

Course Structure and Curriculum

Dual Degree Program (B. Tech & M. Tech)

In

Engineering and Computational Mechanics
(To be implemented from academic session July, 2025)



Department of Mechanical Engineering
Maulana Azad National Institute of Technology Bhopal
Bhopal -462003, India

VISION AND MISSION OF THE INSTITUTE

VISION

MANIT looks forward to becoming a global centre for technical and professional development of the country.

MISSION

To produce technical professionals abreast with competence, logical mindset, moral and ethical values and inner strength synchronous with the futuristic requirement of global business to strengthen the national economy.

MISSION OF THE DEPARTMENT

The commitment to the cause of value-based education in Mechanical engineering, envisions itself as a fountainhead of innovative human enterprise, with inspiration initiatives for Academic Excellence and to be a centre for imparting world class education in the field of Mechanical Engineering and to conduct extensive quality research and to propel innovations for the betterment of society.

MISSION OF THE DEPARTMENT

- To train young minds and to equip them with the best possible technical knowledge to meet the current and future demands of the industry, academic institutions and research organizations.
- To create infrastructure, motivation and culture for the state-of-the-art research work in the area of Mechanical Engineering.
- To enhance the research and teaching by interaction and development of relation with industries, R&D organizations, and academic institutions.
- To develop an energetic environment for excellence, creativity, perfection and team work.
- To establish Industry-institute linkages for skill development of the professionals

ABOUT THE MECHANICAL ENGINEERING DEPARTMENT

The department of mechanical engineering, being one of the largest and oldest departments of the institute, caters to its students with class tutorial and state-of-the-art laboratories. The department is continuously striving to achieve excellence in education, academic and industry-oriented research as well as consultancy work

with service to the society. Currently, the department offers One Undergraduate (UG) in Mechanical Engineering and Four Postgraduate (PG) programs namely Industrial Design, Thermal Engineering, Robotics & Automation and Industrial Engineering & Management. The department is actively engaged in high quality research in Design, Materials, Thermal, Manufacturing and Industrial Engineering. The department has a well-established tradition of producing excellent engineers and outstanding human beings. It remains committed to multi-faceted development of students, inculcate technical knowledge with a society-centric perspective and inspire them to take multiple original initiatives aimed at making India a powerhouse of knowledge and industrial progress.

We aim to provide our students with a perfect blend of intellectual and practical experiences, that helps them to serve our society and address a variety of needs. Innovative teaching methods, industrial collaborations, and state-of-the-art infrastructural facilities are some of the strengths of the department. It also offers opportunity to students from other departments to opt for minor specialization in accordance with the provisions of New Education Policy (NEP – 2020).

Core Values:

- Academic excellence and integrity.
- Outstanding teaching and service.
- Encourage quest of life-long learning.
- Scholarly research and professional leadership.
- Inculcating global perspective in attitude.
- Appreciation of intellectual excellence and creativity.
- Sensitivity to social responsibility.
- Integration of human values, ethics and professional etiquettes with teaching.

PROGRAMME OBJECTIVES (POs)

PO1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: To prepare the programme as a thorough and step by step preparation of students for higher learning, conducting research and/or ready for employment.

PEO 2: To orient the programme so as to help the students in acquiring professionalism and technical competence.

PEO 3: Widen the horizon of knowledge both in breadth and depth for promoting a scientific approach in solving civil engineering and interdisciplinary problems.

PEO 4: To inculcate human values among the students and encourage them to follow ethical practices.

PEO 5: To encourage students to apply the knowledge for upliftment of society and creation of an environment which will be sustainable and globally compatible.

PEO 6: To develop the department as a leading provider of cutting edge technology in identified areas in the central region.

OUTCOME-BASED EDUCATION

To follow the Outcome-based education under the choice base credit system (CBCS) curriculum across all programs offered. It is targeted at achieving desirable outcomes (in terms of knowledge, skills, attitudes and behaviour) at the end of a program. Teaching with this awareness and making the associated effort constitutes outcome-based education. This entails a regular methodology for ascertaining the attainment of outcomes, and benchmarking these against the program outcomes, consistent with the objectives of the program.

OBE FRAMEWORK

- Identify & define the learning outcomes at all levels and explicitly document the same in the curriculum.
- Organizing the teaching and learning activity through student – centered

activity and project base learning.

- Assessment and evaluation at all levels of learning outcomes i.e. PEOs , POs and COs
- Establishment of Department's Vision and Mission Statements
- The department is to formulate the department's vision and mission statement after deliberation with respective faculty members, industry experts, alumni and parents followed by discussion with BOS members.
- Establishment of Program educational objects, Program outcomes and Program Specific outcome.
- In consistent with department vision and mission statement, the respective heads of department prepare the PEOs, and POs after due deliberation with all stake holders and finalize the same through departmental academic affairs committee (DAAC) and BOS.

PROPOSED PROGRAM 5 YEAR DUAL DEGREE (B. TECH + M. TECH) IN ENGINEERING AND COMPUTATIONAL MECHANICS

The inherent interdisciplinary nature of the course is intended to start at undergraduate level for Engineers and Technologists having capability to work in multidisciplinary environment in emerging fields of energy management, environmental and biological sciences, robotics and work management etc. The faculty members of Mechanical Engineering department of the institute already have enough competence and expertise knowledge by virtue of their diverse background. The faculty is capable of guiding and training the students according to their interest and passion to build a firm foundation and to face challenges successfully and to develop the entrepreneur and leadership qualities due to multi-disciplinary facet of the program for their successful career.

The students are expected to go through a set of fundamental and core engineering courses in their first to seven semesters that will provide a strong background in the engineering, material science, mathematics and computing. A reasonable portion of the curriculum contains non-engineering courses in the areas of basic sciences, Humanities and Social sciences as well. The course of Engineering

and Computational Mechanics pertains to the discipline devoted to the solution of real-life problems through integrated application of mathematical, scientific and engineering principles. A special emphasis is paid to the physical principles underlying modern engineering design.

The program derives its strength from rigorous knowledge of **Solid Mechanics, Fluid Mechanics, Bio-Mechanics and Data Driven Mechanics**. These areas form the basis for Mechanical Engineering and Bio-sciences and have wide applicability in modern engineering. The students will be able to develop a strong background in mathematics and physics along with the extended knowledge domain in core engineering courses. A special emphasis is paid on the application of rapidly emerging field of machine learning and artificial intelligence in mechanics. The laboratory experiments in fluid mechanics and mechanics of materials mainly complement an integrated design sequence.

This UG/PG course is designed keeping in mind the New Education Policy (NEP-2020). The UG exit course in fourth year provide the background to students to work in industry in highly competitive multidisciplinary environment whereas the specialized programs are intended to equip our graduates with the knowledge to function effectively in research organizations and shape them for future successful researcher.

UNIQUE FEATURES OF THE PROGRAMME

- (i) Focus on basic as well as the emerging areas of mechanics such as bio-mechanics -nano mechanics, data driven mechanics, multi-scale and multi-physics modelling.
- (ii) Exposing students to recent trends in computational such as FEM, CFD, Parallel processing, high performance computing, data science machine learning, Artificial Intelligence etc.
- (iii) Exposing students to fundamental and latest techniques in experiments and its importance for model validation.

OBJECTIVES OF INTRODUCING THE NEW COURSE “ENGINEERING AND COMPUTATIONAL MECHANICS”

- To prepare young minds to analyze complex interdisciplinary problems and venturing into the cutting-edge research through computation, analysis and experimentation.
- To develop skill for mechanics related problem solving through machine learning and artificial intelligence techniques.

UTILITY/DEMAND OF THE COURSE IN THE MARKET

The programme is multi-disciplinary in nature where the curriculum is designed keeping in mind the demands of the industries and research organizations. The syllabus is prepared which involves lot of experimental works in the well-equipped laboratories of the institute and to work on providing solutions to the current problems faced by the industries. The students will be involved in internship/training with highly reputed research and industrial organizations for their skill development during the duration of the course. The skill-based education course has provision of working in fully equipped laboratories of the institute. The syllabus also involves use of various commercial software for analysis. The students will have exposure for application of latest techniques like artificial intelligence and machine learning in various fields of study. Figure 1 shows an overview of the proposed course structure keeping in mind the two exit as per NEP guidelines.

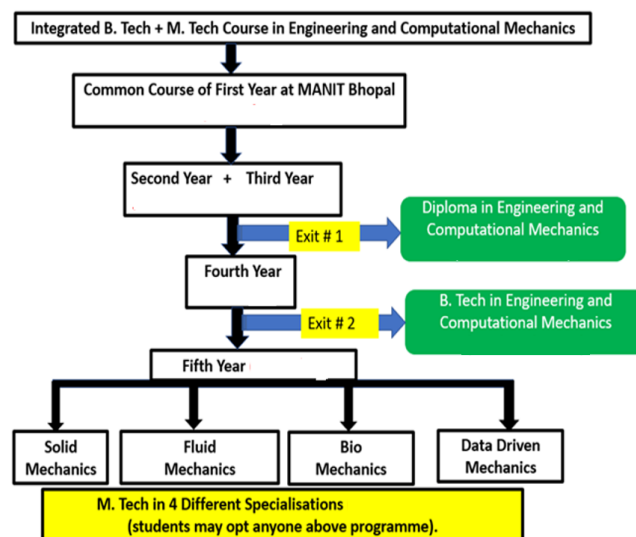


Figure 1 Overview of the proposed course structure

Scheme and Syllabus

First Semester:

(Section A,B,C,D& E)/(Section F, G, H, I & J)

Subject Code	Subject Name	Scheme of Studies Periods per week			Credits
		L	T	P	
MC1101	Mathematics-1	3	1	-	4
PY1102/ CY1107	Physics/ Engineering Chemistry	3	-	-	3
CE1103/ EE1108	Engineering Mechanics/ Basic Electrical & Electronics Engineering	3	1	-	4
ME1104/ME1109	Engineering Graphics/ Manufacturing Science	1	-	-	1
CS1105/CY1110	Computer Programming & Problem Solving/ Environmental Science	2	-	-	2
HS1106/BS1111	Communication Skill/Biology for Engineers	1/2	-	-	1/2
CE1121/EE1125	Engineering Mechanics Laboratory / Basic Electrical & Electronics Engineering Laboratory	-	-	2	1
PY1122/CY1126	Physics Laboratory / Engineering Chemistry Laboratory	-	-	2	1
ME1123/ME1127	Engineering Graphics Laboratory / Manufacturing Science Laboratory	-	-	2	1
CS1124/HS1128	Computer Programming Laboratory / Language Laboratory	-	-	2	1
SA1141/ SA1142/ SA1143/ SA1144	(Life Skill Management/ Physical Education)/ (NSS/ Yoga)	-	-	2	1
Total Hours =25/26		13/14	2	10	20/21
Total Credits					20/21
NCC 1151*	National Cadet Corps I	1	1	-	2

*Not to be counted in SGPA/ CGPA calculations

Second Semester:

(Section A,B,C,D& E)/(Section F, G, H, I & J)

Subject Code	Subject Name	Scheme of Studies Periods per week			Credits
		L	T	P	
MC1201	Mathematics II	3	1	-	4
CY1207/PY1202	Engineering Chemistry/Physics	3	-	-	3
EE1208/CE1203	Basic Electrical & Electronics Engineering/ Engineering Mechanics	3	1	-	4
ME1209/ME1204	Manufacturing Science/ Engineering Graphics	1	-	-	1
CY1210/CS1205	Environmental Science /Computer Programming & Problem Solving	2	-	-	2
BS1211/HS1206	Biology for Engineers/ Communication Skill	2/1	-	-	2/1
EE1221/CE1225	Basic Electrical & Electronics Engineering Laboratory / Engineering Mechanics Laboratory	-	-	2	1
CY1226/ PY1222	Engineering Chemistry Laboratory / Physics Laboratory	-	-	2	1
ME1227/ME1223	Manufacturing Science Engineering Laboratory /Graphics Laboratory	-	-	2	1
HS1228/CS1224	Language Laboratory/ Computer Programming Laboratory	-	-	2	1
SA1241/ SA1242/ SA1243/ SA1244	(Life Skill Management/ Physical Education)/ (NSS/ Yoga)	-	-	2	1
Total Hours =26/25		14/13	2	10	21/20
Total Credits					21/20
NCC 1252*	National Cadet Corps II	1	1	-	2

*Not to be counted in SGPA/ CGPA calculations

Third Semester:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
HS 2101	Fundamental of Entrepreneurship	3	1	-	4
MC MT 2101	Experimental Methods	3	-	-	3
ME CM 2101	Mechanics of Solids	3	-	-	3
ME CM 2102	Fluid Mechanics	3	-	-	3
ME CM 2103	Material Science and Engineering	3	-	-	3
ME CM 2104	Introduction to Sports Biomechanics	3	-	-	3
ME CM 2105	Mechanics of Solids Lab	-	-	2	1
CE XXXX	Fluid Mechanics Lab	-	-	2	1
ME CM 2107	Material Science and Engineering Lab	-	-	2	1
ME CM 2108	Professional Practices	-	2	-	2
	Minor -1*	3	-	-	3*
Total Hours =27		18	3	6	24
Total Credits (Cumulative)					65 (24+41#)
NCC 2151	National Cadet Corps III	1	5	1	7
Total Credits (Cumulative)					11

Fourth Semester:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
ME 2201	Fundamentals of Design Methods	3	-	-	3
MC MD 2201	Probability & Statistics	2	1	-	3
ME CM 2101	Biomaterials and Mechanics	3	-	-	3
ME CM 2102	Engineering Thermodynamics and Heat Transfer	3	1	-	4
ME CM 2103	Machine Learning in Mechanics	3	-	-	3
CS XXXX	Fundamental of Artificial Intelligence	3	-	-	3
ME CM 2204	Biomechanics Lab	-	-	2	1
ME CM 2205	Thermodynamics and Heat Transfer Lab	-	-	2	1
ME CM 2206	Machine Learning Lab	-	-	2	1
	Minor -2*	3	-	-	3*
Total Hours =25		17	2	6	22
Total Credits (Cumulative)					87
NCC 2251	National Cadet Corps IV	2	-	1	3
Total Credits (Cumulative)					14

Fifth Semester:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
ME 3101	Engineering Management	3	-	-	3
ME CM 3101	Finite Element Methods in Engineering	3	1	-	4
ME CM 3102	Viscous Flow Theory	3	-	-	3
EC XXXX	Digital Signal Processing	3	-	-	3
ME CM 3103	Computer Aided Design	3	-	-	3
	Department Elective-1(A)	3			3
ME CM 3104	Computer Aided Design Lab	-	-	2	1
EC XXXX	Digital Signal Processing Lab	-	-	2	1
ME CM 3105	Engineering Computing Laboratory	-	-	2	1
ME CM 3106	Internship/ Industrial Training	-	-	2	1
	Minor -3*	3	-	-	3*
Total Hours =27		18	1	8	23
Total Credits (Cumulative)					110
NCC 3151	National Cadet Corps V	1	5	1	7
Total Credits (Cumulative)					21
[NPTEL/SWAYAM Courses only]		3	-	-	3

Sixth Semester:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
CS 3201	Data Structures and Algorithm	3	1	-	4
ME CM 3201	Computational Fluid Dynamics	3	1	-	4
ME CM 3202	Theory of Vibrations	3	-	-	3
ME CM 3203	Robotics	3	-	-	3
	Department Elective-2(A)	3	-	-	3
ME CM 3204	Robotics Lab	-	-	2	1
ME CM 3205	Vibration Lab	-	-	2	1
ME CM 3206	Computational Fluid Dynamics Lab	-	-	2	1
ME CM 3207	Mini Project	-	-	2	1
	Minor -4*	3	-	-	3*
Total Hours =25		15	2	8	21
Total Credits (Cumulative)					131
NCC 3251	National Cadet Corps VI	2	-	1	3
Total Credits (Cumulative)					24

*NCC as an additional course and **Minor-4: To be taught to students from another department.

Seventh Semester:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
HS 4101	Engineering Economics & IPR	3	-	-	3
ME CM 4101	Experimental Methods in Fluids and Solids	3	-	-	3
ME CM 4102	Mechanics of Advanced Materials	3	-	-	3
	Department Elective-3(A)	3	-	-	3
	Department Elective-4(A)	3	-	-	3
	Open Elective-1(C)	3	-	-	3
ME CM 4103	Experimental Methods in Fluids and Solids Lab	-	-	2	1
ME CM 4104	Project -1	-	-	4	2
ME CM 4105	Intrenship/Field Training	-	-	2	1
	Minor -5*	3	-	-	3*
Total Hours =23		15	-	8	19
Total Credits (Cumulative)					150

Eighth Semester:

Course code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
ME CM 4251	Department Elective -5(A) [NPTEL/SWAYAM Course only]	3	-	-	3
ME CM 4252	Department Elective -6(A) [NPTEL/SWAYAM Course only]	3	-	-	3
ME CM 4201/ ME CM 4202	Project -2 / Internship	-	-	16	8
ME CM 4203	General Proficiency	-	-	-	1
Total Hours =22		6	-	16	15
Total Credits (Cumulative)					165

Ninth Semester:

Course code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
	Course as per Specialization 1	3	-	-	3
	Course as per Specialization 2	3	-	-	3
	Course as per Specialization 3	3	-	-	3
ME CM 5101	Dissertation Phase - 1	-	-	20	10
Total Hours =26		6	-	20	19
Total Credits (Cumulative)					184

Tenth Semester:

Course Code	Course Name	Scheme of Studies Periods per week			Credits
		L	T	P	
ME CM 5201	Dissertation Phase- 2	-	-	40	20
Total Hours =40		-	-	40	20
Total Credits (Cumulative)					204

List of Department Electives (Group A)**Group A Electives: Fifth Semester [Department Elective 1(A)]**

Course Code	Course Name
ME CM 3151	Fracture Mechanics
ME CM 3152	Advanced Mechanics of Solids
ME CM 3153	Mechanical Behavior Materials
ME CM 3154	Marine Dynamics
ME CM 3155	Basics of Product Design
ME CM 3156	Fundamental of Robotics
ME CM 3157	Theory of Elasticity
ME CM 3158	Numerical Methods and Computations
ME CM 3159	Smart Material and Structures

Group A Electives: Sixth Semester [Department Elective 2(A)]

Course Code	Course Name
ME CM 3251	Smart Materials: Modelling and Applications
ME CM 3252	Optimization Methods in Engineering
ME CM 3253	Bio-Modeling & Simulation
CE XXXX	Structural Analysis
CE XXXX	Reinforced Cement Concrete Structures
CS XXXX	Human Computer Interface

Group A Electives: Seventh Semester [Department Elective 3(A)]

Course Code	Course Name
ME CM 4151	Aircraft Structures
ME CM 4152	Aeroelasticity
ME CM 4153	Introduction to Digital Twins
ME CM 4154	Multi Scale Modelling and Computations
ME CM 4155	Introduction to Soft Robotics
ME CM 4156	Theory of Plasticity
ME CM 4157	Introduction to Microfluidics
ME CM 4158	Computational Material Science
ME CM 4159	Machine Design

Group A Electives: Seventh Semester [Department Elective 4(A)]

Course Code	Course Name
ME CM 4161	Turbulence and its Modeling
ME CM 4162	Dynamics of Mechanical Systems
ME CM 4163	Structural Dynamics
ME CM 4164	Structural Health Monitoring
ME CM 4165	Soft Computing
ME CM 4166	Parallel Processing in Computational Mechanics

Specialized Courses for M. Tech (Ninth & Tenth Semesters)

(A) M. Tech in Fluids Mechanics

Subject Code	Subject Name
ME CM 5151	Computational Multi- Body Dynamics
ME CM 5152	Impact Mechanics and Crash Worthiness
ME CM 5153	Introduction to Plates and Shells
ME CM 5154	Continuum Mechanics
ME CM 5155	Composite Mechanics and Structures
ME CM 5156	Micromechanics of Materials
ME CM 5157	Advanced Finite Element Methods

(B) M. Tech in Fluids Mechanics

Subject Code	Subject Name
ME CM 5161	Experimental Methods in Thermal Systems
ME CM 5162	Turbomachines
ME CM 5163	Gas turbines and Jet Propulsion
ME CM 5164	Advanced Computational Fluid Dynamics
ME CM 5165	Aerodynamics
ME CM 5166	Compressible Flow
ME CM 5167	Convective Heat Transfer

(C) M. Tech in Bio-Mechanics

Subject Code	Subject Name
ME CM 5171	Biomaterials
ME CM 5172	Advanced Bio-Mechanics
ME CM 5173	Mechanics of Biological Cells
ME CM 5174	Tissue Engineering
ME CM 5175	Fuzzy Sets & Models in Biology

(D) M. Tech in Data Driven Mechanics

Subject Code	Subject Name
ME CM 5181	High Performance Computing
ME CM 5181	Sustainable Engineering Systems
ME CM 5181	Database Management Systems
ME CM 5181	Data Mining and Visualization



Detailed Syllabus

Course content of Courses in the B. Tech. Programme:

MC 1110 Mathematics – 1 (3–1–0–4)

Curve Tracing, Singular points, Asymptotes, Expansion of Functions: Taylor's and Maclaurin's theorem. Partial differentiation: Euler's theorem, Differentiation of composite functions, Taylor's Series. Maximum and Minima of functions of two or more variables, Lagrange method of undetermined multipliers. Multiple Integral: Double and triple integral, Change of order of integration, Beta and Gamma functions, length of curves, Area, Volume and Surfaces of solids of revolution. Vector Calculus: Vector Differentiation, Gradient, Directional Derivative, Divergence & Curl of Vector point function, Line Integral, Surface Integral, Gauss Divergence Theorem, Strokes theorem & Green's Theorem. Ordinary Differential Equation: Differential Equation of First Order and Higher Degree, Linear Differential Equation with Constant Coefficient of Higher Order, Cauchy's Differential Equation, Method of Variation of Parameter, Simultaneous Differential Equation, Second Order Differential Equation.

PY 1102 Physics (3–0–0–3)

Wave Optics: Interference and Diffraction, Michelson's interferometer, Solid State and Semi-Conductor Physics: Energy bands in solids, Electron and hole mobility, Hall effect, PN junction transistor, Transistor parameters, Photo cell and Solar cell, Quantum Mechanics: Schrodinger wave equation, Particle in a box, Harmonic oscillator, Tunnel effect, Nuclear Physics: Nuclear properties, Nuclear models, Particle accelerator, Fission & Fusion, Chain reaction, Nuclear reactor, Particle detectors, Laser and Fiber Optics: Laser phenomena, Ruby and He-Ne laser and applications, laser holography, Types of optical fibers, Attenuation, Fiber losses, Fiber optics communication, Theory of Relativity: Transformation equations, Time dilation mass energy equation, Electron ballistics: Motion of charged particles in electric and magnetic field, Electron microscope, Mass spectrographs.

HS 1106 Communication Skills (1–0–0–1)

Communication: a vital necessity for good management, Communication process, Barriers to communication viz, organizational, individual, and interpersonal, Dealing with these barriers. Effective communication and modern techniques of spoken and written communication. Electronic devices in communication: computers (LAN, WAN, MAN), Facsimile, Telephone, Teleconferencing, Internet, E-Commerce. Oral communication skills – verbal and non-verbal communication. Executive speaking and listening skills, Presentation skills, Body language, Voice modulation, Negotiation skills, Development of positive personal attitudes, Personal SWOT analysis and development of career plan, Identifying the job, Selection process, Written test- structural, situational, and psychological analysis, Principles of interviewing, Reducing stress, Retaining control, Setting objectives for the interview, Planning and preparation – the challenge of face to face skills. Written communication skills – writing techniques and guidelines, Letter writing- basic principle and purpose, Body language of business letter, Tone of business letter, Types of business correspondence: inviting quotations, answering quotations, orders, tenders, sales letters, claim and adjustment letters, Writing smart e-mail, credit/collection letters, job application and writing resume, Report writing: types of reports, Parts of a report, Qualities of good report, Drafting reports-preparation, Analysis and interpretation of reports. Developing other skills: interpersonal and human skills, Reading skills, Time management skills: avoiding time wasters and identification of prime time, Choosing an appropriate leadership style, Development of an ideal mix of skills. Communication roadblocks, Dealing with those roadblocks, Writing persuasive proposals, Memorandum,



Department of Mechanical Engineering

Public speaking, Group communication: kinds of discussions-forum discussion, Panel discussions, Symposium discussion and group discussions, Planning and meetings, Setting agendas for meetings, Writing and circulating minutes, Notices, Reading comprehension skills.

CS 1105 Computer Programming and Problem Solving (2-0-0-2)

Introduction to Computer and its organization. Problem solving using Computers by Flowchart and Algorithms. Developing a running computer program in C. C programming using conditions, loop, array, functions, pointers and structures. Introduction to IoT using Arduino.

ME 1104 Engineering Graphics (1-0-0-1)

Basic Concepts-introduction to drawing and engineering drawing, lines, dimensioning, title block, drawing instruments etc., Engineering Scales, Theory of Projections, reference planes, types of projection methods, orthographic projection. Projection of points in different angles, projection of lines, projection of planes, projections using auxiliary planes method Projection of solids- Projection of polyhedrons, Prism and pyramids, Projection of solids of revolution in different positions. Section of solids- cutting planes, auxiliary planes, frustum and truncated parts of solids, Development of solids- principle of development, parallel line method, radial line method.

CS 1124 Computer Programming and Problem Solving Lab (0-0-2-1)

Developing a code running computer program in C code. Development of code in C programming using conditions, loop, array, functions, pointers and structures. Introduction to IoT using Arduino.

PY 1122 Physics Laboratory (0-0-2-1)

- Expt. 1: To plot the characteristics curves of a p-n junction diode and calculate its resistance.
- Expt. 2: To plot the characteristics curves of PNP transistors in CE mode.
- Expt. 3: To perform Melde's Experiment in transverse and longitudinal modes and determine the frequency of an electrically maintained tuning fork.
- Expt. 4: To determine frequency of AC mains using an electrical vibrator.
- Expt. 5: To determine the radius of curvature of a lens by Newton's ring method.
- Expt. 6: To determine the refractive index of the material of the prism for various colors of mercury light using prism and spectrometer.
- Expt. 7: To determine the dispersive power of the material of the prism using spectrometer.
- Expt. 8: To determine the wavelength of different colors of mercury light using a plane transmission grating.
- Expt. 9: To determine percentage of transmission of light for a semitransparent film using Lummer- Brodhum photometer.
- Expt. 10: To study diffraction at a single slit using He-Ne laser.
- Expt. 11: To determine the wavelength of He-Ne laser by Michelson Interferometer.
- Expt. 12: To determine Hall Potential and Hall Coefficient.
- Expt. 13: To study the characteristic of Photo Cell.
- Expt. 14: To verify the formula for the combination of lenses and to determine the cardinal points of the combination using Nodal Slide assembly.
- Expt. 15: To measure resistivity of a semiconductor by Four Probe method at different temperatures and determine the Band-gap.
- Expt. 16: To determine the Plank's Constant using LED.
- Expt. 17: To study the characteristic of Photoconductive material.



Department of Mechanical Engineering

MC 1201 Mathematics – 2 (3–1–0–4)

Matrices: Matrix Algebra, Rank of a Matrix, Solution of a system of Linear Equation. Eigen Values & Eigen Vectors, Cayley Hamilton Theorem, LU Decomposition. Laplace Transforms, Inverse Laplace Transforms, Solution of differential equation by using Laplace transforms, Fourier Series and Fourier Transforms. Partial Differential Equation: Linear & Non-Linear P.D.E of First Order, Homogeneous & Non-Homogeneous Linear P.D.E with constant coefficient of Higher Order, Separation of Variables, Boundary Value Problems of P.D.E: Wave equation & Heat Equation. Function of Complex variables: Calculus of Complex Function and its Applications for the Evaluation of Real Definite Integral. Series solution of Differential Equations, Bessel function and Legendre's Polynomial.

CY 1207 Engineering Chemistry (3–0–0–3)

Lubricants- Introduction, Role and Effects of Friction, Functions of Lubricants, Mechanism of Lubrication – Thick Layer, Thin layer and Extreme Pressure Lubrication. Liquid Lubricants, Physical and Chemical Properties, Their Importance and Testing. FUELS- Introduction, Classification, Calorific value, Characteristic of a Good Fuel, Pulverized Coal. Petroleum: Classification, Types of Cracking, Knocking. Water- Introduction, Steps for Purification of water, Difference between Disinfection and Sterilization, Break Point Chlorination. Hardness: Units and Disadvantages. Scale and Sludge formation, Softening Methods: Lime-Soda Processes (cold and hot both), Numerical problems based on Lime-Soda Processes and water analysis. Materials Polymer: Introduction, Nomenclature, Functionality, Types of Polymerization, Mechanism of Addition Polymerization, Thermosetting & Thermoplastic Polymers, Methods of Moulding of Plastics. Introduction and Mechanism of Chemical and Electrochemical Corrosion, Galvanic Corrosion, Concentration Cell Corrosion, Passivity, Soil Corrosion, Pitting Corrosion, Inter-granular Corrosion, Waterline Corrosion, Stress Corrosion, Galvanic Series, Factors influencing Corrosion, Ways to protect against Corrosion. Introduction of Protective Coatings.

CY 1110 Environmental Science (2–0–0–2)

Structure of Atmosphere, Reactions of Air in Troposphere, Stratosphere, Mesosphere and Ionosphere, Smog formation - causes, effects and control with reactions, Classification and Effects of Air Pollutants (Oxides of S, C, N, Hydrocarbons and Particulates), Ways of Monitoring, Prevention and control of Air Pollution, Greenhouse effect and Global warming - major sources, effects and remedial measures, Ozone layer - mechanism of ozone depletion, Acid rain and their adverse effects, Indoor Pollution - causes and effects, Volatile Organic Compounds – origin and negative effects. Characteristics of water, Types and Sources of Water pollution, Classification of Water pollutants and their detrimental effects, Characterization of waste water (including DO, COD, BOD), Methods and Equipment used in wastewater treatment- Preliminary, Primary, Secondary and Tertiary treatments (including Trickling filters, Aerated lagoon, Activated sludge etc.) Composition and importance of Soil, Soil pollution - sources, effects and control. Basic concept of Ecology, Biogeochemical cycles (Water, Hydrogen, Oxygen, Carbon, Nitrogen, Sulphur, Phosphorus), Effect of pollution on Biosphere. Basic principles and importance of Green Chemistry, Sustainability and its ten commandments.

EE 1125 Basic Electrical and Electronics Engineering (0–0–2–1)

DC circuits: Review of basic concepts of charge, voltage and current, power and energy, Voltage & Current sources, Ohm's Law and its application, effect of temperature on resistance of conductors, semiconductors and insulators. Voltage & Current sources, KCL, KVL, loop and nodal equations, Network theorems, Star-Delta transformations for resistances, Simple series and parallel circuits. AC Circuits: Alternating quantities, RMS and average value, Phase and Phase Difference, Power and power factor, Series and Parallel AC circuits, resonance, Concept of Single Phase and Three Phase Supply; 3-phase Star-Delta connections, Inter-Relation between phase and line values of voltages and currents. Faraday's law of electromagnetic induction, its application to



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transformer and machines. Transformers: construction, principle of operation, phasor diagrams, equivalent circuit, losses and efficiency, OC/SC tests. DC machines: Types of DC machines and their Construction, principle of operation, emf and torque equations, speed and torque control methods, starters. Semiconductor devices and applications: Characteristics of PN Junction Diode and Zener Diode, applications of Zener diodes, half wave and full wave rectifiers, ripple factor, conversion efficiency, Bipolar Junction Transistor: Principle of operation, Input/output & transfer characteristics of BJT in CB, CE, CC configurations and their applications.

CE 1103 Engineering Mechanics (3–1–0–4)

Review of Force, moment and Couple, Equilibrium of rigid bodies, Centroid and Moment of inertia, Beams - Shear force, and Bending moment diagrams. Kinematics and Kinetics of particles: Plane and Space motion, Force, Mass and Acceleration, Work & Energy, Impulse & Momentum, Impact, and Central Force Motion. Kinetics of system of particles: Conservation of Energy and Momentum, Steady mass flow, Variable mass. Plane Kinematics and Kinetics of a rigid body: Relative velocity and Acceleration, Instantaneous centre of zero velocity, Rotating axis, Force, Mass and Acceleration, Work & Energy, Impulse & Momentum. Introduction to three-dimensional kinematics and kinetics of rigid bodies.

ME 1209 Manufacturing Science (0–1–3–3)

Carpentry: Introduction to carpentry, types of timber: study of various tools used in carpentry, types of joints, JOB: Making of “L” joint. Fitting: Introduction to fitting and its tools, JOB: Preparation of rectangular job piece by use of filing and cutting. Foundry: Introduction to casting, study of tools used in making moulds and sands, JOB: preparation of mould. Welding: Introduction to metal joining processes, types of welding processes and joints, JOB: Joining of two M.S plates by metal arc welding. JOB: Joining of two M.S plates by metal arc welding.

EE 1125 Electrical & Electronics Engineering Laboratory (0–0–2–1)

- Expt. 1: Study of basic electrical safety equipment's such as Fuses, Earthings, MCBs, ELCBs and their operation.
- Expt. 2: Study of various Electrical lab tools and their applications.
- Expt. 3: Fault diagnosis and removal in general electrical connection /apparatus.
- Expt. 4: Selection and replacement of different passive components e.g. fuses, lamps and lamp holders, switches, cables, cable connectors etc.
- Expt. 5: Verification of Kirchoff's current law (KCL).
- Expt. 6: Verification of Kirchoff's voltage law (KVL).
- Expt. 7: Measurement of various characteristic values of a Sinusoidal waveform with the help of CRO.
- Expt. 8: Measurement of power and power factor in single phase AC circuits.
- Expt. 9: Measurement of losses in a single-phase transformer using OC and SC Tests.
- Expt. 10: Load test and voltage regulation measurement in a single-phase transformer.
- Expt. 11: Starting and reversing various AC and DC motors.
- Expt. 12: Speed control of DC shunt motor below and above base speed.
- Expt. 13: Measurement of output voltage of half wave diode rectifier and visualization of its waveforms.
- Expt. 14: Measurement of output voltage of full wave diode rectifier and visualization of its waveforms.

CY 1126 Engineering Chemistry Laboratory (0–0–2–1)

Expt. 1: Oxidation - Reduction Titrations: Estimation of percentage of iron using potassium dichromate by internal indicator method and Estimation of percentage of iron using potassium dichromate by external indicators



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Expt. 2: IODOMETRIC TITRATIONS: Iodometric titration of copper sulphate by hypo and Iodometric titration of potassium dichromate by hypo.

Expt. 3: Water Analysis: Determination of alkalinity of water sample by acid method, determination of total hardness in water using EDTA titrations and determination of pH of tap water sample (Demonstration)

Expt. 4: Lubricant Testing: Determination of viscosity and viscosity-index of lubricating oil by

- a. Red Wood Viscometer Number 1 and
- b. Red Wood Viscometer number 2

Expt. 5: Determination of Flash and Fire point of liquid fuel and lubricants by

- a. Cleaveland's Open Cup Method
- b. Abel's Flash Point Apparatus
- c. Pensky Martin's Flash Point Apparatus

HS 2101 Fundamental of Entrepreneurships (3–0–0–3)

Introduction of Entrepreneurship: The Entrepreneurial Perspective Introduction to entrepreneurship, need and importance of entrepreneurship, charms of becoming entrepreneur, evolution of entrepreneurship, characteristics of an entrepreneur, barriers of entrepreneurship, achievement motivation to become entrepreneur, creativity & innovation, decision making and other behavioural aspects of entrepreneurship. Business & Funding Opportunity: Opportunity Recognition and Planning to establish Micro and Small Enterprises, Opportunity identification process, opportunity evaluation process. Sources of finance, Debt financing. Venture capital sources, Lease finance, Banking policies & incentives available to entrepreneurs, Loans-types and benefits, Book keeping and accountancy, working capital management, various financial ratios, Costing, Break-Even-Analysis. Assessment of Market: Market research, market survey, Identification of relevant resources, Steps in establishing an enterprise /industry, procedure and formalities to establish a SSI or business enterprise. Benefits & Incentives: Incentives and benefits available to MSEs and new entrepreneurs, Information about various support agencies. Business Plan: Formulation of Business Plan Preparation of market survey report, techno economic feasibility assessment, preparation of preliminary and detailed business plan. Management of Micro & Small Enterprise: Marketing Management Marketing and sales management, demand forecasting, advertising, product mix, characteristics of a good sales person. Govt. support in marketing, Financial Management of small scale industries, Business Ethics.

ME CM 2101 Experimental Methods (3–0–0–3)

Experimental Analysis: Types of measurements and errors, Relative frequency distribution, Histogram, True value, Precision of measurement, Method of least squares, the curve fitting, General linear regression. Experimental Methods: Principles of Measurement, Basic Elements of a Measuring Device. Displacement measurement, Force and Torque Measurement, Temperature Measurement, Pressure Measurement, Fluid Velocity Measurement, Miscellaneous measurements, Dynamics of Measurements: Dynamic Response of a Measuring Instrument, Response to Transient and Periodic Signals, First and second order systems as well as their Dynamic Response Characteristics.

ME CM 2102 Mechanics of Solids (3–1–0–4)

Stress and Strain: Uniaxial Stress and Strain, Hooke's Law, Stress-Strain Curves, Elastic Constants, Strain Energy, Statically Indeterminate Problems, Thermal Effects, Impact Loading. Biaxial Stress and Strain: Stress at a Point, Stress Transformation, Analysis of Strain, Strain-Displacement Relations, Strain Transformation, Strain Measurements, Principal Stresses and Strain. Bending and Shear Stresses: Pure Bending, Normal Stress and Shear Stresses in beams, Composite Beams, Asymmetric Bending. Torsion of Shaft, Springs, and Pressure Vessels: Torsion of Circular Shaft, Power Transmitted by a Shaft, Compound Shaft, Combined Loadings, Thin-Walled Shells, and Springs (Open and Closed Coils). Deflections of Beams: Equation of Elastic Curve, Methods for Determining Deflections: Double Integration, Macaulay's Method, Moment-Area Method, Castigliano's



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Theorem. Columns and Theories of Failure: Euler's Theory for Long Columns, Rankine-Gordon Formula, Eccentrically Loaded Columns, Theories of failure.

ME CM 2103 Fluid Mechanics (3-0-0-3)

Introduction – scope and relevance; Fluid properties - continuum, density, viscosity, surface tension, velocity, pressure, temperature; Fluid Statics - Hydrostatics, Fluid forces on planes and curved surfaces, submerged and floating bodies, Buoyancy and stability, Atmosphere as a fluid, Fluid Concepts - Streamlines, streaklines, pathlines, viscous vs inviscid flows, laminar vs turbulent flows, compressible vs incompressible flows; Engineering Bernoulli equation; Control Volume analysis: Basic laws - Mass conservation law, thermodynamic laws, Newton's laws, Angular-Momentum principle; Buckingham Pi-theorem; Similitude and modeling - scaling effects, Flows in a pipes and channels - friction factor, flow measurement devices - Venturimeter, Orifice meter. Differential analysis to fluid flow: Conservation of Mass - Coordinate systems, Kinematics - Translation, Rotation, Deformation, Derivation of Governing equations of fluid flows - continuity, Euler equations, Potential flows - Bernoulli equation and applications to external aerodynamics, Navier-Stokes equations, non-dimensional analysis; Exact solutions of Navier-Stokes equations; Internal flows; External flows - Prandtl's Boundary layer theory - flow over a flat plate, concept of similarity; Approximate methods - von Karman Integral analysis; (Thwaites method); Flow separation; Brief introduction to turbulence - characteristics of turbulence, drag crisis.

ME CM 2104 Material Science and Engineering (3-0-0-3)

Engineering Materials, Materials Tetrahedron, Concepts of crystal structure, Bravais lattice, unit cell, planes and directions, linear and planar density, 0,1, 2 and 3 dimensional defects in materials, Importance of defects in determining mechanical properties, Hall-Petch equation and critically resolved shear stress, methods of determining various mechanical properties-Tensile test, Impact test, hardness test, fatigue test and creep test, types of fracture, Definition of phase, phase rule, Concept of solid solution, Unary and binary phase diagrams, concept of tie line, Lever rule derivation and application, Various invariant reactions, applications of various commercially used phase diagrams like Fe-Fe₃C diagram, Theory of nucleation and growth, TTT diagram and various heat treatment processes, various surface hardening processes, precipitation hardening, low alloy steels, stainless steels, aluminum, copper and titanium alloys, Crystal structure, mechanical properties and application of ceramics, Structure and mechanical properties of polymers, concept of crystallinity and glass transition temperature, application of polymers, Introduction to composites, types and fabrication methods of composites, factors determining the mechanical properties of composites. Smart materials and their applications.

ME CM 2105 Introduction to Sports Biomechanics (3-0-0-3)

Introduction of Fundamentals of Biomechanics: Definition of Biomechanics & Sports Biomechanics, Importance of Biomechanics for Sports technique, Goals of Sports Biomechanics – Performance Enhancement. Linear and Angular Kinematics, Linear Kinetics, Angular Kinetics of Human Movement, Basic Concepts: Forms of Motion.

ME CM 2106 Mechanics of Solids Lab (0-0-2-1)

- Expt. 1: Tensile test of Ductile Materials (Mild Steel)
- Expt. 2: Compressive Test of Ductile Materials
- Expt. 3: Brinell Hardness Tester
- Expt. 4: Izod and Charpy Test
- Expt. 5: Micro-Vickers Hardness Tester
- Expt. 6: Torsion of a circular shaft
- Expt. 7: Strain measurement using a strain gauge and data acquisition system
- Expt. 8: Deflection of the simply supported beam through strain gauge and data acquisition system
- Expt. 9: Column and Struts



CE XXXX Fluid Mechanics Lab (0–0–2–1)

- Expt. 1: Jet impact on flat and curved surfaces.
- Expt. 2: Measurement of drag on a circular cylinder in high Reynolds number flow.
- Expt. 3: Energy loss measurements in subcritical and supercritical open channel flow.
- Expt. 4: Measurement of fluid viscosity, and determination of friction factor as a function of Reynolds number in pipe flow.
- Expt. 5: Studying laminar-turbulent transition for flow in a tube.
- Expt. 6: Boundary layer flow over a flat plate.
- Expt. 7: Pressure distribution around a circular cylinder in high Reynolds number flow.

ME CM 2107 Material Science and Engineering Lab (0–0–2–1)

- Expt. 1: To Study different Crystal Structures and prepare their Ball Models.
- Expt. 2: To Prepare the sample of a given material for micro-structural examination.
- Expt. 3: Micro-structural examination of given specimen through metallurgical microscope
- Expt. 4: To measure the Grain size of Polycrystalline Material through Image Analyzer.
- Expt. 5: To measure the Volume fraction of a Phase in a Dual Phase Material through Image Analyzer
- Expt. 6: To measure the Particle size of Particle Reinforcement a given Material through Image Analyzer
- Expt. 7: To Draw Phase diagram for Pb-Sn alloy System through thermal analysis.
- Expt. 8: To Perform the Annealing and Normalizing Processes for a given Mild steel specimen and to observe their effect.
- Expt. 9: To Perform the Hardening and Tempering Processes for a given Mild steel specimen and to observe their effect.
- Expt. 10: To Determine the Hardenability of Steel through Jominy End quench Test.

ME 2201 Fundamentals of Design Methods (3–0–0–3)

Conventional design process: Introduction to design thinking, traditional problem solving versus design thinking, history of design thinking, wicked problems. Innovation and creativity, the role of innovation and creativity in organizations. Various attributes of discoverability in a human machine interface, Knowledge in head and knowledge in world, defining the problem statement. Research- identifying drivers, information gathering, target groups, samples, and feedbacks. Fundamental concepts of critical thinking, the difference between critical and ordinary thinking, characteristics of critical thinkers, critical thinking skill, structuring arguments, recognizing incongruences, five pillars of critical thinking, lateral thinking, argumentation versus rhetoric.

MC MD 2201 Probability & Statistics (3–1–0–4)

Probability and random variable: σ field; measurable space; construction of measure probability and properties; definitions, scope and examples of probability; sample spaces and events; axiomatic definition of probability; joint and conditional probabilities; independence, total probability; Bayes' rule and applications. Definition of random variables, continuous and discrete random variables; cumulative distribution function for discrete and continuous random variables; probability mass function; probability density functions and properties; expectation: mean, variance and moments of a random variables. Distribution Functions : Some special distributions: uniform, exponential, Chi-square, Gaussian, binomial, and poisson distributions; Law of large numbers; Central limit theorem and its significance. Statistics: Scatter diagram; graphical residual analysis, Q-Q plot to test for normality of residuals, autocorrelation and autocovariance functions; stationarity and non stationarity; correlation and covariance. Sampling distributions; point and interval estimation, testing of hypothesis, Goodness of fit and contingency tables, linear regression, ANOVA. Introduction to Stochastic process; white noise; random walk and Brownian motion.



ME CM 2201 Bio-materials and Mechanics (3–0–0–3)

Introduction and importance of biomaterials; Types of biomaterials: Metallic, ceramic, polymeric and composite biomaterials. Classification according to physiological response of biomaterials: bioinert, bioactive and bioresorbable biomaterials; Surface modifications; Surface analysis; Surface-protein interactions; Material-cell interactions: biocompatibility and rejection; Implants and infection; Applications of biomaterials in Tissue engineering, Drug delivery, Biosensing and Diagnostics. Mechanics of Human Motion; Mechanics of response of tissues including bones; Mechanics of Blood flow, Bio solid-fluid interaction.

ME CM 2202 Engineering Thermodynamics and Heat Transfer (3–1–0–4)

Basic concepts and definitions, thermodynamic properties of a pure substance. Work and heat – definition and applications. 1st Law – internal energy and enthalpy, applications to non-flow/closed and flow/open systems (SSSF and USUF). 2nd Law – corollaries, Clausius inequality, entropy. Carnot cycle. Basics of gas-vapor mixtures. Vapor power cycles – Rankine cycle and its modifications. Steam generation and its use – power plants, co-generation, combined cycles. Modes of heat transfer: conduction, convection, radiation; Basic conservation equations; Conduction: Fourier's law, heat diffusion equation, 1-D steady state conduction in extended surfaces, heat generation, lumped capacitance and 1D transient models, semi-infinite wall. Heat transfer coefficients in natural and forced convection; Convection: Forced and free convection - mass, momentum and energy conservation equations, scaling analysis and significance of non-dimensional numbers, thermal boundary layers, heat transfer in external and internal laminar and turbulent flows and use of correlations. Heat exchanger types and analysis: LMTD and effectiveness-NTU method. Introduction to radiative heat transfer; Radiation: properties, Laws, view factor, 3-surface network for diffuse - gray surfaces. Gas radiation

ME CM 2203 Machine Learning in Mechanics (3–0–0–3)

Machine Learning: Overview of Machine learning concepts – Over fitting and train/test splits, Types of Machine learning – Supervised, Unsupervised, Reinforced learning, Introduction to Bayes Theorem, Linear Regression- model assumptions, regularization (lasso, ridge, elastic net), Classification and Regression algorithms- Naïve Bayes, K-Nearest Neighbors, logistic regression, support vector machines (SVM), decision trees, and random forest, Classification Errors, Analysis of Time. Series- Linear Systems Analysis, Nonlinear Dynamics, Rule Induction, Neural Networks Learning and Generalization. Applications of Machine Learning in Mechanics: Case Studies include Identifying faulty/healthy wind turbines, Turbulent Flow Analysis, Leakage Detection in Hydraulic Circuits, Fault Detection in Motor-Bearings, Human Activity Recognition, Heart Sound Classification etc.

CS XXXX Fundamental of Artificial Intelligence (3–0–0–3)

Introduction: Scope; History, Trends and Future Directions. Problem Solving by Search: Production Systems and AI; Graph-Search Strategies: Uninformed Search, Heuristic Search Techniques; Constraint Satisfaction Problems; Stochastic Search Methods; Searching Game Trees: Minimax, Alpha-Beta Pruning. Knowledge Representation and Reasoning: Predicate Calculus in AI: Syntax and Semantics, Expressivity, Unification, Resolution; Resolution Refutation Systems; Situation Calculus. Reasoning under uncertainty: Notion of Uncertainty; Uncertain Knowledge and Reasoning, Probabilities; Bayesian Networks. Planning: Planning with State Space Search; Planning Graphs; Partial Order Planning. Decision Making: Sequential Decision Problems, Algorithms for optimal Policies. Machine Learning: Learning from Observations: Overview of different forms of Learning, Learning Decision Trees, Computational Learning Theory, Statistical Learning Methods, Neural Networks and Connectionist Learning.



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ME CM 2204 Biomechanics Lab (0-0-2-1)

Computer Lab contents: Matlab Programming basics, Image processing basics, Design of Joint: Rigid Body Mechanics based approach, Matlab programming for bone or Aortic Tissue; Matlab programming for blood flow analysis.

Expt. 1: Determine ground reaction forces and moments and locate the center of pressure over time for a normal gait cycle

Gait analysis is the study of locomotion including walking and running. In order to function in the environment, we must be able to move from one point to the other in a certain amount of time; thus, walking speed is often a marker of functional independence. In this lab, you will perform a kinematic gait analysis. Within this analysis, you will quantify variables that help define the efficiency and functionality of a gait pattern.

Equipment:

1. Stop watch (you can use the one on your phone)
2. Measuring tape
3. Tape to mark the beginning and the end of the trajectory
4. Athletic tape, brace or small stone
5. Calculator
6. Excel Software
7. Textbook/Internet to perform research
8. Tablet or Phone with video analysis App (Coach's Eye or HUDL Technique)

Equipment

- a). Stopwatch (you can use the one on your phone)
- b). Measuring tape
- c). Tape to mark the beginning and the end of the trajectory
- d). Athletic tape, brace, or small stone
- e). Calculator
- f). Excel Software
- g). Tablet or Phone with video analysis App (Open-source software app available)

Expt. 2: To investigate the characteristics of electromyography (EMG) signals as they relate to muscle function
Biaxial materials testing machine for Testing the biomechanical properties of a wide range of physiological systems such as tendons and ligaments, joint systems, and large and small bones (Many Experiments can be done through this machine).

Biaxial materials testing machine - a computer controlled, servo hydraulic system capable of measuring axial forces up to 10,000 N and torsional forces up to 100 Nm with its largest load cell. The system also has 2500 N and 250 N load cells, linear extensometers, an environmental chamber, custom-made freeze clamps, and dual-gimbal clamps.

ME CM 2205 Thermodynamics and Heat Transfer Lab (0-0-2-1)

Expt. 1: Internal engine port diagram and engine valve timing Diagram and its performance test on single and double cylinder 4 stroke diesel and petrol engines.

Expt 2: Evaluation of engine friction by conducting motoring/retardation test on single cylinder 4 stroke diesel engine

Expt. 3: Heat balance test on single cylinder 4 stroke diesel engine.

Expt. 4: Determination of air/fuel ratio and volumetric efficiency on 4- stroke diesel engine.

Expt. 5: Thermal analysis and heat balance on electric vehicle battery.



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ME CM 2206 Machine Learning Lab (0–0–2–1)

Expt. 1: To explain the structure of PROLOG, Describe the logic programming of PROLOG.

Expt. 2: To acquire the knowledge about the objects and its working principles in PROLOG and the applications and problems of Artificial Intelligence programs using PROLOG.

Expt. 4: To solve the conventional engineering mechanics related problem using AI and ML.

Expt. 5: To solve the real life engineering mechanics related problem using AI and ML.

ME 3101 Engineering Management (3–0–0–3)

Principles/Functions of Management, Measure of Productivity and ways to enhance Productivity. Management challenges for Engineers. Operations Management and its scope, Production Systems, Facility Location, Facility Planning & Plant Layouts. Industrial Design, Product Design, Product / Project Life Cycle, Quality Control and Quality Management, Forecasting Methods, Introduction to Supply Chain Management. Material Management – Purchasing, Inventory & JIT Systems, Material Resource Planning, Scheduling, Project Management, PERT and CPM, Project Crashing. Introduction to Financial Management, Financial Statements and Analysis, Operations Decision making - Break Even Analysis & Decision Trees. Fundamentals of Marketing Management, Organizational Behavior and Leadership, Strategic Management, Statutory and Legal Issues.

ME CM 3101 Finite Element Methods in Engineering (3–0–0–3)

Introduction: Historical background, basic concept of the finite element method, comparison with finite difference method; Variational methods: calculus of variation, the Rayleigh-Ritz and Galerkin methods; Finite element analysis of 1-D problems: formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its postprocessing. Applications in heat transfer, fluid mechanics and solid mechanics. Bending of beams, analysis of truss and frame. Finite element analysis of 2-D problems: finite element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics; Numerical considerations: numerical integration, error analysis, mesh refinement. Discussion about preprocessors, postprocessors and finite element packages.

ME CM 3102 Viscous Flow Theory (3–0–0–3)

Introduction: stress-deformation relation, vector and tensor, vorticity and circulation, derivation of Navier-Stokes equations; Exact solutions: Couette flow, Hagen-Poiseuille flow, Stokes problems; Complex variable and Potential flow, Two-dimensional boundary layer: Blasius solution, Kármán-Pohlhausen method, effect of pressure gradient, separation and control, Waltz's-Quadrature formula; Flow instability: concept of small-perturbations, linearized stability of parallel viscous flows, Orr-Sommerfeld equation; Turbulent boundary layers: Reynolds stress tensor, energy cascade, mixing length hypothesis, universal law of wall, fully developed turbulent flow through a pipe and channel, power law and effect of wall roughness; Compressible flow: condition of compressibility, subsonic, supersonic and hypersonic flows, shock and Mach waves, shock-boundary layer interactions; Special topics: Transition and turbulence, fluid-solid interaction, free-surface flow, bio-fluids, non-Newtonian flows, CFD and Measurements.

EC XXXX Digital Signal Processing (3–0–0–3)

Concept of frequency in continuous time and discrete time signals –Sampling theorem – Discrete time signals. Discrete time systems –Analysis of Linear time invariant systems –Z transform –Convolution and correlation. Efficient computation of DFT Properties of DFT – FFT algorithms – Radix-2 and Radix-4 FFT algorithms – Decimation in Time – Decimation in Frequency algorithms – Use of FFT algorithms in Linear Filtering and correlation. System Design of Discrete time IIR filter from continuous time filter – IIR filter design by Impulse Invariance. Bilinear transformation – Approximation derivatives – Design of IIR filter in the Frequency domain. Linear phase filter – Windowing techniques – rectangular, triangular, Blackman and Kaiser windows –



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Frequency sampling techniques – Structure for FIR systems. Quantization, round off errors and overflow errors. Multi rate digital signal processing: Concepts, design of practical sampling rate converters, Decimators, interpolators. Polyphasedecompositions. Application of DSP – Model of Speech Wave Form – Vocoder.

ME CM 3103 Computer Aided Design (3–0–0–3)

Introduction and components of Computer aided design (CAD)/Computer aided manufacturing (CAM)/Computer aided engineering (CAE) systems. Basic concepts of graphics programming, Different transformations of points, lines and solid bodies and Projections. Design of curves: Algebraic and Geometric forms, Parametric space of a curve, Blending functions, Reparameterizations, Truncating, Extending and subdividing, Space curve, Straight Lines, Spline, Hermite, Bezier and B-spline Curves. Introduction to NURBS Design of Surfaces: Algebraic and Geometric Form, Tangent and Twist Vectors, Normal, Parametric space of a surface, Blending Functions, Reparameterization of a surface patch, Subdividing, Sixteen Point form, Plane surface, Cylindrical Surface, Ruled Surface, Surface of Revolution, Bezier Surface, B-spline Surface, Rendering, Graphical user interface. Computer aided drafting systems, Geometric modelling systems – wireframe, surface and solid modelling systems. Introduction to Assembly-modelling. Extensive laboratory work on CAD (Solid modeling software).

ME CM 3104 Computer Aided Design Lab (0–0–2–1)

Expt.1: Introduction to Solid Modelling & Pro/E Package and MATLAB Programming.
Expt. 2: Working with advanced modeling tools (Sweep, Blend & Swept Blend), Assembly modelling in Pro/E, Generating, editing and modifying drawings in Pro/E.
Expt. 3: Creating an assembly, moving components, wire frame and surface geometry, Generating of ferguson's cubic surface patches, Bezier surface patches and coons patches.
Expt. 4: Exercises on Analytic Curves (Lines, Circles, Ellipses, Parabolas, Hyperbolas, Conics) using MATLAB Programming.
Expt 5: Exercises on Synthetic Curves (Cubic Spines, Bezier Cures, B-Spine Curves) using MATLAB Programming.
Expt. 6: Working with CAD Data Exchange formats: IGES, ACIS, DXF and STL.

EC XXXX Digital Signal Processing Lab (0–0–2–1)

Fundamentals: Familiarization to Code Composer Studio; development cycle on TMS320C64xx kit; Generation of signals, Fourier representation and z-transform, sampling theorem in time and frequency domains, convolution and correlation, DFT and FFT; FIR and IIR filters; sampling rate converters. Applications: Adaptive filter and experiments on communication such as generation of a n-tuple PN sequence, generation of a white noise sequence using the PN sequence, restoration of a sinusoidal signal embedded in white noise by Wiener Filtering; speech and multi-media applications.

ME CM 3105 Engineering Computing Laboratory (0–0–2–1)

Introduction to ANSYS modules including general steps for solving a problem. Simple mesh generation for one-dimensional or two-dimensional domain; Using appropriate commercial package: A simple 2-D heat conduction problem. Heat convection in a heated cavity. A problem from bluff body flows/shear flows; Using appropriate commercial package: One dimensional problem: A cantilevered beam/simply supported beam with distributed load/concentrated load. An I-beam under distributed/concentrated load. A two dimensional problem: plate under tensile loading. Truss, closed cylinder under pressure.



CS 3201 Data Structures and Algorithm (3–1–0–4)

Introduction to data structures, Algorithm Evaluation, Arrays, Multi-dimensional Arrays, Sparse Matrices, Structure, Pointers. Stacks: representation of stacks and basic operations, application of stacks, prefix, postfix and infix notations and conversion, Recursion, towers of Hanoi. Queues: Types of queues and its application, Linked lists: types of linked list, implementation of stack and queue using linked list. Polynomial representation and arithmetic, Trees: binary tree, ternary tree, tree traversal AVL Trees, Binary search trees. Graphs: representation, traversing, Searching: sequential search, binary search and hashing Sorting: External and Internal Sort, Selection, Sort, bubble sort, insertion sort, radix sort, and bucket sort.

ME CM 3201 Robotics (3–0–0–3)

Introduction to Robotics, Automation, History, Laws, Classifications by coordinate system, Robot components, Concept of work space, Basic robot motions - Point to point control - Continuous path control. Coordinate frames, Mappings: Changing descriptions from frame to frame, Translations, Rotations and Transformations, Kinematic Modelling of the manipulator, D-H Representation, Forward Kinematics and Inverse Kinematics. Classification of end effectors, Tools as end effectors, Mechanical, Adhesive, Vacuum, Magnetic grippers. Gripper design. Active and passive grippers. Introduction to actuators, classification, Pneumatic, Hydraulic and Electrical actuators, Applications. Introduction to sensors. Classification, Types of sensors: Position sensors, Potentiometers, Force sensors, Encoders, etc., Applications. Robot applications in Machining – Welding – Assembly – Material handling – Loading and unloading – spray painting.

ME CM 3202 Theory of Vibrations (3–0–0–3)

Vibration of single degree of freedom (sdf) systems- Free vibration, Forced vibration. Types of damping – viscous, Coulomb, structural and material damping models- Equivalent viscous damping. Response of sdf system to arbitrary excitation (Transient Vibration)- Convolution integral – method of Fourier transforms. Vibration of two degree of freedom systems-Undamped free vibration of the two dof systems -matrix eigenvalue problem – natural frequencies and natural modes – elastic and inertial coupling. Vibration of multi dof systems- Equations of motion – formulation and solution of matrix eigenvalue problem – computational methods for the solution of matrix eigenvalue problem – decoupling of equations of motion by modal analysis.

ME CM 3203 Computational Fluid Dynamics (3–0–0–3)

Basic equations of Fluid Dynamics: General form of a conservation law, Equation of mass conservation, Conservation law of momentum, Conservation equation of energy. The dynamic levels of approximation. Mathematical nature of PDEs and flow equations. Basic Discretization techniques: Finite Difference Method (FDM). Analysis and Application of Numerical Schemes: Consistency, Stability, Convergence, Fourier or von Neumann stability analysis, Modified equation, Application of FDM to wave, Heat, Laplace and Burgers equations. Integration methods for systems of ODEs: Linear multi-step methods, Predictor-corrector schemes, ADI methods, The Runge-Kutta schemes. Vorticity-stream function formulation. Solution of Navier-Stokes equations using MAC algorithm. The Finite Volume Method (FVM) and conservative discretization.

ME CM 3204 Robotics Lab (0–0–2–1)

Expt. 1: Verify the Position & Orientation of the end effector of the 3-DOF (RPR) manipulator using Robo-Analyzer.

Expt. 2: Obtain the joint angles of 3-DOF (RRR) manipulator by using Robo-Analyzer.

Expt. 3: Development of Trajectory for 2-DOF manipulator using Robo-Analyzer software.

Expt. 4: Write a program for 3-wheeled mobile robot to move forward, stop, turn left and turn right using Arduino.

Expt. 5: Control of an autonomous line following robot using IR sensors.

Expt. 6: Control of an autonomous obstacle avoidance robot using ultrasonic sensor.



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- Expt. 7: Write the program using Arduino for Human Following Robot.
Expt. 8: Development of control algorithm for 4-DOF robotic Manipulator.
Expt. 9: Calculate the gait angles and dynamic balance margin of the 16-DOF humanoid robot.

ME CM 3205 Vibration Lab (0-0-2-1)

- Expt. 1: To find the speed at which jump phenomenon occurs in the Cam Follower System.
Expt. 2: Verification of Gyroscopic couple formula.
Expt. 3: To obtain the Static and Dynamic Balancing on the experimental apparatus.
Expt. 4: To determine the whirling speed of shaft.
Expt. 5: Measure the logarithmic decrement of a one degree of freedom mass spring damper system for various damping medium, air, water and oil.
Expt. 6: Investigate the forced harmonic response of a single degree of freedom under damped system to changing mass spring stiffness and damping.
Expt. 7: Measure the logarithmic decrement of a one degree of freedom mass spring damper system for various damping medium, air, water and oil.
Expt. 8: Study of Four bar mechanism with different Inversions.
Expt. 9: To study the governors and to obtain controlling force curve of Watt, Porter, Proell and spring controlled governors.
Expt. 10: Study of different Clutches.
Expt. 11: Study of Brakes and Dynamometers

ME CM 3206 Computational Fluid Dynamics Lab (0-0-2-1)

- Expt. 1: To get acquainted with explicit scheme of finite difference method for solution of parabolic partial differential equation with special reference to one dimensional heat conduction equation.
Expt. 2: To be familiar with implicit scheme of finite difference method for solution of parabolic partial differential equation with special reference to one dimensional heat conduction equation.
Expt. 3: To be conversant with semi-implicit scheme of finite difference method for solution of parabolic partial differential equation with special reference to one dimensional heat conduction equation.
Expt. 4: To appreciate the importance of second order elliptic partial differential equations viz. Laplace and Poisson equations and its solution by finite difference method.
Expt. 5: To solve hyperbolic PDEs such as wave equation by finite difference method.
Expt. 6: To understand the application of the finite volume method (FVM) to solve simple diffusion problems involving conductive heat transfer.
Expt. 7: To be familiar with finite volume method for the Laplace equation on two-dimensional grids.
Expt. 8: To understand finite volume method for the wave equation in two dimensions. and write a C or C++ program to implement it.
Expt. 9: To be conversant with the SIMPLE algorithm for calculating pressure and velocities.



HS 4101 Engineering Economics and IPR (3–0–0–3)

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis – V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning. Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods. Make or buy decision, Value engineering – Function, aims, and Value engineering procedure.

ME CM 4101 Experimental Methods in Fluids and solids (3–0–0–3)

Review of errors in measurements and other statistical concepts related to errors and their combinations, and probability distributions. Advanced techniques in fluid flow: Hot wire Anemometry, Laser Doppler Velocimetry and particle sizing, particle Image Velocimetry, Volumetric methods: Tomo PIV and background oriented Schlieren, Derived Quantities from PIV: Vorticity, strain rate and pressure. Applications related to Strain gauges, Clip gauges, Piezoelectric sensors, and Ultrasonic sensors. Coherent gradient sensing (CGS). 2D Digital image correlation (DIC) for full field measurements. Moire fringe methods. Particle image velocimetry (PIV). Hardness testing of the common engineering materials. Characterization of solids under compression, tension and shear. Fatigue and Creep testing. Drop tower. Modal analysis and structural vibrations. Sound absorption characterization of the material.

ME CM 4102 Mechanics of Advanced Materials (3–0–0–3)

Composites, Various reinforcements and matrix materials, Interfaces, polymer matrix, ceramic matrix, micromechanics and macromechanics of composites, Piezoelectric Actuators and Sensors, Piezoelectricity, Piezoceramics and their characteristics, Electromechanical Constitutive Equations, Hysteresis and nonlinearities in piezoelectric materials, Basic sensing mechanism, sensor calibration, Shape memory alloys (SMA) behaviour, Phase transformation, Origin of one way and two way shape memory effect, Constrained behaviour of SMA, Various constitutive models, Testing of SMA Wires, Comparison of Constitutive Models with Experiments, Damping Capacity of SMA, Power Requirements for SMA Activation, Composite Structures with Embedded SMA Wires, Magnetostriction, Review of Basic Concepts in Magnetism, Mechanism of Magnetostriction, Constitutive Relations, Magnetostrictive Actuators, Magnetostrictive Sensors, Magnetic Shape Memory Alloys, Electrostrictives and their constitutive relations, Electrorheological (ER) and Magnetorheological (MR) Fluids, Fundamental composition and behaviour, Modelling of ER/MR fluid behaviour, ER/MR fluid dampers, Case studies of various applications of active and smart materials in integrated systems.

ME CM 4103 Experimental Methods in Fluids and Solids Lab (0–0–2–1)

Expt. 1: Application of strain gauge techniques: Lecture on strain gauge based methods, Cantilever beam and Portal frame experiments.

Expt. 2: Application of Strain Gauge techniques: experiment on combined bending and torsion.

Expt. 3: Applications of photoelasticity: demonstration of photoelastic techniques.

Expt. 4: Applications of photoelasticity: Calibration of the photoelastic constant, Determination of the stress field in a beam under bending.

Expt. 5: Determination of friction factor as a function of Reynolds number in pipe flow.

Expt. 6: Studying laminar-turbulent transition for flow in a tube.

Expt. 7: Boundary layer flow over a flat plate.

Expt. 8: Pressure distribution around a circular cylinder in high Reynolds number flow.



Elective Courses

ME CM 3151 Fracture Mechanics

Griffith's theory of brittle failures; Irwin's stress intensity factors; Linear elastic fracture mechanics: The stress analysis of crack tips, Macroscopic theories in crack extension, Instability and R-curves, Crack tip plasticity, K as a failure criterion, Mixed mode of fracture, Analytical and Experimental methods of determining K; Elastic plastic fracture mechanics: Crack tip opening displacement, J Integrals, Crack growth resistance curves, Crack tip constraint under large scale yielding, creep crack growth; Microscopic theories of fracture: Ductile and cleavage fracture, ductile-brittle transition, inter-granular fracture; Fatigue crack propagation: Fatigue crack growth theories, crack closure, Microscopic theories of fatigue crack growth; Application of theories of fracture mechanics in design and materials development

ME CM 3152 Advanced Mechanics of Solids

Mathematical Preliminaries: Introduction to tensor algebra: symmetric and skew-symmetric tensor, summation convention, eigenvalue and eigenvector of tensor, spectral theorem, polar decomposition theorem, product of tensor, principal invariants of tensor, coordinate transformation of tensor, Tensor calculus: gradient, divergence, curl, differentiation of scalar function of a tensor. Analysis of Stress and Strain: Definition and notation of stress, Cauchy stress tensor, equations of equilibrium, principal stresses and stress invariants, stress deviator tensor, octahedral stress components, General deformations, small deformation theory, strain transformation, principal strains, spherical and deviatoric strains, Strain-displacement relations, strain compatibility, Generalized Hooke's law, Strain-energy, stress and strain in curvilinear, cylindrical, and spherical coordinates, fundamental equations of plasticity. Problem formulation and solution strategies: Field equations, boundary conditions, stress and displacement formulation, Beltrami-Michell compatibility equations, Lamé-Navier's equations, principle of superposition, uniqueness theorem, Saint-Venant's principle, Brief descriptions about general solution strategies - direct, inverse, semi-inverse, analytical, approximate, and numerical methods. Two-dimensional problems: Plane stress and plane strain problems, generalized plane stress, Antiplane strain, Airy stress function, polar coordinate formulation and solutions, Cartesian coordinate solutions using polynomials and Fourier series method.

ME CM 3153 Mechanical Behaviour of Materials

State of stress, Stress transformation in 2D and 3D, stress tensor, strain, stress and strain deviator, strain energy, Origins of Elasticity, Elastic constants in isotropic and anisotropic materials. Plastic deformation, Stress-strain curves, Failure criterion and yield locus, Octahedral shear stress and strain, plastic stress-strain relations, viscoelastic and viscoplastic deformation. Perfect crystal structures, Imperfections in crystalline solids, Dislocation theory, microscopic basis of plastic deformation in crystalline and non-crystalline materials, strengthening via microstructure and physical size. Fracture of materials, introduction to fracture mechanics, linear elastic fracture mechanics, Fracture toughness, the physics of fracture and toughening mechanisms. Creep and fatigue failure. Tension test, Hardness test, Impact test, fatigue test, creep and stress rupture test, plain strain toughness testing.

ME CM 3154 Marine Dynamics

Free and forced vibration of single degree of freedom systems and small multi-DOF systems. Formulation of the equation of motion for simple systems. Eigenvalue and eigenvector calculations for MDOF systems. Vibration isolation. Rigid body motion - resilient mounting and floating body in waves, including coupled motions. Eigenfrequency-calculation of beams, wires, and rods using the differential equation energy method. Modelling of continuous systems using generalized co-ordinates. Calculation of forced response in time and frequency domain, modal superposition. Numerical time-domain integration methods. Irregular waves and wave spectra,



short-term and long-term statistics of waves. Stochastic analysis of structural responses, including fatigue calculation and extreme response estimation.

ME CM 3155 Basics of Product Design

Introduction: Types of consumer products, Design space, User's perspective to products, Designer's perspective to products, New product development processes and methods. Approaches to Product Design: Design thinking, Material-driven design, Prototype-driven design, Brand-driven design, Industry approaches to Product Design. Innovation by Design: Modes of innovation by design, Methods of exploring problem structure, Methods to understand design intent, Methods to understand design context, Methods to understand users, Methods to frame insights, Methods to generate creative concepts, Methods to frame solutions, Methods to realize offerings, Introduction to different design toolkits.

ME CM 3156 Fundamental of Robotics

Definition and classification of Robots and manipulators, motion and degrees of freedom, motion categories, uses, field of applications, Robot Arm Kinematics: Direct and Inverse, Robot arm dynamics, Manipulator trajectories, control of robot manipulators. Introduction to sensing and vision in robotics.

ME CM 3157 Theory of Elasticity

Surface and body forces, stress tensor and transformation laws, Lagrangian and Eulerian description, strain tensor, equations of elasticity (equilibrium, constitutive law and compatibility, boundary conditions), Uniqueness and St. Venant's principle, Strain energy functions. Two-dimensional problems in rectangular coordinates (polynomial solution, bending of beam, Fourier series solution). Two-dimensional problems in polar coordinates (axisymmetric problems – rotating discs, walled cylinders, plate with a hole, infinite plate with point load, curved beams). Two-dimensional problems in curvilinear coordinates (stress functions in terms of harmonic and complex functions, complex potential function, elliptic coordinates, plate with elliptic holes). Three-dimensional problems (extension of bar under its body weight, pure bending of bars and plates, twist of circular shafts). Torsion (circular and non-circular cross section, membrane analogy, thin walled members, hydrodynamic analogy). Bending of bars with circular, elliptic and rectangular cross section and shear center.

ME CM 3158 Numerical Methods and Computations

Errors in computation: source and types of errors, error propagation. Computer representation of numbers: floating point representation, rounding error and floating point arithmetic. Roots of nonlinear equation in one variable: Direct and iterative methods, order of convergence. Iterative methods for roots of nonlinear system of equations. Linear systems of equations: Direct and iterative methods, rate of convergence of iterative methods, Condition number and ill-conditioned systems. Interpolation: Lagrange, Newton divided difference formula, Newton's interpolations, and errors in interpolation. Approximation: least square and uniform approximations. Differentiation: differentiation using interpolation formulas. Integration using interpolation: Newton-Cotes formulas, Gauss quadrature rules. Ordinary differential equations: Taylor, Euler and Runge-Kutta methods. Implementation of these methods.

ME CM 3159 Smart Material and Structures

Introduction to Smart Material Systems, Overview of smart materials and their applications, Modelling mechanical, thermal and electrical systems (thermo mechanics and electrostatics). Piezoelectric materials: Electromechanical constitutive equations, piezoelectric actuators and sensors, nonlinearities in piezoelectric materials, Shape memory alloys (SMA): Phase transformations, Constrained behaviour, constitutive modelling, Damping capacity, power requirements for activation, Composite structures with SMA wires, Beam and plate modelling with induced strain actuation, Brief overview of electro-strictive and Magneto-strictive materials, Mechanism of magnetostriction and electrostriction, constitutive relations, Magneto-strictive actuators and



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sensors, Electro and Magneto Rheological Fluids, Fundamental composition and behaviour, Modelling of ER/MR, ER/MR Dampers and modelling.

ME CM 3251 Smart Materials: Modelling and Applications

Introduction to Smart Material Systems; Overview of smart materials, Modeling mechanical, thermal and electrical systems (thermo mechanics and electrostatics); Piezoelectric materials: constitutive modelling, piezoelectric beam static and vibration analysis Shape memory alloys (SMA): constitutive modelling, actuation models for SMA, electrical actuation Brief overview of Electroactive Polymers, Magnetostrictive materials, Electro and Magneto Rheological Fluids Mechanics of smart composite structures Transducer applications: Vibration control and damping using piezoelectric materials. Case study: Sensing and control of Smart beams and plates.

ME CM 3252 Optimization Methods in Engineering

Introduction to optimization; Formulation of optimization problems; Classical optimization techniques; single and multi variable unconstrained optimization, constrained optimization; Linear Programming; Non-linear Programming Specialised algorithms for integer programming and geometric programming; Non-traditional optimization algorithms.

ME CM 3253 Bio-Modelling & Simulation

Introduction to Modeling: Process Design – Process Synthesis, Process Analysis, Optimization, Strategy for Process Engineering, Process Plant Simulation; Modeling Aspects – Physical Modeling, Mathematical Modeling, Model Formulation Principles, Fundamental Laws used in Modeling, Cybernetics, Controlled System and Principles of Similarity. The Kinetics of Enzyme-catalyzed Reactions: Michaelis–Menton Kinetics, Evaluation of Parameters in the Michaelis–Menton Equation: Kinetics of Substrate Utilization, Product Formation and Biomass Production in cell cultures – Ideal Batch Reactor, Ideal Continuous-Flow Stirred– Tank Reactor (CSTR), Monod Growth Kinetics, Monod Chemostat Model, and Product yield coefficient and Growth-Cycle Phases for Batch Cultivation. Design and Analysis of Biological Reactors: Ideal Bioreactors – Fed Batch Reactors, Enzyme- Catalyzed Reactions in CSTRs, CSTR Cell Reactors with Recycle and Wall growth, The Ideal Plug-flow Tubular Reactor, Dynamic Models.

CE XXXX Structural Analysis

Basics of structural analysis: static & dynamic loading, linear & nonlinear structural behaviour, geometric & material nonlinearity, hysteretic behaviour; Classical linear analysis of frames and trusses: displacement method, slope deflection equations & matrix displacement method, effect of foundation settlement and temperature; Geometric nonlinear analysis of frames and trusses: displacement method, nonlinear slope-deflection equations & nonlinear behaviour, linearized iterative matrix displacement method, geometric stiffness matrix, tangent stiffness matrix, P- D effect, buckling of frames, tension structures; Material nonlinear analysis of frames: basics of plasticity, distributed plasticity & lumped plasticity, incremental nonlinear analysis.

CE XXXX Reinforced Cement Concrete Structures

Introduction to the design of Concrete structures: Structural Systems, Materials, Loadings and Structural Analysis, Working Stress Design, Ultimate Load Design, Limit State Design; Working Stress Design: Beams for Bending Moment and Shear Force; Limit State Design: Beams for Bending Moment, Shear Force, Bond and Torsion. Axially and eccentrically loaded Columns. Beam-Columns for combined compression and flexure. One and two-way Slabs, Structural Components: Isolated and Combined Footings; Lintels, Stair Cases, Retaining Walls.



CS XXXX Human Computer Interface

HCI foundation and history; Usability life cycle and methods; Design rules and guidelines; Empirical research methods; Models in HCI- GOMS, Fitts' law and Hick-Hyman's law; Task analysis; Dialogue design; Cognitive architecture and HCI ; Graphic User Interfaces & aesthetics; Usability Testing; UML,OOP,OOM; Design Case Studies

ME CM 4151 Aircraft Structures

Introduction to elasticity and aerospace structures Loads on aerospace structures, Beams, Truss and Frame Torsion of noncircular prismatic bars. Curved beams. Stability of structures. Theory of Thin-walled beams, Open and closed cross-section, Torsion and bending of thin-walled beams. Normal stresses and shear flows, shear Centre, bending and torsional stability. Energy and variational based numerical methods.

ME CM 4152 Aeroelasticity

Introduction to aeroelasticity and aeroelastic phenomena, Static and dynamic aeroelastic phenomena using simplified aerodynamic and structural models, 1-Daeroelastic model of airfoil, Divergence of 2-D airfoil and straight wing, Wing loading and deformations, Flutter model of 2-D airfoil, Unsteady aerodynamics, 2-D and 3-D supersonic flow, Subsonic flow, Theodorsen theory, Flutter calculation, Exact treatment of bending – torsion, Flutter of uniform wing, Flutter analysis by assumed mode method, Panel flutter, Numerical aeroelastic calculations using software.

ME CM 4153 Introduction to Digital Twins

Introduction to Digital Twins and establishing the need for Computational Tools in modern engineering. First Principles Modelling using numerical solutions of ODEs and PDEs, Simulation of Dynamic systems in the Time-domain using Block-domain methods & Physical Modelling using Lagrangian Methods. Data-driven Modelling: Data Handling, Filtering and pre-processing, Visualization and Classification, Fitting classification models to data. Case Study or Project.

ME CM 4154 Multi-Scale Modelling and Computation (3–0–0–3)

Micromechanics Fundamentals: Introduction to multiscale modelling, Boundary value problems for small-strain linear elasticity, Integral representation of elasticity solutions, Eigenstrains, Inclusions and inhomogeneities. Analytical Multiscaling Methods: Mean Field Approaches: Heterogeneities and length scale, Representative Volume Element (RVE), Hill's lemma, Bounds for effective moduli, Determination of effective moduli, Eshelby method, Mori Tanaka method, Self-consistent method, Effective properties of fiber-reinforced composite laminates. Semi-analytical Multiscaling Methods:Transformation Field Analysis (TFA): Mechanical influence functions and concentration factors, Overall stiffness and compliance of multiphase systems, Phase transformations, Transformation influence functions and concentration factors, Capabilities of bounds and estimates of overall and local fields.

ME CM 4155 Introduction to Soft Robotics

Soft robots vs Rigid robots, manufacturing techniques of multifunctional soft robot devices: Modeling soft mechanics (numerical, computational, analytical), Introduction to morphological simulation: Soft actuators (Dielectric, pneumatic, fluidics):Soft sensors (Fluidic, solid, composites, textiles):Soft logic (controllers, semiconducting polymer, thin film silicon):Soft energy (thermodynamics, soft batteries, soft combustion) Applications (wearable robotics, space robotics, deep-sea robotics).



ME CM 4156 Theory of Plasticity

Mathematical preliminaries; stress and strain; constitutive responses; physics of plasticity; application of plasticity theory for different materials; Formulation of rate-independent plasticity; maximum dissipation postulate; yield criteria; flow rules and hardening rules; uniqueness theorems; extremum principles in plasticity; limit analysis; shakedown theorems; plane problems in plasticity; slip line theory and its applications; plastic stability; plastic buckling; global and local criteria of plastic stability; strain localization and shear bands; dynamic plasticity; waves; special topics from current research.

ME CM 4157 Introduction to Microfluidics

The fundamentals of fluid flows at micro-scale including intermolecular forces, low Re flows, slip theory, capillary flows and electrokinetics are discussed. The principles of microfabrication with silicon and polymer substrates are illustrated. Theory and design of various microfluidic components including micropumps, micromixers, microvalves etc. are discussed. Few applications of microfluidic systems are also covered.

ME CM 4158 Computational Material Science

Basics of computational materials science: Atomistic theory of matter, Statistical mechanics of materials (equilibrium and non-equilibrium systems and ensembles, Stochastic processes and stochastic modeling), Coarse graining methods, Continuum models of materials and microstructures. Multiscale Simulation Methods: Molecular Dynamics, equilibrium and kinetic Monte Carlo simulation, mesoscopic methods such as Dislocation Dynamics and the Phase Field method, and continuum-level modeling of materials behavior in Finite Element simulations.

ME CM 4159 Machine Design

Introduction to computer aided drafting, IS/ISO codes; Limits, tolerances and Fits, Surface finish; Important symbols in machine drawing. Assembly and part drawings of simple assemblies and sub-assemblies of machine parts viz., couplings, clutches, bearings, gear assemblies, I.C. Engine components, valves, machine tools, etc.

ME CM 4161 Turbulence and its Modelling

Nature of turbulence, Governing equations, Fourier, Lagrangian and Eulerian description of turbulence, Statistical description of turbulence, Kolmogorov's hypotheses, turbulence processes, turbulence closure modelling.

ME CM 4162 Dynamics of Mechanical Systems

Basic Concepts: Inertial coordinate system, Fundamental laws of motion: Newton's laws and d'Alembert's principle, Mechanics of particles and system of particles, Principles of linear and angular momentum, Work-energy principles. Lagrangian Dynamics: Degrees of freedom, Generalized coordinates and generalized forces, Holonomic and non-holonomic constraints, Euler-Lagrange's equation of motion. Multi-Body Dynamics: Space and fixed body coordinate systems, Coordinate transformation matrix, Direction cosines, Euler angles, Euler parameters, Finite and infinitesimal rotations, Time derivatives of transformations matrices, Angular velocity and acceleration vectors, Equations of motion of multi-body system, Newton-Euler equations, Kinematic, Static and Dynamic analysis of planar mechanisms, Cams and Gears, Kinematic revolute joints, Joint reaction forces, Simple applications of planar systems. Stability of Motion: Fundamental concept in stability, Autonomous systems and phase plane plots, Routh's criteria for stability, Balancing of rotating and reciprocating masses. Gyroscopic Motion and stability of aircrafts and vehicles.



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ME CM 4163 Structural Dynamics

Basics of Structural Dynamics, Free Vibration of single degree of freedom, Forced Vibration of single degree of freedom, Force Transmission, Vibration Measurement, Response to Arbitrary Motions, Numerical Methods of Solution, Response Spectrum, Multi-Degree of Freedom Systems.

ME CM 4164 Structural Health Monitoring

Structural Health Monitoring (SHM): Introduction, Methods of SHM- I, Methods of SHM- II, Non-destructive techniques- I, Static and Vibration based Health Monitoring, Sensor technologies used in SHM, SHM using Artificial Intelligence, Damage Identification and assessment and broad applications.

ME CM 4165 Soft Computing

Introduction to Soft Computing: Concept of computing systems. "Soft" computing versus "Hard" computing. Characteristics of Soft computing. Some applications of Soft computing techniques. Fuzzy logic Introduction to Fuzzy logic. Fuzzy sets and membership functions. Operations on Fuzzy sets. Fuzzy relations, rules, propositions, implications and inferences. Defuzzification techniques. Fuzzy logic controller design. Some applications of Fuzzy logic. Genetic Algorithms Concept of "Genetics" and "Evolution" and its application to probabilistic search techniques Basic GA framework and different GA architectures. GA operators: Encoding, Crossover, Selection, Mutation, etc. Solving single-objective optimization problems using GAs. Multi-objective Optimization Problem Solving. Applications of ANNs to solve some real life problems.

ME CM 4166 Parallel Processing in Computational Mechanics

Introduction to multi-processor; multi-core, multi-threaded processing and their clusters, GPUs and CUDA programming, Introduction to parallel processing hardware and software, Open MP, MPI, MPICH, HPC/Clustering tools. Exploring parallelism in solid/fluid mechanics problems and formulation of numerical methods, Partitioning and divide-and-conquer strategies, Parallel algorithms for solving dynamical and non-linear systems, Finite difference and Finite element analysis of plate and shells, Finite elements in fluids, Reduced integration patch test, Dynamic FE analysis.



**Course content of Courses in the M. Tech. Programs:
Specialized Courses for M.Tech**

(I) Specialization: Solid Mechanics

ME CM 5151 Computational Multi- Body Dynamics

Degrees-of-freedom; Rigid body vs flexible body; Spatial kinematics (3-D rotation transformations); Euler theorem, rotation parameterization, Rodriguez formula; Moments and products of inertia; Newton-Euler equations of motion; Lagrange Equation; Generalized forces. Kinematic pairs (joints) with classification of constraints; holonomic and non-holonomic constraints; Springs, dampers, actuators and controllers with brief introduction of controls theory. Relative coordinates, generalized coordinates, Cartesian co-ordinates ; Lagrange' s equations and other approaches; Differential equations (ODE) and differential algebraic equations (DAE); Co-ordinate partitioning and Lagrange multipliers; Types of analyses (kinematic, static, quasi-static, kineto-static, dynamic and linear dynamic). NR method, Jacobian, ODE integrators (Euler methods and Implicit methods); Stability, accuracy and Dahlquist's tradeoff criteria; Stiffness and damping - physical vs numerical; Lock-up, bifurcation and singularities.

ME CM 5152 Impact Mechanics and Crash Worthiness

Rigid body impact, Stress waves in solids, Applications of one dimensional stress wave theory. Reflection at boundaries and interface, Waves in infinite and semi-infinite medium, Plasticity and Plastic Waves, Shock waves and Equation of State, Material Characterization and Impact Tests, Computational Methods for Impact, Applications to Ballistic Impact and Vehicle Collision.

ME CM 5153 Introduction to Plates and Shells

Basic assumptions of two-dimensional (surface) theories Theory of thin plates, bending of rectangular and circular plates, shear deformation theories. General theory of curved shells, Axi-symmetric problems of cylindrical, conical and spherical shells and pressure vessels, membrane problems of cylindrical, spherical and conical shells. Energy methods, Design considerations.

ME CM 5154 Continuum Mechanics

Introduction to multiscale modeling; Bridging Nano, micro and macro scale in materials; Basic equations of continuum mechanics; Micromechanical homogenization theory: Ergodicity principle, representative volume element, periodic boundary conditions, Eigen strain, Eigen stress, inclusions; Effective elastic modulus: self-consistent method, Mori-Tanaka method, Eshelby method, Multi-inclusions problems; Voigt and Reuss bound; Hashin-shtrikmanvariational principles; Micromechanical damage theory; Micromechanics of phase transformation in solids; Nano mechanics: Linear atomic chains, two and three dimensional lattices, Molecular mechanics, Cauchy-Born rule.

ME CM 5155 Composite Mechanics and Structures

Composites, Various reinforcement and matrix materials, Strength and stiffness properties, Effective moduli, Spherical inclusions, Bio-composites, cylindrical and lamellar systems, Laminates: Laminated plates , Analysis and Design with composites, Fiber reinforced pressure vessels, dynamic, inelastic and non-linear effects, Fabrication of composites, Machining of composites, Strength evaluation, Technological applications.



ME CM 5156 Micromechanics of Materials

Introduction to Micromechanics of Materials; Material property charts and the need for new materials, Multiphase materials; Unidirectional composites, Modeling principles, Unidirectional Composites, Modulus, Stress and strain localization, Unidirectional Composites, Shear Modulus, Poisson's ratio, Elastic-plastic loading, Unidirectional composites, Failure, Thermomechanical properties, Short fiber composites, Shear lag model; Homogenization theory, Representative volume element concept, Averaging, Homogenization, Thermal strains and eigenstrains, Mechanical loading and eigenstrains, Dilute approximation, Self-consistent model, Mori-Tanaka method, Finite element modeling aspects; Case study: Multiphase materials; Cellular solids, Honeycomb structures, Elastic properties, Non-linear properties - failure, Properties of foams, Foams - thermal shock properties - energy absorption; Case study: cellular solids; Introduction to damage mechanics, Damage as internal variable, Methods for determination of damage, Thermodynamics of damage, Damage equivalent stress, Kinetic of damage evolution, Ductile Failure models; Case study: Damage Mechanics. Materials by segmentation, Mechanics of segmented materials, Elastic properties, Non-linear properties - failure. Case study: segmented materials.

ME CM 5157 Advanced Finite Element Methods

Preliminary concepts: Index notation and summation rule, Vector and tensor calculus, Mechanics of continuous bodies, Boundary-value problem, Principle of minimum potential energy, and Principle of virtual work, Finite element formulation. Introduction to nonlinear FEA procedures Linear vs. nonlinear problems, Solution procedure, Newton-Raphson method, Incremental N-R method, Incremental secant method. FEA for nonlinear elastic problems: FEA for elastoplasticity, Behavior of ductile material, 1D elastoplasticity, Work hardening (isotropic and kinematic), FEA procedure for 1D elastoplasticity, Multi-dimensional elastoplasticity, Failure criteria, Equivalent stress and effective strain, Hardening model, Rate-independent elastoplasticity, Numerical integration for elastoplasticity, Return-mapping algorithm, Consistent tangent operator, Elastoplasticity with finite rotation, Objective stress rate, Finite deformation elastoplasticity with hyperelasticity, Multiplicative decomposition, Principle of maximum dissipation, Spectral decomposition and time integration, Return mapping in principal stress space, consistent tangent operator. Temporal discretization; Parabolic system (heat transfer problem); Consistent mass and lumped mass, mass lumping technique; Time integration methods: explicit and implicit methods.

(II) Specialization: Fluid Mechanics

ME CM 5161 Experimental Methods in Thermal Systems

Instrument classification, static and dynamic characteristics of instruments, experimental error analysis, systematic and random errors, statistical analysis, uncertainty, reliability of instruments, Variable resistance transducers, capacitive transducers, piezoelectric transducers, photoconductive transducers, photovoltaic cells, ionization transducers, Hall effect transducers. Dynamic response considerations, Bridgman gauge, McLeod gauge, Pirani thermal conductivity gauge, Knudsen gauge, Alphatron. Flow measurement by drag effects; hot-wire anemometers, magnetic flow meters, flow visualization methods, interferometer, Laser Doppler anemometer. Temperature measurement by mechanical effect, temperature measurement by radiation, transient response of thermal systems, thermocouple compensation, temperature measurements in high-speed flow. Thermal conductivity measurement of solids, liquids, and gases, measurement of gas diffusion, convection heat transfer measurements, humidity measurements, heat-flux meters. Detection of thermal radiation, measurement of emissivity, reflectivity and transmissivity, solar radiation measurement. Review of open and closed loop control systems and servo mechanisms, Transfer functions of Mechanical Systems, input and output systems.



ME CM 5162 Turbomachines

Introduction: General Theory and Classification of Turbomachines; Similarity and Dimensional Analysis; Two-dimensional Cascade Theory; Axial and Radial Flow Machines: Turbines, Compressors and Fans; Gas Turbine Power Plant Cycles; Thermal Power plant: Flow through Nozzle and Steam Turbines; Hydraulic Machines: Pelton, Francis and Kaplan Turbines; Pump and Cavitation.

ME CM 5163 Gas turbines and Jet Propulsion

Thermodynamic cycle analysis of gas turbines; open and closed cycles. Axial flow turbines; blade diagrams and design of blading, performance characteristics. Centrifugal and axial flow compressors, blowers and fans. Theory and design of impellers and blading. Matching of turbines and compressors. Fuels and combustion, effect of combustion chamber design and exhaust on performance. Basic principles and methods of heat recovery. Thermodynamic cycle analysis and efficiencies of propulsive devices. Thrust equation, classification and comparison of ram jets, turbojets, pulse jets and rockets. Performance of turbo-prop, turbo-jet and turbo-fan engines.

ME CM 5164 Advanced Computational Fluid Dynamics

Introduction: Finite difference (FDM) and Finite volume (FVM) methods, elliptic, parabolic and hyperbolic equations, Navier-Stokes (N-S) and energy equations, explicit and implicit methods, higher order schemes Solutions of simultaneous equations: iterative and direct methods, Gauss-Seidel iteration, CGS, Bi-CGSTAB and GMRES (m) matrix solvers, different acceleration techniques; Incompressible flow: N-S equation using explicit methods: MAC and SMAC (staggered and collocated grids), semi-implicit methods: SIMPLE and SIMPLER, projection method, higher order discretisations, Compressible Flow: solution of compressible N-S equation, finite volume formulations, geometric flexibility, Jameson's, MacCormack's, Steger and Warming schemes in FVM, flux splitting scheme and upwinding, different acceleration technique, multigrid method; Grid generation: grid generation using algebraic and partial differential equations; N-S equations in irregular geometry: transformation of N-S equation in curvilinear coordinate system, non-orthogonal grid, Uncertainty of numerical results: Sources of uncertainties, independence studies on grid, time-step, domain and initial condition. Turbulence modeling: scales of turbulence, concept of turbulence modeling, different eddy viscosity based models, introduction to large eddy simulation (LES) and direct numerical simulation (DNS).

ME CM 5165 Aerodynamics

Fundamentals of Aerodynamics: Airfoil, Types of Airfoils, Airfoil Nomenclature and its characteristics, NACA series, Applications of Airfoils. Characteristics of Low Speed Airfoil: Effect of incidence on pressure distribution, Lift Curve, Airfoil stalling, Flow Separation, Pitching moment, Span-wise flow variation, downwash, Wind Tunnel and Its type. Incompressible flow over a Two Dimensional Wing: Vortex Sheet, The Kutta Condition, Kelvin's Circulation Theorem and starting vortex, Classical Thin Airfoil Theory – 1. Symmetrical Airfoil 2. Cambered Airfoil, Vortex Panel Numerical Method for Lifting flow over Arbitrary bodies, Viscous flow over Airfoil – Estimation of airfoil drag for laminar flow & Turbulent flow, Transition and flow separation, Modern Low Speed airfoils, Flow over airfoil – The real case. Incompressible flow over a Finite Wings: Introduction to Finite Wing.



Department of Mechanical Engineering

ME CM 5166 Compressible Flow

Fundamentals of compressible fluid dynamics and application to external and internal flows. Quasi-one-dimensional channel flow, extensions, and analysis of multi-dimensional flows in nozzles, diffusers, and inlets. Forces, moments, and loss generation resulting from compressible fluid flow interactions with aerodynamic shapes in subsonic, supersonic, transonic, and hypersonic flight, shock waves, and vortices. Disturbance behavior in unsteady compressible flow.

ME CM 5167 Convective Heat Transfer

Transport equations and boundary conditions; Order of magnitude analysis, Reynolds analogy. Forced Convection: Convective heat transfer in external flows: Boundary layer Approximations to momentum and energy equations, Similarity solution techniques, Momentum and energy integral methods and their applications in flow over flat plates with low and high Prandtl number approximations. Convective heat transfer in Laminar internal flow: (a) Exact solutions to N-S equations for flow through channels and circular pipe, Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Graetz solution), heat transfer in the combined entrance region, (b) Integral method for internal flows with different wall boundary conditions. Elements of turbulent heat transfer.

(III) Specialization: Bio-Mechanics

ME CM 5171 Biomaterials

Introduction and history of biomaterials; Basic classes of engineering materials and structure property correlation; Structure and property of cells and tissues; Property requirement of biomaterials including biocompatibility, and biodegradability; Basic types of biomaterials; Mechanical testing of biomaterials; application of biomaterials (orthopaedic, cardiovascular, dental) including detailed case study, Materials for biomedical devices and packaging (electronic interfacing etc.)

ME CM 5172 Advanced Bio Mechanics

Broad topics: Movement analysis concepts, Research methods, Advanced kinematics, Advanced kinetics, Neuromuscular mechanics, Modelling, Materials, surfaces and equipment, Fluid mechanics, Applied biomechanics (e.g. Ergonomics, Sports injuries, Clinical biomechanics).

ME CM 5173 Mechanics of Biological Cells

Molecular mechanics: Mechanics at the nanoscale: Intermolecular forces and their origins; Single molecules; Thermodynamics and statistical mechanics; Formation and dissolution of bonds: Mechanochemistry; Polymer mechanics, Motion at the molecular and macromolecular level; Muscle mechanics; Experimental methods at the single molecule level—optical and magnetic traps, force spectroscopy, single molecule biophysics. Tissue mechanics: Elastic (time-independent), viscoelastic and poroelastic (time-dependent) behavior of tissues; Continuum and microstructural models, constitutive laws, electromechanical and physicochemical properties of tissues; Physical regulation of cellular metabolism; Experimental methods—macroscopic rheology. Cellular mechanics: Static and dynamic cell processes; Cell migration; Mechanics of bio-membranes.

ME CM 5174 Tissue Engineering

Definition and principles of tissue engineering, Scaffold-based tissue engineering techniques (porous scaffolds, electrospinning, 3D printing), Scaffold-free tissue engineering techniques (cell sheet engineering, self-assembly), Cell sourcing for tissue engineering, Vascularization and innervation of engineered tissues.



Department of Mechanical Engineering

Scaffolds, Cells and Regulators, Case Study of Organ Regeneration, Design Parameters, Design Specifications: Biomaterials, Biocompatibility: Local and Systemic Effects, Design Specifications, Biocompatibility: Scar Formation and Contraction, Degradation of Devices: Corrosion and Wear, Regulation of Medical Devices.

ME CM 5175 Fuzzy Sets & Models in Biology

Fuzzy modeling is a comparatively recent direction of research in fuzzy modeling. As the modeling of biological problems is inherently uncertain, the use of fuzzy sets in this field is a natural choice. The coverage begins with a succinct review of type-1 fuzzy basic theory, before providing a comprehensive and didactic explanation of type-2 fuzzy set components. In turn, Fuzzy Rule-Based Systems, or FRBS, are shown for both types, interval type-2 and type-1 fuzzy sets. Applications include the pharmacological models, prediction of prostate cancer stages, a model for HIV population transfer (asymptomatic to symptomatic), an epidemiological disease caused by HIV, some models in population growth, included the Malthus Model, and an epidemic model refers to COVID-19.

(IV) Specialization: Data Driven Mechanics

ME CM 5181 High Performance Computing

Parallel Processing Concepts; Levels and model of parallelism; Parallel architectures: superscalar architectures, multi-core; Fundamental design issues in HPC: Load balancing, scheduling, synchronization and resource management; Operating systems for scalable HPC; Parallel languages and programming environments; OpenMP, Pthread, MPI, java, Cilk; Performance analysis of parallel algorithms; Fundamental limitations in HPC: bandwidth, latency and latency hiding techniques; Benchmarking HPC: scientific, engineering, commercial applications and workloads; Scalable storage systems: RAID, SSD cache, SAS, SAN; HPC based on cluster, cloud, and grid computing: economic model, infrastructure, platform, computation as service; Accelerated HPC: architecture, programming and typical accelerated system with GPU, FPGA, Xeon Phi, Cell BE; Power-aware HPC Design: computing and communication, processing, memory design, interconnect design, power management; Advanced topics: peta scale computing; big data processing, optics in HPC, quantum computers.

ME CM 5182 Sustainable Engineering Systems

Introduction to Sustainable Engineering: Sustainable development, concepts of sustainable development: three pillar model, egg of sustainability model, Atkisson's pyramid model, prism model, principles of sustainable development, sustainable engineering, threats for sustainability. Environmental Ethics and Legislations: Environmental ethics and education, multilateral environmental agreements and protocols, enforcement of environmental laws in India: The Water Act, The Air Act, The Environment Act. Local Environmental Issues: Solid waste, impact of solid waste on natural resources, zero waste concept and three R concept, waste to energy technology, thermo-chemical conversion, biochemical conversion. Global Environmental Issues: Resource degradation: deterioration of water resources, land degradation, air pollution, climate change and global warming, ozone layer depletion, carbon footprint, carbon trading.

ME CM 5183 Database Management Systems

File Structure and Organization: Data and information, Concept of field, key field; Records and its types, fixed length records and variable length records; Files, operation on files, Primary file organization. Database Management System: Definition of DBMS, file processing system Vs DBMS, Advantages and Disadvantages of DBMS, Users of DBMS : Database Designers, Application programmer, Sophisticated Users, End Users,



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(An Institutional of National Importance under Ministry of Education, Government of India)

Department of Mechanical Engineering

Capabilities of good DBMS, Overall System structure. Data Models : Object Based Logical Model, Record Base Logical Model, Relational Model, Network Model, Hierarchical Model, Entity Relationship Model : Entity Set, Attribute, Relationship Set, Entity Relationship Diagram (ERD), Extended features of ERD. Relational Databases: Relational data model concept, Terms :Relation, Tuple, Attribute, Cardinality, Degree, Domain; Keys : Super Key, Candidate Key, Primary Key, Foreign Key.

ME CM 5184 Data Mining and Visualization

Introduction: Introduction to Data Science, Exploratory Data Analysis and Data Science Process. Motivation for using Python for Data Analysis, Introduction of Python shell iPython and Jupyter Notebook. Essential Python Libraries: NumPy, pandas, matplotlib, SciPy, scikit-learn, statsmodels. Getting Started with Pandas: Arrays and vectorized computation, Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics. Data Loading, Storage and File Formats. Reading and Writing Data in Text Format, Web Scraping, Binary Data Formats, Interacting with Web APIs, Interacting with Databases. Data Cleaning and Preparation. Handling Missing Data, Data Transformation, String Manipulation. Data Wrangling: Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting.