AcSIR-17-ID-002	Basic Chemistry
AcSIR-17-ID-003	Biological Data Analysis
AcSIR-17-ID-004	Cell and Tissue Engineering
AcSIR-17-ID-005	Chemical Biology
AcSIR-17-ID-006	Supramolecular chemistry and green chemistry

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 17

CSIR-Indian Institute of Chemical Biology **CSIR-IICB**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Basic Biology	Course Code	Credits
		AcSIR-17-ID-001	1

Introduction to Chemical Biology; Macromolecular Structure: Protein, DNA, RNA, lipid, polysaccharide structures; detection, quantification and stability of the molecules and their interactions. Enzymes Overview & Enzyme Kinetics: enzyme structure and functions, substrate recognition, mechanism and inhibitions, Kinetics of enzyme reactions, types of inhibitions, allostericity and regulation. Nucleic Acids & Protein Synthesis: DNA replication, transcription (mRNA synthesis) and translation (protein synthesis). Cell Communication and Signaling: ligand-receptor interaction, autocrine and paracrine modes of signaling, communication through adherens junctions ; Metabolic Pathways: protein, lipid and carbohydrate metabolism, amino acid and nucleotide metabolism. Drug Discovery: drugs from nature and their interaction. Drug target identification and validation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 17

CSIR-Indian Institute of Chemical Biology	**CSIR-IICB**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Basic Chemistry**	**Course Code**	**Credits**
		AcSIR-17-ID-002	**1**

Thermodynamics, Solutions and Ions ;Chemical bonding and molecular structure; Chemical Kinetics ; Stereochemistry; Introduction to drug discovery (medicinal chemistry approach) ; Drug target, discovery and development (forward and reverse approach).

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 17

CSIR-Indian Institute of Chemical Biology	**CSIR-IICB**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Biological Data Analysis**	**Course Code**	**Credits**
		AcSIR-17-ID-003	**1**

Genomics: concepts, tools and techniques. Data analysis and probable interpretation
Epigenomics: concepts/techniques/analysis/interpretation.
Metagenomics: concepts/techniques/analysis/interpretation.
Transcriptomics (mRNA): concepts, tools and techniques. Data analysis and probable interpretation.
Transcriptomics (miRNA): concepts, tools and techniques. Data analysis and probable interpretation.
Proteomics: concepts, tools and techniques. Data analysis and probable interpretation Metabolomics: concepts, tools and techniques. Data analysis and probable interpretation.
Immunomics/immume phenotyping
Multi-omics: concepts, tools and techniques. Data analysis and probable interpretation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 17

CSIR-Indian Institute of Chemical Biology CSIR-IICB

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title: Cell and Tissue Engineering	Course Code	Credits
	AcSIR-17-ID-004	1

Thermodynamics, Solutions and Ions ;Chemical bonding and molecular structure; Chemical Kinetics ; Stereochemistry; Introduction to drug discovery (medicinal chemistry approach) ; Drug target, discovery and development (forward and reverse approach).

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 17

CSIR-Indian Institute of Chemical Biology	**CSIR-IICB**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Chemical Biology	Course Code	Credits
		AcSIR-17-ID-005	1

An overview of Chemical Biology, Protein-protein interactions and its inhibitors, Ligands for protein surfaces Ligands for Nucleic Acid surfaces, Chemical Genetics, Synthetic and semi synthetic proteins, Applications of chemical biology, enzyme based biosensors, catalytic antibody

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 17

CSIR-Indian Institute of Chemical Biology	CSIR-IICB

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Supramolecular chemistry and green chemistry	Course Code	Credits
		AcSIR-17-ID-006	1

Classical and non-classical H-bonding, importance of non-covalent interactions in molecular recognition, introduction of QSAR, drug - receptor interactions, physiochemical empirical and non-empirical parameters, 2D-QSAR approaches, 3D-QSAR approaches, 4D-QSAR and higher approaches, statistical methods in modeling, model validation, application of QSAR in drug discovery. Basic principles and applications of green chemistry: basic understanding, scope and interdisciplinary nature of green chemistry; environmental factors, carbon credit, energy efficiency and atom economy, designing green synthesis, green reagents, green catalysts, phase transfer catalysis in green synthesis, microwave-induced green synthesis ultrasound-assisted green synthesis, aqueous phase reactions, ionic liquid and water as green reaction media, enzyme mediated reactions.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

Course Code	Course Title
AcSIR-18-ID-001	Advanced Organic Chemistry
AcSIR-18-ID-002	Basic Cheminformatics for Chemists
AcSIR-18-ID-003	Basic Chemistry for Engineering
AcSIR-18-ID-004	Basic Concepts of Process Engineering
AcSIR-18-ID-005	Bioenergy and Bioproduct Engineering
AcSIR-18-ID-006	Biology for Chemists
AcSIR-18-ID-007	Biology for Engineering
AcSIR-18-ID-008	Biotechniques & Instrumentation
AcSIR-18-ID-009	Chemical Engineering for Process Chemistry
AcSIR-18-ID-010	Chemistry for biology
AcSIR-18-ID-011	Crop Protection
AcSIR-18-ID-012	Environmental and Microbial Technology
AcSIR-18-ID-013	Fundamentals of Devices for Energy Conversion & Storage
AcSIR-18-ID-014	Fundamentals of Catalysis
AcSIR-18-ID-015	Fundamentals of Lipid Science & Technology

Course Code	Course Title
AcSIR-18-ID-016	Introduction to Bioinformatics
AcSIR-18-ID-017	Introduction to Nanoscience & Nanotechnology
AcSIR-18-ID-018	Molecular Modelling for Chemists
AcSIR-18-ID-019	Numerical methods and Process Modeling
AcSIR-18-ID-020	Polymers for Functional Applications
AcSIR-18-ID-021	Principles of Pharmacology and Toxicology
AcSIR-18-ID-022	Proteomics and its Application
AcSIR-18-ID-023	Techniques for Identifying Newer Drug Molecules
AcSIR-18-ID-024	Techniques for Identifying Newer Pesticide Molecules
AcSIR-18-ID-025	Understanding Chemical Biology

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	**CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Advanced Organic Chemistry	**AcSIR-18-ID-001**	**1**

Retrosynthetic analysis, C-C and C-X bond formations, photochemistry, reaction mechanism, reactive intermediates and reagents in organic synthesis, Stereochemistry.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Basic Cheminformatics for Chemists	Course Code	Credits
		AcSIR-18-ID-002	1

Introduction to Cheminformatics and its Scope, Chemical space, chemical information and databases, Chemical File Formats SMILES, SDF creation, Molecule Drawing, Chemical Databases Like PubChem, Drugbank, Chembl etc, Fingerprint Generation & Analysis Structure Similarity Molecular Descriptors & Analysis Structure Search: Sub-Structure, Exact-Structure Search, Case Study.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology **CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Basic Chemistry for Engineering	Course Code	Credits
		AcSIR-18-ID-003	1

Thermodynamics Solutions and Ions Chemical bonding and molecular structure Chemical Kinetics. General Reactions such as alkylation's, oxidations and reduction, hydrogenation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	**CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary — **Total Credits 2**

Title:	Basic Concepts of Process Engineering	Course Code	Credits
		AcSIR-18-ID-004	1

Reaction progress kinetic analysis; Streamlining reaction steps; route selection; families of reagents useful for scale-up; solvent selection; selecting solvents based on physical characteristics; Physical and chemical causes of processing problems.
Engineering aspects in process chemistry.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Course Code	Credits
Bioenergy and Bioproduct Engineering	AcSIR-18-ID-005	1

Introduction: Fossil Resource and Environmental Concern, Linear economy, Circular economy, Bioeconomy, Biobased Production (Energy/Fuels/Materials/Chemicals), First, Second, Third and Fourth Generation, Sustainable Production and Consumption, Low Carbon Economy.
Feedstock- Biomass, Biowaste (Solid, liquid), Gaseous, Waste Valorisation.
Biocatalysts - Bacteria, Algae, Fungi, Yeast, Plants.
Bioprocesses/Bioconversions: Fermentation, Anaerobic, Acidogenesis, Anoxygenesis, Photosynthesis, Thermochemical Conversion, Transesterification.
Biorefinery- Circular Approach, Biorefinery Systems and Models.
Sustainability Analysis of Process/Product: Life Cycle Assessment (LCA)
Project (T)+I276+I275

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology **CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Biology for Chemists	Course Code	Credits
		AcSIR-18-ID-006	1

Science at the Interface of Chemistry and Biology; Introduction to Chemical Biology to encompass a survey of major topics, technologies, and themes in drug discovery, Screening methods for the identification of lead molecules. Current screening methods in chemical biology including cell based and target based automated assays; Overview of drug delivery systems with special emphasis on lipid mediated targeted gene delivery systems; siRNA as a tool in chemical biology; Biological applications of RNAi. Small molecule mediators of cell signaling pathways, Rational designing of cancer therapeutics: understanding molecular basis of selected cancers for designing drugs and targeted ligands, Emerging vaccine adjuvants; DNA vaccination strategy for cancer ,Special molecules for different diseases- Case studies such as for psoriasis and cancer.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Biology for Engineering	Course Code	Credits
		AcSIR-18-ID-007	1

Origin of Life: History of Earth, Life and Evolution, Chemical origin of life (Miller's Experiment), Darwin Theory.
Structural and Functional Unit of Life: Cells (microbial, plant and mammalian origins), Cell structure, Biomolecules (Proteins/enzymes).
Central Dogma of Life: DNA structure, replication, transcription and translation.
Microbiology: Classification, Prokaryotes, Species and strains, Agriculture, Industry, Medicine and Biotechnology Applications.
Metabolism, System Biology, Bioinformatics, Biomimicry.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology **CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Biotechniques & Instrumentation	Course Code	Credits
		AcSIR-18-ID-008	1

Principles and applications of Centrifugation, Chromatography, Electrophoresis and spectroscopy. Immuno-techniques: ELISA, Immuno-fluorescence, Immuno-histochemistry, immunoprecipitation, ChIP, etc. Automation in Drug Discovery: High-Content and High- Throughput Screening procedures.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Chemical Engineering for Process Chemistry	Course Code	Credits
		AcSIR-18-ID-009	1

Process chemistry and chemistry essentials for chemical engineers,, understanding impurities, process analysis - the importance of mass and energy balances, introduction to chemical reaction engineering, heat and mass-transfer operations, concepts of fluid flow, particle systems, process control, scale-up in chemical engineering, engineering approach to problem solving, , initial design steps-process routes, basic conceptual process design, flow sheeting, mass and energy balances, materials balance-single system & multisystem processes, phase equilibria, reactor design, separation processes, process control, process and personal safety, process integration, sustainability, chemical project economics, Flow Chemistry & processes, Case studies.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Chemistry for biology	Course Code	Credits
		AcSIR-18-ID-010	1

Atoms to building blocks of biology (atoms, molecules, chemical bonds), Forces in biology (different types of interactions, such as hydrophobic, Vander Waals), chirality in biomolecules, Understanding the basis of chemistry in biological assays , Rational designing of cancer therapeutics; Basis of drug targeting Development of nano-formulations & their biological applications Special molecules for different diseases- Case studies.

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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology — CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Crop Protection	AcSIR-18-ID-011	1

Major pests of crops; Insect - plant relationship; Principles of insect physiology; Toxicology and pathology; Insecticide resistance and residue monitoring; Biopesticides and integrated pest management.

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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	**CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Environmental and Microbial Technology**	**Course Code**	**Credits**
		AcSIR-18-ID-012	**1**

Concepts of environmental Microbiology, Complexity of microbial world, Environmental Ecology and Eutrophication, Fundamentals of microbial nutrition, Overview of microbial metabolism, Microbial diversity, Microbes and climate change, Water microbiology, Biodegradation and bioremediation, Microbial biogeochemistry, Microbial biofilm and corrosion, Concepts of microbial reactors, Perception of bioenergy, Hazardous waste bioremediation Biotransformation.

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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary — **Total Credits 2**

Title:	Course Code	Credits
Fundamentals of Devices for Energy Conversion & Storage	**AcSIR-18-ID-013**	**1**

Fundamental understanding solar cells, dye, organic and hybrid solar cells, design considerations for materials dyes and small organic molecules for solar cells, electrolyte and hole transport materials for solar cells, Understanding energy storage devices, Batteries and Supercapcitors, materials for batteries and supercpacitor, conducting polymer applications in energy generation and storage, polymer electrolytes.

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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	**CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Fundamentals of Catalysis	**AcSIR-18-ID-014**	**1**

Fundamental of homogeneous and heterogeneous catalysis, adsorption, diffusion, kinetics, equilibrium and rate expressions; Chiral catalysis, Surface science in catalysis, Catalytic materials; Supports; Active components, Classes of reactions and types of reactors; Catalyst preparation methods; Characterization of catalysts; Brief introduction of organo and electro-catalysis; Structure-activity-property-stability of catalysts.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology **CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Fundamentals of Lipid Science & Technology	**AcSIR-18-ID-015**	**1**

Basic concepts of oils and fats, lipids, types of lipids, fatty acids, triglycerides, glycerol, phospho and sphingolipids, sterols, prenols, polyketides lipids, etc, structure of lipids, basic physical chemistry and interactions of lipids, membrane, energy storage, signalling and other biological functions of lipids, metabolism of lipids, medicals, nutraceutical and food applications of lipids.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Introduction to Bioinformatics	Course Code	Credits
		AcSIR-18-ID-016	1

Introduction to Bioinformatics and its Scope, Biological Databases Like NCBI, EMBL, PDB, UniProt, KEGG etc., Genome sequencing projects, Human Genome Project, Applications of Bioinformatics. Introduction to databases, Type and kind of databases, Applications and limitations. Literature Search Databases, Nucleic acid and protein databases, Animal and plant databases, Biotechnological databases, Motifs and Pattern Databases, Databases for species identification and classification, Structural databases. Database Retrieval and deposition systems. Web tools and resources for sequence analysis: Pairwise and multiple sequence Alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, Restriction map analysis, primer design, Gene prediction, Phylogenetic Tree, Protein structure prediction and visualization.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology **CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Introduction to Nanoscience & Nanotechnology	Course Code	Credits
		AcSIR-18-ID-017	1

Introduction to nanomaterials and nanotechnology, understanding top down and bottom¬up approaches, synthetic methodologies, processing, functionalization and characterization of nanomaterials, concepts on low-dimensional structures: Quantum wells, Quantum wires, and Quantum dots, Nano clusters & Nano crystals, science and application of fullerenes, carbon nano tubes and graphene, Nanocomposites, Organic nanomaterials, Application of nanomaterials and nanocomposites in catalysis, biology, coatings, water purification and healthcare devices & products.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	**CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Molecular Modelling for Chemists**	**Course Code**	**Credits**
		AcSIR-18-ID-018	**1**

Elements of modelling. Computational modelling methods as standard tools by organic chemists for searching for, rationalizing and predicting structure and reactivity of organic, bio-organic and organometallic molecules, Molecular visualization, atom coordinates, input geometries, Design of new molecules. Semi-empirial methods, ab ignition electronic structure methods Multiscale modelling: QM. MM, combination force field + classical mechanics, molecular dynamics and Monte-Carlo simulations, Chemical interactions and Molecular modeling, Docking, Chemical Properties prediction & ADMET, Drug Discovery Case Study.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Numerical methods and Process Modeling	Course Code	Credits
		AcSIR-18-ID-019	1

Fundamentals of mathematical modeling Chemical Process Modeling Numerical methods Process optimization Process simulation using Software Packages

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	**CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:		Course Code	Credits
	Polymers for Functional Applications	**AcSIR-18-ID-020**	**1**

Fundamentals of polymers, types and class of polymers, understanding polymerization techniques, characterization of polymers, structure property relation in polymers, application of polymers for coatings, composites, nanocomposites, adhesives, packaging etc, Conducting polymers, Polymers for energy and drug delivery applications.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	**CSIR-IICT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Principles of Pharmacology and Toxicology**	**Course Code**	**Credits**
		AcSIR-18-ID-021	**1**

A general introduction to Pharmacology and Toxicology, Topics include absorption, distribution, biotransformation, elimination and calculation of dosages, Experimental design and data analysis for Pharmacology and Toxicology, Interdisciplinary Toxicology, Routes of administration. General principles and the application of toxicological knowledge are discussed including clinical toxicology, forensic toxicology, and risk assessment, Determination of median lethal concentration (manual calculations) Anticancer drugs and environmental agents exert their cytotoxic effects through DNA damage, The biochemical principles and molecular mechanisms underlying the toxicity of drugs and foreign agents.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

CSIR-Indian Institute of Chemical Technology CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Proteomics and its Application	Course Code	Credits
		AcSIR-18-ID-022	1

Introduction to Proteomics and its advantages over genomics. 1D and 2D Gel Electrophoresis: pI, Isoelectric focussing, 2 dimensional gel Staining methods and analysis. Protein spot/Band processing for Mass spectrometric analysis. Introduction to Mass spectrometry and application of MALDI-TOF/TOF and electrospray/ liquid chromatography - mass spectrometer. Spectral Peak Annotation and Database search. Shotgun Proteomics, Protein quantification using Mass spectrometry: ITRAQ, and SILAC. Application of chemical proteomicsin drug design, Practical Training for 1D and 2 D gel electrophoresis and subsequent mock practice for Mass spectrometric analysis of processed protein spot using MALDI-TOF/TOF

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Techniques for Identifying Newer Drug Molecules	Course Code	Credits
		AcSIR-18-ID-023	1

An overview of the various screening methodologies including in vitro and in vivo models. Correlations between in vitro and in vivo experiments. Choosing a right model and its relevance to human disease. Principles of high throughput screening (HTS). An overview of ex vivo techniques with special reference to isolated tissue experiments. An overview of methods for identifying hit molecules from NCEs. In vitro cell culture based screening techniques in the area of diabetes.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Techniques for Identifying Newer Pesticide Molecules	Course Code	Credits
		AcSIR-18-ID-024	1

Classification of evaluation (Agricultural pest and Public health important vectors), Larvicidal, Pupicidal, Insecticidal, Anti-feedant, Insect growth regulators. Xenobiotics exposure/effect assessment using alternate animal models, How to evaluate commercial products.

AcSIR Academic Centre Code: 18

CSIR-Indian Institute of Chemical Technology	CSIR-IICT

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Understanding Chemical Biology	Course Code	Credits
		AcSIR-18-ID-025	1

Science at the Interface of Chemistry and Biology; Introduction to Chemical Biology to encompass a survey of major topics, technologies, and themes in drug discovery. Screening methods for the identification of lead molecules . Current screening methods in chemical biology including cell based and target based automated assays; Overview of drug delivery systems with special emphasis on lipid mediated targeted gene delivery systems; siRNA as a tool in chemical biology; Biological applications of RNAi. Small molecule mediators of cell signaling pathways.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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19	CSIR-IIP	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-19-ID-001	Basic Electronics
AcSIR-19-ID-002	Environmental Science
AcSIR-19-ID-003	LCA and Sustainabilitv

AcSIR Academic Centre Code: 19

CSIR-Indian Institute of Petroleum	CSIR-IIP

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Basic Electronics	Course Code	Credits
		AcSIR-19-ID-001	1

Fundamentals of electronics: Current, voltage, resistance and resistivity.
Energy and power, Alternating current and direct current, Peak value, Average value and RMS value
Passive Components: Resistors, capacitors, inductors and transformers, Kirchhoff's law
Active components: P-N Junction diode, Forward and Reverse bias, Diode (P N Junction) as rectifier, Half wave, Full wave and Bridge rectifier, Photo Diode, Light Emitting diode.
Digital Electronics: Logic gates and their symbols
Transducers: Temperature, pressure and flow, temperature control, pressure control, flow control, level control, load cell and their connections with PLC.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 19

CSIR-Indian Institute of Petroleum CSIR-IIP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Environmental Science	Course Code	Credits
		AcSIR-19-ID-002	1

The basic concept of material flow, and resource efficiency, circular economy
Sustainable energy systems: Energy conversion principles and technologies, carbon footprint, global uptake.
Environmental: Air Emissions and Ambient Air Quality, Energy Conservation, Wastewater, and Ambient Water Quality, Water Conservation, Hazardous Materials Management, Waste Management.
Occupational Health and Safety: General Facility Design and Operation, Communication and Training, Physical Hazards, Chemical Hazards, Biological Hazards, Radiological Hazards, Personal Protective Equipment (PPE), Special Hazard Environments, Monitoring.
Community Health and Safety: Water Quality and Availability, Structural Safety of Project Infrastructure, Life and Fire Safety (L&FS), Traffic Safety, Transport of Hazardous Materials, Disease Prevention, Emergency Preparedness, and Response
Construction and Decommissioning: Environment, Occupational Health & Safety, Community Health & Safety, Definition of Standards, Development of Standards, Importance of Standards, National Standards/BIS, International Standards/ISO and ISO.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 19

CSIR-Indian Institute of Petroleum CSIR-IIP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	LCA and Sustainabilitv	Course Code	Credits
		AcSIR-19-ID-003	1

Sustainabilitv and Sustainable Development, Background, context setting and developing Life Cycle thinking.
Methodical Framework of LCA, The phases of LCA. Goal and scope definition,Inventor analysis. Impact Assessment.
Introduction to LCA Methodology, Life Cycle of a Cotton Shirt and a paper clip: Production from raw material (cotton/iron), use phase, and disposal after useful life. Environmental impact - LCA of paper vs. Polythene bags. Fossil Fuel vs. EV, Decision making using Life Cycle Assessment data, Procedure to conduct LCA with the help of SimaPro software, Setting up an LCA problem, LCA of a Wooden Shed: Setting up system Boundary, Setting up LCA Problem, Entering data, differentiate between inputs from Techno sphere and Nature data. Modelling "end of use" phase. Waste Treatment, Entering Complete LCA, Impact Assessment and Analysis of LCA results,
LCA of Biodiesel Production from Jatropha Oil: System Boundary, Different Steps of Life Cycle. Preparation of LCA inventory. Utilization and Impact of By-Products (Oil cake and Glycerol), Usage phase set-up B30 Blend vs. Fossil Diesel.
Entering complete Life Cycle and Impact Assessment, Analysis of the results.
LCA of Bio ethanol from Sugarcane Bagasse, with all the required steps as in above case studies.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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Course Code	Course Title
AcSIR-20-ID-001	Biochemical Engineering
AcSIR-20-ID-002	Biodiversity
AcSIR-20-ID-003	Bioinformatics
AcSIR-20-ID-004	Biology of infection
AcSIR-20-ID-005	Biology of inheritance
AcSIR-20-ID-006	Biology of Macromolecules
AcSIR-20-ID-007	Biopharmaceutical development
AcSIR-20-ID-008	Biotechniques and Instrumentation
AcSIR-20-ID-009	Cell Signaling
AcSIR-20-ID-010	Chemical Biology
AcSIR-20-ID-011	Genomics: Information flow in Biological Systems
AcSIR-20-ID-012	Molecular and Cellular Mechanisms of Defence
AcSIR-20-ID-013	Protein Science and Proteomics
AcSIR-20-ID-014	Systems Biology

AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology	CSIR-IMTech

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Biochemical Engineering	AcSIR-20-ID-001	1

Bio-reactions and bioreactors, Introduction to bioprocess engineering, Interaction of chemical engineering, biochemistry and microbiology, Cell growth and product formation kinetics, Mammalian cell culture, Biocatalysis, immobilization of cells and enzymes, Types of reactors, Mass transfer and heat transfer, Asepsis and sterilization, Scale up and scale down of bioprocesses, Downstream processing, Principles of choosing a separation/ purification process, Intracellular and extracellular product recovery methods, Bioprocess synthesis.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology	**CSIR-IMTech**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:		Course Code	Credits
	Biodiversity	**AcSIR-20-ID-002**	**1**

Universal tree of life: domains of life, bacteria, archaea and eukarya, Prokaryotic species concept: Characterization of prokaryotes, Polyphasic taxonomy, Overview of microbial diversity, Methods, and limitations in studying microbial diversity.
Molecular phylogeny: Different types of genes used for phylogenetic studies and their importance, Metagenomics and its applications, World of fungi: Diversity, taxonomy, classification, preservation and their maintenance, Microbial life in the biosphere, Interactions between the microorganisms and ecosystem, adaptations to the extreme environments.
Phototrophic Bacteria: Methods of cultivation and applications, Microbial diversity, Bio-prospecting, Applications and economic importance, Anaerobic microbes, Methods to cultivate the anaerobic microorganisms and their metabolism.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology CSIR-IMTech

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Bioinformatics	Course Code	Credits
		AcSIR-20-ID-003	1

Biological Databases - Database- introduction and definition. Primary, secondary and tertiary databases. Type and kind of databases. Literature (PUBMED and MEDLINE). Nucleic acid and protein databases (GenBank, EMBL, SWISS PROT, UNIPROT etc.). Plants and Animal databases (Ensembl Genome project, Flybase, Maize GDB). Structural databases- PDB, PDBsum, NDB, CATH, SCOP etc. Motifs and Pattern Databases- PROSITE, Pfam, etc. RNA databases: RNABase etc. Carbohydrates and lipid databases- GlycoSuiteDB, LIPIDAT etc. Database Retrieval and deposition systems- SRS, Entrez, Bankit, etc. and AutoDep. Protein-Protein Interaction Networks and databases- DIP (Database of Interacting Proteins), BIND - Biomolecular Interaction Network Database, Yeast Interaction Database etc. siRNA/miRNA resources. File formats- GenBank, EMBL, fasta, free format etc. Alignment of Sequences - Sequence alignmentintroduction and concepts; Sequence comparison using DOT matrix. Scoring matrices (Identity, Chemical, Substitution- PAM, BLOSUM); Local and global alignment concepts. Dynamic programming (Needleman-Wunch, Smith-Waterman algorithm). Similarity and percent identity score (open, extended gap penality). Multiple sequence alignment-introduction and concepts. Types of multiple sequence alignment techniques. Description of major software (MSA, CLUSTALW, PILEUP). Database Scanning and Sequence similarity searches. Algorithm of FASTA. Description of BLAST algorithm. Various BLAST programs (e.g., BLASTP, BLASTN). Concept of iterative search (PSI-BLAST and PHI-BLAST). Application of PSSM profile. Sequencing and Annotation of Genomes - Introduction to genomes. Sequencing techniques. Sequencing of whole genomes. Next Gen Sequencing. Assembling of Genomes from Short Reads. Concept of Metagenomics. Types of repeats and repeat finding techniques. Structure of genes. Prediction of gene in prokaryotic and eukaryotic genomes. Prediction of promoter prediction in E.coli and in eukaryotes. Description of major gene prediction methods. Comparison of genomes. Genome projects and sequence archive databases. Phylogenetic Analysis - Evolutionary analysis. Relationship of phylogenetic analysis to sequence alignment. Genome complexity. Concept of evolutionary trees. Methods-maximum parsimony method, distance methods, the maximum likelihood approach. Sequence alignment based on evolutionary model. Reliability of phylogenetic predictions. Complications from phylogenetic analysis – Protein Structure Analysis - Protein Structure –Introduction. Protein Structure analysis. Secondary structure assignments (DSSP). Protein Structure

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology | CSIR-IMTech

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Biology of infection	Course Code	Credits
		AcSIR-20-ID-004	1

Evolution of Bacterial Pathogens: a) Genetic basis of Virulence b) Techniques involved in identification of virulence genes c) Population Genetics of pathogen - Glycobiology paradigm in host-pathogen interactions. Delivery of Virulence factors through various transporter systems - Regulation of Virulence gene expression : a) One and Two component signal transduction, b) Quorum sensing mediated virulence expression c) Environmental signals (such as pH, osmotic stress, temperature, antibiotics, NO, host factor etc) mediated virulence traits Molecular pathogenesis of Bacterial pathogens, Protozoan pathogens (Malaria) and Fungal pathogens (Candida albicans). Model systems to understand the function of unique virulence factors.

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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology	**CSIR-IMTech**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Biology of inheritance**	**Course Code**	**Credits**
		AcSIR-20-ID-005	**1**

Classical and molecular genetics of bacteria, Molecular genetics and genome wide approaches in yeasts, Nucleic acids structure and topology, Central dogma and concepts on DNA transactions, Replication, Transcription & Transposition, DNAprotein contact probing, Molecular mechanisms and dynamics of replication control, Licensing mechanisms, Telomeres, Transcriptional regulation and gene expression, Genetic Recombination, Chromatin structure and remodeling, Mechanisms of RNA interference, Ribozymes and riboswitches, Genome imprinting.

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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology	CSIR-IMTech

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Biology of Macromolecules	Course Code	Credits
		AcSIR-20-ID-006	1

Protein conformation, Protein crystallography, Protein-protein interaction, enzymes Protein-nucleic acids interaction, Cryo-EM – SAXS, Protein structure analysis, Macromolecular complexes, Membrane proteins, Classification of proteins, Structural bioinformatics.

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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology	**CSIR-IMTech**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Biopharmaceutical development	Course Code	Credits
		AcSIR-20-ID-007	1

Concepts & emerging trends in biopharmaceutical (Vaccine & Biotherapeutics) development, Fermentation process development for biopharmaceuticals: recombinant microbial fermentation & mammalian cell culture based bioprocesses, recombinant DNA technology in biopharmaceutical development, new generation vaccines & biotherapeutics development, reverse vaccinology approach for vaccine discovery, concepts of vaccine immunology, vaccine induced immunity: humoral and cellular immunity, vaccine adjuvants and delivery systems

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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology CSIR-IMTech

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Biotechniques and Instrumentation	Course Code	Credits
		AcSIR-20-ID-008	1

Instruments: Acquaintance and handling of instruments (For example: weighing balance, pH meter, centrifuges, HPLC, FPLC, PCR machine etc).
Techniques in Biology : Handling of microbes and their basic characterization, Taxonomic characterization microbes and biochemical tests for characterization of a bacterium by Gram staining, MRVP test, Lactose fermentation, fatty acid profiling etc. Recombinant DNA technology: Concept of cloning, Plasmid DNA isolation, bacterial transformation with plasmid DNA, restriction digestion etc.
DNA sequencing: scope, application and troubleshooting. Protein expression and purification (concept of chromatography) Biochemical/biophysical techniques, MALDI and its application, Steady state fluorescence spectroscopy and its use.
Protein-DNA interaction: Electrophoretic mobility shift assay and use of phosphoimager, X-ray crystallography: Crystallization of proteins. Application of NMR. Cell Biology tools, Use of electron microscopy, Applications of confocal microscopy, Use of flowcytometer, Tools and techniques of Fermentation, Animal handling

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CSIR-Institute of Microbial Technology	CSIR-IMTech

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Cell Signaling	AcSIR-20-ID-009	1

Quorum sensing and social behavior in prokaryotes, Cell signaling in Fungi, Pheromone response pathway, nutrient sensing, osmosensing signal transduction pathway, Cell signaling softwares, Control mechanisms in cell signaling, System level and genome scale understanding of signaling pathways, Cell signaling in Metazoan, Differentiation and disease, cell communication, Methods in cell signaling research, kinase, phosphatase, GTPase etc assay , Use of inhibitors and non-hydrolysable analogs, Use of dominant and recessive mutants, Analog sensitization, Multiplex western blotting, Protein-protein and proteinligand interactions, FRET and FRAP analysis, Applications of Fluorescence microscopy in cell signaling research.

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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology	**CSIR-IMTech**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Chemical Biology**	**Course Code**	**Credits**
		AcSIR-20-ID-010	**1**

Organic chemistry and biology, Chemical biology and computers, Lipid and sugar chemistry, Drug discovery through screening, Enzyme conformation activity.

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AcSIR Academic Centre Code: **20**

CSIR-Institute of Microbial Technology	CSIR-IMTech

Course 2 : Inter-disciplinary / Cross-disciplinary — **Total Credits 2**

Title:	Course Code	Credits
Genomics: Information flow in Biological Systems	**AcSIR-20-ID-011**	**1**

Introduction, Next-generation sequencing technologies, Strategies for large scale DNA sequencing, Library preparation and sequencing of a genom, Computational assembly of a genome, Information sources for genomics, Principles of sequence analysis, Annotation and analysis of a genome, Evolutionary concepts in genomics, Genomes and the protein universe, Genome properties, DNA Repeats in genomes, Phylogenomics: Introduction to comparative genomics, Comparative genomics, Population genetics- Case study, genomics approach, Metagenomics, Analysis of gene expression.

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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology CSIR-IMTech

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Molecular and Cellular Mechanisms of Defence	Course Code	Credits
		AcSIR-20-ID-012	1

Introduction to Immunology, Historical perspective of immunology, Immune organs, Immune cells, Innate immunity, Adaptive immunity, Cellular Immunology, T and B cell biology, antigen presenting cells, Major histocompatibility complex (MHC), Signaling and effectors of immune system, Immunoglobulins, cytokines, chemokines and cell signaling, Disease and immunity, Immunology of infectious diseases, cancer, autoimmune disorder and hypersensitivity-mediated diseases, Recent trends in immunolog, Reproductive immunology, immunodiagnostics and immunotherapy.

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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology	CSIR-IMTech

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Protein Science and Proteomics	Course Code	Credits
		AcSIR-20-ID-013	1

Transcription and protein translation, protein post-translational modifications, protein folding, protein degradation machines, Protein compartmentalization, Enzymes, Interactions of proteins with receptors, nucleic acids, ligands and substrates, therapeutics proteins, protein spectroscopy, chemical biology tools for studying proteins, proteomics, glycobiology

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AcSIR Academic Centre Code: 20

CSIR-Institute of Microbial Technology CSIR-IMTech

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Systems Biology	Course Code	Credits
		AcSIR-20-ID-014	1

Introduction - Mathematical Tools for systems biology - Physico-chemical understanding of the system - Building kinetic and statistical mechanical model of biological processes - Modeling of gene expression - Systems biology of signal transduction - Autoregulation and kinetic proof readings in biology - Modeling of biological processes at multi-level

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22	CSIR-IITR	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-22-ID-001	Basic Chemistry
AcSIR-22-ID-002	Bio Techniques and Instrumentation
AcSIR-22-ID-003	Computer Applications & Informatics
AcSIR-22-ID-004	GLP, NABL, Animal Handling, Analytical Tools and Instrumentation, Risk Assessment, Biosafety, Entrepreneurship
AcSIR-22-ID-005	Introduction to Bioinformatics

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 22

CSIR-Indian Institute of Toxicology Research	**CSIR-IITR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Basic Chemistry**	**Course Code**	**Credits**
		AcSIR-22-ID-001	**1**

Thermodynamics Solutions and Ions Chemical bonding and molecular structure Chemical Kinetics Stereochemistry, Introduction to drug discovery (Medicinal chemistry approach) Drug target, discovery and development (forward and reverse approach)

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AcSIR Academic Centre Code: 22

CSIR-Indian Institute of Toxicology Research CSIR-IITR

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Bio Techniques and Instrumentation	Course Code	Credits
		AcSIR-22-ID-002	1

Affinity chromatography, gel filtration chromatography, high performance liquid chromatography (HPLC), PCR,restriction fragment length polymorphism (RFLP), Agarose gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE), two dimensional gel electrophoresis, MALDI-TOF, LCMS/MS, ELISA, RNAi, blotting techniques, Microarray technology. Separation and characterization of biopolymers, UV/Visible Spectrophotometry, Co-immunoprecipitation, transfection, transgenics, Light microscopy, Fluorescence microscopy, fixation and staining techniques, Transmission electron microscopy (TEM), Scanning, electron microscopy (SEM), flow cytometry.

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AcSIR Academic Centre Code: 22

CSIR-Indian Institute of Toxicology Research **CSIR-IITR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Computer Applications & Informatics	Course Code	Credits
		AcSIR-22-ID-003	1

Computation/bioinformatics computers: Introduction, evolution and classification of computers, Fundamentals of computing, Bit and Byte, Introduction to types of hardware and software, Components of computer, Introduction to operating systems. Introduction to computer viruses.
Network: Introduction, Network structure and architecture, Hierarchical networks, Ethernet and TCP/IP family of protocols, Transport protocol design, Types of network, Topologies of network, Router, Switch, Data communication, Concept of wireless networking, LAN, WAN, MAN, Security of the network, Fire-walls, Network applications information technology: Concepts of client server architecture, Concept of search engine, Database search engines. Introduction to internet introduction to word, Power point and excel introduction to bioinformatics: History of bioinformatics, Genome sequencing projects, Human genome project, Applications of bioinformatics. Introduction to databases, Type and kind of databases, Applications and limitations. Literature search databases, Nucleic acid and protein databases, Animal and plant databases, Ensemble genome project TIGR database, Biotechnological databases, Motifs and pattern databases, Databases for species identification and classification, Structural databases. Database retrieval and deposition systems. Web tools and resources for sequence analysis: Pair wise and multiple sequence alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, Restriction map analysis, primer design, Gene prediction, Phylogenetic tree, Protein structure prediction and visualization.

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AcSIR Academic Centre Code: 22

CSIR-Indian Institute of Toxicology Research CSIR-IITR

Course 2 : Inter-disciplinary Total Credits 2

Title: GLP, NABL, Animal Handling, Analytical Tools and Instrumentation, Risk Assessment, Biosafety, Entrepreneurship	Course Code	Credits
	AcSIR-22-ID-004	2

Good Laboratory Practice (GLP): Principles of GLP, Organization and Personnel, Quality assurance program, Facilities, Equipment, reagents and Materials, Test systems, Standard operating procedures, Reporting and Archiving, National Accreditation Board for Testing and Calibration Laboratories (NABL): Importance, scope and benefits of accreditation in India (NABL), Introduction of ISO/IEC 17025:2005 and ISO 15189:2012, Requirements for certification/ Accreditation from NABL in biological and chemical testing Quality Policy (QA/QC) (Proficiency Testing, Validation, Certified Reference Materials, Data Acquisition, Maintenance and Archiving, Animal Handling: Importance of lab animals, hygiene, disinfectant, sterilization, housing, environmental control, physiology, body systems and physiology, breeding, genetic monitoring, animal feed and nutritional requirements. Analytical Tools and Instrumentation: Thermal methods (TG, DTG, DTA, TMA, DSC), X-ray methods (XRD, XRF, SAXS), NMR (1H, 13C) and other Spectroscopic methods (EPR, IR, UV, Fluorescence), Chromatographic methods (TLC, GC, LC), Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDS, WDS), Quantitative Analysis (AAS, ICP, CHN), Risk Assessment: General principles - Hazard identification, Dose-response, exposure assessment and Risk characterization; REACH Regulation and data requirements for industrial chemicals and plant protection products risk assessment. Biosafety: Initiatives by DBT for regulatory compliance, Functions and approvals of IBSC, Biosafety and Containment facilities. Entrepreneurship: Innovations, Launching Startups, Idea to Product, Product and Process Development, Market Research, Business Plan, Stake Holders, Fundraising.

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AcSIR Academic Centre Code: 22

CSIR-Indian Institute of Toxicology Research	CSIR-IITR

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Introduction to Bioinformatics	Course Code	Credits
		AcSIR-22-ID-005	1

Introduction to Bioinformatics: History of Bioinformatics, Genome sequencing projects, Human Genome Project, Applications of Bioinformatics. Introduction to databases, Type and kind of databases, Applications and limitations. Literature Search Databases, Nucleic acid and protein databases, Animal and plant databases, Ensemble Genome project TIGR database, Biotechnological databases, Motifs and Pattern Databases, Databases for species identification and classification, Structural databases. Database Retrieval and deposition systems. Web tools and resources for sequence analysis: Pair wise and multiple sequence Alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, Restriction map analysis, primer design, Gene prediction, Phylogenetic Tree, Protein structure prediction and visualization

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24	CSIR-NAL	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-24-ID-001	Aerospace Engineering Design
AcSIR-24-ID-002	Aerospace Materials
AcSIR-24-ID-003	Condition Monitoring Concepts and Applications
AcSIR-24-ID-004	Digital Signal and Image Processing
AcSIR-24-ID-005	Introduction to Computational Methods of Fluid Dynamics
AcSIR-24-ID-006	Mathematics for Engineers
AcSIR-24-ID-007	Structural Mechanics

AcSIR Academic Centre Code: 24

CSIR-National Aerospace Laboratories	CSIR-NAL

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:		Course Code	Credits
	Aerospace Engineering Design	AcSIR-24-ID-001	1

Description of process, Design for manufacture and assembly, Multi- physics Modeling: Dimensional analysis Analytical and numerical models with Finite element method, Optimization: Introduction to design optimization Linking models and optimization, NASTRAN for optimization: Case studies, Thermo- mechanical design: Thermo mechanical problems Bi - morph cantilever, Brakes, clutches, Hydro- mechanical design: One- dimensional modelling and simulation of hydraulic sub- systems, retraction and extension of a landing gear system, Pneumatic-mechanical design: One dimensional modelling and simulation of pneumatic sub- system for emergency extension of landing gear system, Electro- mechanical design: Electro- mechanical problems related to steering of an aircraft, shock absorber modelling and simulation, Senso rs: Strain gages, transducer, pressure gage, Project presentations.

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AcSIR Academic Centre Code: 24

CSIR-National Aerospace Laboratories	CSIR-NAL

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Aerospace Materials	Course Code	Credits
		AcSIR-24-ID-002	1

Aerospace Materials: Design requirements for aerospace structural materials, general perspectives of advanced aerospace materials with regard to fuselage, propulsion and space vehicle applications.

Metallic Materials: Aluminium alloys- alloy specifications, temper designatio ns, processing and properties of aerospace grade alloys; magnesium alloys used for aerospace applications; structural steels- various grades of steels used for landing gear, transmission systems and fatigue critical applications; Titanium alloys- classification, mechanical properties, processing and applications of alloys used for compressor applications in gas turbine; Ni - base superalloys- evolution of materials for aero- engine applications, recent developments for aero- gas turbine, advanced thermal barrier coatings on superalloys used for gas turbine.

Composite materials: Introduction to Composite materials, Classification of composites Polymer Matrix Composites (PMC)- Processing of PMC- Joining of composites & Aerospace applications of composites.

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AcSIR Academic Centre Code: 24

CSIR-National Aerospace Laboratories	**CSIR-NAL**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Condition Monitoring Concepts and Applications	Course Code	Credits
		AcSIR-24-ID-003	1

ntroduction to Condition Monitoring: Basic concept, techniques - visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring. Implementation of CBM, comparison of CBM with other maintenance techniques.

Signal Processing Techniques : Probability distribution and density, Fourier analysis, Hilbert Transform, Cepstrum analysis, envelope analysis, Digital filtering, Deterministic/ random signal separation, Time-frequency analysis, Introduction to Wavelets, Continuous Wavelet Transform, Discrete Wavelet Transform, Wavelet Packet Transform, and applications of wavelets. techniques.

Condition Monitoring Techniques: Introduction, data collection, vibration, temperature, acoustic, techniques, instruments, transducers, selection, measurement location, time domain analysis, frequency domain analysis, time- frequency domain analysis and commonly witnessed machinery faults diagnosed by vibration/temperature analysis, Hot spot measurement and thermal images, Acoustic emission monitoring.

Condition Monitoring of Rotating Mechanical Systems: Vibration signals from rotating machines – signal classification, signals generated by rotating machines, signals generated by reciprocating machines, Wear monitoring and lubricant analysis, Rolling element bearing diagnostics and gear diagnostics.

Condition Monitoring of Rotating Electrical Machines : Introduction to motor condition monitoring, operation and failure modes of electrical machines, Structure of electrical machines and their types, typical root causes and failure modes.

Motor Current Signature Analysis: Identifying methods of mechanical faults with Motor Current Signature Analysis (MCSA), faults that can be detected with MCSA: Air- Gap eccentricity, Broken rotor bars, Bearings/gear damage, Shorted turns in stator windings, etc.

Case Studies: Industrial problems related to condition monitoring.

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AcSIR Academic Centre Code: 24

CSIR-National Aerospace Laboratories	CSIR-NAL

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Digital Signal and Image Processing	**AcSIR-24-ID-004**	**1**

Discrete- Time Signal and Discrete- Time System : Introduction to Digital Signal Processing, Sampling and reconstruction, Standard DT Signals, Concept of digital frequency, Linear convolution formulation for 1 - D and 2- D signal, Circular convolution, Linear convolution using circular convolution. LTI system.
Discrete Fourier Transform: Introduction to DFT, IDFT, Properties of DFT, Transfer function of DT System in frequency domain using DFT. Linear and circular convolution using DFT, Introduction to 2- D DFT, Fast Fourier Transform, Spectral analysis using FFT.
Digital Image Fundamentals : Introduction to digital image, Digital image processing system, Sampling and Quantization, Representation of digital image, Image file formats: BMP, TIFF and JPEG.
Image Enhancement: Gray level transformations, Zero memory point operations, Histogram processing, Histogram equalization, Neighborhood processing, Spatial and Frequency domain methods.
Current Research & Applications: Latest research topics in signal & Image processing for aerospace applications.

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AcSIR Academic Centre Code: 24

CSIR-National Aerospace Laboratories CSIR-NAL

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Introduction to Computational Methods of Fluid Dynamics	Course Code	Credits
		AcSIR-24-ID-005	1

Brief introduction to basic laws of fluid Dynamics; Levels of approximation; Demonstration and hands on training for elementary CFD simulations using in- house and commercial tools; Post processing and analysis of CFD simulation data.

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AcSIR Academic Centre Code: 24

CSIR-National Aerospace Laboratories	**CSIR-NAL**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Mathematics for Engineers	Course Code	Credits
		AcSIR-24-ID-006	1

Linear Algebra: Matrices and matrix algebra, Geometry of linear equations, Gauss elimination, LU decomposition, Introduction to vector spaces, Basis and dimension of subspaces, Orthogonal subspaces, Projections, Gram - Schmidt orthogonalization, QR factorization, Linear transformation, Determinants, Introduction to eigen systems, Diagonalization, Singular value decomposition, Applications of linear algebra in engineering problems.

Differential Equations: Introduction to first and second order ODEs, Linear differential equations with constant coefficients, Free and forced oscillation problems, Problems with variable coefficients, Series solutions to ODEs, Fourier series, Legendre and Bessel functions, System of linear differential equations, Phase plane method, Introduction to dynamical system, Concept of stability and equilibrium points, Numerical solutions of differential equations, Applications of differential equations in engineering problems .

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AcSIR Academic Centre Code: 24

CSIR-National Aerospace Laboratories CSIR-NAL

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Structural Mechanics	AcSIR-24-ID-007	1

Basic elasticity- Stress and Strain, Equations of equilibrium, Plane stress and strain, Boundary conditions, Principal stresses and strains, Compatibility equations, Mohr's circle, Stress-strain relationships, Hooke's law; Two-dimensional elasticity problems in Rectangular and Polar coordinates: Stress functions, Bending ofan end-loaded cantilever, Plate with a hole; Torsion of solid sections; Stresses in Simple Structural Members: Axially loaded members, Stresses in beams, Deflection of beams by integration, Euler column buckling, Thin-walled pressure vessels, Yield and fracture criteria, Introduction to bending of thin plates.

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25	CSIR-NBRI	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-25-ID-001	Basic Chemistry for Biologist
AcSIR-25-ID-002	Cell and tissue engineering
AcSIR-25-ID-003	Climate Change and Plants
AcSIR-25-ID-004	Genomics Assisted Breeding of Plants
AcSIR-25-ID-005	Introduction to Bioinformatics
AcSIR-25-ID-006	Phylogenomics
AcSIR-25-ID-007	Soil Fertility and Nutrient Management

AcSIR Academic Centre Code: 25

CSIR-National Botanical Research Institute	**CSIR-NBRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Basic Chemistry for Biologist**	**Course Code**	**Credits**
		AcSIR-25-ID-001	**1**

Solution and ions Types of Solutions, Expressing Concentration of Solutions, Liquid – Liquid mixtures- Ideal liquid mixtures, Raoult's and Henry's law, Ideal and Non-ideal Solutions, Vapour Pressure of Liquid Solution, Colligative Properties and Determination of Molar Mass, Abnormal Molar Masses Chemical bonding Kossel-Lewis Approach to chemical bonding, Ionic or Electrovalent bond, Bond Parameters The Valence Shell Electron Pair Repulsion (VSEPR) Theory, Valence Bond Theory, Hybridisation, Molecular Orbital Theory, Bonding in Some Homonuclear Diatomic Molecules Hydrogen Bonding Thermodynamics Definitions of thermodynamic terms : System, surroundings etc. Types of systems (intensive and extensive properties), State and path functions and their differentials, Thermodynamic processes, concept of heat and work. Law of Thermodynamics internal energy and enthalpy, Chemical kinetics Chemical kinetics and its scope Rate of a chemical reaction, Factor Inflencing Rate of a Reaction (concentration, temperature, pressure, solvent, light, catalyst) mathematical characteristics of simple chemical reactions – zero order, first order, second order, pseudo order, half life and mean life, Integrated Rate Equation Temperature Dependence of the Rate of a Reaction. Collision Theory of Chemical Reactions Natural product chemistry Extraction of Gums and resins, Food colors and textile Dyes, natural molecules of therapeutic value General Pharmacology: Pharmacokinetics, phamacodynamics, receptor Autocoids, Nurotransmittors, messangers, Screening methods in drug development Cell signalling pathway: Principles of Cell Signaling Systems, Structure of GPCRs, G proteins, ion Channels, Regulation of Transcription and Translation :Recent Advances in Signaling Research.

AcSIR Academic Centre Code: 25

CSIR-National Botanical Research Institute CSIR-NBRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Cell and tissue engineering	Course Code	Credits
		AcSIR-25-ID-002	1

Genetic engineering of plant cells -Transgenic plants Methods of direct and Agrobacterium mediated gene transfer (Ti plasmid). Methods for DNA transformation: electroporation, microinjection, particle-gun technology. Strategies for crop improvement with special mention of biotic and abiotic resistant plants and value addition. Recombinase-directed chromosome engineering in plants Cre & lox system FLP& FRT system PhiC31 & aatP-attB system R and RS system/ParA& MRS system Production of pharmaceutically important drugs and therapeutics using genetic engineering Large scale production of secondary metabolites using cell and suspension cultures. Hairy root culture and Ri plasmid, Hairy root cultures as phytochemical factories and process of elicitation. Recombinant therapeutic protein production (medical molecular pharming) in plant cells/tissues. Metabolic Engineering of major metabolic pathways and products. Cloning and characterization of secondary metabolic genes. Bioengineering and other means to develop new plant products. Use of genetic engineering and molecular biology tools for Metabolic Engineering. Plant Cell reactors- type of reactors, comparison of reactor performances, Immobilized plant cell reactors.Genome editing in plants.

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AcSIR Academic Centre Code: 25

CSIR-National Botanical Research Institute **CSIR-NBRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Climate Change and Plants	**AcSIR-25-ID-003**	**1**

Plant Response to Elevated CO2 Impact of Ozone on Plants Impact of UV-B on Plants Climate Exposure/Simulation Systems Ecological Sampling Methods Atmosphere, Weather and Climate Climate Change and Forest Carbon Sequestration Basics of Remote Sensing and GIS Impact of water stress on Plants Impact of elevated temperature on Plants Response of Plants to high radiations Cryptogams as indicators of air pollution and climate change Air Pollution monitoring using Lichens Algae as a source of alternate fuel Practical on Drought Stress/WUE Practical on Air Pollution Monitoring using Lichens.

AcSIR Academic Centre Code: 25

CSIR-National Botanical Research Institute	**CSIR-NBRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Genomics Assisted Breeding of Plants	Course Code	Credits
		AcSIR-25-ID-004	1

1. Underlying genetics for molecular breeding: Mendel and Laws of inheritance, Genome organization and Chromosomes, Cell-Division, Allelic & non-allelic interactions, Basic concepts of Ploidy and variation in ploidy levels, Concept of recombination & linkage distance, linkage disequilibrium, Genetic map & physical map. 2. Basics of plant breeding and various mapping populations: Overview of basic principles & breeding strategies, Different mapping populations, Development of breeding populations (bi-parental, F2, RILs, NILs, DH lines), Merits/demerits of various populations. 3. Molecular markers and MAS: Definition, categories & types of molecular markers, merits/demerits, marker polymorphism, Germplasm fingerprinting, Genotyping strategies using diverse markers, diversity analyses, Marker-Assisted Selection (MAS), Bulk-segregant approach (BSA), Gene tagging & pyramiding, foreground and background selections; marker assisted hybrid (MAH) breeding.4. Linkage mapping and QTLs: Linkage map, principle of linkage mapping, QTLs, Principles of QTL analysis, Methods to detect QTLs, advanced backcross QTL (AB-QTL) analysis, Data acquisition and software analyses, Advantages and limitations of QTL approach. 5. Genome-Wide Association Study (GWAS): Overview, Choice of population, Analysis of population structure, High throughput genotyping, phenotyping, Statistics of association mapping, LD and measure of LD, factors affecting LD. 6. Genomic selection: Genomic selection scheme, Training population, Types of marker platforms, Advantages of genomic selection, Advantages and limitations of genomic selection.7. Genomics assisted breeding for crop improvement: Marker-assisted backcrossing (MABC): a GAB approach for single or multiple traits (gene pyramiding), MAGIC: a recent trend of GAB.

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AcSIR Academic Centre Code: 25

CSIR-National Botanical Research Institute CSIR-NBRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Introduction to Bioinformatics	Course Code	Credits
		AcSIR-25-ID-005	1

Introduction to Bioinformatics: History of Bioinformatics, Genome sequencing projects, Human Genome Project, Applications of Bioinformatics. Introduction to databases, Type and kind of databases, Applications and limitations Literature Search Databases: e.g. PUBMED, MEDLINE Nucleic acid and protein databases: GenBank, EMBL, DDBJ, SWISS PROT, UNIPROT.Animal and plant databases: Ensembl Genome project TIGR database, Maize GDB etc. Biotechnological databases: EST, STS, GSS, HTG SNP Motifs and Pattern Databases: PROSITE, Pfam, BLOCKS, PRINTS etc. Databases for species identification and classification: GBIF, ICTV, taxonomy browser at NCBI etc. Structural databases: PDB, PDBsum, NDB, SCOP, CATH etc. Database Retrieval and deposition systems: SRS, Entrez, Bankit, Seqin, Webin, AutoDep. Web tools and resources for sequence analysis: Pairwise and multiple sequence Alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, Restriction map analysis, primer design, Gene prediction, Phylogenetic Tree, Protein structure prediction and visualization.

AcSIR Academic Centre Code: 25

CSIR-National Botanical Research Institute CSIR-NBRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Phylogenomics	Course Code	Credits
		AcSIR-25-ID-006	1

What is Phylogenomics? Basic tenets of Phylogenomics and its Applications in R&D Phylogenomics – Reconstruction of Tree of life and overview of phylogenetics/ phylogenomics studies in plants; Chloroplast genomes and applications. Experimental approaches in Phylogenomics: Data generation and analysis Phylogenomics data – Tree building Phylogenomics – Tree building Methods Distance and Character based Phylogenomics – Bayesian analysis, Neural networks Phylogenomics – DNA Barcoding

Phylogenomics – Understanding Co-evolution; Pair-wise vs Diffuse Coevolution; Mutualistic/ Obligate Mutualism– Myrmecophyly; Angiosperm radiation and Beetle diversity; Yucca Plant- yucca moth coevolution; Fig and Wasp Coevolution, etc. Phylogenomics – Plant Parasites Evolution; Parasitic Plant Diversity; Comparison of chloroplast genomes of autotrophic and parasitic plants; Loss or horizontal gene transfer in parasitic plants ; exchange of mRNAs between parasitic plants and hosts Phylogenomics – MADS Box Genes and other case studies Phylogenomics – Morphological Evolution and Gene Function in Plants: Evidences of ancient gene functions in Sporophyte and Gametophyte evolution/Leaf Evolution/ Flower evolution in plants Phylogenomics – Applications- Lateral Gene Transfer/ Horizontal Gene Transfer (LGT/HGT):Evidences of LGT/HGT within and among prokaryotes and eukaryotes with examples of LGT/HGT between bacteria ; Fungi Insect; EudicotsMonocots; Algae Sea slug Exercise on Nucleic Acids & Protein Sequences Assembly, Editing , In-silico Analyses Exercise on Tree building using Nucleic Acids & Protein Sequences Exercise on Nucleic Acids & Protein Sequences Assembly, Editing , In-silico Analyses

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AcSIR Academic Centre Code: 25

CSIR-National Botanical Research Institute	CSIR-NBRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Soil Fertility and Nutrient Management	Course Code	Credits
		AcSIR-25-ID-007	1

Theory Introduction to soil fertility and productivity, Factors affecting soil fertility and productivityEssential plant nutrients, classification of nutrients based on utilization and biochemical functions in plants, macro and micro nutrients, primary and secondary nutrients, beneficial elements, criteria of essentiality of elements Deficiency symptoms of essential and micronutrients in plants Physiological aspects of nutrients requirement of the plant Use of biofertilizers for crop production Precision nutrient management (PNM) for optimum yield and quality of the plant, Integrated plant nutrient management (IPNM), Site Specific Nutrient Management (SSNM) Salt affected soils, their formation and classification- saline, alkaline, saline-alkali soils, their characteristics and management Heavy metals toxicity and their remedial measures Practical Determination of organic matter (Organic carbon) in soil and interpretations Determination of available Nitrogen in soil and interpretations Determination of available P in soil and interpretations Determination of available K, Ca and Mg in soil and interpretations Determination of available S in soil and interpretations Determination of Gypsum requirement of saline and alkali soils.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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Course Code	Course Title
AcSIR-26-ID-001	Advanced Algorithms
AcSIR-26-ID-002	Basic Chemistry for Biologists
AcSIR-26-ID-003	Basic Chemistry for Engineers
AcSIR-26-ID-004	Basic mathematics & Numerical Methods
AcSIR-26-ID-005	Basic techniques in biology
AcSIR-26-ID-006	Biostatistics
AcSIR-26-ID-007	Carbon allotropes
AcSIR-26-ID-008	Chemoinformatics
AcSIR-26-ID-009	Computation and Bioinformatics
AcSIR-26-ID-010	Functional Ceramics
AcSIR-26-ID-011	Introduction to Chemical Biology
AcSIR-26-ID-012	Introduction to Nanoscience and Nanotechnology
AcSIR-26-ID-013	Modern Magnetic Materials

AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	CSIR-NCL

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Advanced Algorithms	Course Code	Credits
		AcSIR-26-ID-001	1

Course Objective: The aim is to introduce students to the theory behind computing. This should help them in two ways: (1) design better code and (2) identify which computational problems in their research provably can or cannot be solved e ciently.

Modules: Asymptotic notation, recurrences, Sorting, divide and conquer, Elementary data structures, Dynamics programming and greedy algorithms, NP completeness.

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	CSIR-NCL

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Basic Chemistry for Biologists	AcSIR-26-ID-002	1

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and nonbonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis.

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	CSIR-NCL

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Basic Chemistry for Engineers	AcSIR-26-ID-003	1

Thermodynamics Solutions and Ions Chemical bonding and molecular structure Chemical Kinetics Stereochemistry Introduction to drug discovery (Medicinal chemistry approach) Drug target, discovery and development (forward and reverse approach.

AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	**CSIR-NCL**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Basic mathematics & Numerical Methods**	**Course Code**	**Credits**
		AcSIR-26-ID-004	**1**

Determinants and Matrices, Complex Variables, Vector analysis, Infinite Series, Special Functions, Differential Equations, Interpolation and Approximation, Numerical differentiation and Integration, Basic Linux, Introduction to Algorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/GnuplotAlgorithms, basic programming, Shell and Shell Scripting, Network Computing and Parallel Computing, Matlab/Scilab/Octave/Gnuplot.

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	CSIR-NCL

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Basic techniques in biology	AcSIR-26-ID-005	1

Basic techniques in microbiology Basic techniques in plant tissue culture Basic techniques in plant molecular biology Basic techniques in animal cell culture Basic Entomological techniques Microscopy - Light and florescence Freeze drying, centrifugation, ultra-centrifugation, ultra-filtration, etc. Electrophoretic techniques (DNA/RNA/Protein-Native/denaturing) / IEF and Agarose / PAGE / Capillary electrophoresis Chromatography techniques (Ion exchange, Affinity, Gel filtration) Purification and characterization of biomolecules (Proteins & metabolites).

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	**CSIR-NCL**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Biostatistics	**AcSIR-26-ID-006**	**1**

Summarization of Data: measures of center, dispersion, skewness Dependence of variables: Correlation, linear regression, logistic regression Basic probability distributions: Binomial, Normal, Chi-squares. Estimation of parameters: method of moments, maximum likelihood Testing of hypotheses: (a) parametric tests: t-test, z-test, chi-squares test, ANOVA (b) non-parametric tests: Mann-Whitney, Kruskal Wallis, Kolmogorov-Smirnov.

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory CSIR-NCL

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Carbon allotropes	Course Code	Credits
		AcSIR-26-ID-007	1

Ensembles, Thermodynamic functions and Distribution function, g(r),Imperfect Gases, Kinetic theory of gases, Time dependent processes, Phase transitions.

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	CSIR-NCL

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Chemoinformatics	Course Code	Credits
		AcSIR-26-ID-008	1

Course Objective: To help students understand the fundamentals of chemoinformatics, appreciate complementary aspects of chemoinformatics for design of bioactive molecules and materials, understand the chemical reactivity at atomic level.

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	**CSIR-NCL**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:		Course Code	Credits
	Computation and Bioinformatics	**AcSIR-26-ID-009**	**1**

Computers: Introduction, Evolution and Classification of computers. Fundamentals of computing. Bit and Byte, Introduction to types of Hardware and Software. Components of Computer. Introduction to operating systems. Introduction to Computer Viruses. Network: Introduction. Network structure and architecture, Hierarchical networks, Ethernet and TCP/IP family of protocols, transport protocol design. Types of network, Topologies of network, Router, Switch, Data Communication, Concept of Wireless networking, LAN, WAN, MAN, Security of the network, Fire-walls, Network Applications Information Technology: Concepts of client Server Architecture, Concept of search Engine, Database search engines. Introduction to Internet Introduction to Word, Powerpoint and Excel Introduction to Bioinformatics: History of Bioinformatics, Genome sequencing projects, Human Genome Project, Applications of Bioinformatics. Introduction to databases, Type and kind of databases, Applications and limitations. Literature Search Databases, Nucleic acid and protein databases, Animal and plant databases, Ensembl Genome project TIGR database, Biotechnological databases, Motifs and Pattern Databases, Databases for species identification and classification, Structural databases. Database Retrieval and deposition systems. Web tools and resources for sequence analysis: Pairwise and multiple sequence Alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, Restriction map analysis, primer design, Gene prediction, Phylogenetic Tree, Protein structure prediction and visualization.

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	**CSIR-NCL**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Functional Ceramics**	**Course Code**	**Credits**
		AcSIR-26-ID-010	**1**

Advanced electronic ceramics, High temperature ceramic super conductors, Dielectric ceramics, Microwave ceramics, Low k materials, SOFC materials, Solid-ionic conductors, Phosphor materials, Impedance analysis, Varistors, Sensors, Ceramic magnets, Thermal shock resistance and Super plastic ceramics.

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	**CSIR-NCL**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Introduction to Chemical Biology**	**Course Code**	**Credits**
		AcSIR-26-ID-011	**1**

Chemical biology, Synthetic biology, Structure, Function and chemistry of biological macromolecules including amino acids, Proteins, Nucleic acids and Carbohydrates, Chemical kinetics and thermodynamics in biology, Chemical reactions and chemical diversity in biology, Chemistry of Enzymes, Lipids, Fats & Steroids, Drug discovery, Drugs from nature, Drug interaction.

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	CSIR-NCL

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Introduction to Nanoscience and Nanotechnology	Course Code	Credits
		AcSIR-26-ID-012	1

General considerations, Introduction, Definitions, Consequences of size reduction, Properties: Structural, Thermodynamic, Optical, Electrical and magnetic properties, Methods of synthesis, Surface modifications, Factors governing the stability and assembly, Characterization of nanomaterials, Applications of Nanomaterials

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AcSIR Academic Centre Code: 26

CSIR-National Chemical Laboratory	CSIR-NCL

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Modern Magnetic Materials	**AcSIR-26-ID-013**	**1**

Types of magnetism, Molecular field theory, Measurement techniques, Magnetoresistance (AMR, GMR, CMR, TMR), Hard and soft magnets, New magnetic materials, Applications.

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27	CSIR-NEERI	2	Inter-disciplinary / Cross-disciplinary

Course Code	Course Title
AcSIR-27-ID-001	Air Pollution Science & Engineering
AcSIR-27-ID-002	Biodiversity and Conservation
AcSIR-27-ID-003	Biological Treatment in Chemical Perspective
AcSIR-27-ID-004	Biological Treatment Technologies
AcSIR-27-ID-005	Conservation and Restoration Ecology
AcSIR-27-ID-006	Ecological Engineering
AcSIR-27-ID-007	Energy Conversion and Environment
AcSIR-27-ID-008	Environmental Chemistry & Toxicology
AcSIR-27-ID-009	Environmental Impact and Risk Assessment
AcSIR-27-ID-010	Environmental Microbiology & Biotechnology
AcSIR-27-ID-011	Environmental Microbiology & Ecology
AcSIR-27-ID-012	Environmental pollution & Toxicology
AcSIR-27-ID-013	Groundwater Flow and Contaminant Transport Through Porous Media
AcSIR-27-ID-014	Municipal Solid and Biomedical Waste Management
AcSIR-27-ID-015	Municipal Water and Wastewater Systems

27 CSIR-NEERI

2 *Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-27-ID-016	Physicochemical Treatment Technologies
AcSIR-27-ID-017	Physicochemical Treatment-Chemical Perspective

AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute **CSIR-NEERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Air Pollution Science & Engineering	Course Code	Credits
		AcSIR-27-ID-001	1

Air Pollutants and their Effects: The air pollution system; Gases and particulate; Atmospheric sources, sinks, transport; Effects of health and environment; Criterial pollutants, ambient and source standards.
Aerosols: Characterisation of aerosols, size distributions, measurement methods;
Transport behaviour: diffusion, sedimentation, inertial, electrical and thermal; Aerosol
Dynamics: nucleation, condensation and coagulation, Radiation properties – visibility, climate effects; principles of particulate control systems.
Gaseous Pollutants: Vapour-liquid and vapour-solid equilibria; Diffusion and Interfacial mass-transfer; Control systems.
Air quality management: dispersion modeling, source apportionment methods.

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AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute | CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Biodiversity and Conservation	Course Code	Credits
		AcSIR-27-ID-002	1

Introduction to biodiversity: Species diversity, Genetic diversity, Community and Ecosystem diversity.
Biodiversity magnitude and distribution: Speciation and build-up, Diversity gradients and related hypotheses, Biodiversity and ecosystem function, Methods for biodiversity monitoring.
Biodiversity and ecosystem services: Provisioning, regulating, cultural and supporting.
Threats to biodiversity: Natural and anthropogenic, Species extinctions, IUCN threat categories, Red data book.
Invasions: Causes and impact.
Biodiversity conservation, principles and strategies; in situ and ex situ conservation, Protected area network.
Mega diversity zones and hot spots: Concepts, distribution and importance.
Convention on biological diversity, Biodiversity Act., NBSAP
Use of biodiversity: Source of food, medicine, raw material, aesthetic and cultural.
Biodiversity prospection.

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AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute **CSIR-NEERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Biological Treatment in Chemical Perspective	**AcSIR-27-ID-003**	**1**

Classification of biochemical operations; Stoichiometry and kinetics of biochemical operations; Modelling of suspended growth systems (basic model for CSTRs; Extensions of the basic model; Methods of biomass recycle and retainment; Techniques for evaluation of kinetic and stoichiometric parameters; Multiple microbial activities in reactors); Design and evaluation of suspended growth processes (guiding principles; Iterative nature of process design and evaluation; Basic decisions during design; Levels of design; Factors to be considered during design); Biological nutrient removal (carbon, nitrogen and phosphorous removal); Anaerobic treatment (process options, components of anaerobic reactions that influence process design); Attached growth reactors (process description and applications); Biodegradation of xenobiotic organic chemicals.

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AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute | CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Biological Treatment Technologies	AcSIR-27-ID-004	1

Biological Treatment of Wastewater – Aerobic System, Biological processes for domestic and industrial waste water treatments; Aerobic systems - activated sludge process, trickling filters, biological filters, rotating biological contractors (RBC), Fluidized bed reactor (FBR), expanded bed reactor, Inverse fluidized bed biofilm reactor (IFBBR) packed bed reactors air- sparged reactors.

Biological Treatment of Wastewater: Anaerobic System Anaerobic biological treatment - contact digesters, packed column reactors, UASB. Theory and design of biological unit operations; aerobic and anaerobic processes; Aerobic unit operations for organic carbon removal such as activated sludge, tricling filter, oxidation ditch, oxidations ponds, aerated lagoons, root zone treatment, vermifilter etc. Anaerobic operations for organic carbon removal such as UASB, filters, fluidized/expanded bed systems etc. Biological unit operations for nitrogen and phosphorus removal.

Theory and design of Sludge treatment, sludge thickening, sludge drying, incineration, aerobic and anaerobic digestion of sludges. Theory and design of wastewater disposal and systems; disposal to inland water bodies, sea/ocean disposal; land/underground disposal.

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AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Conservation and Restoration Ecology	Course Code	Credits
		AcSIR-27-ID-005	1

Introduction to Conservation Ecology: Principles, postulates and ethics. Population dynamics and conservation: Genetic variation and its loss, variation in natural populations, mechanisms of population regulation, habitat specific demography, population viability analysis Species and habitat conservation: Prioritizing species and habitat, protected area networks, theory of reserve design Diagnosis and prediction: Predicting ecological consequences of changes, environmental impact assessment Conservation strategies: Planning and management, plan process for species and site management; general principles of management; models of sustainable development Ecology of disturbed ecosystems: Ecosystem dynamics and stability, disturbances, impact of disturbances on the structure and functioning of ecosystems Aims and strategies of restoration: Concepts of restoration, ecosystem reconstruction, major tools used in restoration Restoration of biological diversity: Acceleration of ecological succession, reintroduction of biota Degradation and restoration of natural ecosystems: Forest, grassland and lake Restoration of degraded soils: Saline/sodic soils, contaminated soils, mine spoils.

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AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Ecological Engineering	Course Code	Credits
		AcSIR-27-ID-006	1

Ecological engineering for restoration of degraded ecosystems,
Ecology of disturbed ecosystems: Disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems.
Concepts and strategies of ecosystem restoration, Biological and biotechnological tools of restoration.
Restoration of biological diversity: Acceleration of ecological succession, Reintroduction of biota.
Degradation and restoration of Forests ecosystems, Grassland ecosystems, Aquatic ecosystems, Wetlands.
Restoration of wastelands and degraded soils: Restoration of contaminated soils and soil fertility, Mine spoil restoration.

References:

1. Begon, M., Townsend, C. R., and Harper, J. L. Ecology from Individuals to Ecosystems. Wiley-Blackwell, USA. 2005.
2. Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007.
3. Chapman, J. L. and Reiss, M. J. Ecology: Principles and Applications. Cambridge University Press, UK. 1998.
4. Cotgreave, Peter and Forseth, Irwin. Introductory Ecology. Wiley-Blackwell, USA. 2002.
5. Cunningham, W. P. and Cunningham, M. A. Principles of Environment Science. Enquiry and Applications. 2nd ed. Tata McGraw Hill, New Delhi. 2004.
6. Frankel, O. H., Brown, A. H. D. and Burdon, J. J. Conservation of Plant Biodiversity.Cambridge University Press, UK. 1995.
7. Gadgil, Madhav and Rao, P.R.S. Nurturing Biodiversity: An Indian Agenda. Centre for Environment Education, Ahmadabad, India. 1999.
8. Gaston, K. J. and Spicer, J. I. Biodiversity: An Introduction. Blackwell, UK. 1998.
9. Jeffries, M. Biodiversity and Conservation. 2nd ed. Routledge, USA.1997.
10. Kohli, R. K., Jose, S., Singh, H. P. and Batish, D. R.. Invasive Plants and Forest
11. Ecosystems. CRC Press / Taylor ad Francis. 2009.
12. Leveque, C. Ecology: From Ecosystem to Biosphere. Science Publishers, USA. 2003. Odum, E.

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AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Energy Conversion and Environment	Course Code	Credits
		AcSIR-27-ID-007	1

Energy crisis: Historical events, Energy requirement of society in past and present situation, Availability and need of conventional energy resources, Major environmental problems related to the conventional energy resources, Future possibilities of energy need and availability.
Non-conventional energy sources: Hydel power plant, Tidal energy, Biomass energy, Wind energy, Hydrogen as a source of energy, Energy conversion technologies, their principles, equipment and suitability in Indian context. Environmental impacts of these technologies.
Solar Energy: Sun as source of energy, Direct methods of solar energy collection, Process of photovoltaic energy conversion, Solar energy conversion technologies and devices, their principles, working and applications, Environmental impacts of solar energy.
Biomass energy: Concept of biomass energy utilization, Types of biomass energy, Conversion processes, Biogas production, Biomass gasification process and technologies, Environmental impacts of biomass energy.
Energy Storage: Types of energy storage, Devices for sensible and latent heat storage, Energy storage in dry batteries, Nickel-cadmium batteries, Secondary heat storage, Chemical storage, Environmental consequences of energy storage systems.
Heat energy recovery systems: Approaches to waste energy utilization, Equipment, Utilization system, Objective & principles of heat transfer, Gas to gas heat transfer, Gas to liquid heat transfer, Recovery of waste heat in coil coating, Non-conventional liquid fuels, Heat recovery by cogeneration.

1. Bewik M.W.M. - Handbook of organic waste conversion.
2. Bokris J.O. - Energy, the solar hydrogen alternative.
3. Rai G.D - Non-conventional Energy Sources.
4. Sukhatme S.P.- Solar Energy.
5. Kiang Y. H.- Waste Energy Utilization Technology.

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AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute **CSIR-NEERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Environmental Chemistry & Toxicology	**AcSIR-27-ID-008**	**1**

Air, water and noise quality standards, Air, water and soil pollutants: Types, Major sources and Effects, Air, water and soil pollutants borne diseases, Pollution management technologies, Major sources of noise pollution, Effects of noise pollution on health, Technologies for noise pollution management.
Radioactive pollutants: Types, Major sources and effects, Transport and transformation of chemicals: Phase Interactions, Degradation of food stuffs (carbohydrates, proteins), Detergents, Pesticides, Hydrocarbons (aliphatic and aromatic), Photolysis, Volatility, Classification of elements, Complex formation, Hydrophobic interactions, Chemical speciation.
Toxicants, Distribution, Metabolism of toxicants, Sites of action, Classification of toxicity, Acute and sub-acute toxicity bioassays, Factors influencing toxicity, Elimination of toxicants, Methods of toxicity testing, Statistical evaluation & assessment, Sediment toxicity, Biochemical markers/indicators, Toxicokinetic, Bioconcentration, bio-accumulation and bio-magnification in the environment.
Xenobiotics, Chemical carcinogenesis, Genotoxicity assays, Neurotoxicity, Skin toxicity, Immunotoxicity, Renal toxicity.
Toxicity of monomers, solvents, intermediates, products, Toxic substrates, Metals and other inorganic Chemicals, Organic Compounds, Persistent chemicals.
Procedures for assessing the risk, Risk measurement and Mitigation of environmental disorders, Factors in risk assessment.

References:

1. Crosby, D.G.1998. Environmental Toxicology and Chemistry, Oxford University Press, New York.Hodgson, A. 2004, A text book of Modern Toxicology, John Wiley and Sons, Inc.NJ.
2. Walker, C. H. et al., 1996. Principles of Ecotoxicology, Taylor and Francis, Inc, ISBN 74803557.
3. Ballantyne, B. Marrs, T. M and Syversen, T. 1999. General and Applied Toxicology 2nd ed. Mac Millan Reference Ltd.
4. Hodson, E. and R.C. Smart, 2001, Introduction to Bio-chemical toxicology, Wiley Interscience, New York.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Environmental Impact and Risk Assessment	Course Code	Credits
		AcSIR-27-ID-009	1

Important legislations related to environment, Duties and responsibilities of citizens for environmental protection, Environmental impact assessment (EIA), Cost benefit analysis, Environmental audit, ISO 14000 standards and certification, Process of environmental clearance for establishment of an industry.

References:

1. Sullivan Rory, Wyndham Hugh, 2001, Effective Environmental Management: Principles and Case Studies, Allen & Unwin, Business & Economics.
2. Chris Park, 2001, The Environment: Principles and Application, Routledge Taylor & Francis Group.
3. John Glasson, Riki Therivel and Andrew Chadwick, 2005, Introduction to Environmental Impact Assessment, UCL Press, London
4. Clair N. Sawyer, Perry L. McCarty and Gene F. Parkin, 2003, Chemistry for Environmental Engineering and Science, 5th ed., TATA Mc. Graw Hill.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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CSIR-National Environmental Engineering Research Institute	CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Environmental Microbiology & Biotechnology	Course Code	Credits
		AcSIR-27-ID-010	1

Classification of microorganisms: prokaryotic, eukaryotic, cell structure, characteristics, Preservation of microorganisms, DNA, RNA, replication, Recombinant DNA technology. Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism, respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, Bioenergetics. Distribution / diversity of Microorganisms in fresh and marine, terrestrial microbes in surface soil, Air outdoor and Indoor, aerosols, biosafety in Laboratory, Extreme Environment, Archaebacteria. Transmission of pathogens: Bacterial, Viral, Protozoan, Indicator organisms of water: Coliforms, total coliforms, E-coli, Streptococcus, Clostridium, Control of microorganisms; Significance in water supplies – problems and control, Concentration and detection of virus, Transmissible diseases. Xenobiotic compounds, recalcitrance.

Hazardous wastes: biodegradation of Xenobiotics. Biological detoxification: market for hazardous biotechnology application to hazardous waste management, examples of biotechnological applications to hazardous waste management, cyanide detoxification, detoxification of oxalate, urea etc., toxic organics - phenols. Bioremediation, Biostimulation of Naturally occurring microbial activities, Bioaugmentation, in situ, ex situ, intrinsic & engineered bioremediation, Solid phase bioremediation, land farming, prepared beds, soil piles, Phytoremediation. Composting, Bioventing & Biosparging; Liquid phase bioremediation, suspended bioreactors, fixed biofilm reactors. Mining and Metal biotechnology with special reference to Copper & Iron. Microbial transformation, accumulation and concentration of metals, metal leaching, extraction and future prospects. Microorganisms and Production of nonconventional fuels:Methane (Biogas), Hydrogen, Alcohols and algal hydrocarbons, Use of microorganisms in augmentation of petroleum recovery. Biological treatment processes – aerobic and anaerobic, a -oxidation, β-oxidation, nitrification and denitrification, Biological Treatment of Wastewater: Aerobic System, Biological processes for domestic and industrial waste water treatments; Aerobic systems - activated sludge process, trickling filters, biological filters, rotating biological contractors (RBC), Fluidized bed reactor (FBR), expanded bed reactor, Inverse fluidized bed biofilm reactor (IFBBR) packed bed reactors air- sparged reactors, Biological Treatment of Wastewater – Anaerobic System Anaerobic biological treatment - contact digesters,

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AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute	**CSIR-NEERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Environmental Microbiology & Ecology	**AcSIR-27-ID-011**	**1**

Microbes as tools for understanding the biological processes: Physiology, Biochemistry, Genetics, Molecular biology, Genomics, Proteomics.

Microbes and environment: Pollution abatement, Bioindicators, Restoration of degraded ecosystems, Biodegradation, Bioremediation, Biogenic gases, Microbes in biological warfare.

Applications of microbes in fermentation processes: Types, design and maintenance of bioreactors, Application of fermentation technology in industry.

Medical microbiology: Microbes as causal agents of human and animal diseases; Immunology: Basic concepts, Vaccines, Immunotherapy.

Role of microbes in agriculture: Nitrogen economy, Plant health, Biological control.

Symbiotic associations: Concepts, types and applications.

Microbes in food and dairy industry: Mushrooms, Fermented foods, Microbial spoilage of food and dairy products, Toxins.

Extremophiles and their biotechnological applications.

Microbial technology: Biosensors, Biomolecules, Enzymes.

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CSIR-National Environmental Engineering Research Institute CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Environmental pollution & Toxicology	AcSIR-27-ID-012	1

Types, major sources and effects of air/water/soil pollutants, air/water/soil borne diseases and technologies for air/water/soil pollution management.
Major sources of noise pollution, effects of noise pollution on health and technologies for noise pollution management, Types, major sources and effects of radioactive pollutants, Air, water and noise quality standards.
Transport and transformation of chemicals, Phase Interactions Degradation of food stuffs (carbohydrates, proteins), Detergents, Pesticides, hydrocarbons (aliphatic and aromatic), Photolysis, Volatility, Classification of elements, Complex formation, Hydrophobic interactions, Chemical speciation.
Toxicants, Distribution, Metabolism of toxicants, sites of action, classification of toxicity, acute and sub-acute toxicity bioassay, Factors influencing toxicity, Elimination of toxicants, Methods of toxicity testing, Evaluation - statistical assessment, sediment toxicity, Bio- chemical markers/indicators, Toxicokinetic, Bioconcentration, Bio-accumulation and Bio magnification in the environment.
Xenobiotics, Chemical carcinogenesis, Genotoxicity assays, Neurotoxicity, Skin toxicity, Immunotoxicity. Renal toxicity, Endocrine disruptors, hormones, receptors.
Toxicity of monomers, solvents, intermediates, products, toxic substrates, Metals and other inorganic Chemicals, Organic Compounds, Persistent chemicals.
Procedures for assessing the risk, Risk measurement and Mitigation of environmental disorders, Factors in risk assessment.

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CSIR-National Environmental Engineering Research Institute | CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Groundwater Flow and Contaminant Transport Through Porous Media	Course Code	Credits
		AcSIR-27-ID-013	1

Water movement in the subsurface; Groundwater and the hydrologic cycle; The groundwater environment; Types of aquifers; Sources of contamination; Saturated flow: continuity equation; Darcy's Law; Equation of flow; Analytical solutions and numerical modeling; Unsaturated flow; Ground water sampling methods and analyses.
Transport of contaminants; Transport equation; Dispersion and diffusion in porous media; Reaction terms; Analytical solutions; Soil chemistry; Groundwater quality; Common soil minerals and components; Forces at soil-water interfaces;
Adsorption and surface complexation models; Interaction of non-polar compounds with soils; Soil chemical kinetics; Modelling Groundwater Pollution; Coupling of contaminant-soil interactions with transport; Reaction and transport of trace metals, ligands and nonpolar organic solutes.

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CSIR-National Environmental Engineering Research Institute CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Municipal Solid and Biomedical Waste Management	Course Code	Credits
		AcSIR-27-ID-014	1

Solid waste management: Sources, Composition and properties of Municipal solid waste, Engineering principles, Generation of solid waste, Onsite handling, Storage and processing including segregation, Collection of solid waste, Transfer and transport, Processing techniques and equipments, Recovery of resources, Conversion products and energy, Composting, Recycling, Incineration and pyrolysis, Disposal of solid waste including sanitary landfill, planning, siting, design, closure and postclosure monitoring, Regional/Integrated solid waste management related issues.
Biomedical waste: Regulatory framework, Categorization, Generation, Collection, Transport, Treatment and Disposal.

1. Tchobanoglous, G., Theisen, H., and Vigil, S.A., Integrated Solid Waste Management: Principles and Management Issues, McGraw Hill Book Company, Singapore, 1993.
2. Powes, P.W., How to Dispose of Toxic Substances and Industrial Waste, Noyes Data Corporation, England, 1976.
3. Pavoni, J.L., Handbook of Solid Waste Disposal, Solid Waste Management, Van Nostrand-Reinhold Co., 1975.
4. Mantell, C.L., Solid Waste Management, John Wiley, New York, 1975.

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AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute **CSIR-NEERI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Municipal Water and Wastewater Systems	Course Code	Credits
		AcSIR-27-ID-015	1

Working principles and design of various physical and chemical treatment systems for water and wastewater, Water treatment concepts: Pretreatment, primary treatment, Secondary treatment, Tertiary treatment. Water quality characteristics & standards.

Biological treatment of wastewater: Aerobic system.

Biological processes for domestic wastewater: Aerobic systems, Activated sludge process, Trickling filters, Biological filters, Rotating biological contractors (RBC), Fluidized bed reactor (FBR), Expanded bed reactor, Inverse fluidized bed biofilm reactor (IFBBR), Packed bed reactors, Air- sparged reactors.

Anaerobic System: Anaerobic biological treatment, Contact digesters, Packed column reactors, UASB.

Theory and design of physicochemical unit operations: Screening, Grit, removal equalisation, Sedimentation, Floatation, Caogulation-flocculation, Filtration, Disinfection, Membrane processes, Desalination, Ion-exchange, Aeration/gas transfer, Precipitation, Adsorption.

Hydraulics of treatment plant: Flow measurement and hydraulic control points, Hydraulic analysis of unit operations, Hydraulic profile through the treatment plant.

References:

1. Bajwa, G.S. Practical Handbook on Public Health Engineering, Deep Publishers, Shimla, 2003
2. “Manual on water supply and Treatment”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
3. “Manual on Sewerage and Sewage Treatment”, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1993.
4. Metcalf and Eddy, Wastewater Engineering, Treatment and Reuse, Tata McGraw Hill, New Delhi, 2003.
5. Qasim, S.R., Motley, E.M. and Zhu.G. Water works Engineering – Planning, Design and Operation, Prentice Hall, New Delhi, 2002.
6. Lee, C.C. and Shun dar Lin, Handbook of Environmental Engineering Calculations, Mc Graw Hill, New York, 1999.
7. Hendricks, D. ‘Water Treatment Unit Processes – Physical and Chemical’ CRC Press, New York, 2006.

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AcSIR Academic Centre Code: 27

CSIR-National Environmental Engineering Research Institute CSIR-NEERI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Physicochemical Treatment Technologies	Course Code	Credits
		AcSIR-27-ID-016	1

Theory and design of physicochemical unit operations; screening, grit, removal equalisation, sedimentation, floatation, caogulation-flocculation, filtration, disinfection, membrane processes, desalination, ion-exchange, aeration/gas transfer, precipitation, adsorption. Hydraulics of treatment plant; flow measurement and hydraulic control points, hydraulic analysis of unit operations, hydraulic profile through the treatment plant.

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Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Physicochemical Treatment-Chemical Perspective	Course Code	Credits
		AcSIR-27-ID-017	1

Overview of mass transfer and reactor concepts; Mass transport mechanisms; Ideal reactors, non-idealities, Mass balance in various reactor configurations.
Particle separation processes; Coagulation and flocculation processes, Particle surface charge, surface potential and stability of colloidal dispersions; Sedimentation and flotation processes, Gravity thickeners, clarifiers and flotation systems; Filtration and Ultrafiltration Processes, Modeling approaches for rapid sand filters.
Solute separation processes; Gas transfer processes, Diffused and surface Aeration and Air stripping of volatile contaminants in packed tower; Adsorption and ion exchange processes, sorption isotherm models and rates considerations, Sorption in completely mixed and packed bed reactors; Precipitation processes; Reverse osmosis and electrodialysis.
Species transformation processes; Chemical oxidation / reduction processes, disinfection using chlorine and UV.

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28	CSIR-NGRI	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-28-ID-001	Geosciences (Geophysics, Geology, Geochemistry, GIS)

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 28

CSIR-National Geophysical Research Institute CSIR-NGRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Geosciences (Geophysics, Geology, Geochemistry, GIS)	Course Code	Credits
		AcSIR-28-ID-001	4

The solar system: Origin of the solar system, Earth and other planets.
Fundamentals of geochemistry: Origin of elements, geochemical classification of elements, ion substitutions and geochemical distribution and dispersal of chemical elements.
Fundamentals of crystallography: Definitions of crystalline and amorphous states, morphology of crystals, symmetry elements, Miller indices and classification of crystals into 7 systems. Basic mineralogy: definitions, physical and optical properties of minerals and descriptive mineralogy of olivine, pyroxene, garnet, amphibole, micas, quartz, feldspars and feldspathoides and oxides.
Fundamentals of petrology: Definition of rocks, classification, basics of petrography, descriptive petrology of: (a) Igneous rocks– granite, granodiorite, syenite, porphyritic granite, pegmatite, gabbro, dunite, dolerite, rhyolite, basalt; (b) Sedimentary rocks- mode of formation, source, transportation and deposition, classification of sedimentary rocks, brief description of conglomerate, breccia, sandstone, shale, limestone, dolomite; (c) Metamorphic rocks- definition, types and agents of metamorphism, grades and zones of metamorphism. Description of quartzite, marble, slate, phyllite, schist, gneiss, charnockite and khondalite.
The dynamic Earth: Surface processes, concepts of plate tectonics, plate boundaries, subduction zones, hotspots and mantle plumes, flood basalt provinces, triple junctions, midoceanic ridges, transform faults, island arcs, foreland basins, back arc basins, seamounts, bathymetry, continental drift, sea floor spreading, making and breaking of continents (Pangaea, Rodinia, Gondwanaland).
Concept of stratigraphy: Standard geological time scale, principles of correlation, introduction to ore minerals, ore and ore deposits, brief account of mineral resources of India.
Gravity and Figure of the Earth: (a) Size and shape of the Earth, Gravitation, Figure of the Earth, Geoid; (b) Density distribution in the Earth, Gravity anomalies; (c) Concepts of Isostasy.
Seismology and Internal Structure of the Earth: (a) Elastic waves and their propagation, physical properties of rocks, P-waves, S-waves, surface waves including Rayleigh and Love waves, identification of phases in seismograms. (b) Structure of the earth, crust, mantle, core, lithosphere and asthenosphere. (c) Types of seismographs, earthquake magnitude and intensity, location of earthquakes, types of earthquake faulting, focal mechanism; (d) Great earthquakes, seismic hazard.

Earth's Heat: (a) Heat flow, sources of heat inside the Earth, Heat transport in the Earth, Thermal storage and transport properties of rocks, rock radioactivity. (b) Distribution of heat flow in continents and oceans, equation of heat conduction, continental and oceanic geotherm. 10. Geomagnetism and Palaeomagnetism: (a) Magnetic elements and description of the Earth's magnetic field; (b) Origin of Earth's magnetic field, magnetic reversals; (c) Palaeomagnetism, continental drift and polar wander.
Methods in Exploration Geophysics: Fundamentals of (a) Controlled source seismic studies, seismic refraction and reflection methods, (b) Gravity and magnetic methods, (c) Electrical and electromagnetic methods, (d) Radioactive methods and (e) Well logging; applications in geosciences.
Geographical Information System (GIS): Software, techniques and applications in geosciences.

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29	CSIR-NIO	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-29-ID-001	Introduction to Oceanography

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 29

CSIR-National Institute of Oceanography CSIR-NIO

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Introduction to Oceanography	Course Code	Credits
		AcSIR-29-ID-001	2

Physical properties of sea water and their distribution, light and sound propagation in sea water, Water masses and thermohaline circulation, Wind-driven circulation- Global Ocean, Wind-driven circulation- Indian Ocean, Oceanic processes, Waves and Tides, Geological time scale and major physicochemical and biological events in earth's history, Plate Tectonics and Seafloor Spreading, Ocean floor morphology, Marine geophysical methods of exploration, Introduction to Paleoclimate studies, Introductory Marine Geochemistry, Introduction to Biological Oceanography, General microbial ecology, Phytoplankton ecology, measurement and control of primary production, Zooplankton ecology, measurement and control of secondary production, Benthic Ecology, Benthic-Pelagic coupling, Benthic biomass structure and production, Changing environment and Food web dynamics, Elemental Composition of seawater and Behaviour of substances, Distribution of Nutrients in the Oceans, Biogeochemical cycling in the marine Environment, Global Climate Change & Ecosystem
Impacts, Exchange of materials across interfaces, Sampling and analytical tools in ocean chemistry

Practical Modules

Practical 1: Sediment texture, carbon analyses and basic geochemical analyses

Practical 2: Micropaleontology

Practical 3: Interpretation of geological features & sedimehtary strata from the processed seismic section, and conversion of time section into depth
section

Practical 4: General Microbiology Techniques

Practical 5: Primary and Secondary production; measurement and new production

Practical 6: Collection, qualitative and quantitative enumeration techniques, Phytoplankton, Zooplankton and Benthos

Practical 7: Measurement of dissolved oxygen in seawater

Practical 8: Dissolved Nutrients

Practical 9: Dissolved gases, pH scales and Carbon dioxide system.

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Course Code	Course Title
AcSIR-30-ID-001	Foundations of Mathematics
AcSIR-30-ID-002	An Introduction to Proability and Statistics

AcSIR Academic Centre Code: 30

CSIR-National Institute of Science, Technology and Development **CSIR-NISTADS**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Foundations of Mathematics	**AcSIR-30-ID-001**	**1**

Course Description: This course introduces students to the basic concepts and applications of mathematics. Students learn how to identify key ideas of mathematics, to detect and generate workable structures using them, and to model system processes in different disciplines. The applications of the mathematical knowledge are in fields as diverse as sociology, biology, growth and diffusion processes in epidemiology, economics and statistics, engineering, telecommunications and messaging, etc.

Learning Objectives: The main learning objective of this course is to enable students to think analytically in a planned, informed and efficient manner. This goal involves formalize different types of mathematical concepts, Plan and execute applications of concepts in physical problems, Interpret and synthesize the meaning of the results with respect to a specific question, goal, or task.

Topics Covered: Calculus, Numbers, Integers, Rational and irrational numbers, Real number continuum, Associated mathematical operations on numbers, Functions, limits, and continuity, Definition of single variable and multivariable functions, Limits of functions, Continuous and discontinuous functions, Derivatives and integrals, Ordinary derivatives of common functions, Derivatives as rates, Partial derivatives, Indefinite integrals of ordinary functions, Definite integrals as the limit of a sum, Definite integrals as areas, Differential equations and dynamical systems, Introduction to ordinary differential equations, Dynamical systems and their behavior in time, Optimization and constraints, Understanding optimization problems, Constraints, Optimization subject to constraints, Algebra and trigonometry, Binomial theorem, Permutations and combinations, Basic trigonometric functions Logarithms

Linear Algebra: Set theory, Elements of sets and operations on them, Vectors, Concept of vectors, Operations on vectors (addition; subtraction; dot products; compositions; etc.), Matrices, Matrices and determinants, Matrix operations (addition; subtraction; products; inversion; etc.), Eigenvalues and eigenvectors.

Application of Mathematics interdisciplinary approach.

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AcSIR Academic Centre Code: 30

CSIR-National Institute of Science, Technology and Development CSIR-NISTADS

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:		Course Code	Credits
	An Introduction to Proability and Statistics	AcSIR-30-ID-002	1

Probability and Statistics are the pillars of mordern and evolved data based research having its application in almost all disciplines. This course is aimed to familiarise students with basic concepts and notions of the Probability and Statistics and also to develop their understanding through numerous excersises. The course is designed for Ph.D. students to strengthen their fundamentals and ideas about the applications of Probability and Statistics in their research.

Probablity and Statitics for a long time have been appreciated in basics sciences such as Mathematics and Physics while now a days these are being applied in almost all areas of research ranging from Agriculture, biology, economics to sociology etc. The objective of the course it to train the students from the first principal so that they would be capable of using these efficiently in their research.

Introduction to Statistics: Introduction to Statistics: Relevance of statistics, Mathematical models deterministic and Stochastic, Concept of Random variables- Discussion on the concept, Simulation of Pseudo-random numbers, Concept of Populations and Samples, Parameters and Statistics.

Review of basic concepts, Measurement theory, Levels of measurement, Numerical measures of data, Graphical presentation of data, Chebyshev's theorem, Measurement uncertainty.

Probability theory: Probability Theory, Axioms of probability, Measure of Probability, Joint Probability, Marginal Probability, Conditional Probability and Baye’s Theorem, Venn Diagram, Distribution functions and their applications - discrete and continuous distributions, Simulation of coin-toss and introduction to Binomial and Multinomial distributions, Pascal triangle, Derivation Binomial distribution from coin-toss example, Emergence of the Bell curve in coin-toss.

Theoretical distributions: Probability mass and probability density function, Characteristics of theoretical distributions, Moments, Central Moments and Cumulants, Binomial Distribution and negative-Binomial distribution, Normal (Gaussian) and Poisson's distributions and their relations to Binomial and negative-Binomial distribution, General features of normal distributions, Probability calculations with normal distributions, Normal distribution tables Assessing Normality, Normal Probability Plot Interpretation, Simulation of Normal distribution, Bivariate normal distribution and correlations, Central Limit Theorem.

Data samplin: Methods for selecting sampling locations and times, sampling theory, Sample size determination for different sampling designs.

Tests of hypothesis: Basic understanding of hypothesis, Hypothesis testing parametric and non-parametric tests.

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31	CSIR-NML	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-31-ID-001	Advanced Metallurgical Thermodynamics
AcSIR-31-ID-002	Corrosion & Control
AcSIR-31-ID-003	Introduction to Materials
AcSIR-31-ID-004	Kinetics of Metallurgical Processes
AcSIR-31-ID-005	Principles and Advances in Iron Making
AcSIR-31-ID-006	Principles and Advances in Steel Making
AcSIR-31-ID-007	Principles of Physical Metallurgy

AcSIR Academic Centre Code: 31

CSIR-National Metallurgical Laboratory	**CSIR-NML**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Advanced Metallurgical Thermodynamics	**AcSIR-31-ID-001**	**1**

Introduction to Thermodynamics, First Law of Thermodynamics and related thermodynamics laws, second law of thermodynamic and related properties.
Third law of thermodynamics and related issues. Concept of free energy, standard state etc. Fugacity, activity, concept of standard state. Equilibrium constant involving gas and condensed phases. Dependence of equilibrium constant and free energy on temperature. Thermodynamics of solution partial molar quantities, Route's law, Henry's law, Alternative standard state, Sieverts law, Mixing, excess functions, Gibbs Duhem equation, regular solution involving multi component systems. Ellingham diagram and its application in metallurgical system. Phase equilibria, Construction of binary and ternary phase diagram. Concept of computational thermodynamics. Application of Computational thermodynamics using thermocal.

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AcSIR Academic Centre Code: 31

CSIR-National Metallurgical Laboratory CSIR-NML

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Corrosion & Control	Course Code	Credits
		AcSIR-31-ID-002	1

Interaction of metals with environments, formation of electrical double layer at metals - environments interface, mixed potential theory of corrosion, Stearn-Geary and Tafel equations, stress assisted corrosion and cracking , principles involved in controlling corrosion,Development of corrosion resistant alloys and materials, protective coatings, cathodic andanodic protection, passivity, Pourbaix diagram for metals and alloys, Corrosion inhibitors.

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AcSIR Academic Centre Code: 31

CSIR-National Metallurgical Laboratory	**CSIR-NML**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Introduction to Materials**	**Course Code**	**Credits**
		AcSIR-31-ID-003	**1**

Inter-atomic Interactions & Materials; Solid state of Material: Bonding in solids Atoms in a Solid Material: Basic Concepts of Crystallography, Concept of reciprocal lattice in structure determination. Packing of atoms in 3d-space. Defects in solids. Phases and concept of phase transformation Diffusion and Diffusion Less Transformations. Concept of Mechanical behavior of Materials.

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CSIR-National Metallurgical Laboratory **CSIR-NML**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Kinetics of Metallurgical Processes	**AcSIR-31-ID-004**	**1**

Kinetics of Metallurgical Processes

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AcSIR Academic Centre Code: 31

CSIR-National Metallurgical Laboratory	**CSIR-NML**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Principles and Advances in Iron Making**	**Course Code**	**Credits**
		AcSIR-31-ID-005	**1**

Principles of iron making, Techniques of agglomeration (sintering and pelletization), Raw materials characterization (RI, RDI, Swelling index, Tumbler, shatter), BF iron making process and modeling, Sponge iron making (coal base, gas base). Alternative routes of iron making (COREX, HISMELT).

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AcSIR Academic Centre Code: 31

CSIR-National Metallurgical Laboratory	CSIR-NML

Course 2 : Inter-disciplinary / Cross-disciplinary | **Total Credits 2**

Title:	Principles and Advances in Steel Making	Course Code	Credits
		AcSIR-31-ID-006	1

Principles of steel making, Different processes of steel making, Secondary steel making, Ingot casting and continuous casting, Electric processes (EAF and induction furnace), alloy steel making.

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AcSIR Academic Centre Code: 31

CSIR-National Metallurgical Laboratory	CSIR-NML

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Principles of Physical Metallurgy	AcSIR-31-ID-007	1

Crystal structures and defects in solid; Diffusion; Thermodynamics and kinetics of transformations; Equilibrium phase diagram; Solidification; Solid state phase transformations; Strengthening mechanism; Engineering alloys.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

32	CSIR-NPL	2	Inter-disciplinary / Cross-disciplinary

Course Code	Course Title
AcSIR-32-ID-001	Electromagnetic Wave Characterization for Physicist and Biologist
AcSIR-32-ID-002	Electromagnetic Waves Characterizations for Physicist and Biologist
AcSIR-32-ID-003	Engineering Materials
AcSIR-32-ID-004	Environmental Chemistry & Metrology
AcSIR-32-ID-005	Materials Metrology
AcSIR-32-ID-006	Metrology in Chemistry
AcSIR-32-ID-007	Microwave Metrology

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory	CSIR-NPL

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Electromagnetic Wave Characterization for Physicist and Biologist	AcSIR-32-ID-001	1

Advanced electromagnetism: Electric and magnetic fields in vacuum and matter, Maxwell's equations, Electromagnetic waves in dielectric media & conducting media, Sources of electromagnetic radiation, Electromagnetic shielding.
Scattering Parameters and their applications: Analysis of two ports and multiports network by using transmission matrix and S-parameters, S-parameter analysis of the microwave circuits.
Industrial application of microwaves: Microwaves in biomedical applications especially in hyperthermia, Microwaves based localized heating, S-parameters based EM material Characterizations.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory CSIR-NPL

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Electromagnetic Waves Characterizations for Physicist and Biologist	Course Code	Credits
		AcSIR-32-ID-002	1

Advanced Electromagnetism: Electric and magnetic fields in vacuum and matter, Maxwell's equations. Electromagnetic waves in dielectric media. Electromagnetic waves in conducting media. Sources of electromagnetic radiation, Electromagnetic shielding. Scattering Parameters and their applications: Analysis of two ports and multiports network by using transmission matrix and S- Parameters; Sparameter analysis of the microwave circuits; Industrial Application of Microwave: Microwave in Biomedical especially in Hyperthermia and Microwave based localized heating, S- parameters based EM Material Characterizations.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory	CSIR-NPL

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Engineering Materials	Course Code	Credits
		AcSIR-32-ID-003	1

Classification of engineering materials, material properties, selection of material, advanced and futuristic materials, smart materials, nanomaterials; phase diagram, equilibrium & kinetics, stable & metastable phases, nucleation and growth, metals. alloys and solid-solutions; ceramics, polymers, composites; crystal imperfections, defects, dislocations; elastic and plastic deformation, stress-strain curves, work hardening & dynamic recovery, strengthening mechanisms; solidification and crystallization, recovery, recrystallization and grain growth; creep, fatigue, fracture, oxidation and corrosion; materials processing techniques : liquid metallurgy, powder metallurgy, spray forming; secondary processing techniques : extrusion, forging, rolling; mechanical and metallurgical characterization, structureproperty correlations; lightweight materials, metal matrix composites, polymer matrix composites, ceramic matrix composites, carbon-based composites, nanocomposites, super-hard materials,
dielectric, ferroelectric and piezoelectric materials, magnetic materials.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory	CSIR-NPL

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Environmental Chemistry & Metrology	AcSIR-32-ID-004	1

Basics of air, water and soil pollution, Sources and impact of air pollution, Transport of air pollutants, Analytical chromatographic technique (GC) and its application in Environmental Chemistry, Quality assurance/Quality Control, Concept of qualitative and quantitative analysis of atmospheric aerosols samples, Trace gases/Green House Gases (GHGs), Measurements of trace gases/GHGs using online gas analyzers. Primary Ozone standard, Estimation of uncertainty in calibration of ozone analyzer.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory **CSIR-NPL**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Materials Metrology	Course Code	Credits
		AcSIR-32-ID-005	1

Basics of Metrology. Introduction to Reference materials includes preparation of |
reference material, homogeneity test. stability assessment. traceability,
uncertainty estimation. Introduction to ISO 1 7025. Scope and content of ISO 1 7025, (I) Management requirements (2) Technical requirements,
Test and calibration methods validation. Equipment, Measurement traceability,
Sampling, Assuring quality of test results, Reporting the results. Versailles Project on Advanced Materials and Standards (VAMAS). structure and its objectives, technical working areas, inter lab comparisons, forming of new technical areas, development of new methods and standards. Testing of materials.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory	**CSIR-NPL**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Metrology in Chemistry	**AcSIR-32-ID-006**	**1**

Basics of measurement in chemistry (MiC); Role of Standards, Reference Materials (R.Ms), Certified reference materials (CRMs), Secondary reference materials (SRMs), Working reference materials (WRMs), Importance of Bharatiya Nirdeshak Dravyas (BNDs). Method validation and quality control emphasized to Analytical procedures,

Control Charts, Inter laboratory comparisons (ILCs), Traceability in Chemical measurement, Uncertainty measurements for chemical parameters.

Development of BND related to Chemical Parameters in accordance with ISO 17034:2016. Basic principle of sophisticate instrument viz. AAS, ICPOES, HR-ICPMS and IC. Practical training on sample preparation gravimetrically and determination of

analytes / measurand by AAS, ICP-OES, IC.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory	CSIR-NPL

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Microwave Metrology	Course Code	Credits
		AcSIR-32-ID-007	1

Introduction to Primary standards in
Microwave Measurement : I. Micro-calorimeter, WBCO, Air Lines, GTEM, SAR measurement system, Uncertainty evaluation associated in microwave measurement, Review of antenna theory, Different Types of Antenna: dipoles, monopole and loop, antennas, linear and planar arrays, helical antennas, microstrip antennas and arrays Antennas.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

Course Code	Course Title
AcSIR-33-ID-001	Animal models in Biomedical Research
AcSIR-33-ID-002	Basic Chemistry
AcSIR-33-ID-003	Biology for Chemist
AcSIR-33-ID-004	Bioresources and Biodiversity
AcSIR-33-ID-005	Cancer Biology
AcSIR-33-ID-006	Nanobiology
AcSIR-33-ID-007	Nanobiology & Nanobiotechnology
AcSIR-33-ID-008	Nutraceutical & Nutrigenomics
AcSIR-33-ID-009	Pathogenesis and applications of plant viruses
AcSIR-33-ID-010	Plant Cell & Tissue Engineering

AcSIR Academic Centre Code: 33

CSIR-Institute of Himalayan Bioresource Technology — CSIR-IHBT

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Animal models in Biomedical Research	AcSIR-33-ID-001	1

History and introduction, Ethical guidelines, various model animals, selection of animal models, alternative models, housing and handling of laboratory animals, dosing, blood collection and necropsy procedures, laboratory animal biosafety and biosecurity, genetic monitoring, diseases of lab animals and zoonosis

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 33

CSIR-Institute of Himalayan Bioresource Technology	CSIR-IHBT

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Basic Chemistry	Course Code	Credits
		AcSIR-33-ID-002	1

Chromatography and Analytical Techniques: Theory and Applications; Principle of Green Chemistry; Green Chemistry: Principles and applications; Natural products: applications in medicinal chemistry and drug design; Reverse Pharmacology; Polyphenols and Flavonoid: Occurrence, Distribution, Biosynthesis and their importance in Plants, Animals and Humans; Terpenoids: Introduction, Distribution, Classification and their Biosynthetic Pathways; Alkoloids: Nomenclature, Isolation, characterization and their role in plants.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 33

CSIR-Institute of Himalayan Bioresource Technology	**CSIR-IHBT**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Biology for Chemist**	**Course Code**	**Credits**
		AcSIR-33-ID-003	**1**

Cell lines, ex vitro, in vitro, ex vivo and in vivo assays, IC50 and EC50 determination for lead optimization; Introduction to animal models and in vivo pharmacology; Clinical Biochemistry and histopathology; Traditional systems of medicine: use of herbal remedies and potential of drug development from natural products, Alternative to animals in drug discovery.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 33

CSIR-Institute of Himalayan Bioresource Technology	CSIR-IHBT

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title: Bioresources and Biodiversity	Course Code	Credits
	AcSIR-33-ID-004	1

Phyto-taxonomy principles and fundamentals, Hotspots, Mega-diversity, Threat categorization, Conservation initiatives, Principles and Practices of Ecology, habitats, Biomes, Community and continuum, Community organization, Diversity, Succession, Productivity, Trophic organization and Plant invasion, Principles of remote sensing, Sensors, Platforms, Digital image processing, Introduction and component of GIS, GIS data types, GIS analysis.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 33

CSIR-Institute of Himalayan Bioresource Technology	**CSIR-IHBT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Cancer Biology	Course Code	Credits
		AcSIR-33-ID-005	1

Introduction to cancer, cancer types and their prevalence, diseased and cancerous cell: morphological and microscopic features, important tumor markers, molecular basis of Key Players like carcinogens, tumor virology, oncogenes, tumor suppressor genes, cell cycle regulation in cancer development angiogenesis and malignancy, Hypoxia/ tumor cell microenvironment and important signaling pathways involved in cancer progression, cell death: nacrosis and apoptosis. Role of Histopathological & Immunocytochemical techniques in cancer diagnostics and research, initiation and propagation of cancer cells in cell culture systems. Aggressive tumors: Gleason score in pathology, Orthotropic and xenografted models: Importance and their limitations in understanding cancer.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 33

CSIR-Institute of Himalayan Bioresource Technology	CSIR-IHBT

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Nanobiology	AcSIR-33-ID-006	1

Nanobiotechnology and nanomaterials, Nanomaterials synthesis, Characterization of nanoparticles, Biomolecules-nanoparticle interaction, applications in nanomedicines and nanodiagnostics.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 33

CSIR-Institute of Himalayan Bioresource Technology CSIR-IHBT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Nanobiology & Nanobiotechnology	AcSIR-33-ID-007	1

Introduction, physicochemical properties and application of nanoscience and nanotechnology ; Nanomaterials synthesis (Bottom-up and top-down methods of synthesis); Characterizations of nanoparticles using spectroscopy and microscopy; Biomolecules- nanoparticle interaction (Cellular response of nanoparticles, biodegradable nanoparticles and their in vivo fate, Pathways for cellular uptake of nanoparticles), Nanomedicines and nanodiagnostics; Toxicity concerns of nanomaterials.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 33

CSIR-Institute of Himalayan Bioresource Technology	CSIR-IHBT

Course 2 : Inter-disciplinary / Cross-disciplinary   Total Credits 2

Title:	Nutraceutical & Nutrigenomics	Course Code	Credits
		AcSIR-33-ID-008	1

Dietary supplements and their relation to nourishment, Nutraceutical and Functional food, bioactive molecules as dietary supplements, interaction between bioactive dietary supplement in specific diseases, in vitro cellular and molecular mechanism of bioactive molecules and safety assessment. Nutrition and its importance in human health, nutrition and human genetic diversity, epigenomic and nutrition, ethical issue and social implication, nutritional enrichment and quality improvement of food products, nutrient toxicity and safety assessment, national and International standards, regulations and recommendation for human nutrition.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 33

CSIR-Institute of Himalayan Bioresource Technology	CSIR-IHBT

Course 2 : Inter-disciplinary / Cross-disciplinary | **Total Credits 2**

Title:	Pathogenesis and applications of plant viruses	Course Code	Credits
		AcSIR-33-ID-009	1

Introduction to viral pathogens, Basic differences between plant and animal viruses, Symptom and diversity of plant viral pathogens and their insect vectors, classification rules, Transmission characteristics of plant viral pathogens, viral diagnosis, applications of plant viruses for protein expression, vaccine production and functional characterization of plant genes (VIGS).

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 33

CSIR-Institute of Himalayan Bioresource Technology CSIR-IHBT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Plant Cell & Tissue Engineering	Course Code	Credits
		AcSIR-33-ID-010	1

Production of disease free quality planting materials; Somaclonal variations; Haploids; Endosperm culture, triploid production and its application; Protoplast culture, somatic hybrids and cybrids; Molecular mechanisms regulating metabolic pathways and cellular processes, Recombinant technology, Optimization and upscaling of engineered cells /tissue for higher secondary metabolite production.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

35 CSIR-AMPRI

2 *Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-35-ID-001	Computer Simulation and Modelling
AcSIR-35-ID-002	Heat Treatment
AcSIR-35-ID-003	Integrated Sensor Systems
AcSIR-35-ID-004	Material Engineering and Characterization
AcSIR-35-ID-005	Material Engineering for Inter-Disciplines
AcSIR-35-ID-006	Material Synthesis and Processing
AcSIR-35-ID-007	Nano Science and Nanotechnology
AcSIR-35-ID-008	Phase Transformation
AcSIR-35-ID-009	Polymer Science and Engineering
AcSIR-35-ID-010	Tribology-Science and Engineering

AcSIR Academic Centre Code: 35

CSIR-Advanced Materials and Processes Research Institute **CSIR-AMPRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Computer Simulation and Modelling	Course Code	Credits
		AcSIR-35-ID-001	1

Basic concepts, approach and significance, meshing, software, hardware, algorithms, introduction to finite element analysis, steps in finite element analysis, plane stress and plane strain, axi-symmetric conditions, elements in 2d and 3d problems, development of element and global stiffness matrix, convergence criteria, linear and non-linear analysis, features of FEA software, pre-processing, post- processing and analysis in different software Artificial neural network (ANN), supervised and unsupervised learning of ANN, fuzzy logic, fuzzy logic rules, engineering applications of modeling and optimization.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 35

CSIR-Advanced Materials and Processes Research Institute **CSIR-AMPRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Heat Treatment	**AcSIR-35-ID-002**	**1**

General principles and concepts, equilibrium diagram, lever rule, TTT diagram, processes, atmospheres (salt baths, gases), furnaces, quenching media, mechanism of quenching, mechanism and kinetics of oxidation, carburization and decarburization, vacuum as controlled atmosphere, residual (thermal and transformation) stresses, shape and size distortion and control, quenching cracks, transformation induced plasticity Heat treatment of steels and cast irons: Fe-Cequilibrium diagram, carbon equivalent, effects of alloying elements on heat treatment parameters, annealing, normalizing, hardening, hardenability, tempering, austempring, martempering, ausforming, subzero treatment, patenting, themomechanical treatments, case hardening (carburinzing, nitriding, carbonitriding, aluminizing, sheradizing), microstructural changes during heat treatment, malleablizing, fluidized bed treatments, induction hardening, selection of heat treatment parameters and cycles, thermal cycling, Heat treatment of some common Non-ferrous(Al-, Zn-, Mg- and Cu-based) alloys (solutionizing, natural and artificial ageing, continuous and discontinuous precipitates, grain growth and precipitate coarsening, coherent, semicoherent and incoherent precipitates, coherency strains, ASTM temper designations).

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 35

CSIR-Advanced Materials and Processes Research Institute **CSIR-AMPRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Integrated Sensor Systems	**AcSIR-35-ID-003**	**1**

Fundamentals of sensors and networked sensor systems, with special emphasis on sensor-fabrication. Smart Materials and Devices, Physics of Low Dimensions Devices, Electrochemical Sensors, Optical Sensors, Piezoelectric Sensors, Humidity Sensors, Field Effect Transistor, Micro and Nanofabrication Technologies and Characterization Techniques, Sensors Modelling and Simulation, Nanophotonics, Science and Technologies of semiconductor, Integrated Chip to System Design, Micro/Nanofluidics and sensor, Flexible sensors, Quantum dots based sensors, Micromachining, 3D Printing in Sensors, Nanorod-sensor probes; Magnetic Particles-sensor probes; NanowiresFET sensing system, Micro-Electro-Mechanical Systems (MEMS), Nanomachines, Advanced carbon nanotube/Graphene structures for sensing applications.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 35

CSIR-Advanced Materials and Processes Research Institute	CSIR-AMPRI

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Material Engineering and Characterization	Course Code	Credits
		AcSIR-35-ID-004	1

Property Characterization Basic concept, approach and methodology, SI units and their uses, test types, design of experiments, factors controlling test results, sources of error in experimental results, confidence limit, standard deviation, determinate and indeterminate errors, properties (physical, mechanical, chemical, electrochemical, thermal, tribological, rheological, interfacial, magnetic, electrical), compositional, phase and microscopic analysis (surface, subsurface, removed mass) and
interpretation, specimen preparation, quantitative metallography, microstructure-property correlation, failure analysis, interpretation of information, microanalysis, corrosion characterization (electrochemical/galvanic series, potential-pH diagram), chemical and thermal analysis of minerals and wastes, toxicity studies of solid wastes, evaluation of mechanical properties, characterization of radiation shielding
and nano materials.
Separation Techniques Introduction & classification of chromatographic methods, theory of chromatography, retention time, relationship between retention time and partition coefficient, the rate of solute migration, differential migration rates, bandbroadening & column efficiency, kinetic variables affecting band broadening.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 35	
CSIR-Advanced Materials and Processes Research Institute	CSIR-AMPRI
Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Material Engineering for Inter-Disciplines	Course Code	Credits
		AcSIR-35-ID-005	1

Periodic table and specific features/characteristics of group wise elements, electronic structure of materials (ionic, covalent, coordinate, conduction, valence, metallic and van der Waal bonds, noncrystalline and amorphous), crystalline solids (crystal system, unit cell, space lattice, Miller indices, packing factor, coordination number, slip system, planes and directions in crystals), defects, diffusion, thermal and electrical conduction, electronic & ionic conduction, semiconductors, solid solution, intermetallic compounds, Hume-Rothery rules, dielectric behaviour (types of polarization, frequency dependence of dielectric permittivity, piezo and ferroelectricity), solution and transport phenomena, solid/liquid interfaces, electrical double layer, introduction to polymers, classification of polymers, structure and properties of polymers, polymer composites, techniques of polymerization, Material classification (metals and alloys, foams, composites, polymers, ceramics, functional and smart materials, semiconductors,nanostructured materials, construction materials etc.)

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 35

CSIR-Advanced Materials and Processes Research Institute CSIR-AMPRI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Material Synthesis and Processing	Course Code	Credits
		AcSIR-35-ID-006	1

Basic concept and approach, material systems/types (metals and alloys, composites, polymers, ceramics, industrial wastes, porous materials/foams, sandwich, fibres etc.), synthesizing and processing techniques (casting, secondary deformation, powder metallurgy, foaming, process modelling, fibre extraction), characteristics, application potential and limitations Concept, approach and methodology, techniques for metallic materials (liquid metallurgy, powder metallurgy, deformation processing, severe plastic deformation, thermo mechanical treatment, heat treatment, surface modification/ engineering, joining, plasma and laser processing, rapid prototyping), functionally graded materials, natural and bio fibres, natural fibre composites, biodegradable composites, hybrid composites, polymers (moulding, extrusion, heat treatment, post curing and joining

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 35

CSIR-Advanced Materials and Processes Research Institute	CSIR-AMPRI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Nano Science and Nanotechnology	Course Code	Credits
		AcSIR-35-ID-007	1

Concept and approach, Introduction to nanomaterials: Definition and classification, top down and bottom up approaches, Synthesis methodologies, processing and characterization techniques, functionalization and applications, Fundamental properties of various primary material classes (metals, ceramics and polymers), Size dependent properties, Challenges in processing bulk ceramic nanomaterials, Processing structure properties of important bulk nanomaterials, Mechanical, thermal, tribological and biological properties.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 35

CSIR-Advanced Materials and Processes Research Institute **CSIR-AMPRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Phase Transformation	Course Code	Credits
		AcSIR-35-ID-008	1

Principles and concepts, free energy - composition diagrams, diffusion in solids, high diffusivity paths, nucleation and growth, homogeneous and heterogeneous nucleation, interface and diffusion controlled growth, coherent, semicoherent and incoherent interfaces, transformations controlled by heat flow like solidification, various growth mechanisms, kinetics of eutectic and eutectoid transformations, precipitation and dispersion strengthening, recovery, static and dynamic recrystallization, grain growth, peritectic, spinodal, pearlitic, ferritic, and martensitic transformations, ordered-disordered transformation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 35

CSIR-Advanced Materials and Processes Research Institute	**CSIR-AMPRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Polymer Science and Engineering**	**Course Code**	**Credits**
		AcSIR-35-ID-009	**1**

Introduction to polymers, polymer crystallinity, classification of polymers, structure & properties, techniques and aspects of structure determination, crystalline polymers, supermolecular organization of amorphous polymers, concept of physical states, the rubbery state, elasticity of an ideal rubber, kinetics theoryof rubber elasticity, elasticity of a system of isolated polymeric chains, James-Guth theory, glassy state, transition of polymer from the rubbery to the glassy state, theories of glass transition, thermal, mechanical and electrical properties of polymers, heat capacity of polymers & solids, theories of heat capacity of polymers, thermal conductivity of polymers and dielectrics, structural scattering, thermal expansion of polymers and solids, equations of state for thermal expansion of solids, mechanical behaviour of polymers, strength and durability, mechanism of polymer fracture, thermofluctuational theory, effect of relaxation processes on strength properties, DMA of polymers, physics of polymers, characterization (morphology, mechanical, chemical, thermal, degradation and rheological behaviour), processing (additives, moulding, extrusion, injection moulding, thermoforming etc.) and recycling, engineering and special polymers Introduction to conducting polymers, synthesis of PANI, synthesis of polypyrrole, electrical testing of conducting polymers, applications of conducting polymers, carbon filled polymers. Physical properties of PANI, Electrical properties of PANI, PANI Composites

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 35

CSIR-Advanced Materials and Processes Research Institute	**CSIR-AMPRI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:		Course Code	Credits
	Tribology-Science and Engineering	**AcSIR-35-ID-010**	**1**

Tribology (basic definition, concept and approach, Archard's laws, delamination theory), friction and wear types/modes (adhesion, abrasion, erosion, fretting, chemical etc.), wear testing (configurations, systems, methodology), high temperature tribology, simulated tests, measurement techniques, surface, subsurface and debris analysis, mechanism maps, controlling factors, interpretation of information, microstructure-property correlation, lubrication modes and types (mixed, boundary, hydrodynamic, elastohydrodynamic), Stribeck curve, P-V limit, lubricants (basic requirements, features, types, additives), tribomaterials (basic concept & approach, functions, material types and development, applications)Introduction to tribology of polymers (basic definition, concept and approach, Archard's laws, delamination theory), friction and wear types/modes (adhesion, abrasion, erosion, fretting, chemical etc.), wear testing (configurations, systems, methodology), measurement techniques, surface, subsurface and debris analysis, controlling factors, microstructureproperty correlation, P-V limit, lubricants (basic requirements, features, types, additives).

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

36	CSIR-IMMT	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-36-ID-001	Analysis of water Quality
AcSIR-36-ID-002	Basic Chemistry
AcSIR-36-ID-003	Bio Techniques and Instrumentation
AcSIR-36-ID-004	Biodiversity
AcSIR-36-ID-005	Biofuels
AcSIR-36-ID-006	Bioremediation
AcSIR-36-ID-007	Computer Network and Network Security
AcSIR-36-ID-008	Energy & Environment
AcSIR-36-ID-009	Energy Materials
AcSIR-36-ID-010	Environmental Science
AcSIR-36-ID-011	Industrial Instrumentation
AcSIR-36-ID-012	Materials Characterization Techniques
AcSIR-36-ID-013	Nanomolecular Chemistry
AcSIR-36-ID-014	Organometallic Chemistry
AcSIR-36-ID-015	Process Design & Simulation

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

36	CSIR-IMMT	2	Inter-disciplinary / Cross-disciplinary

Course Code	Course Title
AcSIR-36-ID-016	Process Instrumentation & Control
AcSIR-36-ID-017	Recycling ff Material Resources
AcSIR-36-ID-018	Separation Process
AcSIR-36-ID-019	Solid State Chemistry
AcSIR-36-ID-020	Spectroscopic Techniques in Chemical Analysis
AcSIR-36-ID-021	Synthesis and Devices of Peroveskite Materials
AcSIR-36-ID-022	Technologies for Mineral Resource Utilization

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology	**CSIR-IMMT**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Analysis of water Quality**	**Course Code**	**Credits**
		AcSIR-36-ID-001	**1**

Overview of water pollution, Sources of water pollution, Categories of water pollution, Effects of water pollution, Water contaminants, Prevention of water pollution, Analysis water quality: Physical parameters, Chemical parameters, Toxic inorganic substances, Microbiological water quality – an overview, Coliform tests – Fecal coliform and Total coliform, Other non-coliform bacteria in water, Standard plate count of water samples, Other methods of microbe detection in water.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology	CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Basic Chemistry	Course Code	Credits
		AcSIR-36-ID-002	1

Thermodynamics, Solutions and Ions, Chemical bonding and molecular structure, Chemical Kinetics Stereochemistry, Introduction to drug discovery (Medicinal chemistry approach), Drug target, discovery and development (forward and reverse approach).

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology **CSIR-IMMT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Bio Techniques and Instrumentation	Course Code	Credits
		AcSIR-36-ID-003	1

Separation and characterization: Principles and applications of centrifugation: high speed, ultra and differential centrifugation. Chromatography: affinity, ion exchange, hydrophobic chromatography, size exclusion and reverse phase chromatography, GLC, HPLC, HPTLC, GCMS, LCMS and Flash chromatography. Microscopy: Microscopy and Imaging: Light Microscopy, Bright and dark field, phase contrast, Fluorescence, Confocal, atomic force, transmission electron and scanning electron microscopy, cryo-EM, Surface Plasmon Resonance. Spectroscopy: Spectrophotometry: UV-Visible, absorption and emission spectrophotometry, AAS and Mass spectrometry, NMR Spectroscopy, stead-state and time-resolved fluorescence spectroscopy. Vibrational spectroscopy, circular dichroism and dynamic light scattering, Magnetic resonance spectroscopy. Techniques in Molecular biology : DNA/RNA isolation, plasmid isolation, designing of primers, RFLP, RAPD, ISSR, PCR, Realtime PCR, agarose, polyacrylamide and 2D-PAGE, poly/mono-clonal antibodies, ELISA, blotting and hybridization techniques, DNA sequencing. Cloning: vectors, expressing cloned genes.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology **CSIR-IMMT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Biodiversity	**AcSIR-36-ID-004**	**1**

Aims, objectives and dynamics of Plant biodiversity, Bio-geographic regions of plant biodiversity in India and world, Diversity within different plant groups, Assessment of biodiversity through classical taxonomic methods, Ecological methods for plant diversity inventorying, Role of Biosphere Reserve, National Parks, Wild Life Sanctuaries, Sacred Grooves in biodiversity conservation, Species distribution and endemism, Biodiversity and its sustainable uses, Biodiversity and traditional knowledge, Development of plant databases and its management, Biodiversity legal and policy instruments, Biodiversity, ecosystem function and ecosystem processes, Ecological niche, Impact of climate change on plant biodiversity.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Biofuels	Course Code	Credits
		AcSIR-36-ID-005	1

Biofuel and its benefits for sustainable bioenergy production; Advantages of using biofuels compared with fossil fuels; Renewable feedstocks, their production, availability; Categories of biofuels- first generation biofuels, -second generation biofuels, - third generation biofuels; Biofuel production system- process, scale up, production; Challenges in biofuel production– yields, scalability, cost, food vs fuel, environmental impact.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology **CSIR-IMMT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Bioremediation	**AcSIR-36-ID-006**	**1**

Principles and Applications, Bacterial Remediation of Metal and Metalloid Contamination, Bioremediation through Fungi and Mycorrhiza, Biodegradation of Recalcitrant Organic Wastes, Phytoremediation of Contaminated Water, soil & Constructed Wetlands, phytoremediation and Role of Nutrient Management, Role of Nanotechnology in Bioremediation Scope of Soil Carbon Sequestration in Degraded Soils, Limiting Factors in Bioremediation, Processes, Biodiversity, Climate change research, Microbe-Plant interactions, Eco-restoration and Remediation technologies, Environmental pollution and importance of microbes: Microbial diversity in different Ecosystem, Constructed wetlands for treatment of Wastewaters, Microbial diversity in different Ecosystem, Resource recovery from waste, Bio-energy Environmental Biotechnology Environmental Management: Waste management through Eco-friendly approaches, Concept and dynamics of ecosystem, biogeochemical cycles; Types of ecosystems, Community structure and organisation Protocols/ Techniques of Soil Bioremediation using Microbes Protocols/ Techniques of Soil Phytoremediation Protocols/ Techniques of Phytoremediation for Aquatic Ecosystems Use of Soil Enzymology in Monitoring of Bioremediation.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Computer Network and Network Security	Course Code	Credits
		AcSIR-36-ID-007	1

Introduction. Network structure and architecture, Hierarchical networks, Ethernet and TCP/IP family of protocols, transport protocol design. Types of network, Topologies of network, Router, Switch, Data Communication (ISDN, Cable Modem), Communication Media (Coaxial Cables, Fiber Optics etc.), Optical vs. copper networking, Concept of Wireless networking, LAN, WAN, MAN, Security of the network, Principles of Network Security, Network Security Terminologies, Network Security and Data Availability, Components of Network Security, Network Security Policies, Fire-walls,. Network Applications.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Energy & Environment	Course Code	Credits
		AcSIR-36-ID-008	1

Important Indian minerals & related environmental issues; Environmental impact due to mining in Orissa; Case study on graphite resources of Orissa and environmental management, Environmental issues related to mining, processing and products – solid wastes, Environmental impact analysis and management plan, Case studies related to environmental management of minerals and materials industries; Effluent treatment (nutrients removal) through microbial activity, Vulnerability and adaptation technologies for sustainable development, Pollution generation and management – Effluents, Environmental laws and global issues related to environment, Conservation of energy in different production and processing steps, Energy audit in mineral and material processing industries

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology	**CSIR-IMMT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Energy Materials**	**Course Code**	**Credits**
		AcSIR-36-ID-009	**1**

Energy: Conversion routes, Potential of solar energy.
Solar to electrical energy conversion: Photovoltaic cell basics, Efficiency and stability limitations of PVs.
Solar to chemical fuel conversion: Photosynthesis basics, Solar fuel generation pathways, Photocatalysts design aspects.
Materials design: Semi-conductors, Battery materials, Perovskite materials for PVs, Photocatalysts design, Materials for hydrogen technology, Catalysts, Porous materials.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology	**CSIR-IMMT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Environmental Science**	**Course Code**	**Credits**
		AcSIR-36-ID-010	**1**

Energy and Environment: Basic concepts of energy and environment in mineral, metallurgical and chemical industry. Pollutant source and control: Air, water and solid waste pollution and their control measure.Cleaner production and life cycle analyses: Reuse/ recycle/ recovery/ source reduction/ raw material substitutions, Basics of EIA and Environmental audit, Public participation in environmental decision making, Life Cycle Analyses, steps and tools, Emerging technologies for sustainable environmental management, Identification and evaluation of emerging environmental issues in air, water, waste water and solid waste. Biological waste treatment: Qualitative and quantitative characterization of waste, Waste disposal, Principle of Biological treatment like aerobic and anaerobic treatment systems, Suspended and attached Biological waste water treatment system. Advanced wastewater system: Root zone technology, Wetlands, Centralized versus decentralized systems. Environmental chemistry: Chemical equilibrium and kinetics fundamentals, Acidity, alkalinity, buffers and buffer intensities, EH-pH diagram, Solubility diagrams, Oxidation and reduction reactions.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology **CSIR-IMMT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Industrial Instrumentation	**AcSIR-36-ID-011**	**1**

Generalized performance characteristics of instruments: Static characteristics, Dynamic characteristics.
Motion and dimensional measurement: Relative translational and rotational displacement measurement, Relative translational and rotational velocity measurement, Relative acceleration measurement.
Pressure measurement: Manometer, Elastic transducers, Low pressure measurement, High pressure measurement.
Flow measurement: Local flow velocity, Gross volume flow rate, Gross mass flow rate.
Temperature measurement: Thermal expansion methods, Thermoelectric sensors, Electrical resistance sensors.
Radiation & miscellaneous measurements: Liquid level, Humidity.
Computer-aided experimentation: Functional description of the system.
Hazard and safety: Enclosures, Intrinsic safety, Prevention of ignition.
Recent developments.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology	CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Materials Characterization Techniques	Course Code	Credits
		AcSIR-36-ID-012	1

Interaction of X-rays with matter, Crystal structures: X-ray diffraction techniques and applications. X-ray spectroscopic (XPS, XAS etc), Electron diffraction, Microstructural analysis using optical microscopy, Electron microscopies, Transmission electron microscopy (TEM), Scanning electron microscopy (SEM) and scanning probe microscopic, Atomic force microscopy (AFM), Scanning tunnelling microscopy (STM). Microchemical characterization using energy dispensive spectroscopy (EDS), X-ray fluorescence (XRF), Auger electron spectroscopy (AES), Electron probe micro-analyzer (EPMA), Infrared, and Raman spectroscopies, Nuclear magnetic resonance (NMR) spectroscopy, Secondary ion mass spectroscopy (SIMS), Liquid chromatography-mass spectrometry (LC-MS), Inductively copied plasma mass spectrometry (ICP-MS), Size and surface area analysis.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology	**CSIR-IMMT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Nanomolecular Chemistry**	**Course Code**	**Credits**
		AcSIR-36-ID-013	**1**

Nanomolecules: bridging gap between atoms and nanoparticles: Introduction of nanomolecules, Nomenclatures, Difference between Nanomolecules and Nanoparticles, Gas phase nanomolecules, solution phase nanomolecules, magic numbers, noble metals.
Well defined synthesis of nanomolecules: Gas phase synthesis, top-down synthesis, bottom up synthesis, Importance of well-defined precursors, reaction mechanism, reduction and oxidation in nanomolecules synthesis, solid state method.
Crystal structure of nanomolecules: Crystallization Methods and Techniques, Single crystal X-ray crystallography, Mass spectrometry of nanomolecules, molecule like structure, alloy clusters.
Structure-property relationship: HOMO-LUMO transition, optical properties, fluorescence properties, aggregation induced emission, electrochemical properties, chirality etc.
Functionalization and application: Surface functionalization, Ligand exchange, bio-conjugation, catalysis, sensing, antibacterial, and therapeutic applications of nanomolecules.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology **CSIR-IMMT**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Organometallic Chemistry	**AcSIR-36-ID-014**	**1**

Definition, classifications and bonding: Organometallic chemistry of d-block elements: 18-electron rule, concept of hapticity; electron count in complexes.

Metal carbonyls: Synthesis and physical properties, classification, bonding and infrared spectrum, selected reactions.

Cluster Compounds: Low and high nuclearity clusters, electronic charge, structures, metal carbonyl clusters, inorganic metal clusters.

Reactions of organometallic complexes: Substitution, oxidative addition, reductive elimination, insertion and deinsertion.

Alkyl, alkene, alkyne, allyl, buta-1,3-diene and carbene complexes: Synthesis, structure and bonding.

Catalysis: Homogeneous and heterogeneous catalysts, Terminology in catalysis: Turnover, turnover number (TON), turnover frequency (TOF). Hydrogenation, Hydroformylation, Monsanto process, Wacker process, Ziegler-Natta polymerization, C-C coupling reactions, Olefin Metathesis and metathesis polymerization.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology	**CSIR-IMMT**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Process Design & Simulation**	**Course Code**	**Credits**
		AcSIR-36-ID-015	**1**

Preliminary resource evaluation methods; Identification and development of process flow sheet; Elementary evaluation of plant performance; Spread-sheet development for plant data analysis; Introduction to simulation environment using MODSIM, simulator structure, numerical analysis of simulation, sequential method of simulation, practical application of plant simulation; Materials and energy balance, mass balance smoothing, data reconciliation in terms of grade and recovery, analysis of complex flowsheet for mass balancing, examples of material balance smoothing; Application of modeling and residence time distribution concepts for plant data interpretation; Parameter estimation: linear regression, one, two, and multi-linear regression; models nonlinear in parameters; Case studies of typical process plant design and operation.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Process Instrumentation & Control	Course Code	Credits
		AcSIR-36-ID-016	1

Introduction to instrumentation in process industry, Different types of sensors and actuators, Computerized data acquisition, Monitoring and analysis of data (Time series and spectral analysis), Process control, PID Control, Introduction to PLC, SCADA & DCS, Networking and communication in industry, Artificial neural network & Fuzzy logic based control.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Recycling ff Material Resources	Course Code	Credits
		AcSIR-36-ID-017	1

Mining and metallurgical wastes classification, investigation and evaluation of waste deposits, waste and circulatory management during recycling.
Unit operations involving materials recycling processes such as pre-treatment (physical and chemical), roasting, calcination, sintering, leaching, solid-liquid separation; Solution, concentration and purification techniques—precipitation, cementation, solvent-extraction, evaporation, crystallization, electrowinning, electroremediation; Resources and recycling technologies across the major materials sectors, and case studies including wastes in steel and aluminium production; Recycling of E-wastes and secondaries; Economic evaluation and project implementation: Flow-sheet development, mass and energy balance, costing, techno-economic feasibility report (TEFR) preparation, financial investment in waste recycling, project planning and implementation, work safety.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Separation Process	Course Code	Credits
		AcSIR-36-ID-018	1

Gravity Concentration Techniques: Basic principles, processes, ore characteristics required for applying gravity separation techniques, main applications and related problems. Concentration criteria for gravity process.
Jigs: Basic principle of Jigging, types of jigs and their relative merits and demerits for beneficiation metallic and non metallic ores. Variables affecting Jigging, Jigging practice and operation.
Spirals: Spiral concentration principles, types of spirals and their main applications.
Shaking Tables: Principle, role of riffles, different types of tables and their applications.
Heavy Media Separators: Principles of heavy media separation, dense medium, types of separators, laboratory heavy liquid test, efficiency of dense medium separator, Organic efficiency.
Advanced Gravity Separators: Multi Gravity Separators (MGS), Floatex Density Separator, Knelson Concentrator, Falcon Concentrator - their mechanism of operation and circuit configurations.
General flowsheets involving gravity separation for different minerals.
Coal preparation techniques for both coking and non coking coals. Washability characteristics. Flowsheets for different coals.
Magnetic and Electrostatic Separation Techniques: Magnetic Separators - principle of magnetic separation, dry magnetic separators, wet high intensity magnetic separators (WHIMS), high gradient magnetic separators (HGMS), super conducting magnetic separators and their applications in mineral industries.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology | CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Solid State Chemistry	AcSIR-36-ID-019	1

Crystal structure & defects: Crystalline and amorphous solids, One and two dimensional lattices, Crystal systems, Bravais lattices, Point groups, Ionic radii ratios, Types of ionic solid structure: CsCl, NaCl, ZnS, Na_2O, CaF_2, $CdCl_2$, NiAs, ZnO, CdI_2, Cs_2O, PbO, TiO_2, ReO_3, perovskite ABO_3, $YBa_2Cu_3O_7$, K_2NiF_4, Ag_2HgI_4, Spinel and olivine, Types of defects: Equilibrium, Nonequilibrium, Point, Line, Planar, nonstoichiometry, Frenkel and Schotky defects.
Bonding & electron transport: Atoms to molecules to crystals, Orbitals, Bonds, Bands, Electronic structure of solids, Band theory, Nonmetals, Metals, Metal-nonmetal transitions, Transport properties, Techniques, Electrical conductivity.
Solid state synthesis: Solid sta tereactionio, Chemical precursor method,Cco-precipitation, Sol-gel, Metathesis, Self-propagating high temperature synthesis, Ion-exchange reactions, Intercalation / deintercalation reactions, Hydrothermal and template synthesis, High pressure synthesis.
Electrical properties: Band theory of solids-metals and their properties, Semiconductors: Extrinsic and intrinsic, Hall effect, Thermoelectric effects (Thomson, Peltier and Seebeck), Insulators: Dielectric, Ferroelectric, Pyroelectric and piezoelectric properties.
Superconductivity: Basics, discovery and high Tc materials.
Magnetic properties: Dia, para, ferro, ferri, and antiferro magnetic types, Soft and hard magnetic materials, Select magnetic materials such as spinels, garnets and perovskites, Hexaferrites and lanthanide-transition metal compounds, Magnetically ordered solids.
Thermal analysis: TGA, DTA, and DSC.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology	CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Spectroscopic Techniques in Chemical Analysis	Course Code	Credits
		AcSIR-36-ID-020	1

The course covers both basics principles, theories, and fundamental applications of modern photon and electron based spectroscopies that has been used by researchers to analyze the molecular and electronic structure, impurity of atoms and molecules in the field of chemistry, biochemistry, environmental and materials. The techniques include Absorption, Emission, Raman, Fourier Transform Infra-Red (FT-IR), Nuclear Magnetic Resonance (NMR), Mass, X-ray Diffraction (XRD), X-ray Photoelectron (XPS) spectroscopies. The focus will be using spectroscopy to solve experimental problems and provide interpretation of observed phenomena.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Synthesis and Devices of Peroveskite Materials	Course Code	Credits
		AcSIR-36-ID-021	1

Nanoscale materials: Introduction to metals, Semiconductors and insulator materials at nanoscale. Semiconductors and electronic confinement, Quantum dots (QDs), Quantum wells, Size dependent optical properties, Band gap both direct and indirect. Comparison in materials properties from bulk to nano.

Semiconductor perovskites, Crystal structures and modelling,

Semiconductor in perovskite crystals, Understanding their formation, Crystal structure analysis, Crystal modelling, Correlation of crystal planes from XRD with HR-TEM.

Reaction mechanism, Formation chemistry and surface chemistry with emphasis on perovskites materials, Synthetic technics of perovskites-colloidal synthesis, Hot injection synthesis, Anti-solvent vapor assisted crystallisation, Inverse temperature crystallisation, Surface chemistry, Surface ligand binding chemistry, Shape control to form different morphologies, Stability of perovskites.

Theoretical calculations and predictions for synthesis of novel perovskite:

Density functional theory calculations to predict novel perovskite materials, Nontoxic perovskites, Chalcogenides perovskites, Lead free halide perovskites.

Perovskite materials for energy generation and energy storage applications:

Perovskite materials for optoelectronics, Photovoltaics, Photodetectors, transistors, Energy storage materials. Self-assembly of perovskites to make thin film photovoltaics. Charge generation in perovskite semiconductors. Materials processing for perovskite solar cells. Design optimization of perovskite photovoltaics and light emitting device applications.

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AcSIR Academic Centre Code: 36

CSIR-Institute of Minerals & Materials Technology	CSIR-IMMT

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Technologies for Mineral Resource Utilization	Course Code	Credits
		AcSIR-36-ID-022	1

Particulate technology, Particle size distribution, Sizing methodology, Size-reduction and classification processes, Particulates in suspension, Stability, Rheology and settling, Solid-liquid separation methods, Physics, chemistry, and engineering design as applied to gravity, Magnetic, electrostatic, and froth flotation processes.

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37	CSIR-IIIM	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-37-ID-001	Basic Chemistry for Interdisciplinary Sciences
AcSIR-37-ID-002	Biology for Chemists
AcSIR-37-ID-003	Biology for Interdisciplinary Sciences
AcSIR-37-ID-004	Computer Applications and Informatics
AcSIR-37-ID-005	Tools and Techniques in Biology
AcSIR-37-ID-006	Understanding bioinformatics

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 37

CSIR-Indian Institute of Integrative Medicine CSIR-IIIM

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Basic Chemistry for Interdisciplinary Sciences	Course Code	Credits
		AcSIR-37-ID-001	1

Introduction to Chemistry with reference to Drug Discovery Process, Introduction to Spectroscopy, Introduction and Principles of various analytical techniques (NMR, Mass, UV and IR spectroscopy), Introduction to Chromatographic Techniques, Introduction to Natural Product Chemistry, Introduction to Medicinal Chemistry, Use of chemistry Software to write correct molecular structures, Use of scifinder to find out different biological and chemical parameters, Use of Natural Product Dictionary Databases and Molecular Docking Studies.

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AcSIR Academic Centre Code: 37

CSIR-Indian Institute of Integrative Medicine	**CSIR-IIIM**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Biology for Chemists**	**Course Code**	**Credits**
		AcSIR-37-ID-002	**1**

Interdisciplinary Laboratory Training for Chemistry students: Cell Culture Techniques, Enzyme Assays, Cell Based Assays, Isolation of DNA and RNA and quantification, Protein Estimation by various techniques, Introduction to Flowcytometry, Confocal Microscopy, Fluorescence Microscopy, Electron Microscopy, Electrophoresis, High Throughput Screening Platforms, Animal handling, drug administration, collection and preservation of blood, fluid, tissue and organ samples, Non invasive in vivo imaging of animals.

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AcSIR Academic Centre Code: 37

CSIR-Indian Institute of Integrative Medicine	**CSIR-IIIM**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Biology for Interdisciplinary Sciences	Course Code	Credits
		AcSIR-37-ID-003	1

An Introduction to Disease Process. An introduction to biological macromolecules: Proteins, Nucleic Acids, Carbohydrates, Steroids, Fats. Structure and Function of Biological Macromolecules and Their Importance in Disease Process as Drug Targets. Basic Molecular Biology Techniques and Principles: Isolation of DNA & RNA, RT-PCR, Gene Cloning, Cloning Vectors and Host Organisms used for Genetic Engineering. Gene Transfer Techniques: Chemical Transformation, Electroporation, Electrophoresis and its application in Biological Sciences, Introduction and Applications of Gene Cloning. Cell Culture Basics (Plant, Microbial and Mammalian Cell Culture Techniques). Introduction to Cell Culture Techniques, Various Types of Cell Cultures, Morphology of Cells, Cell Counts and Cell Viability Testing, Maintenance of Aseptic Conditions, Safety Considerations (Personal & Environmental), Preservation and Storage of Cell Cultures, Application of Cell Cultures in Drug Discovery, Biosafety Levels and their Applications in Drug Discovery and Diagnostics.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 37

CSIR-Indian Institute of Integrative Medicine	CSIR-IIIM

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Computer Applications and Informatics	Course Code	Credits
		AcSIR-37-ID-004	1

Introduction, Evolution and Classification of Computers: Fundamentals of Computing, Bit and Byte, Introduction to types of Hardware and Software, Components of Computers, Introduction to Operating Systems, Introduction to Computer Viruses, Network Structure and architecture, Hierarchical Networks, Ethernet and TCP/IP family of protocols, Transport protocol design, Types of Network, Topologies of Network, Router, Switch, Data Communication, Concept of Wireless networking, LAN, WAN, MAN, Security of the Network, Firewalls, Network Applications information Technology: Concept of Client Server Architecture, Concept of Search Engine, Database Search Engines, Introduction to Internet, Introduction to Word, Powerpoint, Excel Applications of Bioinformatics: History of Bioinformatics, Genome Sequencing Projects, Human Genome Project, Literature Search Databases, Nucleic Acid and Protein Databases, Animal and Plant Databases, Ensembl Genome Project, TIGR Databases, Biotechnology Databases, Motif and Patters Databases, Databases for Species identification and Classification, Structural Databases, Database retrieval and Deposition System, Web tools and resources for sequence analysis, Pairwise and multiple sequence Alignment, Sequence Similarity Search, BLAST, Pattern Recognition, Motif and Family Prediction, Restriction Map Analysis, Primer Design, Genen Prediction, Phylogenetic Tree, Protein Struction Prediction and Visualization.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 37

CSIR-Indian Institute of Integrative Medicine	CSIR-IIIM

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Tools and Techniques in Biology	Course Code	Credits
		AcSIR-37-ID-005	1

Gene cloning, RNA interference, DNA editing techniques (Zinc Finger Proteins, TALENs, CRISPR-Cas), Polymerase chain reaction (PCR), RT-PCR and real time PCR, ELISA, Flow cytometry, Confocal Microscopy. Animal cell culture technique and cell viability tests, Cryopreservation of cells, genetic transformation of plants, Spectrophotometry, Fluorimetry, Chromatography, Electrophoresis, Immunological and Radioisotope Techniques, Immunohistochemistry, Gene therapy, Chemotherapy and advanced Radiotherapy techniques in cancer. DNA hybridization techniques - Southern, Northern & Western blots, Restriction fragment length polymorphism, measurement of photosynthesis, chlorophyll florescence, In situ hybridization and FISH, CPCSEA guidelines for maintenance, breeding and experimentation using laboratory animals, Recent advances in Transgenic and Knockout animals.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 37

CSIR-Indian Institute of Integrative Medicine	CSIR-IIIM

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Understanding bioinformatics	Course Code	Credits
		AcSIR-37-ID-006	1

Applications of Bioinformatics: History of Bioinformatics, Genome Sequencing Projects, Human Genome Project, Literature Search Databases, Nucleic Acid and Protein Databases, Animal and Plant Databases, Ensembl Genome Project, TIGR Databases, Biotechnology Databases, Motif and Patters Databases, Databases for Species identification and Classification, Structural Databases, Database retrieval and Deposition System, Web tools and resources for sequence analysis, Pairwise and multiple sequence Alignment, Sequence Similarity Search, BLAST, Pattern Recognition, Motif and Family Prediction, Restriction Map Analysis, Primer Design, Genen Prediction, Phylogenetic Tree, Protein Struction Prediction and Visualization.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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2 *Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-38-ID-001	Advanced diagnosis and therapy
AcSIR-38-ID-002	Advances in Bioorganic chemistry
AcSIR-38-ID-003	Advances in catalysis
AcSIR-38-ID-004	Atmospheric science
AcSIR-38-ID-005	Basic Chemical Biology
AcSIR-38-ID-006	Bio-Cement and Bio-Concrete
AcSIR-38-ID-007	Biochemical Genetics and Plant Breeding
AcSIR-38-ID-008	Biochemical Pharmacology
AcSIR-38-ID-009	Biodiversity and Environmental Sciences
AcSIR-38-ID-010	Bio-Engineering
AcSIR-38-ID-011	Biomass Conversion
AcSIR-38-ID-012	Building and Road Materials
AcSIR-38-ID-013	Computer Application and Informatics
AcSIR-38-ID-014	Drugs from Nature
AcSIR-38-ID-015	Electronic Instrumentation

Course Code	Course Title
AcSIR-38-ID-016	Engineering Geology and Geo-Hazards Mitigation
AcSIR-38-ID-017	Environmental Nanotechnology
AcSIR-38-ID-018	Environmental study
AcSIR-38-ID-019	Geochemistry
AcSIR-38-ID-020	Geotechnical Engineering & Geohazard Mitigation
AcSIR-38-ID-021	Herbal Productsand Human Health
AcSIR-38-ID-022	Introduction to Bioinformatics
AcSIR-38-ID-023	Mathematical Physics
AcSIR-38-ID-024	Membranes
AcSIR-38-ID-025	Organic materials and application
AcSIR-38-ID-026	Petroleum Refinery Engineering
AcSIR-38-ID-027	Physics of Manufacturing Processes
AcSIR-38-ID-028	Plant Physiology and Biochemistry
AcSIR-38-ID-029	Separation Science

CSIR-North East Institute of Science & Technology	CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary — **Total Credits 2**

Title:	Course Code	Credits
Advanced diagnosis and therapy	AcSIR-38-ID-001	1

Nanoparticles in medicine, Basic understanding of phototehrmal therapy, Temperature and health: Thermal therapies, Conventional thermal treatment techniques, Nanotechnology based thermal therapies, Nanoparticles for Photothermal therapies, Carbon nanostructures in Photothernmal therapy, Biocompatibility of the carbon nanostructure, Quantum dots in Photothermal therapy, In vitro Photothermal treatments, In vivo Photothermal therapy. photodynamic, nanomedicine, prodrug, MRI, drug-delivery system.

AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	**CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Advances in Bioorganic chemistry**	**Course Code**	**Credits**
		AcSIR-38-ID-002	**1**

Amino Acids, Peptides & Proteins, Design of oligo/poly peptides, Peptide hormones and their pharmaceutical significance, Peptide mimetics as therapeutics, Chemistry of Carbohydrates (Mono and disaccharides, polysaccharides), Bacterial polysaccharides, starch and cellulose, derivatives of cellulose, Protecting groups, Glycosylation reactions, carboxy methyl cellulose and gun cotton, structure, Conformational analyses, glycoconjugates), Nucleic acids, Structure & function of DNA and RNA, Nucleic acid mimetics & their therapeutic applications, Steroids, Drug discovery, Basic principles of medicinal chemistry, non-covalent bonds in biological system.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	**CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Advances in catalysis	**AcSIR-38-ID-003**	**1**

Suzuki, Heck, Stille, Sonagashira coupling for C-C bond formation, Metathesis reaction by Grubbs and Schrock catalysts, Milstein catalysis by aromatization/dearomatization, Metal-Ligand cooperation, Click reaction, Hartwig-Buchwald catalysis for C-N bond formation reactions, Modern catalytic reactions (hydrogenation, dehydrogenation, amide from alcohol, amine to nitrile) photocatalytic synthesis, Organocatalysis.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Atmospheric science	Course Code	Credits
		AcSIR-38-ID-004	1

Physical Meteorology: Thermal structure of the atmosphere and its composition.
Radiation: Basin Laws, Rayleigh and Mie scattering, Multiple scattering, radiation from the sun, Solar constant, Effect of clouds, Surface and planetary albedo. Emission and absorption of terrestrial radiation, Radiation windows, radiative transfer, Greenhouse effect, Net radiation budget.
Thermodynamics of dry and moist air: Specific gas constant, Adiabatic and isoentropic processes, Entropy and enthalpy, Moisture variables, Virtual temperature, Clausius–Clapeyron equation, Adiabatic process of moist air, Thermodynamic diagrams: Hydrostatic equilibrium, Hydrostatic equation, Variation of pressure with height, Geopotential, Standard atmosphere, altimetry. Vertical stability of the atmosphere: Dry and moist air parcel and slice methods, Tropical convection.
Atmospheric electricity: Fair weather electric field in the atmosphere and potential gradients, Ionization in the atmosphere. Electrical fields in thunderstorms, Theories of thunderstorm electrification.
Cloud Physics: Cloud classification, Condensation nuclei, Growth of cloud drops and ice-crystals, Precipitation mechanisms: Bergeron, Findeisen process, Coalescence process, Precipitation of warm and mixed clouds, Artificial precipitation, Hail suppression, fog and cloud – dissipation, Radar observation of clouds and precipitation, Radar equation, Rain drop spectra, Radar echoes of hail storm and tornadoes, Radar observation of hurricanes, Measurements of rainfall by radar.

References:

1. Basics of Atmospheric Science, By Chandrasekar, Chandrasekar A., PHI Publication
2. Atmospheric Science for Environmental Scientists, edited by C. Nick Hewitt, Andrea V. Jackson, John Wiley

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology **CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Basic Chemical Biology	Course Code	Credits
		AcSIR-38-ID-005	1

Chemical diversity in nature, Biochemistry of amino acids, peptides, proteins, coenzymes,vitamins and nucleic acids, Enzyme catalysis, Biosynthetic pathways, Biochemical pathways, molecular signalling, introduction to drug discovery, disease and drug targets, Metal based drugs, Porphyrins, Corrins, hydroporphyrins,Metal ions in biology,metallo-proteins and their communication,photosynthesis, nitrogen fixation in nature, Chemical reactions and chemical diversity in nature, Reactive oxygen species, their utilization in hydroxylation and epoxidation, Design and synthesis of supramolecular drugs, precision medicine.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Bio-Cement and Bio-Concrete	Course Code	Credits
		AcSIR-38-ID-006	1

Microbial cell structure, basic instruments for microbiology, sterilization, media, microbial isolation, purification, nutrition, growth and maintenance, applied microbiology.
Concept of Bio-cement, Bio-concrete and Self-Healing concrete. Micro-organism and role of micro-organism in concrete, Isolation of Bacteria, Selection of Bacteria, Culturing and Sub-Culturing of Bacteria, Microbiologically Induced Calcium Carbonate Precipitation (MICCP), Bio-cement and its advantages, Preparation and mix design of Bio-cement and Bio-concrete, Testing and evaluation of microbial concrete, Application of Bio-cement and Bio-Concrete.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Biochemical Genetics and Plant Breeding	AcSIR-38-ID-007	1

Principle of genetics : Laws of inheritance, linkage, crossing over, recombination analysis, genotyping concepts for genetic mapping, construction of genetic linkage map for gene and qualitative trait loci (QTL) mapping. Introduction to linkage mapping software packages and interfaces breeding by design. Methods of plant breeding, self incompatibility and their sequences. Heterosis breeding, Mating design, stability parameters, pure line, back cross, pedigree methods and SSD.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	**CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Biochemical Pharmacology**	**Course Code**	**Credits**
		AcSIR-38-ID-008	**1**

Cell injury, oxido reductive stress, reactive oxygen species, antioxidant defense mechanisms, apoptosis and necrosis, acute and chronic inflammation, Cytokines and chemokines, Growth factors, biology of vascular endothelium, neuropeptides, transport proteins, cell adhesion molecules and matrix proteins, oxygen intermediates, atrial peptides Toxicology and Free Radicals Pharmacology: Details of Heavy metals and heavy metal antagonists, Abnormal action of drugs such as tolerance, addiction, habituation, idiosyncracy, allergy, hypersensitivity, antagonism, synergism, potentiation, tachyphylaxis, Adverse drug reactions and its monitoring. Hepatotoxicity and drugs used to correct hepatic function, Immunotoxins, OECD guidelines for toxicity evaluations and in-vitro screens for specific toxicities. Protocols in organ and other toxicology studies. Generation of free radicals, role of free radicals in etiopatholgy of various diseases, protective activity of antioxidants.

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Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Biodiversity and Environmental Sciences	**AcSIR-38-ID-009**	**1**

Biodiversity and conservation: Overview, types of protected area, protected areas, Environmental and Forest policies and Laws.Scope of environmental studies, Environmental studies in a multidisciplinary approach.Ecosystems – major types, structure and functions, productivity of ecosystems and sustenanceGlobal warming and Climate Change, Hydrology and water resources, Wetlands management, Urbanization and environment, Social Issues and the Environment.Planetary Health: Overview, issues and crisis and future perspectives.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	**CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Bio-Engineering**	**Course Code**	**Credits**
		AcSIR-38-ID-010	**1**

Bio-engineering: introduction and concept overview, Microbial fermentation: enzymes and metabolic pathways, Introduction to chemical reaction engineering: General (type of reaction, reaction kinetics, reactor types), Bioreactors: principles, design, types and applications,Metabolic bio-engineering (genetic level) of microbes for sustainable utility: concept and strategies, Computer-aided bioprocess design: overview on bioprocess simulation, Bioprocess simulation and scheduling: bio-engineering upstream tools, bio-engineering downstream tools, Cost analysis.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology | CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Biomass Conversion	AcSIR-38-ID-011	1

Introduction to bioenergy, biofuels and chemicals from biomass, Energy classification, Global & National energy scenarios, Interrelationship between energy and environment, Energy classification-Primary &Secondary energy, commercial & non-commercial energy, non-renewable & renewable energy, primary energy resources, commercial energy production, energy conservation and its importance.

Classification and characterization of biomass. Various pre-treatment processes of biomass. Introduction and perspective of biofuels/biorefineries, biofuel production and applications, environmental impact of biofuel, Biofuel. Thermochemical conversion of biomass: Combustion, gasification, pyrolysis (flash, fast and slow), torrefaction etc., thermochemical unit operations (Pyrolysis, Gasification, Combustion), Catalysis for biomass conversion, Catalytic processes: Catalytic pyrolysis, catalytic up-gradation of bio-oil. Catalytic conversion of biomass to chemicals. Effect of micro level of engineering such as surface properties, pore structure, dispersion of the active metals, acidic and basic properties of the catalysts, and their catalytic activity and selectivity, and stability towards different reaction, Case studies from the published paper in the literature and where solid catalysts are used for the manufacture of high value-added products will be discussed during the course.

Biochemical conversion processes to biofuels: Bioethanol, biobutanol, algal oil and other valuable chemicals such as poly-unsaturated fatty acids.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Building and Road Materials	Course Code	Credits
		AcSIR-38-ID-012	1

Introduction: Types and various properties of building materials; Cement: basic chemistry and types of cement; measurement of consistency, strength, soundness of cement; Mix design of cement concrete, requirements of properties of cement concrete for building construction, lightweight concrete, special concrete: polymer concrete composites, etc.., Types and nomenclature of bricks, concrete blocks, AAC blocks. Aggregate: Shape, size and different properties of aggregates and test requirements; Steel: Types and size of reinforcements and their properties; Laboratory tests for quality checking on building materials. Introduction of Road Materials: soils and aggregates, new materials for soil stabilization, Geosynthetics (Applications and Economics), Production of Quality Aggregates, Requirements of Aggregates for different types of Pavements, Factors Affecting Adhesion of Bitumen with different Aggregate, Durability, Transportation and Economics. Beneficiation of Marginal Materials, New Materials for Subbase and Base Courses. Characterization of waste plastics and polymers, Properties and Applications of industrial and municipal waste as Soil & Aggregate, Characterization, beneficiation and use of Fly ash and coal mining waste; Characterization and Use of Demolition Waste. Paving Bitumen: Composition, Structure and Rheology, Durability, Performance. Rubber and Polymer Modified Bitumen, Bitumen Emulsion, Modified Bitumen Emulsions, Foam Bitumen, Rejuvenating Agents, Cutback Bitumen, Hard Bitumen, Oxidized Bitumen, Cold Mix.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Computer Application and Informatics	Course Code	Credits
		AcSIR-38-ID-013	1

Computers: Fundamentals of computing. Introduction to operating systems. Introduction to Computer Viruses. Network: Introduction. Network structure and architecture, Hierarchical networks, Ethernet and TCP/IP family of protocols, transport protocol design. Types of network, Topologies of network, Router, Switch, Data Communication, Concept of Wireless networking, LAN, WAN, MAN, Security of the network, Fire-walls, Network Applications Information Technology: Concepts of client Server Architecture, Concept of search Engine, Database search engines. Introduction to Internet. Introduction to Word, Powerpoint and Excel. Introduction and application of Bioinformatics, Genome sequencing projects, Introduction to biological databases, Type and kind of biological databases, Nucleic acid, protein databases and structure database: Applications and limitations. Web tools and resources for sequence analysis: Pairwise and multiple sequence Alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, primer design, Gene prediction, Phylogenetic Tree construction and analysis. Structural Bioinformatics: Protein structure prediction and visualization, computer aided drug design, structure-based drug design, concept of structure-activity relationship (SAR) and quantitative structure-activity relationship (QSAR), Lipinski rule of five, concept of absorption, distribution, metabolism, and excretion (ADME), Mechanism of action of drug molecules: drug receptor/target-interactions, Molecular docking and Virtual screening.

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CSIR-North East Institute of Science & Technology **CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Drugs from Nature	**AcSIR-38-ID-014**	**1**

Natural products based drug discovery: Importance, lead, clinical trials in drug discovery research, Case studies of marketed natural product drugs, herbal formulation, bioformulation, A brief overview of drug discovery approach, Cause of diseases, Target identification, Target validation, Modeling, Synthesis and SAR, Drug Delivery, Clinical Trials, Etiology, pathogenesis, prevention, drug targets and chemotherapy, drug resistance and remedies of tropical infectious diseases, Etiology and remedies of diseases developed through metabolic disorders.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology **CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Electronic Instrumentation	Course Code	Credits
		AcSIR-38-ID-015	1

Characteristics of, JFET, UJT, SC R &.CMOS Transistors & Amplifiers, Single stage RC coupled amplifier and its frequency response. The concept of feedback. Positive and Negative feedback. Advantages of Negative feedback. Emitter follower and Darlington Pair.
Introduction to digital gates (AND, OR, NOT & NAND) Combination logic – basic building blocks, Qualitative treatment of Multiplexers, Demultiplexes, Encoders and decoders. Sequential logic: Basic RS flip-flop, D, T, JK flip-flop, Qualitative treatment of counters and shift registers. Memory: Read only Memory (ROM) &, Random Access Memory (RAM).
Operational amplifiers: Characteristics of ideal operational amplifiers. Feedback equation. Applications: Inverting (amplifiers); Non-inverting amplifiers, Integrator, Differential for summing amplifier, Differential amplifier, DC Voltage follower, Pulse width discriminator. Basic concepts of instrumentation: A descriptive treatment of instrument as a part of system. Linear systems, Static and Dynamic characteristics error and uncertainty in measurements.
Amplitude and frequency response characteristics of geophones, critical and optimum damping, seismic amplifier and its frequency response, principles of magnetic tape recording, digital multiplexed recording and shot moments, principles of binary gain ranging amplifier and floating point, dynamic range, Automatic Gain Control (AGC) circuit, Programmable Gain Control (PGC), timing system and recording formats (SEG A, SEG B and SEG C)
Introduction to Microprocessors : Evolution of microprocessors, organisation, architecture and pin description of 8085 microprocessor, addressing modes and instruction set, input / output interfacing devices (8255, 8251), simple programs for addition / subtraction, developmental trends in microprocessor technology (8086, 80186, 80286, 80386, 80486 and Pentium). Application of Microprocessors: Microprocessors in Geophysical Instrumentation, Microprocessor based data acquisition, frequency, temperature and voltage measurements using microprocessors.

References: 1. Millman and Halkias Electronic devices and Circuits, International student Edition, Mc Graw-Hill International Book Company, 1972.
2. D. Patranabis., Principles of industrial instrumentation.
3. W.D. Cooper, Electronic instrumentation and Measurement techniques, Prentice Hall of India Pvt. Ltd., New Delhi 1979.
4. Anthony S. Maneva, Solid state electronic circuits for Engineering Technology (McGraw – Hill, Kogakusha, Ltd., International student edition 1983.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Engineering Geology and Geo-Hazards Mitigation	Course Code	Credits
		AcSIR-38-ID-016	1

Engineering Geology: types of rocks, characterization of rocks and rock mechanics; Igneous, Sedimentary and metamorphic; Important characteristics of geological materials, Geological structures: fold, fault, discontinuities; Surface processes: Weathering & erosion, movement of slopes, fluvial processes, Geological Hazards, Risk Assessment and Planning, Ground behavior, Effect of site conditions on ground motion characteristics.

Engineering interventions in geohazard management & mitigation, structural & non-structural interventions, Introduction of earthquakes and seismology, microzonation map study, Seismic hazard assessment, Seismic vulnerability and risk assessment of building structures; Landslide : causes of landslide and its mitigation measures; Soil erosion : soil erosion causes, soil investigation and its protection measures.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Environmental Nanotechnology	AcSIR-38-ID-017	1

Application of nanotechnology to environmental issues, Nano-geochemistry, Nanomineralogy, use of nano clusters as catalyst, Fullerene, cleaning up organic chemicals polluting ground water using nanotechnology, Cleaning up oil spills, Cleaning Volatile Organic Compounds (VOCs) from air, Potential environmental benefits, Use of nano materials for radioactive waste clean- up in water, Nano pollution, Toxicological impacts of nano -materials, Potential health hazard posed by exposure to nano materials, Nanocatalysts for environmental applications, Carbon-based catalyst.

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CSIR-North East Institute of Science & Technology | CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Environmental study	AcSIR-38-ID-018	1

Aims and objectives of environmental impact assessment (EIA). Environmental impact statement (EIS) and environmental management plan (EMP). EIA guidelines. Guidelines for environmental audit. Environmental management system standards (ISO14000 series).

Environmental pollution and issues related to environment, Environmental protection, Climate change, Global warming, Wasteland reclamation, Biodiversity and its conservation, hot-spot of biodiversity, from unsustainable to sustainable development, its environmental impact.

References:

1. Environmental Pollution Science – by Ian L. Pepper, Charles P. Gerba, Mark L. Brusseau, Elsevier
2. Understanding Our Environment - An Introduction to Environmental Chemistry and Pollution – by R Harrison, Royal Soc. Of Chemistry
3. Conserving and valuing ecosystem services and biodiversity: economic, institutional and social challenges – by K. N. Ninan, Achim Steiner, Earthscan
4. Biodiversity: Conserving Endangered Species (Green Technology) – by Anne Maczulak, Facts on File

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology **CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Geochemistry	Course Code	Credits
		AcSIR-38-ID-019	1

The atmosphere and oceans: Sources, sinks, and geochemical cycling, Overview of the origin of the elements, their abundance and the nature of their existence in the Earth's crust. Principles for extraction of elements belonging to different groups in the period table. Stable isotopes and isotope fractionation of H, C, O, S. Trace element and rare-earth geochemistry, Coal geochemistry, Medical geology.

1. Treatise on Geochemistry, Vol. 1, Meteorites, Comets and Planets, Vol. Editor: Andrew M Davis
2. Geochemistry – W M White
3. Stable Isotope Geochemistry – by Jochen Hoefs, Springer
4. Medical Geology – A regional synthesis– by Olle Selinus, R B Finkelman, Jose A. Centeno (Eds)

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Geotechnical Engineering & Geohazard Mitigation	Course Code	Credits
		AcSIR-38-ID-020	1

Geo-hazards, types and nature, geological processes related to geohazards. Understanding earthquake vulnerability and tsunami, landslide potential, flash flood, mudflow and volcanoes.
Stress-strain behaviour, Type of deformation, Hooke’s law, Young’s law, Bulk and shear modulus in Earth, Poisson’s ratio. Dynamic and kinematic analyses of rocks, Failure criteria for intact rock and rock masses, Fracture mechanism.
Peak ground acceleration, Strong motion duration, Response spectrum, Fourier spectrum, Power spectral density function, Effect of site conditions on ground motion characteristics. Engineering interventions in geohazard management & mitigation, structural & non-structural interventions.

References:

1. Fundamentals of earthquake engineering – by Amr S Elnashai, Luigi Di Sarno
2. Landslides: Risk Analysis and Sustainable Disaster Management – by Kyoji Sassa et al., Springer
3. Geotechnical Special Publication No. 178, Geocongress 2008 Geosustainability and Geohazard Mitigation, Ed. by - Krishna R. Reddy Milind V. Khire Akram N. Alshawabkeh

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology **CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Herbal Productsand Human Health	**AcSIR-38-ID-021**	**1**

Basic principles on selection of raw materials, processing for extraction and characterization. Preparation and formulations, disease modelling and bio-efficacy studies (In vitro, in vivo, clinical trials), quality control, stability test, packaging and regulatory guidelines.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Introduction to Bioinformatics	Course Code	Credits
		AcSIR-38-ID-022	1

Introduction and application of Bioinformatics, Genome sequencing projects, Introduction to biological databases, Type and kind of biological databases, Nucleic acid, protein databases and structure database: Applications and limitations. Web tools and resources for sequence analysis: Pairwise and multiple sequence Alignment, Sequence similarity search: BLAST, Pattern recognition, motif and family prediction, primer design, Gene prediction, Phylogenetic Tree construction and analysis. Structural Bioinformatics: Protein structure prediction and visualization, computer aided drug design, structure-based drug design, concept of structure-activity relationship (SAR) and quantitative structure-activity relationship (QSAR), Lipinski rule of five, concept of absorption, distribution, metabolism, and excretion (ADME), Mechanism of action of drug molecules: drug receptor/target-interactions, Molecular docking and Virtual screening.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology **CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Mathematical Physics	Course Code	Credits
		AcSIR-38-ID-023	1

Vector algebra and vector calculus, linear independence, basis expansion, Schmidt orthogonalisation. Matrices: Representation of linear transformations and change of base; Eigen values and eigenvectors; Functions of a matrix; Cayley-Hamilton theorem; Commuting matrices with degenerate eigenvalues; Orthonormality of eigenvectors, Concepts of tensors.

Complex numbers, triangular inequalities, Schwarz inequality. Function of a complex variable : single and multiple-valued function, limit and continuity; Differentiation; Cauchy-Riemann equations and their applications; Analytic and harmonic function; Complex integrals ,Cauchy's theorem (elementary proof only), converse of Cauchy's theorem, Cauchy's Integral Formula and its corollaries; Series - Taylor and Laurent expansion; Classification of singularities; Branch point and branch cut; Residue theorem and evaluation of some typical real integrals using this theorem.

Theory of second order linear homogeneous differential equations. Singular points: regular and irregular singular points; Frobenius method; Fuch's theorem; Linear independence of solutions: Wronskian, second solution. Sturm-Liouville theory; Hermitian operators; Completeness. Inhomogeneous differential equations: Green's functions

Special functions. Basic properties (recurrence and orthogonality relations, series expansion) of Bessel, Legendre, Hermite and Laguerre functions., generating function Integral transforms. Fourier and Laplace transforms and their inverse transforms, Bromwich integral [use of partial fractions in calculating inverse Laplace transforms]; Transform of derivative and integral of a function; Solution of differential equations using integral transforms, Delta function.

Non-linear Systems : Non-linear equations and their application in geophysics.

References:

1. Mathematical methods for physics, by G ARFEKEN
2. Matrices and Tensors for physicists, by A W JOSHI
3. Advanced engineering mathematics, by E KREYSZIG
4. Special functions , by E D RAINVILLE
5. Special functions by W W BELL
6. Mathematical method for physicists and engineers by K F REILYU, M P HOBSON and S J BENCE
7. Mathematics for physicists, by MARY L BOAS

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology | CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Membranes	AcSIR-38-ID-024	1

Basic principles of membrane operations. Different types of Membrane Processes: Principles and Applications, microfiltration, ultrafiltration, nanofiltration, reverse osmosis, gas separation, vapour permeation and pervaporation, dialysis, electrodialysis, transport through porous membranes, gas mixtures, concentration polarization and fouling. Membrane materials: polymeric, inorganic and liquid, Membrane preparation: phase inversion, immersion precipitation, track-etch method, sol-gel process, interfacial polymerization, dip-coating process, film stretching and template leaching; characterization of membranes; Transport Phenomena in Membrane Processes: Navier Stokes Theory of Mass, Heat and Momentum Balances, Diffusion, Convection and Size Exclusion etc., Mathematical Modelling and Simulation, Concentration polarization and fouling, Technical evaluation of different membrane processes compared to traditional separation processes, Membranes for Liquid operations, Gas separation, pervaporation, membrane contactors, performance criteria, membrane distillation, electrodialysis, membrane bioreactors, Membranes in biotechnology, membranes in chemical industry, membranes in the food industry, membranes used as reactors, membranes in wastewater treatment, Thin film composite and thin film nanocomposite membrane and their application in separation technology and process design.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	**CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	**Organic materials and application**	**Course Code**	**Credits**
		AcSIR-38-ID-025	**1**

Polyaromatic hydrocarbons, Organic sensing materials, Organic fluorescence and phosphorescence materials, Organic semiconductor, Boron nitrides.

AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology **CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Petroleum Refinery Engineering	Course Code	Credits
		AcSIR-38-ID-026	1

Fundamental principles of origin and occurrence of petroleum crude and its exploration, Composition of petroleum, classification and physical properties, Characterization of crude oil and refinery products, the status of petroleum refining in India, future refining trends; Crude Distillation Process, Pretreatment of crude, atmospheric distillation unit (ADU), vacuum distillation unit (VDU), Thermal and Catalytic cracking, Catalytic reforming, Hydro treating and Hydrocracking; Light end processes: alkylation, isomerization and polymerization; Heavy end processes: Hydrocracking, Hydrotreating, vis-breaking, coking, deasphalting and dewaxing, dehydrogenation processes; Lube oil base stock (LOBS) production: Dewaxing and deoiling, deasphalting, lube hydrofinishing, bitumen air blowing, Sweetening and Desulphurization, Hydrodesulphurization of petroleum products; Energy conservation in petroleum refineries, New Trends in petroleum refinery operations, Biorefinery concept.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary   Total Credits 2

Title: Physics of Manufacturing Processes	Course Code	Credits
	AcSIR-38-ID-027	1

Introduction of mechanics of manufacturing processes. Stresses and Strain: stress and strain behavior of materials, plastic and tangent modulus, work hardening, plastic instability in tensile test, empirical stress-strain equations, effect of pressure, strain-rate and temperature, analysis of stress tensor, analysis of strain and strain rates, objective stress rates. Plasticity: the criteria of yielding, isotropic and anisotropic hardening, rules of plastic flow, Levy-Mises and Prandtl Reuss equations, anisotropic flow rule, Hill’s 1948 and 1979 yield criteria for anisotropic yielding. Upper bound theorem and its application in processes like rolling, wire drawing, extrusion, forging and machining. Lower bound theorem with a few applications. Slab method and its application in process like asymmetric rolling, forging, wire drawing and extrusion. Heat transfer analysis in manufacturing. Workability and dynamic materials model.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology	CSIR-NEIST

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title: Plant Physiology and Biochemistry	Course Code	Credits
	AcSIR-38-ID-028	1

Introduction to plant physiology and biochemistry, physiological and molecular responses of plant against biotic and abiotic stress, advances in mineral nutrition, secondary metabolites photosynthesis and ecological adaptation.

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AcSIR Academic Centre Code: 38

CSIR-North East Institute of Science & Technology **CSIR-NEIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Separation Science	**AcSIR-38-ID-029**	**1**

Basic principles of chromatographic separations, Adsorption, Desorption, Adsorption models, Membrane separation, Special properties of surfaces and interfaces, Electronic structure of surfaces, Surface modification and its applications, Nanoscale catalysis and applications, Surface spectroscopy and microscopy tools for nanocatalysis, membrane separations, Different types of Membrane Processes: Principles and Applications, Membrane materials: polymeric, inorganic, Transport Phenomena in Membrane Processes: Navier Stokes Theory of Mass, Heat and Momentum Balances, Diffusion, Convection and Size Exclusion etc., Mathematical Modelling and Simulation,, Concentration polarization and fouling, membranes separation in industries, Thin film composite and thin film nanocomposite membranes.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

39 CSIR-NIIST

2 *Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-39-ID-001	Basic Chemical Engineering Principles and Applications
AcSIR-39-ID-002	Biology for Chemists
AcSIR-39-ID-003	Bioprospecting for natural resources
AcSIR-39-ID-004	Chemistry for Biologists
AcSIR-39-ID-005	Chemistry for Engineers
AcSIR-39-ID-006	Chemistry for Physicists
AcSIR-39-ID-007	Materials to Devices
AcSIR-39-ID-008	Supramolecular Chemistry and Soft Materials

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 39

CSIR-National Institute for Interdisciplinary Science and Technology — CSIR-NIIST

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Basic Chemical Engineering Principles and Applications	Course Code	Credits
		AcSIR-39-ID-001	1

Units and dimensions, Partial pressure, Vapor pressure, LLE, VLE, Laws of thermodynamics, Gibbs free energy, Fugacity, Fugacity coefficients, Adiabatic process, Humidity and saturation.
Flow of fluids: Introduction, Nature of fluid, Viscosity, Velocity profile, Types of fluid motion, Laminar and turbulent flow, Fluidization, reciprocating, rotary, and centrifugal pumps.
Heat transfer: Conduction, Convection (natural, forced, phase change), radiation.
Heat exchangers: Double pipe, Shell and tube, Flow arrangement in heat exchangers, Temperature distribution across heat exchangers (LMTD and AMTD), Solar thermal engineering.
Mass transfer: Mass transfer and its applications, Principles of molecular diffusion, Diffusivity, Convective mass transfer and mass transfer coefficient, Theories of mass transfer, Individual gas and liquid phase mass transfer coefficient, Concept of stage wise contact processes, Equipment for gas liquid contact.
Mechanical operations: Size reduction, Motion of particles in a fluid, Terminal velocity, Sedimentation, Liquid filtration, Membrane separation, Centrifugal separation.
Reaction engineering: Kinetics of homogeneous reactions, Design for single reaction systems using batch and continuous reactors.

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AcSIR Academic Centre Code: 39

CSIR-National Institute for Interdisciplinary Science and Technology CSIR-NIIST

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Biology for Chemists	Course Code	Credits
		AcSIR-39-ID-002	1

Different types of cells, cell structure and function, cell division, general metabolism, photosynthesis, respiration, central dogma of life, gene expression and its regulation General introduction, overall understanding of the course content. Cell as a basic unit of life, Prokaryotic and eukaryotic cell. Cellular Organelles and functions: Endplasmic reticulam, Golgi complex, Mitochondria, Chloroplast, Ribosomes, Lysosomes, Peroxisomes, Nuclear (Nuclear envelope with nuclear pore complex, nucleolus, nucleplasm and chromatin). Vacuole, Cytosol and Cytoskeletal structures (Microtubles, Microfilaments and Intermediate filaments) Extracellular matrix. Bioenergetics: Thermodynamics, Gibbs free energy, endergonic & exergonic reactions, Standard state free energy changes, Relationship between equilibrium constant and DG'o, Feasibility of reactions. ATP-Structure, properties and energy currency of the cell, Importance of Coupled reactions, High energy compounds, Introduction to Metabolism - Catabolism, anabolism, catabolic, anabolic and amphibolic pathways. Carbohydrate Metabolism: Introduction, Aerobic and anaerobic pathways: Glycolysis, Gluconeogenesis and its regulation. TCA cycle, Electron Transport chain, Oxidative phosphorylation, & production of ATP, balance sheet of glucose oxidation, Pentose phosphate pathway, light and dark reactions, c4 pathway. Cell Division-basic concepts involved in cell division of prokaryotes (Binary fission) and eukaryotes (meiosis and mitosis). Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO2 fixation-C3, C4 and CAM pathways. Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway. Central dogma of life, gene expression and its regulation- Nucleic acid, DNA-Genetic material, carrier of Genetic information, Double Helical structure, Replication, Error in replication and repair. RNA-types, mRNA, Transcription. Proteins- Aminoacids-Genetic code, Translation. Gene expression in Prokaryotes and eukaryotes. Regulation of gene expression.

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CSIR-National Institute for Interdisciplinary Science and Technology	CSIR-NIIST

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Bioprospecting for natural resources	Course Code	Credits
		AcSIR-39-ID-003	1

Bacteria, actinomycetes, fungi, microalgae and other microbes for industrial applications; biomass resource mapping and conversion. Isolation, cultivation and preservation of aerobic Bacteria. Concepts and methods involved in Identification and classification of bacteria. Role of fungi in the era of industrial biotechnology, Selective isolation of Aquatic, Lichenized, Coprophilous, Endophytic and Insects associated fungi; Ex situ conservation of fungi; Screening methods of fungal entomopathogens as endophytes. Microalgae: Brief classification of Algae, commercially important Algae, Biomolecules from microalgae, Different strategies to enhance the lipids Applications of Algae and cyanobacteria in agriculture, environment and health. Yeast and industrial applications.

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AcSIR Academic Centre Code: 39

CSIR-National Institute for Interdisciplinary Science and Technology CSIR-NIIST

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Chemistry for Biologists	Course Code	Credits
		AcSIR-39-ID-004	1

Basics of organic chemistry, chemical bonding and molecular structure, nomenclature, stereochemistry, classes of organic molecules, functional groups, structure of biomolecules such as nucleic acids, amino acids, proteins, carbohydrates, lipids etc. Basic organic chemistry characterization techniques, fundamentals of NMR & Mass Spectroscopy, Chromatography (TLC to UPLC) techniques. Solutions and ions, acids, bases & salts, pH & pKa, applications of the Henderson-Hasselbalch equation, biological buffers, salt hydrolysis Introduction to thermodynamics, laws of thermodynamics, concept of enthalpy, entropy, free energy, reaction coupling in biological context, introduction to chemical kinetics, rate laws for elementary reactions of different orders, enzyme kinetics, enzyme inhibition, various binding interactions in biological context

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AcSIR Academic Centre Code: 39

CSIR-National Institute for Interdisciplinary Science and Technology CSIR-NIIST

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Chemistry for Engineers	AcSIR-39-ID-005	1

Basics of organic chemistry, chemical bonding and molecular structure, nomenclature, stereochemistry, classes of organic molecules, functional groups, structure of biomolecules such as nucleic acids, amino acids, proteins, carbohydrates, lipids etc.

Basic organic chemistry characterization techniques, fundamentals of NMR & Mass Spectroscopy, Chromatography (TLC to UPLC) techniques.

Solutions and ions, acids, bases & salts, pH & pKa, applications of the Henderson-Hasselbalch equation, biological buffers, salt hydrolysis.

Introduction to thermodynamics, laws of thermodynamics, concept of enthalpy, entropy, free energy, reaction coupling in biological context, introduction to chemical kinetics, rate laws for elementary reactions of different orders, enzyme kinetics, enzyme inhibition, various binding interactions in biological context.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Chemistry for Physicists	**AcSIR-39-ID-006**	**1**

Basics of organic chemistry, Chemical bonding and molecular structure, Nomenclature, Stereochemistry, Classes of organic molecules, Functional groups, Structure of biomolecules such as nucleic acids, Amino acids, Proteins, Carbohydrates, Lipids, etc.

Basic organic chemistry characterization techniques, Fundamentals of NMR & mass spectroscopy, Chromatography (TLC to UPLC) techniques.

Solutions and ions, acids, bases & salts, pH & pKa, Applications of the Henderson-Hasselbalch equation, Biological buffers, Salt hydrolysis.

Introduction to thermodynamics, Laws of thermodynamics, Concept of enthalpy, Entropy, Free energy, Reaction coupling in biological context, Introduction to chemical kinetics, Rate laws for elementary reactions of different orders, Enzyme kinetics, Enzyme inhibition, Various binding interactions in biological context.

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AcSIR Academic Centre Code: 39

CSIR-National Institute for Interdisciplinary Science and Technology **CSIR-NIIST**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Materials to Devices	**AcSIR-39-ID-007**	**1**

Optoelectronic materials and devices: Materials for energy, Conversion fabrication techniques, Solution processing-thermal evaporation, Opto-electronic characterization, Practical sessions on fabrication and characterization.

Advanced ceramic materials and devices: MLCC, HTCC, LTCC, Printed thick film devices, Thin film devices, Piezo-ceramics, LTCC based micro-heaters, Customized device packaging, Die-bonding, Wire-bonding, MEMS packaging.

Flexible electronic devices: Flexible energy harvesters, Piezoelectric nanogenerator (PENG), Triboelectric nanogenerator (TENG), Flexible sensors for physical parameters and bio-signals, Wearable antennas and heating devices.

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AcSIR Academic Centre Code: 39

CSIR-National Institute for Interdisciplinary Science and Technology	CSIR-NIIST

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Supramolecular Chemistry and Soft Materials	AcSIR-39-ID-008	1

Fundamentals, developments and biological importance of supramolecular chemistry. Supramolecular interactions; Multiple hydrogen bonding; Jorgensen model for H- bonding; Self-assembly and soft materials. Cooperativity; Molecular recognition; Host-guest complexes; Molecular capsules; Self-assembled nanotubes. Supramolecular polymers; Low molecular weight organogels; Applications of supramolecular chemistry and self-assembly.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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41 CSIR-SERC

2 *Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-41-ID-001	Artificial Intelligence
AcSIR-41-ID-002	Biology for Engineers
AcSIR-41-ID-003	Chemistry for Engineers
AcSIR-41-ID-004	Material Science
AcSIR-41-ID-005	Nanotechnology
AcSIR-41-ID-006	Nonlinear Science
AcSIR-41-ID-007	Renewable Energy

AcSIR Academic Centre Code: 41

CSIR-Structural Engineering Research Centre	**CSIR-SERC**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Artificial Intelligence**	**Course Code**	**Credits**
		AcSIR-41-ID-001	**1**

Evolution of artificial intelligence (AI): Foundations, scope, problems, and approaches of AI.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 41

CSIR-Structural Engineering Research Centre CSIR-SERC

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Biology for Engineers	AcSIR-41-ID-002	1

Origin and Evolution Life;Basic concept of Cells: composition, structure, Basic concept of Biomolecules; Computational Biology; applications.

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AcSIR Academic Centre Code: 41

CSIR-Structural Engineering Research Centre	CSIR-SERC

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Chemistry for Engineers	AcSIR-41-ID-003	1

Solutions, Colloids, Nano-particles Solutions, Importance of Nano-particles and Application in Construction; Introduction to Materials chemistry; Composite materials.

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AcSIR Academic Centre Code: 41

CSIR-Structural Engineering Research Centre	**CSIR-SERC**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Material Science	Course Code	Credits
		AcSIR-41-ID-004	1

Introduction: Materials Science and Engineering, Classification of Engineering Materials, Levels of Structure, Structure-Property Relationships in Materials, Micro-structural analysis; Fundamentals of Fracture, Types of fracture, Theoretical fracture strength of brittle materials, Ferroelectric materials, Frequency Dependence of the Dielectric Constant, Dielectric Strength, Dielectric Materials.

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AcSIR Academic Centre Code: 41

CSIR-Structural Engineering Research Centre	CSIR-SERC

Course 2 : Inter-disciplinary / Cross-disciplinary — **Total Credits 2**

Title:	Course Code	Credits
Nanotechnology	**AcSIR-41-ID-005**	**1**

Concept and approach; Introduction to nanomaterials; Cement chemistry; Materials chemistry; use of nano materials in constrction.

AcSIR Academic Centre Code: 41

CSIR-Structural Engineering Research Centre	CSIR-SERC

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title: Nonlinear Science	Course Code	Credits
	AcSIR-41-ID-006	1

Introduction, linear versus nonlinear, dynamical systems: from simple to complex, harmonic-oscillator, phase space, paradigms of nonlinearity, chaos and coherent structures, sine-Gordon equation, coherent structures in nature.

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AcSIR Academic Centre Code: 41

CSIR-Structural Engineering Research Centre **CSIR-SERC**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Renewable Energy	**AcSIR-41-ID-007**	**1**

Introduction; RE sources; structural system; challeges; Wind turbine structure; solar energy structures; offshor RE structures.

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42	CSIR-NISCAIR	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-42-ID-001	Basics of Bioinformatics
AcSIR-42-ID-002	Environment and Climate Change Communication
AcSIR-42-ID-003	Health Communication
AcSIR-42-ID-004	Patent Informatics
AcSIR-42-ID-005	Science Communication for Scientists and Science for Science Communicators
AcSIR-42-ID-006	Scientometrics
AcSIR-42-ID-007	STI Policies

AcSIR Academic Centre Code: 42

CSIR-National Institute of Science Communication and Information **CSIR-NISCAIR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Basics of Bioinformatics	**AcSIR-42-ID-001**	**1**

Bioinformatics: History, Sequence and nomenclature, Information sources, Databases and retrieval tools, BLAST, NGS data and other analysis using bioinformatic tools, Applications, and Challenges.

References:

1. B D Singh, Biotechnology, Kalyani Publishers, 2010.
2. H S Chawla, Introduction to Plant Biotechnology 3rd Edition, CRC Press, 2009.
3. Sandy B Primrose and Richard Twyman, Principles of Gene Manipulation and Genomics, Wiley-Blackwell, 2006.
4. Arthur M Lesk, Introduction to Bioinfomatics, Oxford University Press, 2014.
5. Supratim Choudhury, Bioinformatics for Beginners: Genes, Genomes, Molecular Evolution, Databases and Analytical Tools, Academic Press, 2014.

AcSIR Academic Centre Code: 42

CSIR-National Institute of Science Communication and Information	**CSIR-NISCAIR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Environment and Climate Change Communication**	**Course Code**	**Credits**
		AcSIR-42-ID-002	**1**

Climate Change: Background Information, Definitions, Historical overview, Causes, Consequences and Control measures/ mitigation.
Natural: wild fires , volcanic eruptions, radiation etc. Anthropogenic: GHGs, deforestation, land use pattern etc. Global warming, Hurricanes and cyclones, Change in hydrological cycle: Erratic rainfall, droughts and floods; Sea level rise; Ocean acidification; Erosion; agricultural yields, health impacts. Afforestation; Control over GHGs emission; IPCC and PACT; Kyoto Protocol.
Climate change communication: Challenges, insights, and opportunities:
Climate journalism; Ways to communicate climate change; climate change attitudes and knowledge.
Environmental Communication: Introduction and Definition of Environmental Communication (background, scope, importance etc.): Communication by environmental components; Environmental communication and public awareness; Environmental education, ethics and world views; Gaia hypothesis; Ecocentrisism and technocentrism.
Seven major areas of study and practice in environmental communication, Environmentalism and Environmental Activism: Polluter Pays Principle (PPP), User Pays Principle (UPP); The Precautionary Principle (PP);
Principle of Effectiveness and Efficiency; The Principle of Responsibility; The Principle of Participation; The Principle of Proportionality; Concept of resource and waste. Reducing consumerism; The theory-practice nexus
o Strategies for Communicating Environmental Issues.

References:

1. Hardy J T, Climate Change: Causes, Effects, and Solutions, Wiley publications, 2003, pp. 260.
2. S. Clayton & C. Manning, Psychology and Climate Change: Human Perceptions, Impacts, and Responses, First edition, Academic Press, 2018, pp. 312.
3. R Cox, Environmental communication and the public sphere, Second edition, SAGE Publication, Singapore, 2010, pp. 385
4. R. R. Jurin, D. Roush and J. Danter, Environmental communication: Skills and Principles for Natural Resource Managers, Scientists and Engineers, Second edition, Springer, London, 2010, pp. 310.

AcSIR Academic Centre Code: 42

CSIR-National Institute of Science Communication and Information **CSIR-NISCAIR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Health Communication	Course Code	Credits
		AcSIR-42-ID-003	1

Health communication: objectives, formats, application and importance, Impact of media representation and popular culture on understandings of disease and health, Health literacy and its implications, Framework to communicate health information effectively, Comparison of different media strategies for popularization, advocacy, and intervention in, relation to public health, Theories and models of health communication

Application of health communication strategies for development and empowerment among marginalized population groups, Media and communication strategies to combat diseases and promote health, Role of health campaigns to making people aware about health.

Telemedicine: Expanding Health Care into Virtual Environments.

References:

1. Diane Berry, Health Communication: Theory and Practice, Open University Press, 2006.
2. Teresa L. Thompson, Alicia M. Dorsey, Katherine I. Miller & Roxanne Parrott (Editors), Handbook of Health Communication, Lawrence Erlbaum Associates, 2003.
3. T.L. Thompson (Editor), Encyclopedia of Health Communication, SAGE Publications, 2014.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 42

CSIR-National Institute of Science Communication and Information CSIR-NISCAIR

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Patent Informatics	Course Code	Credits
		AcSIR-42-ID-004	1

Introduction and structure of a patent document, Invention, research publication and patent.
Patenting process: Invention disclosure, patent filing, prosecution and grant in different jurisdictions, Patent Acts & Rules: India vs World, Structure of patent specification.
Patent informatics: tasks to tool, Patent information system, Big patent data to actionable insights, Patent data mining & visualisation tools-patentability invalidity and patent classification, Patent prospecting towards entrepreneurship, Patent mapping for evidence-based research & policy making, Patent licensing, Patent valuation, Patent portfolio management (Small and large organizations), Technology transfer.

References:

1. R.P. Merges and F. Duffy, Patent Law and Policy: Cases and Materials, Carolina Academy Press, 2017.
2. L. Bently and B. Sherman, Intellectual Property Law, Oxford University Press, 2014
3. Robert A. Klinck, Patent Litigation Primer: A Guide for Inventors and Business Owners, CreateSpace Independent Publishing Platform, 2015.
4. David Hitchkock, Patent Searching Made Easy: How to Do patent searches on the internet & in the Library, NOLO, 2009. Reese, H., How to License Your Million Dollar Idea, Wiley, 2002.

AcSIR Academic Centre Code: 42

CSIR-National Institute of Science Communication and Information **CSIR-NISCAIR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Science Communication for Scientists and Science for Science Communicators	Course Code	Credits
		AcSIR-42-ID-005	1

Importance of communication in science, opportunities and challenges in science, Communication for scientists: Bridging the gap between scientists and science communicators, Cultural, practical and policy related role of science communication in wider society, Important historical scientific events and scientific landmarks, Success stories of science communication in India (TKDL, Vigyan Rail, VIPNET Clubs, JIGYASA, Science Channel etc.), Importance of science-society interface for the social and national development, Challenges and prospects of scientists to become a science communicator, Hype vs Reality in science communication.

Science communicators: Cheerleader or watchdog, How to deal with misinformation in science communication, How to extract the needful info from the scientists about a report/story.

References:

1. J V Vilanilam, Science Communication and Development, SAGE Publications Pvt. Ltd., 1993.
2. Grant Allen and Sam Illingworth, Effective Science Communication: A Practical Guide to Surviving as a Scientist, IOP Publishing, 2016.
3. Craig Cormick, The Science of Communicating Science: The Ultimate Guide, CSIRO Publishing, Australia, 2019.
4. Pallava, Bagla and V.V. Binoy (Editors), Bridging the Communication Gap in Science and Technology Lessons from India, Springer Singapore, 2017.
5. David J. Bennett and Richard C. Jennings, Successful Science Communication, Cambridge University Press, 2011.
6. Manoj Kumar Patairiya, Vigyan Evam Praudyogiki Sanchar (Hindi), Prabhat Prakashan; 1st edition, 2010.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 42

CSIR-National Institute of Science Communication and Information CSIR-NISCAIR

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Scientometrics	Course Code	Credits
		AcSIR-42-ID-006	1

Basic concepts: Bibliometrics, Informetrics, Scientometrics – Meaning, definitions and scope. Historical development.

Study and application of Classical Bibliometric Laws – Lotka's law of scientific productivity, Bradford's law of scatter, and Zipf's law of word occurrence. Other notable regularities: 80/20 rule, Success-breeds-success model.

Science Indicators and Policy. Science Indicators. Science Policy Development. Web Impact Assessment. Link Analysis. Trends in informetrics.

Databases and Research Metrics: Indexing databases, Citation databases, Web of Science, Scopus, etc. Impact Factor of journals, Citation indices: h-index, g-index, i10-index, etc.

References:

1. Peter Vinkler, The Evaluation of Research by Scientometric Indicators, Chandos Publishing, 2010.
2. Mari Jibu and Yoshiyuki Osabe (Eds.)., Scientometrics, IntechOpen, 2018.
3. Loet Leydesorff, The challenge of scientometrics: The development, measurement and self-organization of science communications, Universal Publishers, 2001.
4. Rafael Ball, An introduction to bibliometrics, Chandos Publishing, 2017.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

AcSIR Academic Centre Code: 42

CSIR-National Institute of Science Communication and Information CSIR-NISCAIR

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	STI Policies	Course Code	Credits
		AcSIR-42-ID-007	1

Evolution of S&T Policies of India, S&T related policy instruments (such as Industrial policy, startup policy, biotech policy and policies on areas such academic ethics, datasharing, scientific social responsibility) enacted by S&T ministries, S&T departments and agencies (National as well as States). Linkages among these policy instruments and programs, coherence and successful implementation.
Sectoral policies, Policy guidelines in international STI policies, models/frameworks to promote effective policy and program linkages (Best practices at global, regional, national and sub-national levels), Coordination among S&T ministries, departments and agencies, criteria for planning, monitoring and impact assessment. Centre - State Partnership regarding socio-economic development.
Evaluation of STI policies, Key components of STI policy governance structure their roles and responsibilities.
Policy research, policy review, evidence, forecasts, assessments, and roadmaps. PM STIAC.

References:

1. Gustavo Crespi and Gabriela Dutrénit, Science, Technology and Innovation Policies for Development, Springer, 2014.
2. C.A. Tisdell, Science and Technology Policy: Priorities of Governments, Springer, 1981.
3. Pawan Sikka, Science Policy: New Strategies for India’s Modernization, Uppal Publishing House, 2008.
4. A FRAMEWORK for Science, Technology and Innovation Policy Reviews, United Nations Conference on Trade and Development, United Nations, 2019.
5. The Role of Science, technology and Innovation policies to Foster the implementation of the Sustainable Development Goals, Europian Commission, Editors: Enrico Giovannini, Ingeborg Niestory, Mans Nilssson, Francoise Roure and Michel Spanos, 2015.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
Approved at the 27th meeting of Senate, AcSIR on Sep 10, 2020

Course Code	Course Title
AcSIR-43-ID-001	Advanced Coal Science
AcSIR-43-ID-002	Advanced Organic Chemistry
AcSIR-43-ID-003	Clean Development Mechanisms
AcSIR-43-ID-004	Communication Technologies For Underground Mines
AcSIR-43-ID-005	Environmental Chemistry
AcSIR-43-ID-006	Environmental Risk Assessment in Mines
AcSIR-43-ID-007	Fly Ash Management
AcSIR-43-ID-008	Geology, Remote Sensing and GIS
AcSIR-43-ID-009	In Situ Gasification and CBM
AcSIR-43-ID-010	Mine Fire, Accidents and Disasters - Analysis and Prevention
AcSIR-43-ID-011	Mining Land Reclamation and Biodiversity Conservation

AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research CSIR-CIMFR

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:		Course Code	Credits
	Advanced Coal Science	AcSIR-43-ID-001	1

Introduction to coal geology and petrology. Coal classification, physical & chemical structure and properties of coal, macro-molecular structure of coal, structure and behaviour relationship, coal solubilization and structural modification of coal (chemical and thermal), low temperature oxidation of coal including coal weathering and spontaneous combustion, computer aided molecular design (CAMD) of coal including application of different sophisticated instrumental techniques. Introduction to clean coal technology and coal bio- processing. Environmental issues in coal industry and ash utilisation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research	**CSIR-CIMFR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Advanced Organic Chemistry	**AcSIR-43-ID-002**	**1**

Stereochemistry, reaction mechanism, C-C and C-X bond formations, Retrosynthetic analysis, photochemistry, pericyclic reactions, reactive intermediates, Methods of asymmetric synthesis and their application in total synthesis, oxidation-reduction reactions, organocatalysis, metathesis reactions.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research	**CSIR-CIMFR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	**Clean Development Mechanisms**	**Course Code**	**Credits**
		AcSIR-43-ID-003	**1**

Clean Development Mechanism (CDM) background, definition, goals, GHGs, sectors eligible for CDM; National authority CDM India; financial issues and carbon market; benefits. The Kyoto Protocol: Article 12; CO_2 equivalent calculation; CDM operationalization, modalities and procedures for CDM project, project cycle, scope for CDM in coal industries, case studies.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research — CSIR-CIMFR

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Communication Technologies For Underground Mines	AcSIR-43-ID-004	1

Difficulties of underground mine communication; Wired Communication: Types of Wired Communication, Carrier Current System, Optical fibre Communication; Semi-Wireless Communication: Leaky Feeder Based System, Location and Monitoring for Personal Safety, Digital Enhanced Cordless Telecommunications (DECT), Ethernet; Wireless Communication: Pocket Pagers, Walkie-Talkie System, Bluetooth, Wireless Fidelity (Wi-Fi), World Interoperability for Microwave Access (WiMAX), Radio Frequency Identification Technique, Ultra Wideband Communication, Through-the-Earth Communication System, Very Low frequency and Low Frequency Propagation, Hybrid communication systems; Installation techniques of different communication system; Maintenance.

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AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research CSIR-CIMFR

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Environmental Chemistry	Course Code	Credits
		AcSIR-43-ID-005	1

Environmental chemistry: introduction; Water: properties; acid-base reactions, electrochemistry, pH; Eh; Chemical methods in treating water and wastewater; water disinfection. Thermodynamics and kinetics of air pollutants; chemical and photochemical reactions in atmosphere. Soil chemistry: nature and importance; acid-base and ion-exchange reactions in soils; colloidal chemistry of inorganic constituents, clays, organic matter and soil humus; adsorption desorption reactions, ion exchange, degradation of pesticides and hazardous substances in soil.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research — CSIR-CIMFR

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Course Code	Credits
Environmental Risk Assessment in Mines	AcSIR-43-ID-006	1

Environmental behaviour of chemicals, Stressor characteristics, Ecosystem potentially at risk, Ecological effects; Characterization of exposure, exposure analyses, exposure profile, ecosystem characterization; Hazards & its effect assessment; Toxicity of chemical pollutants in organisms, dose-response relationships, toxicity of mixtures of chemicals, ecotoxicity, carcinogenesis; Risk Characterization and risk management; Summary and interpretation of ecological significance and remedial action goals. Case studies. Occupational diseases, their effects and prevention; recognition, evaluation and control of physical hazards. Industrial toxicology – local and systemic and chronic effects temporary and cumulative effects; exposure to carcinogens. Industrial hygiene.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research **CSIR-CIMFR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Fly Ash Management	**AcSIR-43-ID-007**	**1**

Fly ash generation, characterisation, physical and chemical properties; mineralogy; potentially toxic inorganic and organic substances; liming equivalent, and engineering properties; Ash collection, ammonia dozing; handling and transportation in TPPs; Ash utilisation polices; Ash pond: structure; management; abandoned ash pond reclamation. Environmental health hazards from fly ash; Leaching characteristics of fly ash; Utilisation of fly ash in agriculture; forestry; wasteland reclamation; reclamation of low-lying area; Fly ash in mine stowing; cement industry, clay, tiles, brick making, embankment; land filling; Value added products from fly ash.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research **CSIR-CIMFR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Geology, Remote Sensing and GIS	Course Code	Credits
		AcSIR-43-ID-008	1

Origin of earth and its internal structure; Different geological discontinuities; Maps and cross sections; Concept of plate tectonics and its role in hydrocarbon exploration; Principles and techniques of remote sensing; Application of remote sensing for exploration in coal basins; Micro wave Remote Sensing; Thermal and hyper spectral remote sensing and its applications to earth resources and mines management; LIDAR application in mining; GIS and its application in mineral and mining sector; GPS: concept, satellite systems, differential GPS and Global Navigation Satellite Systems; Application of remote sensing in earth resource assessment in mining and mine management related studies.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research CSIR-CIMFR

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	In Situ Gasification and CBM	Course Code	Credits
		AcSIR-43-ID-009	1

Concept and methodologies of coal gasification; Underground coal gasification - definition, concept and methods, Characterization and correlation of properties of coal for CBM and UCG; Coal bed methane - definition, origin of coal bed methane; Geological controls of methane generation from coal; Global coal bed methane potentials, UCG and CBM exploration, reserve estimation and exploitation; Methodologies for extraction of coal mine methane, CBM policy/ regulations; Clean development mechanisms.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research CSIR-CIMFR

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Mine Fire, Accidents and Disasters - Analysis and Prevention	Course Code	Credits
		AcSIR-43-ID-010	1

Causes and types of mine fire; Fire risk assessment; Detection and Assessment of spontaneous heating/fire; Gas hazards; Methods of sampling of gases from fire area; Mine gas Analysis; Thermo-compositional Investigation; Environmental affects due to fire; Fire prevention and combating; Fire combat methods; Dealing with long standing fires; Fire fighting equipment.
Types and Causes of mine accidents; Dangerous occurrences in mines; Study of mine accidents and its analysis; Mine accidents and disasters; Analysis of mine accidents and preventive measures.
Types and causes of mine disaster; Mine inundation; Design of underground dams; Mine explosion; Mine rescue; Mine disaster control and mitigation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 43

CSIR-Central Institute of Mining and Fuel Research **CSIR-CIMFR**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Mining Land Reclamation and Biodiversity Conservation	Course Code	Credits
		AcSIR-43-ID-011	1

Biotic and abiotic components; land use and land cover classification; Causes of damage to land, landscape planning and visual impact; waste disposal, overburden dumps and tailings impoundment; land use categories; pre-mining investigations; Deposit, topography and equipment; top soil characteristics, removal, storage; Reclamation of mined land and coal waste dumps; planning and monitoring; Afforestation programmes, application of mulches, stabilizing agents and fertilizers; plant species establishment, soil characteristics, soil amendment, selection of species, economics of reclamation, Bioremediation practices and application, factors influencing bioremediation, bioremediation system and process; EIA / EMP; Policies, guidelines and legislation related to ecology and biodiversity conservation.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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44 CSIR-URDIP

2 *Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-44-ID-001	Basics of patent searching
AcSIR-44-ID-002	Bioinformatics
AcSIR-44-ID-003	Cheminformatics - Informatics in pharmaceutical/chemical research
AcSIR-44-ID-004	Patent informatics
AcSIR-44-ID-005	Substantive Patent Law- India and Europe
AcSIR-44-ID-006	Substantive Patent Law- United States
AcSIR-44-ID-007	Traditional knowledge protection

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 44

CSIR-Unit for Research and Development of Information Products **CSIR-URDIP**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Basics of patent searching	**AcSIR-44-ID-001**	**1**

Patent searches: Overview and importance, What and why of patent searches, Tools for patent searches (keywords, operators-Boolean and special eg proximity, Truncations and wildcards etc), Different types of searches, Optimizing search strategy and search query, Using key terms and classification schemes, Steps to carry out effective searching, Process flow, Understanding the patent search fields, Types of searches.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 44

CSIR-Unit for Research and Development of Information Products	CSIR-URDIP

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	Bioinformatics	Course Code	Credits
		AcSIR-44-ID-002	1

What is bioinformatics, Basic concepts, Sequence, structure and function, Bioinformatics databases, Type of databases, Secondary nucleotide sequence databases, Sequence motif databases, Protein structure databases, Other relevant databases such as KEGG, DockGround, Sequence alignment and database searching, scoring matrix, Dynamic programming, Heuristic methods, Statistics of sequence alignment score, Multiple sequence alignment, Hidden Markov Models.
Protein structure alignments, structure superposition, RMSD, Different structure alignment algorithms, Protein secondary structure predictions, Protein tertiary structure modelling, Protein folding and dynamic simulation, Comparative modelling, Threading, Combined modelling approaches, Protein quaternary structure modelling.

Rapid development programming languages (Python, Perl), relational databases (SQL), Java, exploratory data analysis in R.

Techniques for designing efficient algorithms and basic mathematical methods for analyzing their performance. Paradigms for algorithm design: divide-and-conquer, greedy methods, graph search techniques, dynamic programming. Protein-protein docking algorithms, Semi-flexible docking: Side-chain refinement, Protein-ligand docking algorithms, Multiple-threading algorithms.

References:

1. Mount, David. Bioinformatics: Sequence and Genome Analysis. CSL Press, 2004. ISBN:0-87969-687-7
2. Husmeier, Dirk et al. - Probabilistic Modeling in Bioinformatics and Medical Informatics - Springer, 2004. ISBN: 1-85233-778-8
3. Rigden, Daniel - From Protein Structure to Function with Bioinformatics, Springer, 2009. ISBN: 978-90-481-8058-5
4. Gu , Jenny; Bourne , Philip E. - Structural Bioinformatics. Wiley, 2009 ISBN-13: 978-0-470-18105-8
5. Model, Mitchell L. - Bioinformatics Programming Using Python Practical Programming for Biological Data, O'Reilly Media, 2009. ISBN-978-0-596-15450-9
6. Tisdall, James D. - Beginning Perl for Bioinformatics: An Introduction to Perl for Biologists. O'Reilly Media, 2001. ISBN-978-0-596-00080-6
7. Bal, Harshawardhan; Hujol, Johnny. - Java for Bioinformatics and Biomedical Applications. Springer, 2006. ISBN-13: 978-0-387-37237-8

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 44

CSIR-Unit for Research and Development of Information Products CSIR-URDIP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Cheminformatics - Informatics in pharmaceutical/chemical research	Course Code	Credits
		AcSIR-44-ID-003	1

Introduction to cheminformatics: Aims, scope, role of cheminformatics in pharmaceutical/chemical research, Representation and manipulation of 1D, 2D and 3D molecular structures, Molecular file formats (SMILES, WLN, SDF, MOL), Molecular patterns, SMARTS, SMIRKS, Molecular descriptors, Calculation of descriptors reflecting physical and chemical properties of the molecules, including fingerprints and methods used for evaluation of molecular similarity and for selection of structurally diverse and representative subsets properties, Calculation of physico-chemical properties such as solubility and partition coefficients, pharmacological properties such as absorption and distribution, and global properties such as oral bioavailability and "drug-likeness" data analysis, Molecular similarity and molecular diversity analysis. Similarity index, Molecular Database Screening: (Lipinski Rule: Drug/Lead like molecules) Clustering and Statistical analysis for Molecular Informatics (PLS, PCA, PCR, kNN, ANN, Correlation and regression analysis), Modeling of small molecules using molecular mechanics and quantum mechanics methods. Quantitative structure activity relationship (QSAR), Quantitative structural property relationship (QSPARs), Quantitative structural Toxicity Relationship (QSTR), Pharmacophore modeling, In silico virtual screening, Docking studies.

Rerences:

1. Leach, Andrew R.; Gillet, Valerie J. - An introduction to Chemoinformatics - Kluwer Academic Press, 2003. ISBN: 1402013477
2. Bunin B.A. et al. - Chemoinformatics: Theory, Practice, & Products - Spingerlink, 2007. ISBN 978-1-4020-5000-8
3. Gasteiger, Johann; Thomas, Engel - Chemoinformatics: A Textbook - Wiley- VCH, 2003. ISBN: 3527306811.
4. Oprea, Tudor I. - Chemoinformatics in drug discovery - Wiley-VCH, 2005
5. Ekins, Sean, ed. - Computer Applications in Pharmaceutical Research and Development - Wiley, New Jersey, 2006

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 44

CSIR-Unit for Research and Development of Information Products CSIR-URDIP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Course Code	Credits
Patent informatics	AcSIR-44-ID-004	1

Introduction to IPR, Understanding Patents and Patent Legislation, Requirements of Patentability, Patent Treaties, Reading a patent, Anatomy of a patent and implications, Dissecting the parts, Independent and dependent claims, Claim interpretation, Evaluating strengths and weaknesses of a patent, File history and implications.
Introduction to Patinformatics: Patent Families, Patent Citations, Relationships and Trend Analysis, Patent Intelligence.
Patent Searching: Types of searches, Patentability, Validity, Infringement, Clearance (FTO), State of the art, Landscape search.
Search methodologies, Key word searches, Patent classification systems, Introduction to patent databases (Free and Paid), Searching on various patent databases, Patent analysis and mapping, Patent analysis and mapping tools, Patent information for strategic planning and technology management, Patent indicators and patent statistics for policy making, Planning R&D investments and measuring R&D performance
Hands-on: Patent searching, Patent search and analysis reports for various end uses.

References:

1. Adams, Stephen R. - Information Sources in Patents - K G Saur Verlag, 2005. ISBN: 9783598244438
2. Hunt, David; Nguyen, Long; Rodgers, Matthew - Patent Searching: Tools & Techniques - John Wiley & Sons, Inc., 2007
3. Hitchcock, David - Patent Searching Made Easy : How to Do Patent Searches on the Internet & in the Library - Nolo, 2009. ISBN: 9781413310368
4. Gibbs, Andy; DeMatteis, Bob. - Essentials of Patents - John Wiley & Sons, Inc. 2003. ISBN: 9780471250500

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 44

CSIR-Unit for Research and Development of Information Products CSIR-URDIP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title: Substantive Patent Law- India and Europe	Course Code	Credits
	AcSIR-44-ID-005	1

History of patenting in India, Indian patent office (IPO), Indian Patents Act, 1970; Patents (Amendment) Act, 2005 and TRIPS Compliance, Patents Rules, 2003 (Updated till 2016 amendment), Manual of Indian patent office practice and procedure (MPPP)
National Intellectual Property Rights Policy 2016, Indian Patent Office as International Search Authority (ISA) and International Preliminary Examining Authority (IPEA) under PCT filing.
European Patent Convention, WIPO Substantive Patent Law Treaty (SPLT)
Illustrations and examples will be cited to explain the content.

References:

1. Indian Patent Act and Rules
2. https://www.epo.org/law-practice/legal texts/html/epc/2016/e/EPC_conv_20180401_en_20181012.pdf

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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AcSIR Academic Centre Code: 44

CSIR-Unit for Research and Development of Information Products **CSIR-URDIP**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Substantive Patent Law- United States	**AcSIR-44-ID-006**	**1**

Title 35 of the United States Code:
(Part-I) United States Patent and Trademark Office USPTO (Sec 1-42)
(Part II) Patentability of Inventions and Grant of Patents
(Part III) Patents and Protection of Patent Rights
(Part IV) Patent Cooperation Treaty
Patent Trial and Appellate Board (PTAB)
Manual of Patent Examining Procedure (MPEP)
Illustrations and examples will be cited to explain the content.

References:

https://www.uspto.gov/web/offices/pac/mpep/index.html
Ninth Edition, Revision 08.2017, Last Revised January 2018
https://www.uspto.gov/web/offices/pac/mpep/mpep-2100.pdf
Chapter-Patentability
https://www.uspto.gov/patent/laws.../manual-patent-examining-procedure
Patent Examination Procedure

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AcSIR Academic Centre Code: 44

CSIR-Unit for Research and Development of Information Products CSIR-URDIP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Traditional knowledge protection	Course Code	Credits
		AcSIR-44-ID-007	1

Definition of traditional knowledge, characteristics, uses in herbal drugs and abuses, different types of protection of traditional knowledge, Plant Variety Protection Act.
Databases specific for searching traditional knowledge related information.
Traditional knowledge and scope for patent protection: Guidelines and specific laws in India will be discussed with illustrations of case studies.

1. The Protection of Biodiversity and Traditional Knowledge in International Law of Intellectual Property, Jonathan Curci, Publisher: Cambridge University Press
2. Patents as protection of traditional medical knowledge, Petra Ebermann, Series: European Studies in Law and Economics (EDLE)
3. Traditional Knowledge and Intellectual Property: A Handbook on Issues and Options for Traditional Knowledge Holders in Protecting their Intellectual Property and Maintaining Biological Diversity, Hansen, Stephen and VanFleet, Justin, American Association for the Advancement of Science (AAAS)
ISBN: 0-87168-690-2

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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45	CSIR-4PI	2	*Inter-disciplinary / Cross-disciplinary*

Course Code	Course Title
AcSIR-45-ID-001	Advanced Numerical Techniques
AcSIR-45-ID-002	High Performance Computing
AcSIR-45-ID-003	Mathematical methods in weather and climate predictions
AcSIR-45-ID-004	Mathematical Modelling
AcSIR-45-ID-005	Numerical Weather Prediction
AcSIR-45-ID-006	Overview of Artificial Intelligence
AcSIR-45-ID-007	Statistical Methods and Modelling

AcSIR Academic Centre Code: 45

CSIR-Fourth Paradigm Institute CSIR-4PI

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Advanced Numerical Techniques	Course Code	Credits
		AcSIR-45-ID-001	1

Ordinary Differential Equations: Initial Value Problems: Single step methods, Multi step methods. Boundary Value Problems: Shooting Method, Finite Difference Methods, Finite Element Method. Partial Differential Equations: Finite Difference Discretization, Finite difference treatment of 2nd order nonlinear PDE of parabolic, elliptic types, Hyperbolic problems.

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AcSIR Academic Centre Code: 45

CSIR-Fourth Paradigm Institute	CSIR-4PI

Course 2 : Inter-disciplinary / Cross-disciplinary — Total Credits 2

Title:	High Performance Computing	Course Code	Credits
		AcSIR-45-ID-002	1

Introduction to high performance computing, HPC best practices, Linux shell programming, Batch processing and scheduling.

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AcSIR Academic Centre Code: 45	
CSIR-Fourth Paradigm Institute	**CSIR-4PI**
Course 2 : Inter-disciplinary / Cross-disciplinary	**Total Credits 2**

Title:	Course Code	Credits
Mathematical methods in weather and climate predictions	**AcSIR-45-ID-003**	**1**

Introduction to weather and climate predictions, Mathematical methods used in weather and climate predictions, Singular vectors, Stochastic optimals. Chaos and deterministic predictability, Ensemble forecasts.

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AcSIR Academic Centre Code: 45

CSIR-Fourth Paradigm Institute	**CSIR-4PI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Mathematical Modelling	Course Code	Credits
		AcSIR-45-ID-004	**1**

Modeling with linear functions, Modeling with exponential functions, Modeling with polynomial functions.

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AcSIR Academic Centre Code: 45

CSIR-Fourth Paradigm Institute	**CSIR-4PI**

Course 2 : Inter-disciplinary / Cross-disciplinary | **Total Credits 2**

Title:	**Numerical Weather Prediction**	**Course Code**	**Credits**
		AcSIR-45-ID-005	**1**

Governing equations, Numerical representation, Numerical stability, Computational grids, Vertical coordinates, Sub-gridscale processes (parameterizations), Global vs. limited area models, Coupled models, Post- processing of model output-gridded forecast verification.

AcSIR Academic Centre Code: 45	
CSIR-Fourth Paradigm Institute	CSIR-4PI
Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Overview of Artificial Intelligence	Course Code	Credits
		AcSIR-45-ID-006	1

Evolution of artificial intelligence (AI): Foundations, scope, problems, and approaches of AI.

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AcSIR Academic Centre Code: 45

CSIR-Fourth Paradigm Institute	**CSIR-4PI**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Statistical Methods and Modelling	Course Code	Credits
		AcSIR-45-ID-007	1

Basic concepts: Discrete and continuous data, Sample and population, Events and probability, Frequency, Table and frequency distribution, Random variable and expectations, Basic persistence model, ARIMA model.

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Course Code	Course Title
AcSIR-64-ID-001	Geology for Biologists
AcSIR-64-ID-002	Evolutionary biology and ecology
AcSIR-64-ID-003	Theoretical and practical aspects of biodiversity
AcSIR-64-ID-004	Earth System Science
AcSIR-64-ID-005	Biogeochemistry
AcSIR-64-ID-006	Botany for Geologists
AcSIR-64-ID-007	Resilience and social-ecological systems interaction

AcSIR Academic Centre Code: 64

DST-Birbal Sahni Institute of Palaeosciences | DST-BSIP

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Geology for Biologists	AcSIR-64-ID-001	1

Geology and its Scope, Basic Geology principles; Geological Time Scale; Different rock types, their origin, texture and uses; Sedimentary Rocks in detail; Different depositional environment; Fundamental of Structural Geology; Interior of Earth; Basic mineralogy; Principles of Stratigraphy and Biostratigraphy. Concept of Field Geology.

References:

Lyell, C. 2005. Principles of Geology. United Kingdom: Penguin Books Limited.
Brookfield, M. E. (2008). Principles of Stratigraphy. Germany: Wiley.
Fletcher, R. C., Fletcher, R. C., Pollard, D. D. (2005). Fundamentals of Structural Geology. United Kingdom: Cambridge University Press.

Reommended at the 4th meeting of Board of Studies, AcSIR on Sep 7, 2020.
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DST-Birbal Sahni Institute of Palaeosciences **DST-BSIP**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Evolutionary biology and ecology	Course Code	Credits
		AcSIR-64-ID-002	1

Why study evolution? History of, and evidence for evolution, evolutionary ecology, philosophy of biology, evolutionary developmental biology, conservation biology evolution of behavior, evolution of life histories, evolutionary psychology, systematics, palaeobiology, evolution & development size and shape, molecular evolution, evolutionary genetics, phylogenetic analysis, coevolution, both micro- and macroevolutionary studies, human genetic variation and evolution, the history of life, biogeography, analyzing the fossil record, field ecology and its coevolution.

References:

Cruzan, M B. 2018. Evolutionary Biology: A Plant Perspective. United States: Oxford University Press.
Niklas, K J 2016. Plant Evolution: An Introduction to the History of Life. United Kingdom: University of Chicago Press.
Agarwal, SK. 2008. Fundamentals of Ecology. India: APH Publishing Corporation.

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DST-Birbal Sahni Institute of Palaeosciences DST-BSIP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:	Theoretical and practical aspects of biodiversity	Course Code	Credits
		AcSIR-64-ID-003	1

Biodiversity – definition, Role of biodiversity, Threats to biodiversity, Biodiversity and climate change, Measurements, Quantifying palaeobiodiversity, Conservation of biodiversity. Functional interaction between land cover and biodiversity, Linking biodiversity to ecosystem functions and services, Assessment of landscape linkage/corridors, Ecological modelling, and use of geospatial tools.

References:

Krishnamurthy, KV. 2017. An Advanced Textbook On Biodiversity Principles And Practice. Oxford & Ibh Publishing.
Gaston, KJ and Spicer, JI. 2004. Biodiversity: An Introduction. Wiley-Blackwell, 208 pp.
Loreau, M, Naeem, S, Inchausti, P. 2004. Biodiversity and ecosystem functioning: Synthesis and Perspectives. Oxford University Press.
Hawksworth, DL. 1995. Biodiversity: Measurement and estimation. Springer.
Fisher, M. 2018. Environmental Biology. Open Oregon Educational Resources.

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DST-Birbal Sahni Institute of Palaeosciences | DST-BSIP

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Earth System Science	Course Code	Credits
		AcSIR-64-ID-004	1

Big bang, Concept of Universe, The solar system: Origin of the solar system, Earth and other planets; Origin and nucleosynthesis of elements, Systems concept, Energy balance, Earth's radiation budget, Hydrologic cycle, Geosphere, Biosphere, Atmosphere, Hydrosphere, Cryosphere, Critical zone, Interactions between systems, Feedback mechanism, Atmosphere-Ocean interactions, , Natural and Anthropogenic forcing factors operative on planet earth such as El-Nino Southern Oscillation, Indian Ocean dipole etc., Detecting perturbations in earth system processes, Earth system history, Global warming.

References:

Rodhe, H., Charlson, R., Jacobson, M., Orians, G. (2000). Earth System Science: From Biogeochemical Cycles to Global Changes. United Kingdom: Elsevier Science.

NASA Advisory Council. Earth System Sciences Committe. (1986). Earth System Science Overview: A Program for Global Change. National Aeronautics and Space Administration. United States.

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AcSIR Academic Centre Code: 64

DST-Birbal Sahni Institute of Palaeosciences DST-BSIP

Course 2 : Inter-disciplinary / Cross-disciplinary Total Credits 2

Title:		Course Code	Credits
	Biogeochemistry	AcSIR-64-ID-005	1

Solar radiation, Greenhouse gases, Ocean circulation, Orbital forcing, Basic forces within Ocean and Atmosphere, Chemical solubility of important gases in Oceans, Carbon cycle, Nitrogen cycle, Sulphur cycle, Phosphorus cycle, Oxygen cycle and metal cycle. Organic matter chemistry, Dissolved organic matter, soil microbial activity, Life metabolic pathways, Redox chemistry

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DST-Birbal Sahni Institute of Palaeosciences	**DST-BSIP**

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Botany for Geologists	Course Code	Credits
		AcSIR-64-ID-006	1

Plant kingdom: latest classification; an introduction to different types of plants, Palynology: history, branches, basic principles, and applications. Collection of polleniferous materials from modern samples (i.e. living flowers, spider webs, tree barks and honey samples etc.) and sediments; Extraction of pollen grains from modern pollenniferous materials and fossil sediments, reference pollen slide preparation; Case studies: modern pollen deposition and its relationship with the extant vegetation, palaeoclimate reconstruction based on pollen records. Non-Pollen palynomorphs: an auxiliary tool for decoding the palaeoenvironment, coprophilous fungi and their potential as indicators of past grazing activity, diatom as a tool for deciphering palaeoecology, phytolith in palaeoecological studies, melissopalynology, forensic palynology. Mega fossils and their role in understanding the past.

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AcSIR Academic Centre Code: 64

DST-Birbal Sahni Institute of Palaeosciences | DST-BSIP

Course 2 : Inter-disciplinary / Cross-disciplinary | Total Credits 2

Title:	Course Code	Credits
Resilience and social-ecological systems interaction	AcSIR-64-ID-007	1

What are social-ecological systems (SES), Importance of SES, Theory and practice, Various frameworks for analyzing SES, Ostrom model of SES, Mathematical tools to model SES, SES and biodiversity conservation, SES in the Anthropocene, Vulnerability, Adaptive Capacity, Resilience, Regime shifts.

References:

Lyell, C. 2005. Principles of Geology. United Kingdom: Penguin Books Limited.

Brookfield, M. E. (2008). Principles of Stratigraphy. Germany: Wiley.

Fletcher, R. C., Fletcher, R. C., Pollard, D. D. (2005). Fundamentals of Structural Geology. United Kingdom: Cambridge University Press.

66	DST-IASST	2	Inter-disciplinary / Cross-disciplinary

Course Code	Course Title
AcSIR-66-ID-001	Basic Chemistry for Interdisciplinary sciences
AcSIR-66-ID-002	Basic Physics for Interdisciplinary sciences

AcSIR Academic Centre Code: **66**

DST-Institute of Advanced Study in Science and Technology	DST-IASST

Course 2 : Inter-disciplinary / Cross-disciplinary	Total Credits 2

Title:	Course Code	Credits
Basic Chemistry for Interdisciplinary sciences	**AcSIR-66-ID-001**	**1**

Basics of inorganic, organic, physical and biochemistry, Nomenclature (IUPAC), molarity, molality and normality, types of bonding, Ionic, covalent and non-bonding interactions, Acids and bases, Atomic structure, periodic table and periodic properties, stoichiometry, chemical reactions and kinetics, solvent effects, functional groups in organic compounds, general named reactions and reaction mechanisms, carbohydrates, lipids, proteins, nucleotides, enzymes, photosynthesis.

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AcSIR Academic Centre Code: 66

DST-Institute of Advanced Study in Science and Technology	DST-IASST

Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Basic Physics for Interdisciplinary sciences	Course Code	Credits
		AcSIR-66-ID-002	1

Physics in biology, Proteins, DNA, Membranes, Lipid-protein interaction, Protein condensation, Different valent ions, Structures and interactions, Spectroscopic and microscopic techniques in biological systems.

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