



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	ICRIR, 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	IIM, 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-HIPH-Delhi
62	PHFI-HIPH-Hyderabad
63	LVPEI, Hyderabad
64	BSIP, Lucknow
65	NIMR, New Delhi
66	IASST, Guwahati

A serial number for course to distinguish

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

Inter-disciplinary / Cross-disciplinary Courses and Syllabus

Course contents

S.no	AcSIR Centre Code	Name of the Centre	No. Courses	Page .no
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4.	04	CSIR-CDRI	07	25
5.	05	CSIR-CECRI	02	33
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33.	38	CSIR-NEIST	29	326
34.	39	CSIR-NIIST	08	357
35.	41	CSIR-SERC	07	366
36.	42	CSIR-NISCAIR	07	374
37.	43	CSIR-CIMFR	11	382
38.	44	CSIR-URDIP	07	394
39.	45	CSIR-4PI	07	402
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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

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory

CSIR-NPL

Course 2 : Inter-disciplinary / Cross-disciplinary

Total Credits 2

**Title: Electromagnetic Wave Characterization for
Physicist and Biologist**

Course Code

Credits

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.

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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.

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.

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory

CSIR-NPL

Course 2 : Inter-disciplinary / Cross-disciplinary

Total Credits 2

Title:	Environmental Chemistry & Metrology	Course Code	Credits
		AcSIR-32-ID-004	2

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/GHG's using online gas analyzers. Primary Ozone standard, Estimation of uncertainty in calibration of ozone analyzer.

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	2

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, (1) 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.

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory

CSIR-NPL

Course 2 : Inter-disciplinary / Cross-disciplinary

Total Credits 2

Title:	Metrology in Chemistry	Course Code	Credits
		AcSIR-32-ID-006	2

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.

AcSIR Academic Centre Code: 32

CSIR-National Physical Laboratory

CSIR-NPL

Course 2 : Inter-disciplinary / Cross-disciplinary

Total Credits 2

Title:	Materials Processing and Characterization	Course Code	Credits
		AcSIR-32-ID-008	1

Introduction to materials processing techniques, Polymer Processing, Metal Processing, Ceramic Processing, Composites Processing (Metal, Ceramic, Polymer matrix, Carbon-Carbon Composites), Nanomaterials and Nanocomposite Processing. Polymer processing includes, Injection moulding, compression moulding, transfer moulding, blow moulding, film blowing and extrusion. Fiber reinforced composites processing includes filament binding, hand layup, pultrusion. Metal and Ceramic composites processing includes powder Metallurgy, arc melting, melt spinning, spark plasma sintering, hot pressing. Materials Testing, Mechanical Properties such as Tensile, Compression, Bending. Impact, Thermal Shock Resistance, Hardness, Toughness, Ductile to brittle transition. Mechanical behavior of polymers. Crystallization, melting and glass transition. Heat capacity, Thermal expansion, Thermal conductivity. Thermal stresses, Electrical properties.