

POST GRADUATE DIPLOMA PROGRAMME IN

- **ADVANCED MANUFACTURING TECHNOLOGY (PGDAMT)**
- **ROBOTICS (PGDR)**
- **INDUSTRIAL MAINTENANCE ENGINEERING (PGDIME)**

Under the Aegis of



Academy of Scientific & Innovative Research

Set up by an Act of Parliament, An Institute of National Importance



CSIR-Central Mechanical Engineering Research Institute
Durgapur-713209

CSIR - Central Mechanical Engineering Research Institute

The CSIR-Central Mechanical Engineering Research Institute (CSIR-CMERI) is the only national laboratory dedicated to Mechanical Engineering. As a constituent member under the Council of Scientific & Industrial Research, the ambit of the Central Mechanical Engineering Research Institute (CMERI) – a premier establishment dedicated to research and development – extends over mechanical and allied engineering fields.

In India, mechanical engineering technology has accounted for nearly half of the total technology imported. In terms of products, nearly one third of the value of total imports is for mechanical engineering equipment. In order to develop indigenously mechanical engineering technology for the industries so that R&D can play a key role in self-reliance, the Central Mechanical Engineering Research Institute at Durgapur, West Bengal was established in February 1958 with the specific task of development of mechanical engineering technology.

Besides conducting frontline research in the varied areas related to mechanical engineering, the Institute dedicates its R&D efforts towards different mission mode programmes to disseminate appropriate technological solutions for poverty alleviation and societal improvement.

CSIR - CMERI has a dedicated team well balanced in terms of youth and experience of highly qualified professionals and supporting staff spanning the various disciplines under mechanical engineering.

Major Research Areas

The major research areas are represented in the following schematic



In the new millennium, CSIR-CMERI is poised to expand its horizon of research activities so as to steer the country forward in the following cutting-edge and sunrise fields.

Advanced Design, Manufacturing, Immersive Visualization

Design, manufacturing and product development at CSIR-CMERI is suitably aided by a comprehensive CAD-CAM environment supporting collaborative design through analysis of mechanisms, tolerances, interferences of designated parts, etc. Current R&D in material processing is focused on development of rheo die-casting system by integrating semi-solid slurry processing unit. Immersive Visualization affords rapid development of system concepts and analyzing for form, fit, function, logistics, human factors integration, and general feasibility analysis. Expertise in visualization is augmented with the induction of state-of-the-art facilities in Virtual Prototyping and Virtual Reality.

Micro Systems Technology, Surface Engineering & Tribology and Measurements

Micro Systems Technology is associated with the technology of very small parts, actuators, devices and MEMS. Development of microfluidic chips affording precise control of very small quantities of liquid for analyzing gene expression and mutation identification in cells is being targeted. Research in Surface Engineering & Tribology has culminated in the development of μ CNCmill - a five axis micro milling machine for efficient, cost effective and high resolution milling and drilling. A state-of-the-art high precision measurement Lab with NABL Accreditation for myriad gauges and instruments for quality control and assurance in product development has also been established in the area of measurement technologies.

Robotics, Mechatronics and Automation

CSIR-CMERI is undertaking extensive research in the design and development of Autonomous Underwater & terrestrial Vehicles, All Terrain Robots, Subterranean Robots, etc. R&D issues cover mechanical design, attitude control, non-conventional propulsion and manoeuvre (bio-mimicry), actuator development, parallel/distributed computing, navigation and guidance, Collision avoidance, communication protocols, sensor fusion, etc.

Renewable energy, Fluids & Thermal systems

Active research is carried out on fluid flow, heat transfer, combustion, gasification, fluidization, renewable energy, waste management, drying, etc. Additionally, research is carried out on solar-powered adsorption-based space-cooling system, CFD simulation of fluidized bed hydrodynamics. Flow hydrodynamics is also being addressed through wind tunnel experimentation.

Cybernetics, Electronics & Embedded Systems, Drives & Control

Separate R&D groups dedicated to Cybernetics, Electronics & Embedded Systems and Drives & Control are working on electronics and embedded systems based product development. The design of electrical drive and control systems, electrical machines and power electronics products for different R&D and industrial requirements are being carried out.

Post Graduate Diploma Programme

Duration of the course: One year (Two Semesters)

Admission Process

Selection of the students in Post Graduate Diploma course will be done through written test / interview at CSIR-CMERI, Durgapur

No. of Seats: 30 for each programme
(Reservation as per GOI guidelines)

Evaluation Procedure: As per AcSIR guidelines

Proposed Course Fee

1. Admission fee	Rs. 4,000/-
2. Tuition fee per semester for Regular candidate	Rs. 25,000/
3. Tuition fee per semester for Sponsored candidate	Rs. 50,000/
4. Security Deposit (refundable)	Rs. 10,000/-

Hostel Fee

1. Accommodation charge including electricity & water	As per Institute Guidelines
2. Food charges	At actual
3. Deposit (Refundable)	Rs. 2,000/-

Proposed timeline

18.08.2017	Commencement of Academic Session
14-08-2017 To 16-08-2017 (16.08.2017 To 17.08.2017)	Enrolment
28-07-2017 (01.08.2017)	Declaration of Results (on web)
17-07-2017 To 19-07-2017 (25.07.2017 To 26.07.2017)	Aptitude Test/ Interview
29-06-2017 To 30-06-2017 (10.07.2017 To 11.07.2017)	Intimation of Shortlisted Candidates
23-06-2017 (30.06.2017)	Application Closing Date
26.05.2017	Date of Advertisement

Post Graduate Diploma in Advanced Manufacturing Technology (PGDAMT)

At the heart of any manufacturing system, a set of processes that converts raw materials into the desirable configuration contribute significantly to the sustainability of national economy. The proposed course emphasizes on practical training in combination with necessary theoretical aspects on advanced manufacturing areas. This course is designed in a way for the personnel who would like to take up careers in manufacturing industries and for practicing engineers, to get acquainted with technological challenges and opportunities that have witnessed significant growth in the last 5 decades.

All the major economies in the world recorded growth due to the contribution from industries that were innovative in product design and efficient manufacturing. The key to knowledge deployment in a growing economy requires acquaintance of students with the fundamentals of advance manufacturing through pedagogy on current theoretical and practical developments. The manufacturing course will give a detailed understanding on advanced manufacturing by covering topics such as multi-scale (macro to sub- micron size) metal removal process, CAD & CAM, near net shape manufacturing processes, Additive manufacturing and precision measurement and quality assurance. This practical intensive course backed by theoretical lecture, aimed to promote significantly national skill development initiatives for sustainable empowerment.

The programme traverses a wide range of applications that includes manufacturing methods, computer integration and process & device control, with specific emphasis on innovative engineering. This one year post graduate program would provide an exposure to the manufacturing concepts, scientific principles, methodology by providing an opportunity for the students to directly associate with real-life R&D projects to gain hands-on experience.

Eligibility: BE/BTech/AMIE in Mechanical/Manufacturing/Production Engineering or equivalent

Post Graduate Diploma in Advanced Manufacturing Technology (PGDAMT)

SEMESTER I

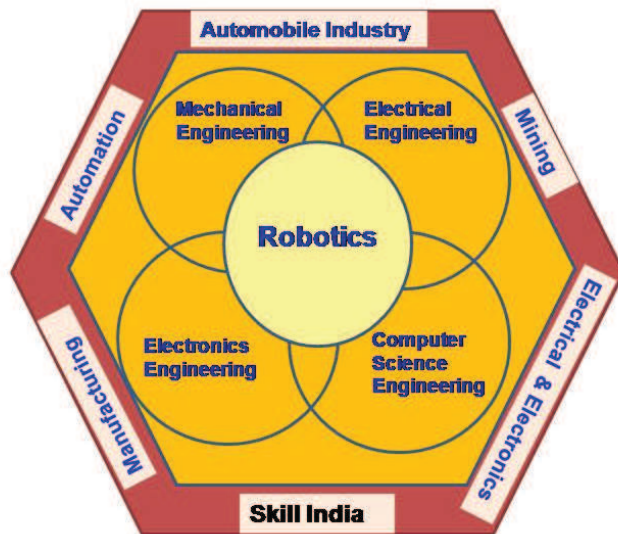
Sl. No.	Course Code	Course Title	Hours/Week			Credit Points
			Lecture	Tutorial	Practical	
1	ENG-CMERI-1-2120	Theory of Manufacturing Processes & Systems	1	0	4	3
2	ENG-CMERI-1-2121	Near-net-shape Manufacturing	1	0	4	3
3	ENG-CMERI-1-2122	Precision Measurement & Quality Assurance	1	0	4	3
4	ENG-CMERI-1-2123	CAD/CAM	1	0	4	3
5	ENG-CMERI-1-2124	Additive and Micro Manufacturing	1	0	4	3
6	ENG-CMERI-1-2149	Seminar	0	1	0	1
Semester Credit Points						16

SEMESTER II

Sl. No.	Course Code	Course Title	Hours/Week			Credit Points
			Lecture	Tutorial	Practical	
1	ENG-CMERI-1-2125	Prototype Assembly & Maintenance	0	2	12	8
2	ENG-CMERI-1-2150	Project Work and Viva-voce	0	2	16	10
Semester Credit Points						18
Total Credit Points						34

Post Graduate Diploma in Robotics (PGDR)

The program on Post Graduate Diploma in Robotics (PGDR) will primarily act as a skill building program under Skill India program for graduate engineers, focusing on laying strong foundation to groom them technically suitable in the field of robotics, as there is an increasing demand for robot assists to robot interventions in industrial workplace. In past three decades, CSIR-CMERI has built its brand value as one of the pioneers in India in the field of robotics starting from development of manipulators in early years to present day research on all terrain mobile robots including serpentine robots, subterranean robots, underwater robots and aerial robots. With the advances in robotics, the micro robot technology and embedded system technology are also gaining prominence in industrial applications. This knowledge, insight and capability building over these years will be handed down to the next generation through this program by experienced faculty using state-of-art resource facilities. The program on PGDR will create a pool of technically trained engineers readily available for industry ,by providing practical training on various modern robot technology so that trained manpower can be fitted in a wide range of industries including automobile, mining, manufacturing, automation, electrical and electronics industries.



This knowledge, insight and capability building over these years will be handed down to the next generation through this program by experienced faculty using state-of-art resource facilities. The program on PGDR will create a pool of technically trained engineers readily available for industry ,by providing practical training on various modern robot technology so that trained manpower can be fitted in a wide range of industries including automobile, mining, manufacturing, automation, electrical and electronics industries.

This one year Post Graduate Diploma in Robotics course is suitable for engineers who have recently graduated as well as those with experience who are seeking to extend their knowledge, or update their qualifications with a view to promotion or other new position in field of robotics. The programme offers fundamental knowledge on a wide range of applications that comprise product design methods, instrumentation & control techniques and computer integration so that modern robotic system can be built for industry as well as for contributing towards Digital India, Make-In-India and Skill India programs. Students undergoing this course are expected to emerge properly equipped to confront challenges across the industrial environment spectrum.

At the end of the course, the engineers are equipped with set of skills and knowledge to apply technical fundamentals for development of robots to address needs of the industries and society.

Eligibility: Eligibility: BE/BTech in Engineering (Mechanical, Electronics/ Electrical, Computer Science or equivalent) with minimum of 60% marks (6.0 CGPA). Candidates with GATE score are preferable.

Post Graduate Diploma in Robotics (PGDR)

SEMESTER I

Sl. No.	Course Code	Course Title	Hours/Week			Credit Points
			Lecture	Tutorial	Practical	
1	ENG-CMERI-1-2126	Fundamentals of Computer Programming & Robot Programming	1	1	2	3
2	ENG-CMERI-1-2127	Introduction to CAD, 3-D Modelling and Robot Mechanics	1	1	2	3
3	ENG-CMERI-1-2128	Embedded system and digital Signal processing (DSP)	1	1	2	3
4	ENG-CMERI-1-2129	Sensors and Actuators	1	1	2	3
5	ENG-CMERI-1-2130	Mobile robotic systems and Industrial robots	1	1	2	3
6	ENG-CMERI-1-2149	Seminar	0	1	0	1
Semester Credit Points						16

SEMESTER II

Sl. No.	Course Code	Course Title	Hours/Week			Credit Points
			Lecture	Tutorial	Practical	
1	ENG-CMERI-1-2131	Robot Control	1	1	2	3
2	ENG-CMERI-1-2132	Robotic Case Studies	0	1	8	5
3	ENG-CMERI-1-2150	Project Work and Viva-voce	0	2	16	10
Semester Credit Points						18
Total Credit Points						34

Post Graduate Diploma in Industrial Maintenance Engineering (PGDIME)

Industrial Maintenance Engineering (IME) is the discipline and profession of applying engineering concepts to the optimization of equipment, procedures, and departmental budgets to achieve better maintainability, reliability, and availability of equipment. With the increasing awareness that maintenance ensures safe and sustainable performance and creates added value in the business process, industries have started considering maintenance as an integral part of the business process while applying a holistic view of the asset engineering and management. Maintenance is to ensure a unit is fit for purpose, with maximum availability at minimum costs. Here, maintenance strategies play pivotal role for smoothly running the complex industrial machineries in a wide range of industries including power, steel, automotive, mining and chemical industries. The proper planning and implementation of maintenance strategies help to trim down expensive breakdowns which may interrupt production of industries. This One Year Post Graduate Diploma in Industrial Maintenance Engineering course is suitable for the engineers who have recently graduated as well as those with experience who are seeking to extend their knowledge, or update their qualifications with a view to promotion or other new position.



This PGDIME intends to acquaint engineers with the fundamentals of Industrial Maintenance through pedagogy on current theoretical and practical developments in this area. The programme traverses a wide range of applications that comprise predictive maintenance, condition monitoring, bearing and lubrication design, corrosion protection, materials, control and sensors, NDT assessment, instrumentation, vibration and reliability, management with specific emphasis on hands on training. The one year research programme aims to provide in-depth exposure to the engineering concepts, scientific principles, implementation methodology and hands-on experience on complex real-life problems that CSIR-CMERI will be undertaking in different specializations related to Industrial Maintenance Engineering.

At the end of the course, engineers are expected to be equipped with set of skills and knowledge to apply technical fundamentals of Industrial Maintenance to address needs of the industries in order to ensure high system dependability and efficient and effective maintenance processes for both new and existing systems

Eligibility: BE/B.Tech/AMIE in Mechanical / Production / Industrial / Instrumentation /Electrical / Chemical / Electronics / Materials / Metallurgical Engineering or equivalent; M.Sc. in Physics /Chemistry / Materials Science.

Post Graduate Diploma in Industrial Maintenance Engineering (PGDIME)

SEMESTER I

Sl. No.	Course Code	Course Title	Hours/Week			Credit Points
			Lecture	Tutorial	Practical	
1	ENG-CMERI-1-2133	Introduction to Vibration and Reliability	1	0	2	2
2	ENG-CMERI-1-2134	Bearings and Machinery Lubrication	2	0	2	3
3	ENG-CMERI-1-2135	Diagnostic Maintenance and Condition Monitoring	2	0	4	4
4	ENG-CMERI-1-2136	Damage Assessment	2	0	2	3
5	ENG-CMERI-1-2137	Instrumentation and Control	1	1	0	2
6	ENG-CMERI-1-2138	Materials Characterization	1	0	2	2
7	ENG-CMERI-1-2149	Seminar	0	1	0	1
Semester Credit Points						17

SEMESTER II

Sl. No.	Course Code	Course Title	Hours/Week			Credit Points
			Lecture	Tutorial	Practical	
1	ENG-CMERI-1-2139	Corrosion and Corrosion Protection	1	0	2	2
2	ENG-CMERI-1-2140	Maintenance Management	1	1	0	2
3	ENG-CMERI-1-2141	Practical Training	0	0	6	3
4	ENG-CMERI-1-2150	Project Work and Viva-voce	0	2	16	10
Semester Credit Points						17
Total Credit Points						34

COURSE DETAILS*

* The course structure, syllabus and credit points of few courses may change subject to the approval of AcSIR.

ENG-CMERI-1-2120	THEORY OF MANUFACTURING PROCESSES AND SYSTEMS	L-T-P-C : 1-0-4-3
<p>Introduction: Overview of Machining Technology, Theory of Chip Formation in Metal Machining, cutting tools and materials.</p> <p>Conventional Manufacturing Processes: Different types of material removal processes, Joining & Forming processes, Machine tools & their structure.</p> <p>Non-Conventional Manufacturing: Electrical Discharge Machining, Electro Chemical Machining, Laser Assisted Machining, Forming and joining.</p> <p>Integrated Manufacturing Systems: Material Handling, Fundamentals of Production Lines Assembly Lines, Cellular Manufacturing, Flexible Manufacturing Systems and Cells, Computer Integrated Manufacturing.</p> <p>Production Planning and Control: Process planning & Scheduling, Inventory Control, Material and Capacity Requirements Planning, Just-In-Time and Lean Production.</p> <p>Experimentation and hands-on for understanding the machines and manufacturing processes, extensive practical study will be carried out.</p>		
ENG-CMERI-1-2121	NEAR NET SHAPED MANUFACTURING PROCESSES	L-T-P-C : 1-0-4-3
<p>Metal Casting: Casting processes, Methoding, Casting defect and salvaging and Solidification of Metal and composite</p> <p>Metal powder processes: Fundamentals of Powder Metallurgy, Metal Injection molding, Powder forging and Sintering</p> <p>Heat treatment: Austempering, Solutionising and ageing, material testing</p> <p>Extensive experiments with related processes covered in theoretical classes for better understanding through practical training</p>		
ENG-CMERI-1-2122	PRECISION MEASUREMENT AND QUALITY ASSURANCE	L-T-P-C : 1-0-4-3
<p>Basics of measurement & Important terms: standards, scales, error, precision, accuracy, inspection and calibration, measuring instruments and their uses, effects of environment in measurement.</p> <p>Coordinate measuring machine (CMM): Its major types and elements, coordinate systems, process, probes and softwares, prismatic component inspection and reverse engineering, causes of parametric errors of CMM and its evaluation.</p> <p>Laser interferometry: Principle in measurement, elements of laser interferometer, measurement of position, straightness, squareness, flatness and angular, performance evaluation CNC machine by laser measurement system and auto error compensation.</p> <p>Surface texture: Surface texture measurement and its importance, instruments used for surface texture measurement, filtering, surface texture parameters, surface data analysis.</p> <p>Machine vision: Machine vision system, principle of working, fields of machine vision system, gray scale image processing techniques, binary imaging, mathematical morphology for shape analysis, photogrammetry.</p> <p>Quality Assurance: Measurement system analysis, quality assurance through gage R & R study, process capability indices, one sided and two sided specifications, statistical control of processes, control charts - X</p>		

bar, s and p, uncertainty of measurement.

Hands-on on study and use of standards and instruments. Extensive practical training with related measurement techniques covered in theoretical classes for better understanding.

ENG-CMERI-1-2123

COMPUTER AIDED DESIGN AND MANUFACTURING

L-T-P-C : 1-0-4-3

Introduction to CAD/CAM: Definition, Historical development of CAD/CAM, Evolution of CAD, Exposure to different CAD platforms, Exposure to different formats of data exchange in CAD, Integration of CAD with manufacturing, Advantages of CAD/CAM.

Concept of machine centers: Principles of Numerical Control, Types and classification of CNC Machine Tools, Features of CNC Systems, Direct numerical control (DNC), Elements of CNC viz. ball screws, rolling guide ways, structure, machining centers and interpolators, drives and controls, standard controllers, control resolution, spatial resolution, accuracy, repeatability, compliance.

CNC programming: Machine coordinate systems, Planning for NC operations, Work holding for CNC operations, APT, Manual ISO Part Programming, Subroutines, Compensation and Offsets, Canned Cycle, Part modeling in CAD/CAM software, Pre-processing of a part model for CNC machining, Tool path generation and simulation for CNC machining.

Economics and Maintenance: Factors influencing selection of CNC Machines, Cost of operation & commissioning of CNC Machines, Maintenance features and Preventive Maintenance of CNC Machines.

Flexible Manufacturing Systems : Concept of Manufacturing Cell, Single Machine Cell, Flexible Manufacturing Cell, Pallet Changers, Automatic Tool Changers, Part Buffers, Flexible Manufacturing Systems (FMS), Typical FMS layouts, Advantages and disadvantages of FMS, Concept of Additive Manufacturing and Rapid Prototyping.

Hands-on on study and extensive practical training on 3D modelling, selection of machining strategies, tool path generation, machining simulation, data transfer techniques including automatic tool changing operations in vertical machining center and CNC lathe covered in theoretical classes for better understanding

ENG-CMERI-1-2124

ADDITIVE AND MICRO MANUFACTURING

L-T-P-C : 1-0-4-3

Module -I: Additive Manufacturing

Introduction: Prototyping, Additive and subtractive manufacturing, (layered manufacturing), Rapid prototyping and Tooling.

CAD Data: CAD data preparation, slicing methods, stair step effects, data transfer and programming.

Reverse engineering: Digitizing and 3D construction methods.

Additive Manufacturing Processes: Principles of layered manufacturing, Laser fundamentals, Processes (Stereo lithography, selective laser sintering, DMD, FDM).

Module-II: Micro Machining

Micro- Nano Scale Manufacturing: Introduction, Micro Machining (milling, EDM, laser micro machining), Micro Injection molding, Nano-scratching, Micro patterning, Design of Micro machines, precision drives and controls, Error budgeting and Micro Factory concepts.

Micro-Nano metrology: Precision Metrology: definitions; laser interferometer; AFM; SEM; TEM.

Hands-on on study and 3D CAD modelling, slicing data preparation and optimization of metal deposition process parameters through practical study.

Hands on study and practical training on micro milling, micro-EDM, nano-scratching for better understanding on material removal mechanisms, accuracy prediction etc. based on advanced micro metrology techniques using optical microscope, SEM and AFM instruments.

ENG-CMERI-1-2125	PROTOTYPE ASSEMBLY & MAINTENANCE	L-T-P-C : 0-2-12-8
<p>Practical training on limits-fits and tolerances for better understanding on assembly requirements of two mating parts including hands on study on measurements and error budgeting of assembled machines/systems.</p> <p>Hand on study on manufacturing of critical miniature components having micro-nano scale geometries. Assembly, Inspection Testing & performance evaluation of micro machines including system engineering.</p> <p>Practical training on product –process design starting from CAD data preparation, slicing, tool path generation & layered deposition of metals to build components by bottom-up approach manufacturing.</p> <p>Workshop practices including CAD design, process planning, scheduling, manufacturing & inspection of live components.</p> <p>Practical training on 3D modeling, selection of machining strategy, tool path generation, data transfer and operation of CNC machine for manufacturing of critical components.</p> <p>Casting simulation, training on sand mould preparation, metal casting and finishing of live components.</p> <p>Hands on study on range of heat treatment processes including solutionizing and austempering of cast components.</p> <p>Hands on study and extensive practical training powder metallurgy and powder injection moulding for manufacturing of small and complex components and assembly plastic parts.</p>		
ENG-CMERI-1-2126	FUNDAMENTALS OF COMPUTER PROGRAMMING & ROBOT PROGRAMMING	L-T-P-C : 1-1-2-3
<p>Module-I: Fundamentals of Computer Programming C Language : Introduction, Operators, Conditional statements and loops, Arrays, Functions (Library functions, user defined function, passing arguments to a function, call by reference, call by value, recursive functions) , Structures and Unions, Pointers, C++ : C++ Overview, Classes in C++, Overloading (operator overloading ,function overloading), Inheritance (overview of inheritance ,defining base and derived classes ,constructor and destructor calls), HTML.</p> <p>Module-II: Robot Programming Visual C++ and its utility in robotics, Matlab: Matrix operations and functions in MATLAB ,MATLAB scripts and functions (m-files) Simple sequential algorithms , Reading and writing data, file handling, Personalized functions , Toolbox structure , Random number generation, Interactive hands-on-session, Perl: Built in functions and user defined functions, Subroutines, Python : Basics of Python, Operators and Expressions, Control flow, Functions, Modules, Problem Solving in python, Input and outputs in python. Tutorial and Practical Hands-on experience with practical and applications of programming methods</p>		
ENG-CMERI-1-2127	INTRODUCTION TO CAD, 3-D MODELLING AND ROBOT MECHANICS	L-T-P-C : 1-1-2-3
<p>Module-I : Introduction to CAD, 3-D Modelling Definition, Historical development of CAD, Evolution of CAD, exposure to different CAD platforms, part and assembly 3-modeling in different CAD platforms, exposure to different formats of data exchange in CAD, generation of 2D drawings from part model, integration of CAD with other platforms and its implementation.</p> <p>Module-II : Robot Mechanics Robotics: State-of-the-Art; types of robots – Geometry and structures; Serial Link Robots; Conventions;</p>		

Kinematics – Position, Orientation, Rotation Matrix, Euler angles, Linear and Angular velocities, accelerations, position and velocity transformations, Jacobians; kinematic constraints; Forward and Inverse Kinematics; Statics – Task space and joint space forces/torques; Force-velocity duality; Stiffness analysis; Robot Dynamics – Principles of rigid body dynamics, notion of Inertia tensor; Robot dynamics algorithms – forward and inverse dynamics; Tendon driven system
 Tutorial and Practical
 Hands-on training, CAD packages (Auto CAD, Solid Works, Inventor, Idea, Catia, ADAMS).
 Robot kinematics, task planning and programming; Force sensing and decomposition; Joint and end-effector stiffness and deflection; hands-on tendon driven system.

ENG-CMERI-1-2128	EMBEDDED SYSTEM AND DIGITAL SIGNAL PROCESSING (DSP)	L-T-P-C : 1-1-2-3
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Module-I : Embedded System
 Digital Electronics Fundamentals, Microcontroller, Basics of state machine, Assembly language programming, Embedded C programming, Algorithm development and its application specific system design with microcontroller and simulation.
 Module-II : Digital Signal Processing (DSP)
 Elements of Analog and Digital Signal Processing, Advantages of Digital over Analog, Sampling Theorem. Discrete Time Signals & Systems – Classification, Analysis of LT Systems, of LTI system Response to Arbitrary Inputs, Causality, Stability, Correlation, Convolution
 Analysis in Z-domain, Fourier Analysis – Continuous & Discrete-Time Fourier Series, Power Density Spectrum, Fourier Transform, Frequency-Domain Characteristics of LTI Systems, DFT & Properties, Fast Fourier Transforms (FFT), Digital Filter Design and applications.
 Tutorial and Practical
 Understanding of DSP concepts using Matlab
 Elements of Code Composer Studio (CCS), DSP Programming with Texas Instruments embedded boards
 Hands-on experience with embedded DSP boards for signal processing requirements in robotics

ENG-CMERI-1-2129	SENSORS AND ACTUATORS	L-T-P-C : 1-1-2-3
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Module-I : Sensors
 Fundamentals of sensor and Transducer, various sensing principle, Resistive sensing element: potentiometer, resistance thermometer, strain gauge, capacitive sensing elements: variable separation, area and dielectric, Inductive sensing elements: variable reluctance and LVDT, RVDT displacement, electrometric sensing elements: velocity, techo, elastic sensing element: force, torque, acceleration, pressure, gyroscope, optical sensor, strain gauge based force-torque sensors proximity and distance measuring sensors, and vision.
 Module-II : Actuators
 Principal of actuator, type of actuators, mechanical actuator, electrical actuator, hydraulic actuator, Pneumatic actuator and other different kinds of actuators – stepper, DC servo and brushless motors, model of a DC servo motor, Smart Material based actuator like Electro active polymer (EAP), ionic polymer metal composite (IPMC), piezoelectric and shape memory alloy actuator etc and its application in robotics.
 Tutorial and Practical
 Hands-on training on various sensing elements like pressure measurements, relative humidity measurements, tachometer, vibration measurements, accelerometers, strain gauge, potentiometer, resistance and

thermometer, torque sensors and laser distance measurements, vision systems and use of sensors in robotics. Hands-on training various types of motors and actuators like DC motor, servomotor, mechanical, electrical actuators, hydraulic actuator, Pneumatic actuator, EAP actuators, IPMC, piezoelectric, SMA actuators and its application.

ENG-CMERI-1-2130

MOBILE ROBOTICS SYSTEMS AND INDUSTRIAL ROBOTS

L-T-P-C : 1-1-2-3

Module -I: Mobile robotic systems

Fundamentals of Autonomous Mobile Robotics, including both perception and planning for autonomous operation. Kinematics and dynamics, Trajectory planning, Vehicle state estimation, Localization, Mapping and Planning.

Module-II: Industrial robots

Introduction of industrial robotics and automation, Robot anatomy, Use of industrial robot in spot welding, continuous welding, Robots in Assembly Operations. Robot cell layouts, multiple robots and machine interface and robot cycle time analysis.

Tutorial and Practical

Hands-on experience on Pioneer WMR, Manipulator Arms, SCARA Robot, Welding Robots etc.

ENG-CMERI-1-2131

ROBOT CONTROL

L-T-P-C : 1-1-2-3

Introduction, Control Principles, Control Objectives, Modelling of Physical systems, Principles of Linear Control-Stability aspects, Root locus technique; Frequency response analysis, Bode Plot, Design of PID Controller, Controller tuning.

State Space Design: Concepts of state, State-space, Representation of Linear system, Controllability and Observability, Stabilizability and Detectability, Observer design, Linear Kalman Filters.

Notion of Nonlinear Control, Basics of Nonlinear Control, Nonlinear Control Methods: Feedback Linearization (Input-state & Input-output linearization); Concepts of Lyapunov Stability and analysis, Sliding Mode Control.

Tutorials and Practical:

Hands on experience with MATLAB/SIMULINK model development

Verification of control performance using P/PI/PID controller.

Modelling and experiments with rectilinear control systems

Case Studies on Nonlinear controller development

Hands-on experience with application of different nonlinear control systems in robotics

ENG-CMERI-1-2132

ROBOTIC CASE STUDIES

L-T-P-C : 0-1-8-5

Different robotic systems case studies and its implementation in on-going projects (Manipulators, aerial robots, industrial robots, micro robots, bio-mimetic robots etc)

Utility of robotic system in Industry.

ENG-CMERI-1-2133

INTRODUCTION TO VIBRATION AND RELIABILITY

L-T-P-C : 1-0-2-2

Single-degree-of-freedom systems: Free vibrations and response of to harmonic, periodic and general excitations, Energy dissipation and damping, Duhamel's Convolution Integral for response to general time varying excitation.

Multi-Degree-of-Freedom Systems: Free Vibration- The Eigen value Problem, Orthogonality of Modal Vectors, Dynamic response by Modal Analysis, Introduction to Rotordynamics and Machine vibration.
Probability concept, Reliability definition, Failure Data Analysis- Mean time to Failure (MTTF), Mean Time Between Failures (MTBF), Maintainability, Availability, etc

ENG-CMERI-1-2134

BEARINGS & MACHINERY LUBRICATION

L-T-P-C : 2-0-2-3

Bearings– Theory and Practice: Types of bearings, Selection of bearings, Bearing nomenclature and terminology, Types and techniques used for mounting and dismounting of bearings, Industrial practices for bearing care, Lubrication of bearings, Bearing life cycle
Bearing Maintenance Technology: Selection of fits and tolerance, Mounting and dismounting, Introduction to bearing failures and their causes, Maintenance tips, Bearing failure analysis
Sealing Solution: Fundamentals of rotary and reciprocating seals, Principles of sealing operations, Understanding of the various seal designs, their applications and most common failure modes.
Lubrication: Base oil, Synthetic Base Oil, Additives, Lubricating Greases, Solid Lubricants: Production, performance Tribochemistry and characterization.
Oil Analysis (T & P): Oil Analysis Maintenance Strategies, Oil Sampling, Lubricant health monitoring, Machinery components health monitoring

ENG-CMERI-1-2135

DIAGNOSTIC MAINTENANCE AND CONDITION MONITORING

L-T-P-C : 2-0-4-4

Maintenance Strategies: Predictive, preventive and condition based; cost effectiveness; Balancing- single plane and multi plane, alignment; Basic Signal Processing Techniques: time domain, frequency domain and time-frequency domain; Machinery Vibration Diagnostics: Machine vibration standards, Fault Signature.
Advanced Diagnostic Techniques: Gear Diagnostics, Rolling Element Bearing Diagnostics, Rotating Machine Diagnostics
Tests for electric motor, power distribution testing, motor control testing including starters, soft starts, variable frequency drive etc. Electric motor, mechanical coupling, test of driven equipments, voltage and current harmonics, power factor.
Practical: Single plane and multi plane Balancing, Alignment

ENG-CMERI-1-2136

DAMAGE ASSESSMENT

L-T-P-C : 2-0-2-3

Damage mechanism of Industrial components (DG/AS/HR): Different damage mechanism of materials: Creep, Fatigue, Erosion, Corrosion, Different characterization methods for damage assessment
Damage assessment through Non Destructive Testing (AS/HR/PKM): Visual examination, video imagescopy. Liquid Penetrant Testing, Magnetic Particle Testing, Ultrasonic Testing, Radiography, Acoustic Emission Testing, In-situ metallography and in-situ hardness.
Residual life assessment (RLA) and failure analysis of industrial components (AS/DG): Introduction to RLA, Material and damage mechanism, Different techniques for quantitative estimation of residual life, Introduction to fracture mechanics in connection with residual life assessment, Failure analysis of industrial components
Practical: Visual and Video Imagescopy Inspection, Magnetic & Liquid Penetrant Testing, Ultrasonic Testing, Industrial Radiography, In-situ Metallography, Metallographic Techniques, Material characterization using optical microscopy, Material characterization using electron microscopy, Mechanical Testing, Acoustic Emission, Techniques of failure analysis

ENG-CMERI-1-2137	INSTRUMENTATION AND CONTROL	L-T-P-C : 1-0-2-2
<p>Sensing techniques and Signal processing approaches: Basics of analog and digital systems , General concepts of measurement systems, Performance terms, static and dynamic characteristics, system accuracy, sources of error, Transducer Fundamentals, resistive, inductive, capacitive, pressure, strain, torque, speed, temperature. Continuous time signals, discrete time signals, sampling theorem, Frequency Analysis and Discrete Fourier Transform</p> <p>Industrial instrumentation and process control: Electromagnetic Relays, Case studies on ladder diagrams, Programmable logic controllers: Construction Working and case studies. RS232, virtual instrumentation. Labview applications.</p> <p>Basic Control: Basic concept of control system, Mathematical model of Physical system, Time domain analysis: steady state and transient response, Frequency domain analysis: Nyquist stability criteria, Design of Controller: PD, PI and PID.</p> <p>Tutorials: Electronic devices, Signal processing , Instrumentation and process controls, Control theory</p> <p>Practical: Testing the I-V characteristics of capacitor, resistor and diodes, Simulation of active and passive filters on MATLAB platform, Study and analysis of actuation of various types of motors, Data acquisition from Piezo-sensors and their calibration, Development of an instrumentation amplifier module, Design of a PID controller for a DC motor, Controlling stepper motor using NI LabView software, Development, simulation and testing of ladder diagrams using RS LOGIX.</p>		
ENG-CMERI-1-2138	MATERIALS CHARACTERIZATION	L-T-P-C : 1-0-2-2
<p>Electron microscopy: TEM, HRTEM, SEM, STEM, EDX</p> <p>Scanning probe microscopy: STM, AFM, LFM, Nanoindenter. Tribological material characterization using AFM:</p> <p>IR/Raman spectroscopy/microscopy; Thermal analysis techniques</p> <p>Practicals: Hands on training on analytical, spectroscopic and microscopic techniques: FESEM, EDX, FTIR/Raman, AFM, Contact angle, Particle Size measurements, Macro and Micro Tribometer.</p>		
ENG-CMERI-1-2139	CORROSION AND CORROSION PROTECTION	L-T-P-C : 1-0-2-2
<p>Basic concept of corrosion: Anodic and cathodic reactions, anodic reaction characterization, cathodic reaction characterization, types of corrosion cells, Pourbaix diagram, Mechanism of chemical, electrochemical corrosion-Pilling Bedworth rule</p> <p>Types of Electrochemical corrosion - galvanic corrosion, differential aeration corrosion, pitting corrosion, stress corrosion; Measurement of corrosion (wt. Loss/Tafel/Impedance/Bode plot); factors influencing corrosion.</p> <p>Corrosion control: Cathodic protection , anodic protection, mixed type protection; Corrosion inhibitors (scope of inhibitor, application of inhibitor, important consideration in selection of inhibitors, classification of inhibitors, inorganic and organic inhibitors, inhibitors application techniques, inhibition efficiency and inhibitor concentration)</p> <p>High temperature corrosion: introduction, oxidation, kinetic behaviour, high Temperature corrosion damage assessment, high temp coating, corrosion protective coatings, case studies.</p> <p>Practical: weight chemical analysis, Tafel Polarization, EIS studies of real specimens, Corrosion Techniques (Aqueous and High Temperature</p>		

ENG-CMERI-1-2140	MAINTENANCE MANAGEMENT	L-T-P-C : 1-1-0-2
Principles of maintenance management, Condition-based maintenance, Managing maintenance workers, Managing finances in maintenance, Managing maintenance information, Maintenance improvement and strategy, Risk management, Maintenance approaches and strategies, Organisation, planning and application of maintenance and maintenance strategies, Technological aspects of engineering economics and accountancy and implementation of maintenance planning systems, Asset operations optimisation .		
ENG-CMERI-1-2141	PRACTICAL TRAINING	L-T-P-C : 0-0-6-3
Condition Monitoring, NDT, Fatigue and Fracture, Macro and Micro Tribology, Waste oil Analysis, Instrumentation Students will be given assessment on real time experimentation in the above areas. Hands-on experience on Pioneer WMR, Manipulator Arms, SCARA Robot, Welding Robots etc.		
ENG-CMERI-1-2149	SEMINAR	L-T-P-C : 0-1-0-1
Each student is required to deliver a presentation twice in first semester on the topics assigned by course coordinator to improve their communication skills and logical thinking and organization of the data collected from various resources.		
ENG-CMERI-1-2150	PROJECT WORK and VIVA-VOCE	L-T-P-C : 1-2-16-10
Systematic study carried out by students on selected topics relevant to real life problems. This study will be carried out by each student under the guidance of faculty in 2 nd semester. Tutorials by the respective faculty on selected research areas/topic. Presentation by a student on literature review, problem definition and plan of study on selected problem. Preparation of report and Viva-voce examination in front of examination panel at the end of study.		

Facilities Available at CSIR-CMERI Relevant to PGDAMT

S No	Facility
1.	Conventional Milling, Drilling, Turning, Grinding, Welding and other Machines, CNC Lathe, Plastic injection moulding m/c, Robotic LASER process set-up, CNC vertical Machining centre, CNC EDM m/c, CNC Milling, Jig boring m/c, CNC wire-cut m/c, Vision based measurement system, CAD/CAM software
2.	Conventional foundry machines and tools, various furnaces, Investment casting facility, Pressure die and rheo pressure die casting facility, Micro and macro injection moulding m/c, Simulation and analysis software (ANSYS, FLUENT etc.), UTM, Differential scanning calorimeter, hardness tester etc.
3.	Micro machining centre, Micro EDm M/c, Optical, Fluorescence & Atomic Force Microscope, High speed camera, Micro fluidic laboratory set-up
4.	Coordinate measuring machine, Laser Interferometer, Universal Measuring Machine (SIP), Horizontal length Measuring machine, OMT Vertical Omtimeter, Micro Optic Angle Dekkor, Micro Optic Auto-Collimeter, 3D optical Proflometer, Perthometer (S6R), Universal Profile Projector, Electrolimit Com-Parator, Slip Gauge Calibrator
5.	Magnetic crack detector (For coil magnetization), Magnetic field indicator & particle test block, Black light (UV) source for Fluorescent inspection, Ultrasonic flaw detector and thickness gauge, Crack depth meter, X-ray Machine, Radiation survey meter, Video- imagescope, Digitally controlled closed loop servo-hydraulic (100 KN) capacity dynamic testing machine with accessories/softwares, Hardness tester (Brinell/Rockwell/Vickers)
6.	Field Emission Scanning Electron microscope (FESEM), Scanning Electron Microscope (SEM), Fatigue strength measuring machine, High temperature Rheometer



High Precision CNC Turn-Mill



Robotic LASER processing set up



Rheo Pressure Die Casting Facility



FESEM with EDS & Straining stage



Micro EDM



Laser Interferometer

Facilities Available at CSIR-CMERI Relevant to PGDR

S No	Facility
1.	Pioneer robot
2.	Robot manipulator
3.	Testing and characterisation of smart actuators
4.	Robot vision system
5.	Embedded system
6.	Electronics, instrumentation and Digital Signal Processing
7.	CAD/CAE with analysis software (Auto CAD, Solid Works, Idea, Inventor, ADAMS, ANSYS etc.)
8.	Programming software (Matlab, Simulink, C, C++, Visual C++, Mathematica etc.)
9.	Academic support
10.	Library

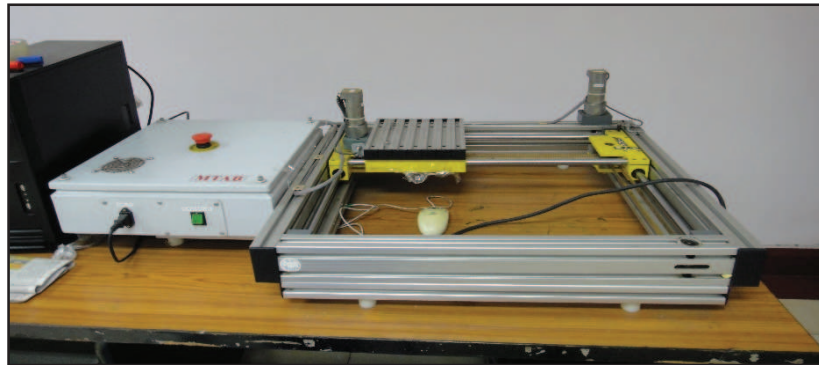
Glimpse of facility



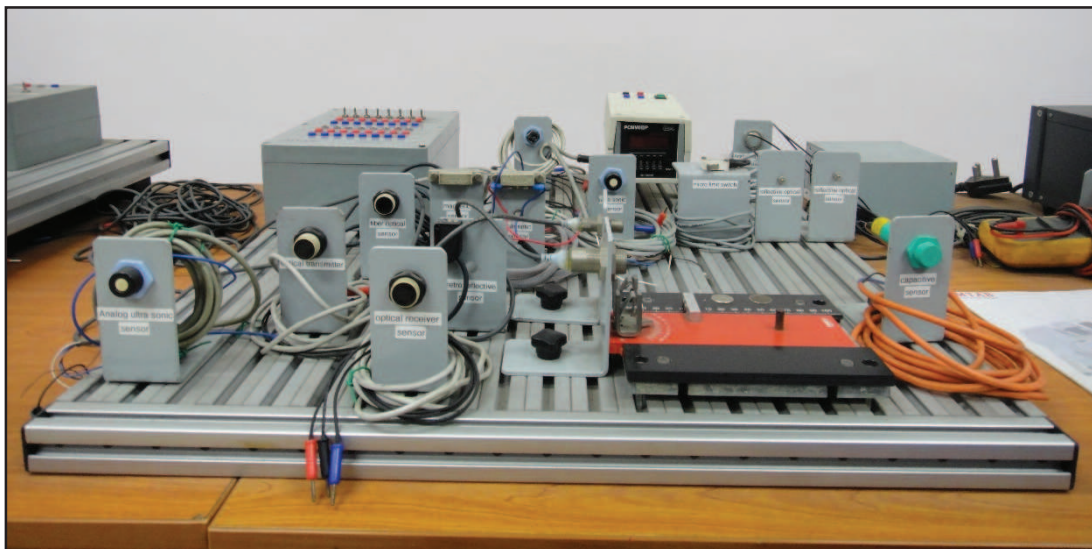
Manipulator arm



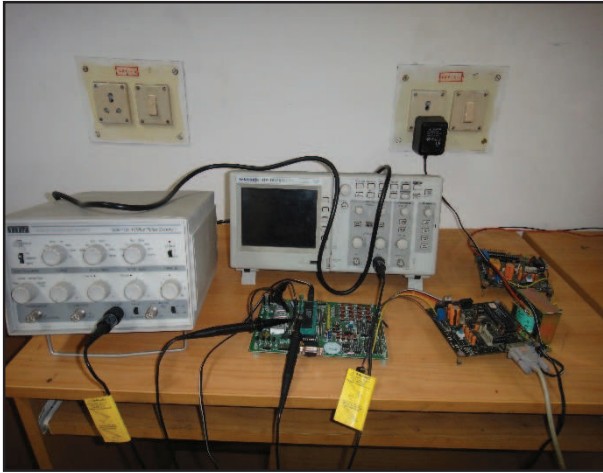
SCARA Robot



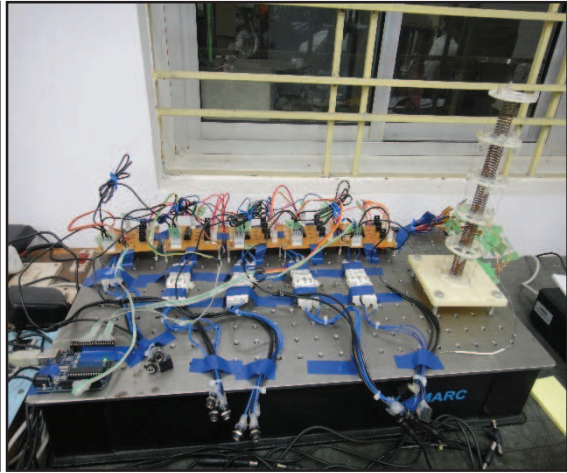
X-Y Plotter of Pioneer Robot



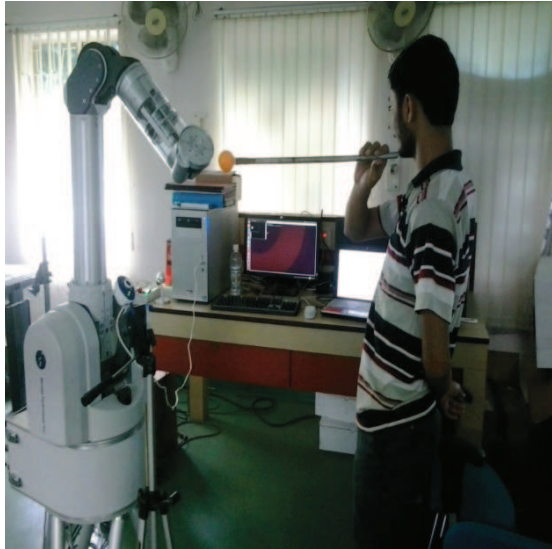
Test setup for inductive and capacitive type proximity sensors



Embedded Control setup



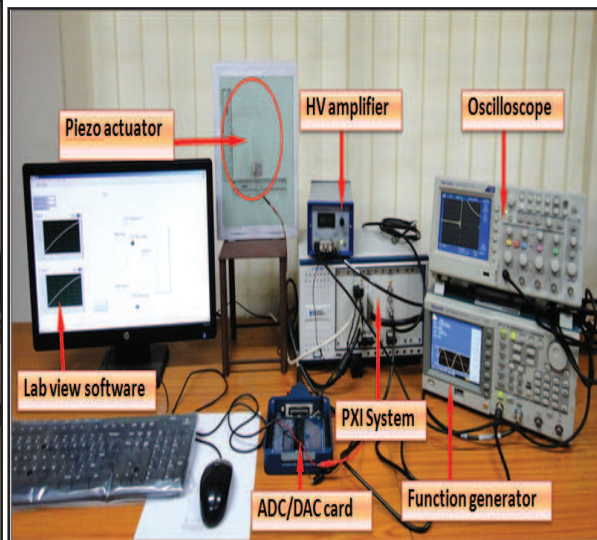
Flexible Manipulator



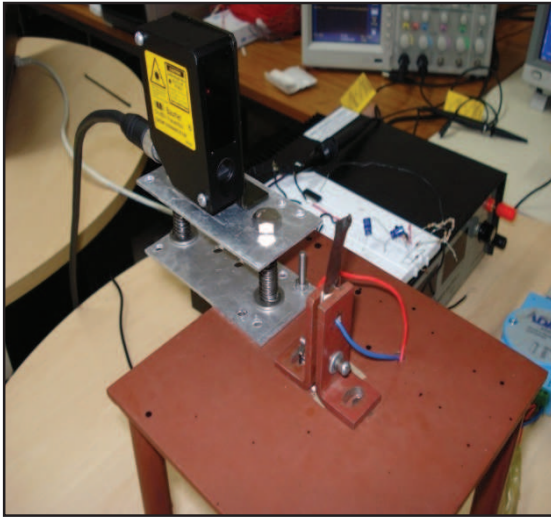
BarretWAM



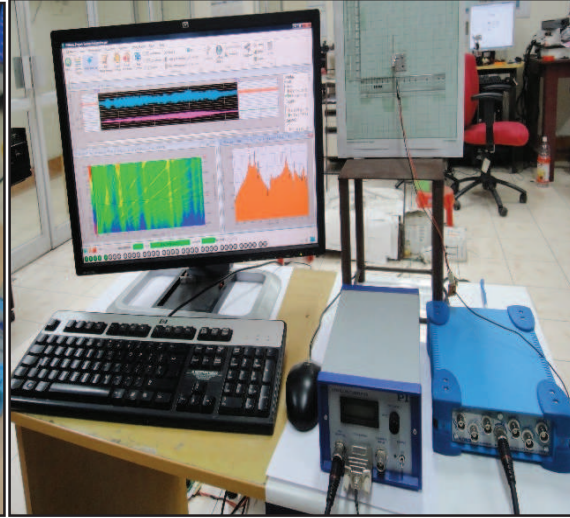
Micro Robotics Lab for testing of smart actuator



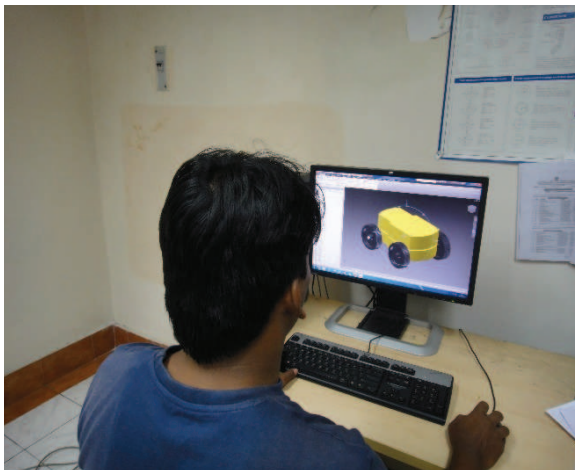
Piezoelectric actuator test setup



IPMC actuator test setup



Frequency analysis Setup



CAD Lab facility



Computer Lab facility



School of Mechatronics



Library Facility

Facilities Available at CSIR-CMERI Relevant to PGDIME

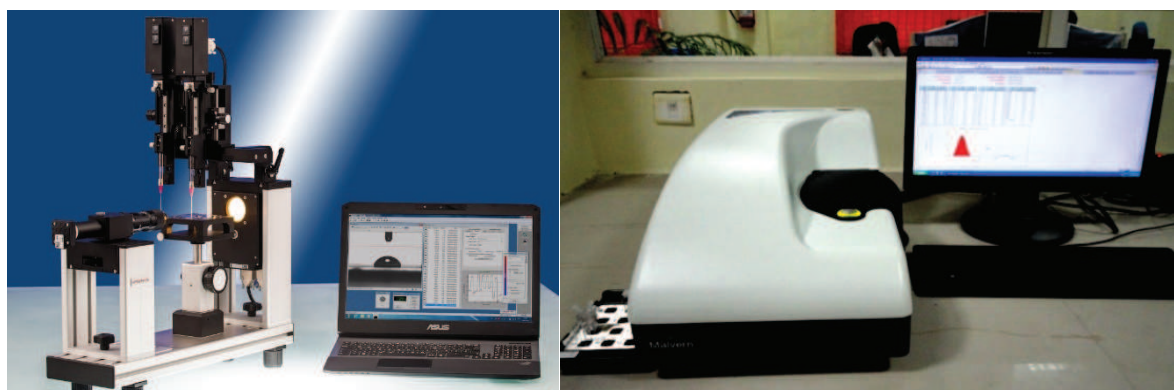
Macro and Micro pin/ball on disc tribometer and Four ball Tester



FTIR, Viscometer, Ferrography, TAN and TBN Analyzer



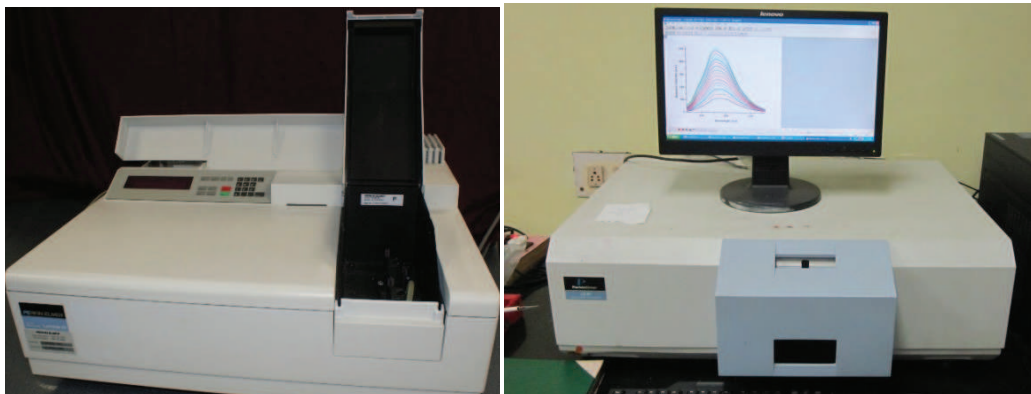
Contact Angle Goniometer and Nanoparticle Size Analyzer



✚ SNOM-AFM-Raman



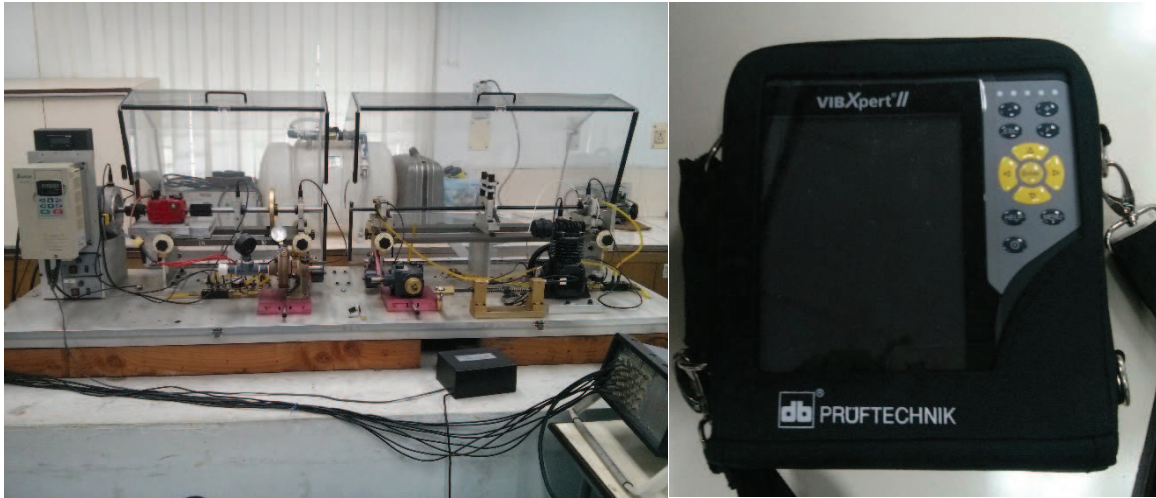
✚ UV-Vis Spectrophotometer and Fluorescence Spectrophotometer



✚ Acoustic Emission Testing



✚ Machinery Fault Simulator, Portable FFT Analyzer, Laser Vibrometer, Electrodynamic Shaker



✚ Magnetic Particle and Dye Penetrant test unit



✚ Ultrasonic Testing Machine



✚ Industrial Radiography, In-situ Metallography and Video Imagescopy
✚ High Temperature Furnace for Corrosion studies

✚ FE-SEM with EDX with in-situ deformation stage and Optical Microscope



✚ SEM with EDX



✚ Rotating bending fatigue machine



AMENITIES

Amenities, be it at the Institution or at the place of residence is a primary element supporting research and innovation. Over the years, CMERI has incrementally augmented the general amenities to support and nurture a peaceful and fulfilling life at the campus. The CMERI residential campus is one of the green spots in the Durgapur steel city. Adequately secured by guard walls all around with regulated gate operation, the CMERI colony is one of the safest places of stay in the city. The colony boasts of three multi-storied complexes that till a short while back used to be the hallmark of the residential campus. Compact Scientists' Apartments provide the young Scientists a cosy ambience of stay during the formative years at the Institute.

The CMERI Staff Club is a meeting place for all members of the CMERI family. Be it the pursuit of recreation, or of an urge to take part in cultural activities, or simply for keeping fit through proper exercises, the Club premises serve as a desired destination. The Club houses two properly maintained badminton courts, has a Multigym facility, a Table Tennis board, and a horde of indoor games such as Carom, Cards, Chess, etc. The Club also has Library with a moderate holding. Adjacent to the Club Auditorium complex reposes a volleyball ground. Two fields are available at two corners of the Colony for outdoor games like football and cricket.



**Residential Complex
& Football Ground**



**CMERI Staff Club Auditorium
with indoor badminton courts**



Medical Centre

CMERI has a small but adequately equipped Medical Centre that caters to the primary health needs of the denizens. The Medical Centre accommodates regular visits by practitioners and moreover serves as a distribution centre for prescribed medicines. CMERI has tie-ups with the local hospitals including a super-speciality hospital at Durgapur.

Life at the Academic Hall of Residence is perhaps ideal for young students and research scholars who are provided with secured, simple and comfortable residence and is released from the worry of arranging for their own meals, which is taken care of by a catering arrangement. CMERI is steadily adding to the existing amenities for making their lives even more enjoyable.

Accommodation for visiting scientists, guests and other stakeholders of research and development is provided in the Main Guest House and in the Executive Hostels in the Residential Campus.



Cricket Field adjacent to the Academic Hall of Residence



Volleyball Ground adjacent to the Academic Hall of Residence



CMERI Guest House



Academic Hall of Residence