# NATIONAL INSTITUTE OF TECHNOLOGY, MIZORAM

**(An Institute of National Importance under Ministry of HRD, Govt. of India)**

**CHALTLANG, AIZAWL, MIZORAM – 796012**

**Phone/Fax: 0389-2341699 / 0389-2341236 / 0389-2341774** **Email: nit_mizoram@nitmz.ac.in**


## DEPARTMENT OF MECHANICAL ENGINEERING

### 8th Semester:

| SL.No | Course code | Subject | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|
| | | **Theory** | **L** | **T** | **P** | |
| 1. | CHL1802 | Environmental Science | 2 | 0 | 0 | 2 |
| 3. | MEL18XX | Elective -III | 3 | 0 | 0 | 3 |
| 4. | MEL18XX | Open Elective | 3 | 0 | 0 | 3 |
| | | **Practical** | | | | |
| 7. | MEP1801 | Project- II | 0 | 0 | 12 | 6 |
| | | **Total** | | | | **14** |

### List of Electives-III for 8th Semester

| SL.No | Course code | Subject | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|
| | | | **L** | **T** | **P** | |
| 1. | MEL1802 | Computational Fluid Dynamics | 3 | 0 | 0 | 3 |
| 2. | MEL1803 | Soft computing | 3 | 0 | 0 | 3 |
| 3. | MEL1804 | Experimental stress Analysis | 3 | 0 | 0 | 3 |
| 4. | MEL1805 | Innovation and entrepreneurship | 3 | 0 | 0 | 3 |
| 5. | MEL1806 | Composite Materials | 3 | 0 | 0 | 3 |

**As per the requirement electives may be modified.**

### List of Open Electives for 8th Semester

| SL.No | Course code | Subject | Teaching Scheme | | | Credits |
|---|---|---|---|---|---|---|
| | | | **L** | **T** | **P** | |
| 1. | MEL1807 | Optimization Techniques | 3 | 0 | 0 | 3 |
| 2. | MEL1808 | Finite Element Method | 3 | 0 | 0 | 3 |
| 3. | MEL1809 | Mechatronics | 3 | 0 | 0 | 3 |
| 4. | MEL1810 | Marketing Management | 3 | 0 | 0 | 3 |
| 5. | MEL1811 | Exergy- A measure of work potential | 3 | 0 | 0 | 3 |

## List of Electives for 8th Semester

### MEL1802: Computational Fluid Dynamics

### 1. Course Description:

Computational Fluid Dynamics introduces you to the concept of Goals of CFD; Problem definition and sources of error. Interpolation and function approximation, method of weighted residuals for function approximations, Fourier (spectral) interpolation and function approximation, derivatives of functions, Discretization methods and grids, performance metrics, designing methods. FVM & FDM for linear/non linear & incompressible/compressible flows; Solution of systems of equations- classical iterative techniques, introduction to multigrid, basic convergence analysis; Navier-Stokes equations- , pressure in incompressible flow, implicit convection, specific methods for incompressible flow- fractional step, stream function /vorticity form; turbulence modelling.

### 2. Learning Outcome:

On completion of the course, the students will be able to:

- Model laminar and turbulent flow using conservation laws.
- Perform discretization of diffusion problems using finite difference and finite volume methods.
- Model one dimensional convection– diffusion problems.
- Solve fluid flow and heat transfer problems using SIMPLE and PISO algorithms
- Apply different turbulence models to flow and heat transfer problems.

### 3. Broad Course Outline:

- Introduction to CFD
- Spatial discretization
- Finite Volume and Finite Difference Schemes

### 4. Text & Reference Books:

- Anderson: Computational Fluid Dynamics: McGraw-Hill Publisher
- Wendt, John F: Computational Fluid Dynamics: Springer Verlag publication, 3rd Ed
- Joel H. Ferziger & Milovan Peric: Computational Methods for Fluid Dynamics: Springer Verlag publication
- S. Patankar: Numerical Heat Transfer and Fluid Flow: Taylor & Francis publication
- P. Niyogi, S. K. Chakrabartty & M. K Laha: Introduction to Computational Fluid Dynamics: Pearson publication

**MEL1804: Experimental Stress Analysis**

## 1. Course Description:

Experimental Stress Analysis introduces you to the concept of Three element rectangular strain rosette, correction, stress gauges, over-deterministic methods for strain analysis, residual stress determination. Application of strain gauges for measurement of load, temperature, pressure, vibration, stress and strain etc. Basic of Optics, Optical Instrumentation Moiré Fringe technique-theory and experimental procedures, Fractional fringe measurement- Tardy's Method, Babinet Soleil Method. Polariscope- Plane polariscope, Circular polariscope, Different Arrangements photo elastic photography, Photo elastic materials-properties, selection, casting methods, calibration. Analysis Techniques-Determination of direction of Principal stresses at given point, Determination of exact fringe order N and the principal stress Separation methods, Method based on Hooke's Law, Electrical analogy method, Oblique incidence method, Shear difference method, Scaling model results to prototype Application of photo elasticity to 2-D and 3-D Stress analysis. Irwin's methods, application. of moiré and isopachic fringe pattern to determine stress intensity factor, mixed mode intensity factors. Bifringent coating- stress-optic and strain-optic relation, sensitivity and coating materials, fringe order determination. Brittle coating technique. Strategy. Plane and spherical waves - coherence - holographic setup – Interferometry -Displacement measurement - obtaining Isopachics.

## 2. Learning Outcome:

On completion of the course, the students will be able to:

- Know Three element rectangular strain rosete, method for stress analysis
- Gain knowledge about application of strain gauge
- Know about Tardy's method, Babinet Soleil method
- Understand Coating techniques and Holograp

## 3. Broad Course Outline:

- Strain Analysis Methods
- Optical Methods of Stress Analysis
- Theory of Photoelasticity
- Optical methods for Determining Fracture Parameters
- Coating Techniques and holography

**4. Text & Reference Books:**


- Budynas: Advance Strength & Applied Stress Analysis: McGraw-Hill, 2/e
- R. S. Sirohi, HC Radhakrishna: Mechanical Measurements: New Age International (P) Ltd. 1997
- F. K Garas, J.L. Clarke and GST Armer: Structural Assessment: Butterworths, London, 1987
- Dove and Adams: Experimental Stress Analysis and Motion Measurement: Prentice Hall of India, 1965
- Sadhu Singh: Experimental Stress Analysis: Khanna Publishers, New Delhi, 1996


**MEL1805: Innovation and entrepreneurship**

**1. Course Description:**

Innovation and entrepreneurship introduces you to the concept of Evolvement of entrepreneurship from economic theory, Entrepreneurship and characteristics of entrepreneurs, Need for education on entrepreneurship, Competency and entrepreneurial competencies. Creativity as a prerequisite to innovation, Innovation and entrepreneurship. Self-assessment and window Self-reflecting self- awareness, Decision-making, Leadership, Motivation. Concept of a planning paradigm for a new venture, Founstase growth model, Fundamentals of feasibility plan. An introduction to patents, trademarks and spy rights, intellectual property right, Business opportunity identification, Need, scope and characteristics of a small scale business industry. Marketing concept, Fundamentals of marketing, Distribution, Promotion, Pricing, Marketing strategy, Break-even analysis. Total quality management, ISO standards, Management information system, Concept of Intellectual Property Right (IPR), Patent, Copyright, and Trademark. Project planning and preliminary project report.

**2. Learning Outcome:**

On completion of the course, the students will be able to:

- Differentiate between Entrepreneur and Intrapreneur and appraise the importance of entrepreneurship in economic growth.
- Justify the need, objectives of Entrepreneurship Development Programs.
- Appraise the steps involved in setting up a business and business project reports.
- Justify the need of financing and accounting.

**3. Broad Course Outline:**

- Introduction
- Entrepreneurship and characteristics of entrepreneurs
- Need for education on entrepreneurship
- Concept of a planning paradigm for a new venture
- Marketing concept

**4. Text & Reference Books:**

- Shankar: Entrepreneurship: Theory & Practice: McGraw-Hill
- Hisrich: Entrepreneurship, by: McGraw-Hill, (Special Indian Edition), 6e
- A.K. Singh: Entrepreneurship Development & Management: Laxmi Publication
- David H. Holt: Entrepreneurship: - new venture creation: Prentice Hall Publication

**MEL1806: Composite Materials**

**1. Course Description:**

Composite Materials introduces you to the concept of Definition, Classification, Types of Matrices Material and Reinforcements, Characteristics & Selection, Fiber Composites, Laminated Composites, Particulate Composites, Prepegs, and Sandwich Construction. Hooke's Law for Different Types of Materials, Number of Elastic Constants, Derivation of Nine Independent Constants for Orthotropic Material, Two Dimensional Relationship of Compliance and Stiffness Matrix. Hooke's Law for Two Dimensional Angle Lamina, Engineering Constants - Numerical Problems. Invariant Properties. Stress-Strain Relations for Lamina of Arbitrary Orientation, Numerical Problems. Introduction, Evaluation of the Four Elastic Moduli, Rule of Mixture, Numerical Problems. Maximum Stress Theory, Maximum Strain Theory, TSA-Hill Theory, Tsai, Wu Tensor Theory, Numerical Problems, Code, Kirchoff Hypothesis, CL T, A, B, and D Matrices (Detailed Derivation) Engineering Constants, Special Cases of Laminates, Numerical Problems.Lay Up and Curing - Open and Closed Mould Processing, Hand Lay, Up Techniques, Bag Moulding and Filament Winding. Pultrusion, Pulforming, Thermoforming, Injection Moulding, Cutting, Machining and Joining, Tooling. Aircrafts, Missiles, Space Hardware, Automobile, Marine, Recreational and Sports Equipment-Future Potential of Composites. Metal Matrix Composites: Re-Inforcement Materials, Types, Characteristics and Selection, Base Metals, Selection, Applications.

**2. Learning Outcome:**

On completion of the course, the students will be able to:

- Know about composite materials
- Know about types of matrices, material and reinforcements
- Gain knowledge about Hooke’s Law for different types of material
- Know about Kirchoff hypothesis
- Know about application developments of aircrafts, missiles, space hardware.

**3. Broad Course Outline:**

- Introduction to Composite Materials
- Macro Mechanics of A Lamina
- Micro Mechanical Analysis of A Lamina

- Biaxial Strength Theories
- Macro Mechanical Analysis of Laminate
- Manufacturing
- Application Developments

**4. Text & Reference Books:**


- Mein Schwartz: Composite Materials Handbook: Mc Graw Hill Book Company.
- K. Kaw Autar: Mechanics of Composite Materials: CRC Press New York.
- Madhujit Mukhopadhyay : Mechanics of Composite Materials and Structures: University Press.
- M. Joness Rober: Mechanics of Composite Materials: Mc-Graw Hill Kogakusha Ltd.
- W Michael: Stress Analysis of Fiber Reinforced Composite Materials: Hyer MGH International.
- K. Chawla Krishan: Composite Material Science and Engineering: Springer.


## List of Open Electives for 8th Semester

### MEL1807: Optimization Technique

**1. Course Description:**

Optimization Technique introduces you to the concept of Convex sets and convex functions, Kuhn-Tucker conditions. Convex quadratic programming: Wolfe's and Pivot complementary algorithms. Separable programming. Problems with positive coefficients up to one degree of difficulty, Generalized method for the positive and negative coefficients. Discrete and continuous dynamic programming (simple illustrations). Unimodal functions, simultaneous uniform search method, Sequential search method, Fibonacci search method, Golden section search method. Univariate search method, Method of steepest descent, Conjugate radiant method, Fletcher Reeves method, Rosen's Gradient projection method, Penalty function method.

**2. Learning Outcome:**

On completion of the course, the students will be able to:

- Know about convex sets and convex function
- Know about Kuhn-Tucker conditions
- Sole problems with positive coefficients up to one degree of difficulty
- Know about Unimodal functions, simultaneous uniform search method

**3. Broad Course Outline:**

- Nonlinear programming
- Geometric programming
- Dynamic programming

- One dimensional Search Methods
- Unconstrained multi-dimensional Search Methods
- Constrained Multi-dimensional Search Methods

**4. Text & Reference Books:**

- Kalyanmoy Deb: Optimization for Engineering-Algorithms and Examples: Prentice-Hall of India Pvt. Ltd., New Delhi.
- Ashok D. Belegundu and Tirupathi R Chandrupatla: Optimization: Concepts and Applications in Engineering: Pearson Education, New Delhi.
- Christos H. Papadimitriou and Kenneth Steiglitz: Combinatorial Optimization: Algorithms and Complexity: Prentice-Hall of India Pvt. Ltd., New Delhi.
- Conley. W: Computer Optimization Techniques: Pntrecelli Book, 1980

**MEL1808: Finite Element Method**

**1. Course Description:**

Finite Element Method introduces you to the concept of historical background, applications, advantages, finite element softwares. Theory of elasticity - stress and equilibrium, stress-strain relationship, strain-displacement, relationship, plane stress, plane strain and axi-symmetric approximation. Temperature effects. Potential energy and equilibrium, Principle of minimum potential energy. Discrete and Continuous systems, Rayleigh-Ritz method, Galerkin method. Solution of Algebraic equations, Banded and skyline solutions. Global, Local and Natural coordinates in 1, 2 and 3 dimensions - Area coordinates. Numerical Integration using Gauss quadrature. Types of elements, Discretization, Mesh generation and numbering. Shape functions - types and properties. Iso parametric formulation. Largrangean and Serendipity elements. Discretisation of domain into elements – generalized coordinates approach - derivation of elements equations - assembly of element equations - transformation matrices - global equations, load vector, properties of stiffness matrices, imposition of Boundary conditions - penalty and elimination approach, multi-point constraints. Finite element formulation of plane trusses, beams and beams on elastic supports. Using constant strain triangle element and iso-parametric quadrilateral element. Axi-symmetric solids subjected to axi-symmetric loading. Features of 3D problems in stress analysis. Scalar field problems - one dimensional heat conduction through composite walls and fins, potential flow. Dynamic problems-Hamilton's principle, Mass matrices, lumped and consistent formulations.

**2. Learning Outcome:**

On completion of the course, the students will be able to:

- Develop some experience with a commercial FEM code and some practical modeling exercises.
- Analyse the displacement-based finite element method for displacement and stress
- analysis and to introduce related a0lytical and computer tools.

- Use 1-D and 2D element stiffness matrices and load vectors from various methods to solve for displacements and stresses calculations.
- Interpret approximate 0ture of the finite element method and convergence of results are examined
- Understand steady state heat transfer formulation of 1D element conduction and convection problem and solving for the temperature distribution using finite element method.
- Understand dy0mic a0lysis of physical model using finite element method and evolution of the frequencies and mode shapes.

**3. Broad Course Outline:**

- Introduction
- Finite element modeling
- One dimensional elasticity problems
- Finite element formulation of 2D problems

**4. Text & Reference Books:**

- Reddy: An Introduction to Finite Element Method: McGraw-Hill, 3/e
- Hutton: Fundamentals of Finite Element Analysis: McGraw-Hill, 1/e
- Krishnamoorthy: Finite Element Analysis: Theory and Programming: McGraw-Hill, 2/e,
- T. K. Chandrupatla and A. D. Belegundu: Introduction to Finite Elements In Engineering: Prentice Hall of India Pvt. Ltd., New Delhi
- S. Rajasekaran: Finite Element Analysis in Engineering Design: Wheeler Publishing,
- K. S. Bathe & E. L. Wilson: Finite Element Method: Prentice Hall of India
- R. D. Cook: Concepts and Applications of Finite Element Analysis: Wiley

**MEL1811: Exergy- A measure of work potential**

**1. Course Description:**

Exergy- A measure of work potential introduces you to the concept of Basic concepts; Thermodynamic equilibrium: The Zeroth law of thermodynamics; Energy conservation: The first law of thermodynamics; The Carnot cycle and Carnot efficiency; The second law of thermodynamics; Reversibility and irreversibility; Characteristics and significance of entropy; Balances for mass, energy and entropy. Introducing available energy or exergy; Available energy referred to a cycle; Quality of energy; Environment and dead state; Exergy of a system; Physical exergy; Chemical exergy; Closed system exergy balance; Exergy rate balance for control volumes at steady state; Exergetic (second law) efficiency. Exergy analysis of expansion, compression and heat transfer processes; Exergy analysis of mixing and separation processes; Standard chemical exergy of gases and gas mixtures; Standard chemical exergy of hydrocarbon (coal, biomass, fuel oil) fuels; Exergetic efficiencies of reacting systems. Introduction; Advantages and benefits of using exergy; Conservation of energy through exergy; Disadvantages and drawbacks of using exergy; Possible measures

to increase applications of exergy in industry; Exergy analysis of drying processes and systems; Exergy analysis of thermal power plant (steam power plant). Thermoeconomics; Economic aspects of exergy; Exergoeconomic analysis methodology; Difference between economic and thermodynamic balances; Exergy, cost, energy and mass (EXCEM) analysis.

**2. Learning Outcome:**

On completion of the course, the students will be able to:

- Know in detail the various concept of Thermodynamics
- Know about exergy, Physical, Chemical exergy
- Do exergy analysis of expansion
- Gain knowledge of advantages and benefits of using exergy
- Understand economics aspects of exergy

**3. Broad Course Outline:**

- Thermodynamic Fundamentals
- Basic Exergy Concepts
- Exergy Analysis of Simple Processes
- Applications of Exergy in Industry
- Exergoeconomic Analysis of Energy Systems

**4. Text & Reference Books**

- Moran and Shapiro: Fundamentals of Engineering Thermodynamics: Wiley – India
- P.Nag: Basic and Applied Thermodynamics: Tata McGraw Hill
- Cengel and Boles: Thermodynamics- An Engineering Approach: McGraw Hill
- Bejan, Tsatsaronis and Moran: Thermal Design and Optimization: John Wiley & Sons

**MEL1809: Mechatronics**

**1. Course Description:**

Mechatronics introduces you to the concept of Definition – Trends - Control Methods: Standalone, PC Based (Real Time Operating Systems, Graphical User Interface, Simulation) - Applications: SPM, Robot, CNC, FMS, CIM. Introduction – Hardware - Digital I/O, Analog input – ADC, resolution, sped channels Filtering Noise using passive components – Resistors, capacitors - Amplifying signals using OP amps – Software - Digital Signal Processing – Low pass , high pass , notch filtering. Pneumatic Actuation Systems - Electro-pneumatic Actuation Systems- Hydraulic Actuation Systems - Electro-hydraulic Actuation Systems - Timing Belts – Ball Screw and Nut - Linear Motion Guides - Linear Bearings - Harmonic Transmission - Bearings- Motor /Drive Selection. TTL, CMOS interfacing - Sensor interfacing – Actuator interfacing– solenoids , motors Isolation schemes- opto coupling, buffer IC's - Protection schemes – circuit breakers, over current sensing, resetable fuses, thermal dissipation - Power Supply – Bipolar transistors / mosfets. Relays and Solenoids - Stepper Motors - DC

brushed motors – DC brushless motors - DC servo motors - 4-quadrant servo drives, PWM's - Pulse Width Modulation –Variable Frequency Drives, Vector Drives - Drive System load calculation. 8051 Microcontroller , microprocessor structure – Digital Interfacing - Analog Interfacing - Digital to Analog Convertors - Analog to Digital Convertors - Applications. Programming – Assembly, C (LED Blinking, Voltage measurement using ADC). Basic Structure - Programming: Ladder diagram - Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls - Data Handling - Analog input / output - PLC Selection - Application.

## 2. Learning Outcome:

On completion of the course, the students will be able to:

- Understand mechatronics system and to produce them for helping to engineering industry and society for improvement and safety.
- Understand the concept of key elements of mechatronics system.
- Gain ability to represent mechatronics system into block diagram & concept of transfer function, reduction and analysis.
- Understand Principle of Sensors, its characteristics & identification of Interfacing of Sensors /Actuators to DAQ micro-controller
- Gain ability to understand of PLC Programming & implement in real life system
- Understand the concept of modelling & A0lysis of mechatronics system
- Gain ability to understand PID control system & implement in real life system.

## 3. Broad Course Outline:

- Introduction
- Signal Conditioning
- Precision Mechanical Systems
- Electronic Interface Subsystems
- Electromechanical Drives
- Microcontrollers Overview
- Programmable Logic Controllers

## 4. Text & Reference Books


- Mahalik: Mechatronics: McGraw-Hill
- W Bolton: Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering: Pearson Education Press, 3rd edition, 2005.
- M.D.Singh/J.G.Joshi: Mechatronics: PHI.
- Newton C Braga: Mechatronics Source Book: Thomson Publications, Chennai.
- N. Shanmugam / Anuradha: Mechatronics: Agencies Publisers

**MEL1803: Soft Computing**

## 1. Course Description:

Soft Computing introduces you to the concept of Fundamental concept – Evolution of Neural Networks – Basic Models of Artificial Neural Networks – Important Terminologies of ANNs – McCulloch-Pitts Neuron – Linear Separability – Hebb Network. Supervised Learning Network: Perceptron Networks – Adaline – Multiple Adaptive Linear Neurons – Back-Propagation Network – Radial Basis Function Network. Training Algorithms for Pattern Association – Autoassociative Memory Network – Heteroassociative Memory Network – Bidirectional Associative Memory – Hopfield Networks – Iterative Autoassociative Memory Networks – Temporal Associative Memory Network. Unsupervised Learning Networks: Fixed weight Competitive Nets – Kohonen Self-Organizing Feature Maps – Learning Vector Quantization – Counter propagation Networks – Adaptive Resonance Theory Networks – Special Networks.Classical Relations and Fuzzy Relations – Tolerance and Equivalence Relations – Noninteractive Fuzzy sets – Membership Functions: Fuzzification – Methods of Membership Value Assignments – Defuzzification – Lambda-Cuts for Fuzzy sets and Fuzzy Relations – Defuzzification Methods. Fuzzy Rule Base and Approximate Reasoning: Truth values and Tables in Fuzzy logic – Fuzzy Propositions – Formation of Rules – Decomposition and Aggregation of rules – Fuzzy Reasoning – Fuzzy Inference Systems (FIS) – Fuzzy Decision Making – Fuzzy Logic Control Systems. Basic Operators and Terminologies in GAs – Traditional Algorithm vs. Genetic Algorithm – Simple GA – General Genetic Algorithm – The Scheme Theorem – Classification of Genetic Algorithm – Holland Classifier Systems – Genetic Programming. Applications of Soft Computing: A Fusion Approach of Multispectral Images with SAR Image for Flood Area Analysis – Optimization of Travelling Salesman Problem using Genetic Algorithm Approach – Genetic Algorithm based Internet Search Technique – Soft Computing based Hybrid Fuzzy Controllers – Soft Computing based Rocket Engine – Control.

## 2. Learning Outcome:

On completion of the course, the students will be able to:

- Know about evolution of neural networks
- Understand Classical Relations and Fuzzy Relations
- Know about Fuzzy Rule Base and Approximate Reasoning: Truth values and Tables in Fuzzy logic
- Gain knowledge about Traditional Algorithm vs. Genetic Algorithm

## 3. Broad Course Outline:

- Introduction
- Associative Memory Networks
- Introduction to Classical Sets and Fuzzy sets
- Fuzzy Arithmetic and Fuzzy Measures
- Introduction to Genetic Algorithm

## 4. Text & Reference Books


- S. Rajasekaran and G.A.V.Pai: Neural Networks, Fuzzy Logic and Genetic Algorithms: PHI, 2003.
- Timothy J.Ross: Fuzzy Logic with Engineering Applications: McGraw-Hill 1997.
- J.S.R.Jang, C.T.Sun and E.Mizutani: Neuro-Fuzzy and Soft Computing: PHI, 2004, Pearson Education.