CSIR - Central Mechanical Engineering Research Institute

The CSIR-Central Mechanical Engineering Research Institute (CSIR-CMERI) is the apex R&D institute for 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.

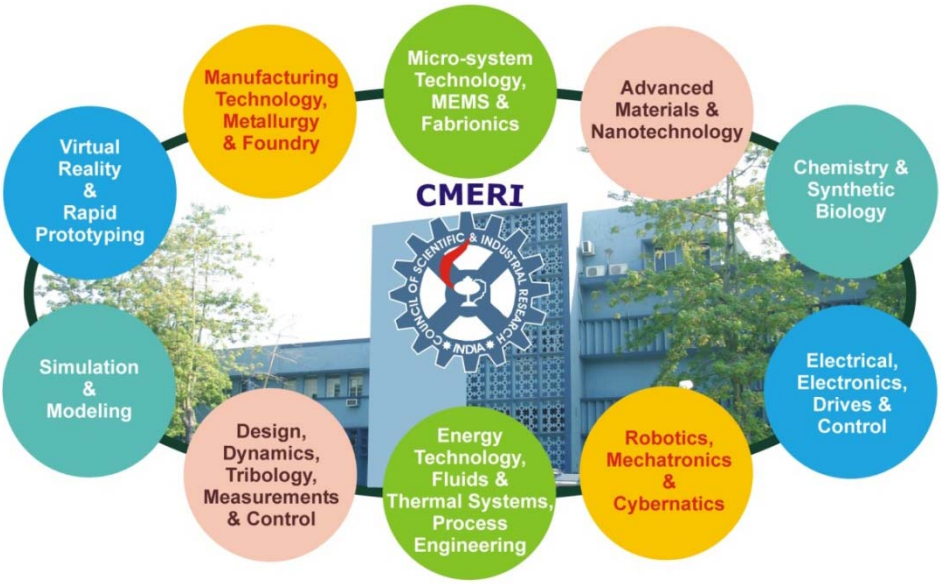
In India, mechanical engineering technology has accounted for nearly half of the total technology imported. In terms of products, nearly one third of the value of total imports is for mechanical engineering equipment. In order to develop indigenously mechanical engineering technology for the industries 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 it 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.

Robotics & Mechatronics

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.

Micro Systems Technology, Surface Engineering & Tribology

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 μCNCmill - a five axis micro milling machine for efficient, cost effective and high resolution milling and drilling.

Materials, Processes, Chemistry & Synthetic Biology

Materials science reposes on characterizing the atomic structure and phases in a particular material in relation to its desired properties and relative performance. CSIR-CMERI is working on the development of Dye-sensitized Solar Cells, Nano Composite Cutting Tool for high speed Machining and Platinization of Nafion towards the development of IPMC.

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 metallurgy and foundry 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.

Design Dynamics, Simulation and Analysis

Simulation and modeling for systems involving computational mechanics is a major module in the R&D agenda of CMERI. R&D is carried out across such diverse areas as FEA, FVA, FDA, Lattice-Boltzmann modeling, Electro-osmotic flow, flow induced vibration and high-speed aerodynamics. Current efforts are directed towards development of a general three-dimensional solver for simulating flow over aircraft wings.

Thermal Engineering

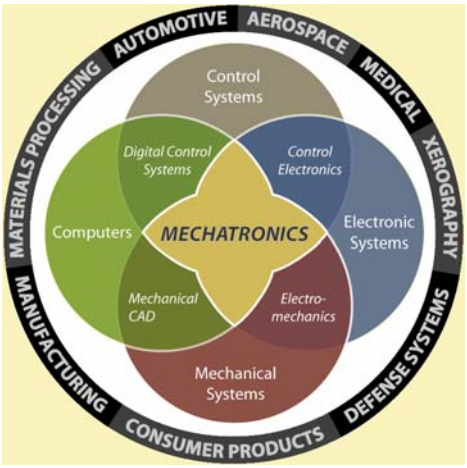
Active research is carried out on fluid flow, heat transfer, combustion, gasification, fluidization, renewable energy, waste management, drying, etc. Additionally, research is carried out on solar-powered adsorption-based space-cooling system, CFD simulation of fluidized bed hydrodynamics. Flow hydrodynamics 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 Research Programme in Mechatronics

Mechatronics is a design philosophy which encourages engineers to concurrently integrate precision mechanical engineering, digital and analog electronics, control theory and computer engineering in the design of “intelligent” products, systems and processes rather than engineering each set or requirements separately. The advantages of the Mechatronics approach to design are shorter design cycles, lower costs, and elegant solutions to design problems that cannot easily be solved by staying within the bounds of the traditional engineering disciplines. Mechatronics further relates to a multidisciplinary approach to product and manufacturing system design.



The Post Graduate Research Programme in Mechatronics intends to acquaint students with the fundamentals of mechatronics through pedagogy on current theoretical and practical developments in this area. The programme traverses a wide range of applications that comprise robotics, product design, instrumentation, manufacturing methods, computer integration and process & device control, with specific emphasis on innovative engineering. The Two Year research Programme aims to provide in-depth exposure to the engineering concepts, scientific principles, research methodology and hands-on experience on advanced real-life R&D projects in different specializations related to Mechatronics

Eligibility : BE/BTech in Mechanical, Electrical, Computer Science/Engg, Mechatronics, Electronics, ECE/ETC/EIE, Radio Physics & Electronics, Production, Manufacturing with minimum of 7.0 CGPA (or minimum of 70% marks).

Post Graduate Research Programme in Applied and Computational Mechanics

Applied and Computational Mechanics is a unique programme highlighting analytical and computational methods for solving engineering problems studying phenomena governed by the principle of mechanics. The primary intention of this MTech Programme in Applied and Computational Mechanics is to train students in this multidisciplinary fields of research where they not only would learn basics of mechanics with associated mathematical and computational tools but also develop the capability of understanding and solving the physical problems of great industrial relevance.

The programme discusses a wide range of subjects in the field of mathematics, solid, fluids and structural mechanics, numerical techniques like finite element methods computer applications. The participants would be provided in-depth exposure to various applied techniques of analytical, numerical and computational nature, scientific principles, research methodology and hands-on experience on advanced real-life R&D projects in different specializations such as stress analysis, nonlinear vibrations & chaos, computational fluid dynamics and heat transfer etc.

Eligibility : BE/BTech in Mechanical Engineering , Aerospace Engineering and Civil Engineering with minimum of 7.0 CGPA (or minimum of 70% marks).

Students undergoing the above programmes are expected to emerge properly equipped to confront challenges across the industrial environment and academic research spectrum.

PhD Programme in Engineering

Broad areas :	**i)**	**Robotics & Mechatronics**
	ii)	**Micro System Technologies**
	iii)	**Surface engineering and Tribology**
	iv)	**Foundry**
	v)	**Cybernetics and Machine Intelligence**
	vi)	**Matrial Science**
	vii)	**Solid Mechanics and Advanced Design**
	viii)	**Fluid Mechanics and Heat transfer**

Who can apply : MTech/ME in Mechanical, Electronics, Computer science, Electrical, Chemical or Aerospace Engineering

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List of Courses to be offered to Post Graduate Students

Sl No.	COURSE CODE	COURSE TITLE	L-T-P-C
1.	ENG(CMERI) 1-001	RESEARCH METHODOLOGY	1-1-0-2
2.	ENG(CMERI) 1-002	MATHEMATICS FOR ENGINEERS	3-0-0-3
3.	ENG(CMERI) 1-381	INTRODUCTION TO MECHATRONICS SYSTEM	3-0-0-3
4.	ENG(CMERI) 1-382	ADVANCED CONTROL SYSTEM	3-0-0-3
5.	ENG(CMERI) 1-383	CAD & COMPUTER GRAPHICS	3-0-1-3
6.	ENG(CMERI) 1-384	ELECTRICAL AND ELECTRONIC CIRCUITS & DEVICES	3-0-1-3
7.	ENG(CMERI) 1-385	MACHINES & MECHANISMS	3-0-0-3
8.	ENG(CMERI) 1-386	ROBOTICS	3-0-1-3
9.	ENG(CMERI) 1-387	MICROCONTROLLERS & EMBEDDED SYSTEM DESIGN	3-0-1-3
10.	ENG(CMERI) 1-388	DIGITAL SIGNAL PROCESSING & APPLICATIONS	3-0-1-3
11.	ENG(CMERI) 1-389	ADVANCED MECHANICS OF SOLIDS	3-0-0-3
12.	ENG(CMERI) 1-390	ADVANCED MECHANICS OF FLUIDS	3-0-0-3
13.	ENG(CMERI) 1-391	MECHANICAL VIBRATIONS	3-0-0-3
14.	ENG(CMERI) 1-392	COMPUTER LAB-I	1-1-2-3
15.	ENG(CMERI) 1-393	FINITE ELEMENT METHODS	3-0-0-3
16.	ENG(CMERI) 1-394	ANALYSIS AND SYNTHESIS OF MECHANISMS	3-0-0-3
17.	ENG(CMERI) 1-395	COMPUTATIONAL FLUID FLOW & HEAT TRANSFER	3-0-0-3
18.	ENG(CMERI) 1-396	COMPUTER LAB - II	0-0-4-2
19.	ENG(CMERI) 2-381	INTRODUCTION TO COMPUTER VISION	3-0-1-3
20.	ENG(CMERI) 2-382	ROBOTICS AND MACHINE INTELLIGENCE	3-0-1-3
21.	ENG(CMERI) 2-383	INTRODUCTION TO NAVIGATION & DATA FUSION	3-0-1-3
22.	ENG(CMERI) 2-384	MICRO SYSTEMS TECHNOLOGIES	3-0-1-3
23.	ENG(CMERI) 2-385	ADVANCED MATERIALS	3-0-1-3
24.	ENG(CMERI) 2-386	OPTIMAL CONTROL	3-0-1-3
25.	ENG(CMERI) 2-387	PRECISION MACHINE DESIGN	3-0-1-3
26.	ENG(CMERI) 2-388	NUMERICAL METHODS & COMPUTER PROGRAMMING	3-0-1-3
27.	ENG(CMERI) 2-389	ELECTRO-MECHANICAL SYSTEMS DESIGN	3-0-1-3
28.	ENG(CMERI) 2-390	ANALYTICAL MECHANICS	3-0-0-3
29.	ENG(CMERI) 2-391	FINITE ELEMENT METHODS FOR FLUID DYNAMICS	3-0-1-3
30.	ENG(CMERI) 2-392	NONLINEAR DYNAMICS & CHAOS	3-0-0-3
31.	ENG(CMERI) 2-393	MECHANICS OF COMPOSITE MATERIALS	3-0-0-3

32.	ENG(CMERI) 2-394	ROTOR DYNAMICS	3-1-0-4
33.	ENG(CMERI) 2-395	COMPRESSIBLE FLOW	3-1-0-4
34.	ENG(CMERI) 2-396	F LOW THROUGH TURBO MACHINES	3-1-0-4
35.	ENG(CMERI) 2-397	FLUIDIZED BED DRYING	3-1-0-4
36.	ENG(CMERI) 2-398	FLUIDIZED BED COMBUSTION & GASIFICATION	3-1-0-4
37.	ENG(CMERI) 2-399	THERMODYNAMICS	3-1-0-4
38.	ENG(CMERI) 2-400	PRINCIPLES OF CASTING SOLIDIFICATION	3-1-0-4
39.	ENG(CMERI) 2-401	CONVECTIVE HEAT & MASS TRANSFER	3-1-0-4
40.	ENG(CMERI) 2-402	TURBULENCE	3-1-0-4
41.	ENG(CMERI) 2-403	STATISTICAL METHODS FOR ENGINEERS	3-1-1-4
42.	ENG(CMERI) 2-404	ADVANCED ELECTRICAL DRIVES	3-1-0-4
43.	ENG(CMERI) 3-001	ADVANCED SELF STUDY	3-1-0-4
44.	ENG(CMERI) 3-002	PROJECT PROPOSAL - I	0-1-2-2
45.	ENG(CMERI) 3-003	PROJECT PROPOSAL - II	0-1-2-2
46.	ENG(CMERI) 3-004	CSIR-800 SOCIETAL PROGRAMME	0-0-8-4
47.	ENG(CMERI) 3-381	ADVANCED COMPUTER ORGANIZATION & ARCHITECTURE	3-1-1-4
48.	ENG(CMERI) 3-382	APPLIED SOFTCOMPUTING	3-1-1-4
49.	ENG(CMERI) 3-383	OPTIMIZATION TECHNIQUES IN ENGINEERING	3-1-1-4
50.	ENG(CMERI) 3-384	LOW POWERED EMBEDDED SYSTEM DESIGN	3-1-1-4
51.	ENG(CMERI) 3-385	COMPUTER AIDED METROLOGY AND MACHINE VISION	3-1-1-4
52.	ENG(CMERI) 3-386	ADVANCED FLUID FILM BEARINGS	3-1-1-4
53.	ENG(CMERI) 3-387	WEAR OF MATERIALS & SURFACE MODIFICATIONS TECHNOLOGIES	3-1-1-4
54.	ENG(CMERI) 3-388	FUNCTIONALIZATION OF SURFACE AND INTERFACES OF BIOMATERIALS	3-1-1-4
55.	ENG(CMERI) 3-389	NANOTRIBOLOGY AND ITS APPLICATION TO MICROSYSTEMS	3-1-1-4
56.	ENG(CMERI) 3-390	ADVANCED PASSIVE AND ACTIVE MAGNETIC BEARINGS	3-1-0-4
57.	ENG(CMERI) 3-391	LATTICE BOLTZMANN AUTOMATA	3-1-0-4
58.	ENG(CMERI) 3-392	ROBOTS WITH JOINT FLEXIBILITY: MECHANICS AND CONTROL	3-1-0-4
59.	ENG(CMERI) 3-393	ARTIFICIAL INTELLIGENCE AND DATA MINING	3-1-0-4
60.	ENG(CMERI) 3-394	ADVANCED COMPUTER VISION	3-1-0-4
61.	ENG(CMERI) 3-395	ADVANCED NAVIGATION & DATA FUSION	3-1-0-4
62.	ENG(CMERI) 3-396	MOBILE ROBOTICS	3-1-1-4
63.	ENG(CMERI) 3-397	ADVANCED ROBOT DYNAMICS AND CONTROL	3-1-0-4

MTech & PhD COURSE DETAIL

ENG(CMERI) 1-001	RESEARCH METHODOLOGY	L-T-P-C : 1-1-0-2
Course Coordinator: S. SenSharma		
General Practices followed in Research – literature and data management; Communication skills – writing and presentation; Intellectual property rights; Scientific ethics & Safety practices.		
ENG(CMERI) 1-002	MATHEMATICS FOR ENGINEERS	L-T-P-C : 3-0-0-3
Course Coordinator: Dr. Pradipta Basu-Mandal		
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.		
ENG(CMERI) 1-381	INTRODUCTION TO MECHATRONICS SYSTEM	L-T-P-C : 3-0-0-3
Course Coordinators: Dr. Ranjit Ray & S.N. Shome		
Overview: What is Mechatronics? Instrumentation and Control System. Sensors & Transducers: Physical Principles & 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..		
ENG(CMERI) 1-382	ADVANCED CONTROL SYSTEM	L-T-P-C : 3-0-0-3
Course Coordinators: S. Nandy		
Introduction & Motivation: Role of Controls in Mechatronics, Mathematical Preliminaries, Review of classical control concepts, Root locus technique; Frequency response analysis, Bode Plot, Design of PID Controller, Controller tuning. State Space Design: Modeling of physical systems, Concepts of state, State-space, Representation of Linear system, Controllability and Observability, State Observers. Advance Controller Design: Kalman Filters as Dynamic System State Observers; Linear Quadratic Regulator (LQR) design, Nonlinear Control Design; Describing function, Phase-plane analysis, Fundamentals of Lyapunov Stability Theory (Autonomous Systems), Advanced Stability Theory (Non-autonomous Systems), Feedback Linearization (Input-state & Input-output linearization); Sliding Mode Control.		

ENG(CMERI) 1-383	CAD & COMPUTER GRAPHICS	L-T-P-C : 3-0-1-3
Course Coordinator: Avik Chatterjee		
Genesis of CAD, Simulation and Visualization, Concepts of CAE and Virtual Prototyping; Geometric Object Modeling – Analytical Representation of Curves & Surfaces, Various Curves and Surfaces (B-Spline, Bezier, NURBS), Intersection calculations, Assembly Modeling Techniques; Computer Graphics: Linear algebra, Screen coordinates, Window coordinates, Graphics library, Rendering pipeline architecture, Homogeneous coordinates & Transformation Matrices, Quaternion, Projection matrices, Types of buffers, Display Interpolation techniques, Lightning, Wireframe, Shading models, Texture mapping, Ray casting, Ray tracing, Normal vectors, Evaluators & NURBS, Modeling of sculpture surface, selection and feedback, Concepts of scenes and scene graphics, Hierarchical Modeling Concepts, Kinematic Simulation of an Hierarchical model, Stereo Visualization.		
ENG(CMERI) 1-384	ELECTRICAL AND ELECTRONIC CIRCUITS & DEVICES	L-T-P-C : 3-0-1-3
Course Coordinators: Ms. Uma Datta & J. Roy Choudhury		
Electric Circuits and Components Network Theorems: Thevenin, Norton, Superposition, Maximum Power Transfer. Circuit Analysis, Transformer, Impedance Matching, Grounding and Electrical Interference, Electrical Safety. Semiconductor Electronics: Diodes and its' application; Operation, characteristics : Three terminal devices –- BJT, JFET, MOSFET; Four terminal devices- SCR, Diac, Triac; Amplifiers using BJT, FET; Operational amplifiers Modern devices: CMOS, MESFET, MODFET, HBT. Computing: Number, system and code conversion, Logic gates, Boolean algebra, Combinational / Sequential Logic circuits – Latch, RS-, JK-, T-, D-, Flip flops, Buffer Register, Counters, Shift registers. Decoder, Encoder, MUX, DMUX, RAM, ROM, PROM, EPROM, EEPROM, Programmable logic devices.		
ENG(CMERI) 1-385	MACHINES & MECHANISMS	L-T-P-C : 3-0-0-3
Course Coordinators: P.S. Banerjee & Dr. R. Sen		
Rotation and Plane motion of a rigid body. Kinematic Pairs, Chains, Diagrams. Four Link Planar Mechanisms and their Inversions. Grubler's criterion and Grashof's criterion. Analysis of planar mechanisms – Graphical and Analytical methods Synthesis of planar mechanisms – Motion, Path and Function generation problems - Graphical and Analytical approaches Introduction to Machine Elements – Cams, Gears, Brakes, Clutches etc Cams – classification of cams and followers, nomenclature, description and analysis of follower motion, pressure angle. Determination of basic dimensions, Synthesis of cam profiles – Graphical and Analytical methods. Gears – terminology, fundamental law of gearing, involute profile. Interference and undercutting, Simple, Compound and Epicyclic gear trains.		
ENG(CMERI) 1-386	ROBOTICS	L-T-P-C : 3-0-1-3
Course Coordinators: Dr. Soumen Sen & S.N. Shome		
Robotics introduction; Classification and Components; Rigid body transformation in R3; Homogeneous representation; Denavit-Hertenberg representation; Forward and Inverse kinematics; Redundant and Non-redundant robots; Differential kinematics, velocities, and their transformations; Geometric and analytical Jacobians; Manipulability, Isotropy and Workspace analysis;		

Manipulator statics; Velocity-force duality; Recursive computation of velocities and accelerations; Manipulator dynamics -Newton-Euler and Euler-Lagrange; Equation of motion;
Path planning in joint and task space; Obstacle avoidance and optimal planning; Review of robot control methods;
Optimization in robotics; Human-robot interaction; joint and link flexibilities; Walking machines and Exoskeletons; Robot hand and multifingered grasp, manipulation and control; Tendon driven manipulator.

ENG(CMERI) 1-387	MICROCONTROLLERS & EMBEDDED SYSTEM DESIGN	L-T-P-C : 3-0-1-3

Course Coordinators: J. Roy Chaudhuri & Shikha

Introduction to embedded systems and architecture, System design using specification and modeling tools
Overview of embedded computing platforms; Microprocessors, Microcontrollers, DSP's and SoC's, Hardware – Software design and partitioning
Design issues, consideration and trade–offs: Performance memory, power, timing, cost, and development time. Memory hierarchy, System Interfaces and Communication with peripheral units, timers counters, Introduction to Real-time system and Real-time Scheduling
Real – time software development: High level languages and Programming issues, Systems performance: Networked embedded systems
Future Trends, Applications, Tutorial & Laboratory .

ENG(CMERI) 1-388	DIGITAL SIGNAL PROCESSING & APPLICATIONS	L-T-P-C : 3-0-1-3

Course Coordinators: J. Roy Choudhury & SRK Vadali

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, Finite & Infinite Impulse Response, Recursive & Non-Recursive Systems, Difference Equations.
Z-Transform – Definition, Properties; Inverse-Z and Analysis in Z-domain.
Fourier Analysis – Continuous & Discrete-Time Fourier Series, Power Density Spectrum, Fourier Transform, Frequency-Domain Characteristics of LTI Systems, DFT & Properties, Linear Filtering Using DFT, Frequency Analysis Using DFT, Understanding FFT.
Digital Filter Design – Characteristics & Design of Filters.
Future Trends, Applications, Tutorial & Hands-on

ENG(CMERI) 1-389	ADVANCED MECHANICS OF SOLIDS	L-T-P-C : 3-0-0-3

Course Coordinators: Dr. Somenath Mukherjee & Dr. Pradipta Basu-Mandal

Stress; Stress tensor, stress transformation, principal stresses. Equilibrium.
Strain; Linear strain components, Compatibility.
Constitutive Relations; Isotropic and orthotropic materials, Failure Theories.
Two dimensional elasticity; Mohr's Circle. Polar co-ordinates. Airy's Stress Function for simple systems. Stress concentration factors.
Stresses in pressure vessels and rotating discs.
Torsion of bars of various sections.
Beam bending; Deflections. Three Moment equation. Unsymmetric bending, bending stress and shear and shear center.
Variational principles; Equilibrium- Virtual work and the Principle of Stationary Potential Energy, Compatibility- Principle of Stationary Complementary Energy, Castigliano's Theorems, Applications.
Elastic Stability; Euler's Bucking Load for columns. Energy methods, Stability of simple frames.

ENG(CMERI) 1-390	ADVANCED MECHANICS OF FLUIDS	L-T-P-C : 3-0-0-3

Course Coordinators: Dr. Satya Prakash Singh, Dr. Sudipta De & Dr. Dipankar Chatterjee		
Equations of fluid mechanics, Derivation of Navier-Stokes equations, Exact solutions of Navier-Stokes equations, Boundary layers, Exact solution of Boundary layer equations, Approximate methods for solving boundary layer equations, Boundary layer control, Axi-symmetric and three-dimensional boundary layers, Unsteady boundary layers, Stability Analysis, Transitional flows, Concepts of Turbulence, Introduction to Compressible Flows.		
ENG(CMERI) 1-391	MECHANICAL VIBRATIONS	L-T-P-C : 3-0-0-3
Course Coordinators: Dr. Pranab Samanta & Dr. Swarup Kumar Laha		
Free vibrations and response of single-degree-of-freedom systems 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; Lagrange's Equations. Free Vibration- The Eigenvalue Problem, Orthogonality of Modal Vectors, Dynamic response by Modal Analysis. Rayleigh's Quotient. Distributed Systems; Exact solutions of free and forced vibrations of bars and beams (axial, torsional and bending). Modal shapes and natural frequencies of continuous systems, Systems with lumped masses, Rayleigh's Principle Approximate Methods; Transfer Matrix Methods, Holzer's Method for Torsional Vibration, Myklestad's Method for bending vibration, Dunkerley's Method, Modal Superposition Methods.		
ENG(CMERI) 1-392	COMPUTER LAB-I	L-T-P-C : 1-1-2-3
Course Coordinators: Dr. Surendra Kumar & Dr. Swarup Kumar Laha		
The Solution of Nonlinear Equations: Iterative Methods, Fixed-Point Iteration, Newton-Raphson and Secant Methods, Polynomial Equations Having Real Roots. Matrices and System of Linear Equations: The Solution of Linear Systems by Elimination, Pivoting, Triangular Factorization, Eigenvalue Problem. Approximation: Uniform Approximation by Polynomials, Data Fitting, Orthogonal Polynomials, Least-Squares Approximation by Polynomials. Differentiation and Integration: Numerical Differentiation, Numerical Integration and Associated Basic Rules, Gaussian Rules. The Solution of Differential Equations: Simple Difference Equations, Numerical Integration by Taylor Series, Runge-Kutta Methods, Multistep Formulae, Predictor-Corrector Methods. Computer programming and code development of the algorithms taught in class.		
ENG(CMERI) 1-393	FINITE ELEMENT METHODS	L-T-P-C : 3-0-0-3
Course Coordinators: Dr. Somenath Mukherjee & Dr. Pradipta Basu-Mandal		
Matrix methods review; Stationary Principles, Rayleigh-Ritz and Hellinger-Reissner Methods. Virtual Work, Governing Equations, Weighted Residual (Galerkin) Method and Weak Forms. Formulations of one-dimensional elements (axial bar, the Euler beam) using Direct and Variational Methods. Solutions to simple truss and frame problems. Interpolation, C0 and C1 elements. Convergence requirements. Isoparametric one and two-dimensional elements; Linear and Quadratic Timoshenko beam elements; shear locking. Linear 2D plane stress /plane strain element; parasitic shear. Reduced integration. Elementary theory of plates and plate elements; Mindlin and Kirchhoff element formulations, Concepts of locking. Full, reduced and selective integration techniques. Axisymmetric elements. The Best-fit paradigm of FEA.		
ENG(CMERI) 1-394	ANALYSIS AND SYNTHESIS OF MECHANISMS	L-T-P-C : 3-0-0-3
Course Coordinators: P S Banerjee & S N Shome		

Particle and Rigid Body Dynamics – Kinematics and Kinetics. Rigid body rotation, Velocity and Acceleration analysis using Instantaneous Centre (IC) of velocity, Corioli's component of acceleration, Plane motion of a rigid body. Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Four Link Planar Mechanisms and their Inversions Kutzbach and Grubler's criterion, Grashof's criterion, Analysis of plane mechanisms – Graphical and Analytical methods Dimensional synthesis of mechanism; Motion, Path and Function generation, precision point approach, Chebyshev spacing, three position synthesis, graphical and analytical approaches for four link mechanisms. Development of simple algorithms and computer programs for solving typical problems on analysis and synthesis of mechanisms.		
ENG(CMERI) 1-395	COMPUTATIONAL FLUID FLOW & HEAT TRANSFER	L-T-P-C : 3-0-0-3
Course Coordinators: Prof. Gautam Biswas, Bittagopal Mondal & Dipankar Chatterjee		
Discretization procedure in Finite-difference and Finite-volume methods. Fundamentals of Fluid Flow Modelling. Staggered and Collocated grids. Explicit methods: MAC, SMAC methods for solving Navier Stokes and Energy equations. Implicit Methods: SIMPLE and SIMPLER. Pressure Solvers: conjugate gradient method, strongly Implicit procedure. Grid-Generation: Algebraic, Transfinite, Poisson equation methods. Finite-volume based Navier-Stokes solution on arbitrary geometry using non-orthogonal grids. Introduction to Turbulence modelling (two equation models).		
ENG(CMERI) 1-396	COMPUTER LAB - II	L-T-P-C : 0-0-4-2
Course Coordinators: Dr. Surendra Kumar, Avik Chatterjee and Dr. Satya Prakash Singh		
Problem solving utilising application software like ANSYS, ADAMS, FLUENT etc.		

ENG(CMERI) 2-381	INTRODUCTION TO COMPUTER VISION	L-T-P-C : 3-0-1-3
Course Coordinators: Dr. S. Majumdar		
Fundamentals of Computer Vision: Role of vision to achieve simple goals i.e. high level capabilities of vision using cognitive processes, geometric models and low level capability for object perception, representation of images. Computer Vision Research and Application on image formation, camera model and camera calibration, properties of projection, interaction of light and its modeling, perspective modeling, homogeneous coordinate, lens equation, types of image digitizers and image digitizing components. Feature Extraction, filtering and edge detection, fourier transform, texture primitives and texture as a pattern recognition problem, wavelets and multiresolution processing including image pyramids, subband coding, Harr Transform; multiresolution expansions and colour processing. Tutorial on Matlab platform & Project		
ENG(CMERI) 2-382	ROBOTICS AND MACHINE INTELLIGENCE	L-T-P-C : 3-0-1-3
Course Coordinators: J. Roy Choudhury		
Artificial Intelligence, Computational Intelligence, Various Machine Learning Algorithms ,Pattern Reorganization, Computer Vision, Fuzzy Expert System, Fuzzy Automata. Fundamentals Of Robotics & Automation., Intelligent Robots, Control Systems and Components . Robot Motion Analysis and Control,Robot End Effectors,tactile and vision sensors in robotics Cognitive system for Human machine interaction. Future Trends, Applications, Tutorial & Laboratory.		
ENG(CMERI) 2-383	INTRODUCTION TO NAVIGATION & DATA FUSION	L-T-P-C : 3-0-1-3
Course Coordinators: Dr. S. Majumdar		
Sensors, Sensing, Model of Sensors & Process uncertainties Introduction to estimation, estimation methods & relation between different estimators State space modeling, LTI Systems & Kalman Filter & Extended Kalman Filter Other Navigation Filters including Bayesian Filters, Information Filters, Particle Filter etc. Various Sensors used in Robotics: Accelerometer, Gyro, Compass, Encoder, Laser, Ultrasonic Sensor, Camera, Sonar, InfraRed Sensor, Tactile Sensor etc. Multisensor Data Fusion Fundamentals; INS, GPS Aided Navigation & Data Fusion Future Trends, Applications, Tutorial & Laboratory		
ENG(CMERI) 2-384	MICRO SYSTEMS TECHNOLOGIES	L-T-P-C : 3-0-1-3
Course Coordinators: Dr. Nagahanumaiah		
Introduction: precision engineering; multi-scale product manufacturing paradigms. Micro- Nano Manufacturing: MEMS foundry processes; micro-mechanical processes; regenerative techniques. Process Modelling: material removal mechanisms; FEA and molecular dynamics based simulations. Design of Micro Machines: sources of error; error mapping; precision drives and controls. Sensors for Precision Manufacturing: sensor systems for process monitoring, multi sensor approaches, signal processing and machine vision systems. Precision Metrology: definitions; laser interferometer; AFM; SEM; TEM. Micro Factory Concepts: micro assembly, composite molding, micro robotics, geometric analysis, decision systems, process planning and micro factory layout designs. Micro-nano systems engineering: module applications; micro-nano scale product design; case studies for biomedical, sensors, and nano technology applications. Tutorial and Laboratory practices.		
ENG(CMERI) 2-385	ADVANCED MATERIALS	L-T-P-C : 3-0-1-3

Course Coordinators: A. Chaudhuri

Basics: Mechanics of materials, mechanical properties, dislocation theory, mechanical testing methods, creep and relaxation behaviour of common engineering materials
Advanced materials: Polymers, conductive polymers, ceramics, composites, nano-composites, smart materials, high temperature materials, bearing materials, materials for sensors and actuators
Material characterization: Optical and X-ray spectroscopy, diffraction methods (X-ray diffraction, Crystallographic texture measurements, electron microscopy (SEM, TEM, EBSD, etc.), Atomic probe micro analysis (AFM), Thermo gravity analysis
Future Trends, Applications, Tutorial & Laboratory

ENG(CMERI) 2-386	OPTIMAL CONTROL	L-T-P-C : 3-0-1-3

Course Coordinators: S. Nandy

Introduction: Problem formulation, Mathematical model, Physical constraints, Form of optimal control, Performance measures, Static optimization techniques.
Dynamic Programming and related topics: Introduction, Principle of optimality, Hamilton-Jacobi-Bellman equation, Continuous linear regulator problems, Pontryagin's maximum principle, Control with constraints, Time optimal control, Optimal tracking control problem.
Variational Approaches: Calculus of variations, Fundamental concepts, Functionals, Euler's equation, Lagrangian, Variational approach, Optimal control law, Necessary conditions, Linear regulator & tracking problems, Multi-variable optimization problem, Linear Quadratic Regulator.
Optimization Methods: Minimum time problems, Minimum control-effort problems, Kalman Filter, Non-linear system optimization, Gradient optimization techniques, Steepest ascent and decent method, Rosenbrock's conjugate gradient method, David-Fletcher-Power method.

ENG(CMERI) 2-387	PRECISION MACHINE DESIGN	L-T-P-C : 3-0-1-3

Course Coordinators: Dr. N.C. Murmu

Economics, project management and design philosophy, principles of accuracy, repeatability and resolution; error budgeting.
Flexure design - linear and non-linear deflection, stiffness and strength, displacement vs force loads, material considerations, fatigue failure and its prevention.
Bearings: rolling contact bearings, flexural bearings, gas bearings and magnetic bearings and design engineering surfaces.
System design - manufacturing considerations, materials, structural design, joint design, support system and kinematic coupling design, sensors, actuators and transmissions and system integration driven by functional requirements and operating physics.
Mini Project – application of theory and heuristics to the design of precision mechanical systems.
Tutorial & Mini Project.

ENG(CMERI) 2-388	NUMERICAL METHODS & COMPUTER PROGRAMMING	L-T-P-C : 3-0-1-3

Course Coordinators: Dr. Partha Bhattacharya

Introduction, finite floating point arithmetic, catastrophic cancellation, chopping and rounding errors; Solution of nonlinear equations; bisection, , Newton's & Muller's method, fixed point iteration;
Numerical optimization, Golden section search, Newton's method optimization; linear algebraic equations; forward Gaussian elimination, pivoting, scaling, back substitution, LU-decomposition, norms and errors, condition numbers, iterations, Newton's method for systems, computer implementation; Interpolation- Lagrange, Newton & inverse ;
Numerical Integration; finite differences, Newton cotes, trapezoidal, Simpson's rule, extrapolation, Gaussian quadrature; Numerical solution of ODE; Euler's method, Runge-Kutta method, multi-step methods, predictor-

corrector methods, rates of convergence, global errors, algebraic and shooting methods, boundary value problems, computer implementation.

ENG(CMERI) 2-389	ELECTRO-MECHANICAL SYSTEMS DESIGN	L-T-P-C : 3-0-1-3

Course Coordinators: Dr. Nagahanumaiah

Introduction: Electro-Mechanical systems and applications: design and analysis of micro-nano positioning systems; ultra precision screw drives; Dual drive positioning systems; flexural joints; design and kinematics analysis of parallel kinematics platforms. High Speed Power Sstems: Distributed loads in electro-mechanical motion drives; Design and dynamic analysis of high speed spindle. Analysis and Synthesis of Fluid Mechanical Systems: hydraulic actuators, micro fluidic flow problems, solving micro pump system design. Instrumentation: sensors, actuators, encoders, servo mechanisms, laser interferometery and other position calibration techniques. Future Trends: Tutorial & Laboratory practices.

ENG(CMERI) 2-390	ANALYTICAL MECHANICS	L-T-P-C : 3-0-0-3

Course Coordinators: Dr. Somenath Mukherjee

Optimum Path: Fermat's Principle, Brachistochrone Problem.
Calculus of Variation in Mechanics for Conservative Systems. Degrees of Freedom and the Configuration Space. The Concept of Functionals and their Variations. Virtual work, the varied path. Hamilton's Principle of Stationary Action, Lagrange's Equations of Motion.
Applications of Lagrange's Equations: Equations of motion of multi-degree of freedom systems. Vibrations of discrete systems (of lumped masses) and continuous elastic systems. Lagrange Multipliers for Constrained Systems. Applications.
Hamiltonian Mechanics: The Legendre Transformations, Hamilton's Cannonical Equations of Motion, Applications.
Accelerating /rotating reference frames. Dynamics of rotation of rigid bodies.
Central force systems; Motion of satellites.

ENG(CMERI) 2-391	FINITE ELEMENT METHODS FOR FLUID DYNAMICS	L-T-P-C : 3-0-1-3

Course Coordinators: : Dr. Satya Prakash Singh & Dr. Gautam Biswas

Fundamental concepts; strong form, weak form, Galerkin approximation; matrix equations, element and global point of view; numerical integration – Gaussian quadrature; temporal discretization - generalized trapezoidal rule; compressible and incompressible flows; implementation of the methods; issues related to high performance computing.

ENG(CMERI) 2-392	NONLINEAR DYNAMICS & CHAOS	L-T-P-C : 3-0-0-3

Course Coordinators: Dr. Pradipta Basu-Mandal

One-Dimensional Flows; Flows on the line & circle: Fixed Points and Stability, Linear Stability Analysis: Uniform-Nonuniform Oscillator, Overdamped Pendulum.
Two-Dimensional Flows; Linear Systems with classifications, Phase plane; Phase Portraits, Fixed points and Linearization, Conservative Systems, Reversible Systems. Limit Cycles, Poincare-Bendixson Theorem, Relaxation Oscillations, Weakly Nonlinear Oscillations.
Bifurcations; Saddlenode, Transcritical, Pitchfork and Hopf Bifurcations.
One-Dimensional Maps; Stability of Fixed Points, Periodic Points, Poincare Map, Logistic Map, Dependence on Initial Conditions.
Two-Dimensional Maps; Sinks, Sources and Saddles, Linear Maps, Coordinate Changes, Nonlinear Maps and the Jacobian Matrix, Stable and Unstable Manifolds. Chaos in Two-Dimensional Maps; Lyapunov Exponents:

Numerical Calculation.
Chaos in Differential Equations; Lorenz Attractor, Lyapunov Exponents for Flows.

ENG(CMERI) 2-393	MECHANICS OF COMPOSITE MATERIALS	L-T-P-C : 3-0-0-3

Course Coordinators: Dr. Surendra Kumar

Introduction to Composite Materials, Classification of composites; Fibres and matrices; Manufacturing, mechanical properties and applications of composites.
Stress-strain relationships for a unidirectional/bidirectional lamina; strengths, thermal and moisture expansion coefficients.
Determination of physical and engineering properties of a unidirectional lamina from the individual properties of the fiber and the matrix, fiber volume fraction, and fiber packing.
Determination of the elastic stiffnesses and mechanical loads on laminate based on the values of individual laminae and the stacking sequence.
Failure Criteria for a unidirectional composite lamina and a laminate; Design of laminated composite and other issues.

ENG(CMERI) 2-394	ROTOR DYNAMICS	L-T-P-C : 3-1-0-4

Course Coordinators: Tapan Kr. Paul & Dr. S.K. Laha

Introduction to rotor dynamics. Flexural vibration & Torsional vibration. Critical speeds of rotors and response to imbalance. Factors affecting them such as gyroscopic action, internal damping, fluid film bearing. Methods for analysis such as Transfer Matrix, FEM etc. Bearing and Seals rotor dynamics. Stability of rotor systems. Balancing of rotors. Concepts of condition monitoring and Signature analysis.

ENG(CMERI) 2-395	COMPRESSIBLE FLOW	L-T-P-C : 3-1-0-4

Course Coordinators: Dr. Sudipta De and Dr. T. Murugan

Brief review of fluid mechanics and thermodynamics, Flow regimes, Governing equations of compressible fluid flow, 1-D inviscid flows, Flow through nozzles and intakes, Mathematical theory of characteristics, Acoustic waves, Normal and oblique shock waves, Unsteady wave motion, The shock tube and moving shock waves, shock tube relations, Flow past wedge and aerofoil, Shock- Boundary layer interaction, Numerical techniques for compressible flows.

ENG(CMERI) 2-396	F LOW THROUGH TURBO MACHINES	L-T-P-C : 3-1-0-4

Course Coordinators: Dr. L.G. Das

Basic thermodynamics and fluid mechanics of turbo machines, dimension less performance characteristics, cascade theory, concept of circulation, lift and drag, conformal transformation developing blade geometry, isentropic flow analysis, axial flow turbine, radial flow turbine, selection of degree of reaction and effect on efficiency, centrifugal compressor and pump, compressor surging,3-D through flow analysis of the combined stator and rotor, performance prediction, cause & effect of secondary flow on the performance, effect of turbo machine geometry and operation characteristics on the performance, off-design performance analysis.

ENG(CMERI) 2-397	FLUIDIZED BED DRYING	L-T-P-C : 3-1-0-4

Course Coordinators: Dr. P.K. Chatterjee

Principle of fluidization, advantages & limitations, Thermal physical properties/Geldart classification, Heat transfer in fludizied bed drying, Basic principles of drying/drying curves, effects of operating parameters, batch/continuous/mechanically assisted fluidized bed dryer, Spouted bed dryer, Diffusion/kinetic/1-2-3 phase

models and design procedures.		
ENG(CMERI) 2-398	FLUIDIZED BED COMBUSTION & GASIFICATION	L-T-P-C : 3-1-0-4
Course Coordinators: Dr. Malay Karmarkar and Chanchal Kr. Loha		
Introduction - Fluidized bed equipment, Features of fluidized bed; Gasification and combustion - Theory, Effect of operating parameters and feed properties. Gas cleaning, Design consideration, Application; Hydrodynamics – Regimes of fluidization, Bubbling and fast fluidized beds, gas-solid flow structure, gas-solid mixing, Gas-solid separators; Heat and mass transfer between fluid and solid; Modeling – equilibrium modeling, kinetic modeling, CFD modeling in bubbling and circulating fluidized systems.		
ENG(CMERI) 2-399	THERMODYNAMICS	L-T-P-C : 3-1-0-4
Course Coordinators: Biplab Chowdhury		
State of Equilibrium, First Law of Thermodynamics, Second Law and Entropy, Availability and Exergy, Postulatory (Gibbsian)Thermodynamics, General Thermodynamic Relationships, Equations of State, Thermodynamic Properties of Pure Fluids and Mixtures, Stability, Chemically Reacting Systems, Reaction Direction and Chemical Equilibrium, Availability Analysis for Reacting Systems, Chemical Kinetics		
ENG(CMERI) 2-400	PRINCIPLES OF CASTING SOLIDIFICATION	L-T-P-C : 3-1-0-4
Course Coordinators: Dr. Sudip Kr. Samanta		
Thermodynamics of solidification; Single phase and alloy solidification; Cellular and Dendritic growth; Mathematical analysis of redistribution of solute during solidification; mechanism of dendritic arm fragmentation, dendritic to equiaxed globular grain transformation, alloying effect on solidification; Solidification of metallic composite materials; diffusion kinetics; Fick's Law of diffusion, diffusion and phase transformation; Multiphase flow Modelling of alloy solidification, Case studies.		
ENG(CMERI) 2-401	CONVECTIVE HEAT & MASS TRANSFER	L-T-P-C : 3-1-0-4
Course Coordinators: Prof. Gautam Biswas and Dr. T. Murugan		
Conservation equations, boundary layers, free convection, forced convection. Heat transfer in laminar and turbulent, internal as well as external flows, mixed convection. Combined convection and radiation. Boiling and Condensation. Molecular diffusion in fluids, mass transfer coefficient. Simultaneous heat and mass transfer; Applications.		
ENG(CMERI) 2-402	TURBULENCE	L-T-P-C : 3-1-0-4
Course Coordinators: Prof. Gautam Biswas and Dr. T. Murugan		
Origin of turbulence, Scales of turbulent motion, Correlation Functions, Kolmogorov Hypothesis and Probability Density Function; Statistical description of turbulence, Experimental techniques, Classical Idealization of Turbulent Flows; Vorticity Dynamics; Dynamics of Turbulent Kinetic Energy and Important Scaling Relations; Mean flow equations and Reynolds stresses; Closure problem; Free and wall bounded shear flows, Space-time correlations, Turbulent flows in pipes and channels, Laws of wall and fully developed turbulence; Spectral dynamics, Modeling Concepts; Direct and Large Eddy Simulation;		
ENG(CMERI) 2-403	STATISTICAL METHODS FOR ENGINEERS	L-T-P-C : 3-1-1-4
Course Coordinators: Dr. Partha Bhattacharya		

Statistical Computing: Graphical representation, Frequency distribution, Measures of central tendency and dispersion, Random variable - it's expectation and variance, Probability models – Binomial-Poission-normal.
Bivariate Frequency Distributions. Scatter Diagram, Product Moment, Correlation coefficient with properties, regression lines, correlation index and ratio, Spearman rank correlation. Multiple linear regression, multiple correlation, partial correlation. Random sampling, expectations and standard error of sampling mean (without derivation), expectation and standard error of sampling proportions.
Point of estimation of parameters, Maximum likelihood estimation, interval estimate of parameters, test of significance based on t, F and CHI square distribution.
Large sample tests, Tests based on Pearsonian frequency CHI-square.

ENG(CMERI) 2-404	ADVANCED ELECTRICAL DRIVES	L-T-P-C : 3-1-0-4

Course Coordinators: S. Sen Sharma

A.C. phase control circuits: Single phase AC voltage regulators and cycloconverters;
Power Inverters: Single phase bridge, three phase bridge and PWM inverters
Drives: Selection. Control and stability of electric drives.
D.C. motor controllers: Armature voltage control of separately exited DC shunts Motor; single quadrant, two quadrant and four-quadrant operation; field current control, micro controller based control circuit for motor control;
A.C motor controllers: Squirrel cage induction motor control, control-stator voltage control, V/F control, control of wound rotor motor, slip power recovery D.C and AC servo motor controller; stepper motor controller; Brushless DC motor controllers;
Drives for Electric and hybrid Vehicles.

ENG(CMERI) 2-405	INSTRUMENTATION & INDUSTRIAL CONTROL	L-T-P-C : 3-0-2-4

Course Coordinators: Shikha

Measurement systems: General concepts, Performance terms, static and dynamic characteristics, system transfer function, system accuracy, sources of error.
Sensors & Transducers: Transducer Fundamentals, resistive, inductive, capacitive, piezoelectric, optoelectronic, pressure, strain, torque, speed, chemical, temperature.
Smart sensors & Intelligent Instrumentation: Smart sensors and its categories; intelligent instrumentation systems.
Programmable Logic Controllers: Construction Types, Hardware, Programming and Applications.
Industrial Communication in Process Control: Smart transmitters, Hardware and Software protocols, RS232, Modbus, GPIB, HART, FF and other IEEE Standards.
Virtual Instrumentation: Graphical programming, loops and charts, arrays, clusters and graphs, case and sequence structures, advantages of VI. Labview applications.

ENG(CMERI) 3-001	ADVANCED SELF STUDY	L-T-P-C : 3-1-0-4
Course Coordinators: Concerned Faculties		
Specialised advanced courses would be offered in consultation with the thesis supervisors and Doctoral Advisory Committee (DAC).		
ENG(CMERI) 3-002	PROJECT PROPOSAL - I	L-T-P-C : 0-1-2-2
Course Coordinators: Concerned Thesis supervisor(s)		
Formulation of a project proposal in specified format in a holistic manner preferably candidate's own research work suitable for submission to appropriate funding agencies.		
ENG(CMERI) 3-003	PROJECT PROPOSAL - II	L-T-P-C : 0-1-2-2
Course Coordinators: Concerned Thesis supervisor(s)		
Formulation of a complete project proposal in specified format on the related subareas of candidate's own research work.		
ENG(CMERI) 3-004	CSIR-800 SOCIETAL PROGRAMME	L-T-P-C : 0-0-8-4
Course Coordinators: Concerned Faculties		
The students have to undertake a project in rural areas for 6-8 weeks in the line with CSIR-800 programme which is primarily prepared at empowering 800 million Indians by way of S&T inventions. The theme for the project may be chosen from CSIR-800 documents and as per expertise available in the laboratory. Students will select the topics in consultation with Doctoral Advisory Committee (DAC).		
ENG(CMERI) 3-381	ADVANCED COMPUTER ORGANIZATION & ARCHITECTURE	L-T-P-C : 3-1-1-4
Course Coordinators: Dr. Partha Bhattacharya		
Introduction of different Computer generations. Design Methodology: Introduction, CPU, registers, BUS, memory. Processor Design: Processor organization, instruction sets, fixed point arithmetic. Control Design: Instruction sequencing, Hardware control, micro-programmed control, minimizing microinstruction size. Memory Organization: Memory technology, Virtual memory, high speed memories. I/O Systems: Programmed I/O, DMA and interrupt, I/O processor. Computer Network: Communication Protocols, Circuit Switch, Message Switch and Packed Switch, CDMA. LAN, WAN etc. communication devices, Cellular Network. Parallel processors, pipeline structures, Vector Processor etc. Pipelined instruction units, Arithmetic pipelined design, Multifunction and array pipelines, designing pipelined processor, Dynamic pipelined and re-configurability, Multiple vector task dispatching.		
ENG(CMERI) 3-382	APPLIED SOFTCOMPUTING	L-T-P-C : 3-1-1-4
Course Coordinators: Dr. Arup Nandi		
Artificial neural network (ANN), Supervised and unsupervised learning of ANN, fuzzy logic, fuzzy membership function distributions, fuzzy logic rules, fuzzy and neuro-fuzzy inference systems, Genetic-fuzzy system, rough sets, The Hopfield Network; Support Vector Machines; Evolutionary algorithms, differential evolution, simulated Annealing, antcolony optimisation, particle swarm optimisation, hybrid-system, engineering applications of modeling and optimisation.		
ENG(CMERI) 3-383	OPTIMIZATION TECHNIQUES IN ENGINEERING	L-T-P-C : 3-1-1-4

Course Coordinators: Dr. Arup Nandi		
Classical optimization methods, unconstrained minimization; Univariate, conjugate direction, gradient and variable metric methods, constrained minimization, Feasible direction and projections. Integer and Geometric programming, multi-objective optimization, genetic algorithms (GAs), multi-objective GA, simulated annealing techniques, engineering applications.		
ENG(CMERI) 3-384	LOW POWERED EMBEDDED SYSTEM DESIGN	L-T-P-C : 3-1-1-4
Course Coordinators: J. Roy Choudhury		
Hardware-software co-design, FSM and Timed automata, Modeling and design, Poware aware scheduling techniques, SDL, SpecChart etc. Architectural synthesis for DSP, Verification of digital systems - finite state automata, ù-automata, FSM; Sampling theorem and digital signal sequence, Frequency response and FIR,DFT and FFT, Tools for DSP Analysis and design, Decimation in time and frequency, FFT algorithms, discrete cosine transform; DSP ASIC Design, Configurable Logic, Design Methodology of power aware systems, VLSI Implementation of DSP Processors, Embedded systems Architecture and assembly instruction set; Adaptive Filters, The LMS Algorithm, Adaptive Lattice Ladder Filters, Recursive Least Squares Lattice Ladder Algorithms.		
ENG(CMERI) 3-385	COMPUTER AIDED METROLOGY AND MACHINE VISION	L-T-P-C : 3-1-1-4
Course Coordinators: Dr. R. Sen		
Precision, accuracy, repeatability, reproducibility, contact and noncontact measurements, challenges of temperature, probes and environment, uncertainty of measurements. Co-ordinate Measuring Machine: construction, process, probing and software, error compensation and alignment, prismatic component inspection, profile and surface measurement. Application of Laser interferometer: Basics, flatness testing, surface contour test, scales and gratings, Moire scales and Moire fringes, diffraction measurement technique. Computer Aided Measurement Techniques: data acquisition, automatic inspection machines, knowledge based system. Vision based inspection system: Basics of image acquisition, Basics of machine vision, morphological operation for shape analysis.		
ENG(CMERI) 3-386	ADVANCED FLUID FILM BEARINGS	L-T-P-C : 3-1-1-4
Course Coordinators: : Dr. N. C. Murmu		
Basic equations of lubrication, analytical solution –finite difference and finite element methods, and application to idealized hydrodynamic bearings. Hydrodynamic instability, mechanism of hydrodynamic instability, oil whirl and stability. Externally pressurized oil bearings – hydrostatic lubrication, fixed restrictors, circular step bearings, rectangular thrust bearings and numerical solution Gas lubricated bearings –governing equations, limiting solutions, slider bearings, externally pressurized gas bearings, porous bearings and whirl instability in journal bearings. Squeeze film bearing –parallel surface bearings, step bearings and some problems under squeeze film lubrication. Elastohydrodynamic lubrication, theoretical considerations, Grubin type solution, film thickness equations, different EHL regimes.		
ENG(CMERI) 3-387	WEAR OF MATERIALS & SURFACE MODIFICATIONS TECHNOLOGIES	L-T-P-C : 3-1-1-4

Course Coordinators: : Dr. N. C. Murmu

Surfaces and Substrates: Surface topography, physico-chemical aspects of solid surfaces, surface interactions. elastic contacts, elastoplastic contacts and importance of substrate.
Friction and Wear: Laws of friction, mechanisms of friction, friction space, stiction, stick slip, surface temperature. Abrasive wear, Adhesive wear, Erosion, Corrosive wear, Fatigue wear, Delamination of wear, and Fretting wear.
Applications: Wear Behavior of Engineering Materials, Metallic materials, Ceramics, Polymers and Industrial applications.
Surface Modifications Techniques: Electro deposition, Flame spraying, Plasma spray, Physical vapour deposition, Chemical vapour deposition, HIP surface treatments, Sol-gel coatings and Spin coating methods.
Lab Works, Tutorials and Mini Project.

ENG(CMERI) 3-388	FUNCTIONALIZATION OF SURFACE AND INTERFACES OF BIOMATERIALS	L-T-P-C : 3-1-1-4

Course Coordinators: : Dr. R. R. Sahoo

Introduction to biomaterials: Metallic, Ceramic, Polymeric, Composite, hydrogel, natural materials.
Characterization of materials, mechanical properties, thermal properties, surface properties and adhesion.
Biofunctionalization of Surfaces, Self-assembly, Polymer directed self-assembly of inorganic biomaterials – Biomimetics; surface and intermolecular forces.
Surface modification, 2D and 3D scaffolds for tissue engineering; Materials for artificial blood vessels, mechanical heart valves, breast implants, orthopedic joints, dental fillings, chin augmentation, devices such as intravenous catheters and drug delivery vehicles, intra-ocular lenses, burn dressings, sutures,
Biomaterials for tissue replacement; biologically functional biomaterials; testing and clearance of biomaterials; evaluation of biomaterials. Hip Joint Prosthesis Fixation: Problems and Possible Solutions, orthopedic implants.

ENG(CMERI) 3-389	NANOTRIBOLOGY AND ITS APPLICATION TO MICROSYSTEMS	L-T-P-C : 3-1-1-4

Course Coordinators: : Dr. R. R. Sahoo

Introduction to Micro and Nanotribology. Overview of surface roughness, adhesion, friction, wear and lubrication. Mechanisms of solid-solid adhesion, liquid medicated contact, lubrication approaches.
Characterization techniques – SFA, STM, AFM, Nanoindenter. Nanotribology, nanomechanics and material characterization using AFM. Overview of surface imaging, adhesion, friction, wear, indentation and lubrication. Metals, Ceramics, Self-Lubricating Films. Tribological Properties of Metallic and Ceramic Coatings. Self-Assembly for Controlling Hydrophobicity, Friction and Wear.
Nanotribology of microsystems, examples with tribological issues. Nanotribological studies of Microsystems' materials and lubricants, superlubricity, Reversible adhesion etc.
Nanomechanics of Nanostructure, measurement of mechanical properties of Nanostructure, FEM analysis of Nano-beams with roughness etc.

ENG(CMERI) 3-390	ADVANCED PASSIVE AND ACTIVE MAGNETIC BEARINGS	L-T-P-C : 3-1-0-4

Course Coordinators: : Dr. Pranab Samanta

Introduction to PMB, basic principles, configurations, merits and demerits, modeling and simulation of PMB.
Electro-magnetics and mathematicl model of AMB, electromechanical structure and operating principles, stored magnetic energy and force, radial magnetic bearing, unbalance pull force.
Basics of active control, introduction to magnetic bearing controls, active suspended machine, PID Control, adjustment of PID gains, interference in two perpendicular axes, unbalance force and elimination.
Methodology for AMB suspended rotordynamics investigation,flexible rotor AMB characterization and control, two axes system, four-axis and five axis systems.
Introduction to ferrofluid, principles, synthesis, characterization, ferrodydrodynamics, design of ferrofluid bearing.

Mini Project / Lab Works,Tutorial.

ENG(CMERI) 3-391	LATTICE BOLTZMANN AUTOMATA	L-T-P-C : 3-1-0-4

Course Coordinators: : Dr. Dipankar Chatterjee and Dr. Bittagopal Mondal

Introduction and Kinetics of Particles: Kinetic theory, Particle dynamics, Distribution function, Boltzmann distribution. The Boltzmann Equation: Introduction to Micro, Macro and Mesoscopic Modeling, Lattice Gas Cellular Automata (LGCA), From LGCA to LBM (Lattice Boltzmann Model), Boltzmann Transport Equation (BTE), Derivation of LBM from BTE, Chapmann-Enskog Expansion, The BGK Approximation, One, Two and Three dimensional Lattice Arrangements, Equilibrium Distribution Function.
The Diffusion Equation: Finite Difference Approximation, Lattice Boltzmann Method, Boundary Conditions, Two Dimensional Heat Diffusion. The Advection-Diffusion Problem, Implementation of LBM for basic fluid flow and heat transfer problems, Some advanced topics like turbulence, two phase flow, MHD etc.

ENG(CMERI) 3-392	ROBOTS WITH JOINT FLEXIBILITY: MECHANICS AND CONTROL	L-T-P-C : 3-1-0-4

Course Coordinators: : Dr. Soumen Sen and S. Nandy

From Rigid to Flexible Robots, Joint flexibility, Stiffness/Impedance variability, Flexible Tendon Driven System, Tendon Routing, Manipulator Statics and Stiffness, Explicit and Antagonistic stiffness variability, Tendon manipulability, Stiffness Controllability, Dynamic model of flexible joint for serial robot, Singular perturbation technique, Control methods for flexible joint robots, Feedback linearization technique, Cartesian Impedance control, Simultaneous control of motion and stiffness in variable stiffness mechanisms.
New generation of human friendly robots, Macro/Mini actuation approach, Antagonistic actuation approach, Variable stiffness in legged machines, exoskeletons and artificial prosthesis.

ENG(CMERI) 3-393	ARTIFICIAL INTELLIGENCE AND DATA MINING	L-T-P-C : 3-1-0-4

Course Coordinators: : Dr. Ranjit Ray and D. Banerjee

Foundation of AI and history of AI intelligent agents, Searching for solutions, uniformed search strategies, Local search for constrain satisfaction problems, Rule based deduction systems, Decision Support System, Data Prediction , Sequence Discovery , Fuzzy Sets and Fuzzy Logic, Game Playing Data Mining, Knowledge Representation & Reasons logical Agents, Resolution, Decision Theory, Classical planning problem, Language of planning problems, planning with state – space search, Robot Motion Planning, Overview of machine learning, Decision tree learning, Two layer artificial neural networks, Multi-layer artificial neural networks, Inductive logic programming, Genetic algorithms, Genetic programming.

ENG(CMERI) 3-394	ADVANCED COMPUTER VISION	L-T-P-C : 3-1-0-4

Course Coordinators: : Dr. S. Majumdar

Review of Computer Vision Fundamentals
Model Fitting: Bilinear models, symmetric model, asymmetric model, classification, extrapolation, translation of the data set.
Structure from Motion & Image Motion: Domain dependent & domain independent motion understanding, optical flow-adjacency, depth and collision, surface orientation and edge detection, egomotion, understanding of image sequences and probability theory for clustering.
Review of Bayes Theorem: Statistical decision theory, Bayes Theorem, Classifier Types-parametric, nonparametric. Classifier training-supervised, unsupervised. Maximum likelihood estimation, Bayesian estimation.
Object Recognition Pose Estimation using analytical or geometrical methods and learning based methods.

Object Tracking with adaptive background generation & shadow removal using single & multi camera tracking techniques with common algorithms for filtering and data Association Other topics include face recognition.		
ENG(CMERI) 3-395	ADVANCED NAVIGATION & DATA FUSION	L-T-P-C : 3-1-0-4
Course Coordinators: : Dr. S. Majumdar		
Review of Navigation Sensors & Navigation methods Probabilistic modeling & its applications to Navigation & Data Fusion (Bayes Filter) Feature detection & Representation & Map building Data Association methods: Innovation Gate, Probabilistic Data Association, Joint Probabilistic Data Association, Multiple Tracking, Correlation based method Simultaneous Localization and Map Building: Theory & Application to Navigation, Multisensor data fusion application, sonar, vision, laser radar, INS, GPS etc. AI based Robotics, Qualitative Modeling Methods, Qualitative and Behavior based Navigation, Learning Systems, Perception Modeling and its application to Robotics.		
ENG(CMERI) 3-396	MOBILE ROBOTICS	L-T-P-C : 3-1-1-4
Course Coordinators: : D. Banerjee and S. Nandy		
Basic Components & Modelling: Introduction, Design considerations, Key issues, Locomotion, Configurations (Legged, Wheeled & Hybrid), Kinematics, Constraints, Dynamics. Sensing & Perception: Sensors, Levels of integration & advantages, Smart Sensors, Interoceptive & Exteroceptive sensors, Sensors for mobile robots (Dead reckoning, Heading, GPS, Vision, Motion sensors, Range finders etc.), Modeling (Allan Variance), Feature extraction. Navigation, Motion Planning & Control: The challenges of Navigation & Localization, Odometry and other dead reckoning methods, Active beacon navigation system, Land mark navigation, Occupancy grids, Path planning, Kalman Filter, SLAM Classical control methods (PID, FLC etc.), Obstacle Avoidance methods. Advanced Robotics paradigms: Behavioural & Probabilistic Robotics.		
ENG(CMERI) 3-397	ADVANCED ROBOT DYNAMICS AND CONTROL	L-T-P-C : 3-1-0-4
Course Coordinators: : Dr. Soumen Sen and S. Nandy		
Introduction to dynamics; Spatial velocity, acceleration and force; Transformations; Momentum and Inertia; Equations of motion of multibody system and constrained motion; Robot kinematics, serial and parallel manipulators, joint models; Forward and inverse dynamics of serial and parallel manipulators, Newton-Euler algorithm, Euler-Lagrange algorithm, Robot-environment contact and impact; Multifingered hand and co-operative multi-manipulator kinematics and dynamics, internal forces and internal motion; Lyapunov stability theory; Position control and trajectory tracking; Joint and task space control; Control of constrained manipulators; Force and Impedance control; Dynamics of manipulator on mobile platform; Modelling and dynamics of underwater robots/vehicles; Thrusters; Vehicle-manipulator dynamics; Control and stability of AUV.		

MTech & PhD Thesis Work

ENG(CMERI) 2-098	MTech DISSERTATION PART-I	L-T-P-C : 0-8-16-16
ENG(CMERI) 2-099	MTech DISSERTATION PART-II WITH VIVA VOCE	L-T-P-C : 0-8-16-16
ENG(CMERI) 3-099	PhD DISSERTATION WITH VIVA VOCE	L-T-P-C : --------