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.
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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.

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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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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

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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
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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Title:	Course Code	Credits
Aerospace Materials	**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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Title:	Course Code	Credits
Condition Monitoring Concepts and Applications	**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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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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Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Introduction to Computational Methods of Fluid Dynamics	**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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Course 2 : Inter-disciplinary / Cross-disciplinary **Total Credits 2**

Title:	Course Code	Credits
Mathematics for Engineers	**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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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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