BIKANER TECHNICAL UNIVERSITY, BIKANER

COURSE SCHEME AND SYLLABUS

M. TECH.
MECHANICAL ENGINEERING

M. Tech. (Mechanical Engineering)

Teaching and Examination Scheme

1st Year –I Semester

THEORY												
		Course		Contact hrs/ week			Marks				Cr
SN	Category	Code	Title	L	T	P	Exam Hrs	IA	ETE	Total	
1	PCC	1MEMME1-01	Numerical Methods in Engineering	3	-	-	3	20	80	100	3
2		1MEMME1-02	Advanced Mechanical Vibrations	3	-	-	3	20	80	100	3
3		1MEMME1-03	Renewable Energy Systems	3	-	-	3	20	80	100	3
4	PEC-I	1MEMME2-04	Advanced Heat and Mass Transfer	3	-	-	3	20	80	100	3
		1MEMME2-05	Mechatronic Systems Design and Applications								
		1MEMME2-06	Gas Dynamics and Turbo Machines								
		1MEMME2-07	IC Engines, Electric and Hybrid Electric Vehicles								
5	PEC-II	1MEMME2-08	Maintenance Engineering	3	-	-	3	20	80	100	3
		1MEMME2-09	Operations Management								
		1MEMME2-10	Manufacturing Strategies								
		1MEMME2-11	Fabrication Techniques of Smart and Composite Materials								
6	OES	1MEMME3-12	Human Values and Professional Ethics	2	-	-	3	20	80	100	2
			Sub Total	17						600	17
PRACTICAL & SESSIONAL											
7	PCC	1MEMME1-13	Thermal & I C Engine Lab	-	-	2	-	60	40	100	2
8	FW	1MEMME4-14	Field Work	-	-	2	-	60	40	100	2
9	AC	1MEMME5-15	Human Values Practice School	-	-	2	-	30	20	-	-
			Sub- Total			6				200	4
			TOTAL OF I SEMESTER	17		6				800	21

***L:** Lecture, **T:** Tutorial, **P:** Practical, **Cr:** Credits*
***ETE:** End Term Exam, **IA:** Internal Assessment*

PCC: Program Core Courses
PEC: Program Elective Courses
Electives Courses (3-4Nos.) should be relevant to the chosen specialization/branch
OES: Other Emerging Subjects: (i) Human Values and Professional Ethics
(ii) Research Methodology
It is decided common for all branches.
FW: Field Work
Student is required to work in the organization/industry concerned with his/her course.
AC: Audit Course
It is mandatory to pass the audit course. However, credit shall not be awarded

M. Tech. (Mechanical Engineering)

Teaching and Examination Scheme

1st Year – II Semester

SN	Category	Course Code	Course Title	Contact hrs/week L	T	P	Marks Exam Hrs	IA	ETE	Total	Cr
THEORY											
1	PCC	2MEMME1-01	Advanced Finite Element Analysis	3	-	-	3	20	80	100	3
2		2MEMME1-02	Industrial Automation and Robotics	3	-	-	3	20	80	100	3
3		2MEMME1-03	Analysis of Newer Machining Processes	3	-	-	3	20	80	100	3
4	PEC-I	2MEMME2-04	Tribology	3	-	-	3	20	80	100	3
		2MEMME2-05	Additive Manufacturing								
		2MEMME2-06	Computer Aided Design and Manufacturing								
		2MEMME2-07	Fracture Mechanics								
5	PEC-II	2MEMME2-08	Signal Analysis and Condition Monitoring	3	-	-	3	20	80	100	3
		2MEMME2-09	Forming Processes & Analysis								
		2MEMME2-10	Intelligent Manufacturing Systems								
		2MEMME2-11	Reverse Engineering								
6	OES	2MEMME3-12	Research Methodology	2	-	-	3	20	80	100	2
			Sub Total	17						600	17
PRACTICAL & SESSIONAL											
7	PCC	2MEMME1-13	CAD/CAM LAB	-	-	2	-	60	40	100	2
8	FW	2MEMME4-14	Field Work	-	-	2	-	60	40	100	2
			Sub- Total			4				200	4
			TOTAL OF II SEMESTER	17		4				800	21

M. Tech. (Mechanical Engineering)

Teaching and Examination Scheme

2nd Year – III Semester

PRACTICAL & SESSIONAL											
SN	Category	Course		Contact hrs/week			Marks				Cr
		Code	Title	L	T	P	Exam Hrs	IA	ETE	Total	
1	PSD	3MEMME6-16	Industrial/Field Project	-	-	28	-	360	240	600	14
2	PSD	3MEMME6-17	Seminar	-	-	4	-	60	40	100	2
		TOTAL OF III SEMESTER				32				700	16

PSD: Industrial/Field Project, Seminar, Dissertation

M. Tech. (Mechanical Engineering)

Teaching and Examination Scheme

2nd Year – IV Semester

PRACTICAL & SESSIONAL											
SN	Category	Course		Contact hrs/week			Marks				Cr
		Code	Title	L	T	P	Exam Hrs	IA	ETE	Total	
1	PSD	4MEME6-18	Dissertation	-	-	32	-	420	280	700	16
		TOTAL OF IV SEMESTER				32				700	16

SEMESTER- I

1MEMME1-01: Numerical Methods in Engineering

Introduction: Objective, scope and outcome of the course.

Approximations: Accuracy and precision, definitions of round off and truncation errors, error propagation.

System of Linear Equations: Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition, iteration methods (Gauss - Siedel); convergence of iteration methods.

Computations of Eigen-values of a Matrix: Power method for dominant, sub-dominant and smallest eigen-values.

Interpolation methods: Newton's divided difference, interpolation polynomials.

Numerical Solution of Ordinary Differential Equations: Initial-value problems: linear multistep methods, Runge Kutta methods, predictor-corrector Adam- Bashforth, Milne's method. Boundary-value problems: the shooting method, finite difference methods.

Finite differences: Review of finite difference operators. Finite Difference Methods: Solution of Elliptic PDE using five point formulae for Laplacian, replacement for Dirichlet and Neumann's boundary conditions; Solution of Parabolic PDE using Crank-Nicholson, du-Fort and Frankel scheme; Solution of Hyperbolic PDE using finite differences (FD). Problems on application to design, thermal and production engineering will be discussed in different topics of the course.

Suggested Readings

1. S.S. Sastry, "Introductory Methods of Numerical Analysis", PHI publication.
2. John H. Mathews, "Numerical Methods Using Matlab, 4/e", Pearson Education, India.
3. M.K. Jain, S.R.K. Iyengar, and R.K. Jain, "Numerical Methods for Scientific and Engineering Computation", New Age Pvt. Pub, New Delhi.
4. B.S. Grewal, "Numerical Methods in Engineering & Science (with Programs in C,C++ &MATLAB)", Khanna Publisher, India.

1MEMME1-02: Advanced Mechanical Vibrations

Introduction: Characterization of engineering vibration problems, Review of single degree freedom systems with free, damped and forced vibrations

Two-degree of Freedom Systems: Principal modes of vibration, Spring coupled and mass coupled systems, Forced vibration of an undamped close coupled and far coupled systems, Undamped vibration absorbers, Forced damped vibrations, Vibration isolation.

Multi-degree Freedom systems: Eigen-value problem, Close coupled and far coupled systems, Orthogonality of mode shapes, Modal analysis for free, damped and forced vibration systems, Approximate methods for fundamental frequency- Rayleigh's, Dunkerely, Stodola and Holzer method, Method of matrix iteration, Finite element method for close coupled and far coupled systems.

Continuous systems: Forced vibration of systems governed by wave equation, Free and forced vibrations of beams/ bars, Applications of finite element method to dynamic analyses of beams,

shells and plates.

Transient Vibrations: Response to an impulsive, step and pulse input, Shock spectrum.

Non-linear Vibrations: Non-linear systems, Undamped and forced vibration with non-linear spring forces, Self-excited vibrations.

Suggested Readings:

1. Advanced Theory of Vibration by JS Rao, New Age International Publishers.
2. Mechanical Vibrations by S S Rao, Pearson Education, New Delhi.
3. Nonlinear Mechanical Vibration by P. Srinivasan, New Age International Publishers, New Delhi.

1MEMME1-03: Renewable Energy System

Energy sources & Availability:

Conventional, Non-conventional, renewable, non-renewable sources of energy, prospects & perspectives & advantages. Introduction to different types of non-conventional source of energy-solar, wind, biomass, OTEC, geothermal, hydrogen energy, fuel cells, MHD, thermonic convertor, thermo-electric power.

Solar Energy:

Solar constant, solar radiation geometry, local solar time, day length, solar radiation measurement, radiation on inclined surface, solar radiation data & solar charts.

Wind Energy :

Wind as a Source of Energy, Characteristics of wind, wind data. Horizontal & Vertical axis wind Mills.

Biomass Energy :

Introduction to biomass, biofuels & their heat content, biomass conversion technologies. Aerobic & anaerobic digester, Factors affection biogestion, biogas plants - types & description. Utilisation of biogas - Gasifiers, direct thermal application of Gasifiers. Advantages & problems in development of Gasifiers, use in I.C. engines.

Other Energy Sources :

Geothermal Energy : Status & estimates, geothermal sources, geothermal systems & their characteristics. Fuel Cells. Principle & Classification, types conversion efficiency, polarization & advantages MHD power generation - principle, types closed & open cycle system materials.

Energy form thermo nuclear fusion, OTEC, hydrogen, thermoionic generation & tidal waves.

Suggested Readings:

1. B. H. Khan, "Non-Conventional Energy Resources". 2
2. Godfrey Boyle, "Renewable Energy".
3. D. P. Kothari, K. C. Singhal, and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies".
4. S. P. Sukhatme and J. K. Nayak, "Solar Energy: Principles of Thermal Collection and Storage"

1MEMME2-04: Advance Heat and Mass Transfer

Brief Introduction of Heat Transfer: Conduction: General heat Conduction equation-initial and boundary conditions. Transient heat conduction: Lumped system analysis-Heisler chartssemi infinite solid-use of shape factors in conduction-2D transient heat conduction-product solutions.

Finite Difference Methods for Conduction: ID & 2D steady state and simple transient heat conduction problemsimplicit and explicit methods. Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations. Derivation of energy equation-methods to determine heat transfer coefficient: Analyticalmethods-dimensional analysis and concept of exact solution. Approximate method-integral analysis.

External Flows: Flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometries for laminar and turbulent flows.

Internal Flows: Fully developed flow: integral analysis for laminar heat transfer coefficient types of flow-constant wall temperature and constant heat flux boundary conditionshydrodynamic & thermal entry lengths; use of empirical correlations.

Free Convection: Approximate analysis on laminar free convective heat transfer boussinesque approximation-different geometries-combined free and forced convection.

Boiling and Condensation: Boiling curve-correlationsNusselts theory of film condensation on a vertical plateassumptions & correlations of film condensation for different geometries.

Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting and absorbing media, specular surfaces, gas radiation-radiation from flames.

Suggested Readings

1. Fundamentals of Heat and Mass Transfer by Frank P. Incropera
2. Heat and Mass Transfer Data Bookby C.P. Kothandaraman
3. Heat and Mass Transfer by Yunus A. Cengel
4. Heat and Mass Transfer by Frank M. White
5. Fundamentals of Heat and Mass Transfer by C.P. Kothandaraman
6. Elements of Heat Transfer/E. Radha Krishna/CRC Press
7. Heat Tranfer/ Hollman J. P./ McGraw-Hill Education
8. Heat Transfer / NecatiOzisik / TMH
9. Heat Transfer / Nellis& Klein / Cambridge University Press

1MEMME2-05: Mechatronic Systems Design and Applications

Introduction: Objective, scope and outcome of the course. Overview of Mechatronics: Historical perspective, Definition, Applications, Block diagram of Mechatronic system, Functions of Mechatronics Systems, Design process, systems, measurement systems, control systems, programmable logic controller, examples of mechatronic systems. Sensors and Transducers : Performance terminology, Displacement, Position, and Proximity Sensors, velocity and motion, Force and torque sensors, f l u i d Pressure, liquid Flow, liquid level, Temperature, Light sensors, Smart material sensors, Micro and Nano sensors, Selectioncriteria for sensors.

Signal conditioning, Operational amplifier, protection, filtering, wheatstone bridge, pulse modulation.

Digital Signals, Analogue and digital signals, digital-to-analogue and analogue-to-digital converters, multiplexers, data acquisition, digital signal processing. Digital Logic, logic gates, applications of logic gates, sequential logic Data presentation systems: displays, data presentation elements, magnetic recording, optical recording, displays, data acquisition systems, measurement systems, testing and calibration.

Pneumatic and hydraulic actuation systems: actuation systems, pneumatic and hydraulic systems, directional control valves, pressure control valves, cylinders, servo and proportional control valves, process control valves, rotary actuators. Mechanical actuation systems: mechanical systems, types of motion, kinematic chains, cams, gears, ratchet and pawl, belt and chain drives, bearings, mechanical aspects of motor selection. Electrical actuation systems: electric systems, mechanical switches, solid-state switches, solenoids, DC motors, AC motors, and stepper motors.

Basic System Models: mathematical models, mechanical system building blocks, electrical systems building blocks, fluid system building blocks, and Thermal system building blocks. System Models: Engineering systems, rotational – translational systems, electromechanical systems, linearity, and hydraulic- mechanical systems. Dynamic responses of systems: modeling dynamic systems, terminology, first-order systems, second order systems, performance measures of second order system and system identification System Transfer Functions: Transfer function, first –order systems, second order systems, systems in series, systems with feedback loops, effect of pole location on transient response. Frequency response: sinusoidal input, phasors, frequency response, bode plots, performance specifications, and stability.

Closed-loop controllers: continuous and discreet control processes, terminology, two-step mode, proportional mode, derivative control, integral control, PID controller, digital controllers, control system performance, controller tuning, velocity control and adaptive control. Microprocessors: control, microprocessor systems, microcontrollers, and applications. Programmable logic controllers: Basic PLC structure, Input/output processing. Mechatronic systems: mechatronic designs, case studies.

Suggested Readings

1. W. Bolton, Mechatronics, Electronic controlsystemsin mechanical and electrical engineering, Pearson Education, 5/e, 2011.
2. David G. Alcaiatore and Michel B. Histand, Introduction to Mechatronics and Measuring Systems, Mc. Graw Hill Int. Edition, 3/e,
3. JamesJ Allen, MicroElectro Mechanical Systems Design,CRCPress.
4. Craig K. C. and Stolfi, F. R., Introduction to Mechatronic System Design with Applications, IEEE Educational Activities Department.
5. Robert H. Bishop. The Mechatronics Handbook, CRC Press

1MEMME2-06: Gas Dynamics and Turbo Machines

Deformation and the rate of strain, the deformation tensor, skew-symmetry of the deformation tensor, symmetry of the stress tensor, polar and non-polar fluids, stokesian and Newtonian fluids, Derivation of the general differential equations of continuity, momentum and energy in vector form, Euler and Navier-Stokes equations, integration of the momentum equation, the generalized Bernoulli's equation.

Exact solution, plane Poiselie and Couette flows, Hagen Poiselle flow through pipes. Flows with very small Reynolds number, Flows with very large Reynolds number, elements of two dimensional boundary layer theory, displacement thickness and momentum thickness, skin friction, Blassius solution for boundary layer on a flat plate without pressure gradient, the Karman-Polhausen integral method for obtaining approximate solutions.

Drag on bodies, form drag and skin friction drag profile drag and its measurement.

Introduction to turbo machines – Transfer of energy to fluids – Performance characteristics – Fan laws – Dimensionless parameters – Specific speed – Selection of centrifugal, axial, mixed flow, Axial flow machines.

Centrifugal Blowers: Theoretical characteristic curves, Eulers characteristics and Eulers velocity triangles, losses and hydraulic efficiency, flow through impeller casing inlet nozzle volute, diffusers, leakage disc friction, mechanical losses, multivane impellers, of impulse type, cross flow fans.

Axial flow fans: Rotor design airfoil theory, vortex theory, cascade effects, degree of reaction, blade twist stage design, surge and stall, stator and casing, mixed flow impellers. Special design and application of blowers induced and forced draft fans for air conditioning plants, cooling towers, ventilation systems, booster systems.

Suggested Readings:

1. A. J. Stepanoff, Turboblowers, John Wiley & Sons.
2. Brunoeck, Fans, Pergamon Press.
3. H. Austin. Church, Centrifugal pumps and blowers, John Wiley and Sons.
4. Dixon, Fluid Mechanics, Thermodynamics of turbo machinery Pergamon Press.
5. Dixon, Worked examples in turbo machinery, Pergamon Press.
6. F.M. White. Fluid mechanics, McGraw Hill
7. Som, Biswas, Fluid mechanics: Tata McGraw Hill.
8. P.K. Kundu, Ira M. Cohen, Fluid mechanics, Elsevier.
9. G. K. Batchelor, Fluid mechanics, Cambridge Mathematical Library.

1MEMME2-07: IC Engines, Electric and Hybrid Electric Vehicles

Gas Exchaniging Processes: Inlet and exhaust processes in the four stroke cycle volumetric efficiency quasi static effects combined quasi static and dynamic effects variation with speed and valve area lift and timing –flow through valves poppet valve geometry and timing flow rate and discharge coefficients, residual gas fraction , exhaust gas flow rate and temperature variation, scavenging in two stroke cyclic engines, scavenging parameters and models actual scavenging processes , flow through ports, super charging and turbo changing – methods of power boosting basic relationships compressors, turbines wave compression devices.

Charge Motion Within The Cylinder: Intake Jet Flow, Mean velocity and turbulence characteristics definitions application to engine velocity data swirl – swirl measurement, swirl generation during induction swirl modification within the cylinder squish pre chamber engine flows crevice flows and blowby flows generated by piston – cylinder wall interaction. UNIT-III:

Combustion in S.I And C.I Engines: Review of normal and abnormal combustion in SI and CI engine cyclic variation in combustion of SI engine , analysis of cylindrical pressure data in SI and CI engine ,MPFI in SI engines common rail fuel injection system in CI engines fuel spray behavior in CI engines.

Electric Vehicles: Introduction: Limitations of IC Engines as prime mover, History of EVs, EV system, components of EV-DC and AC electric machines: Introduction and basic structure, Electric vehicle drive train, advantages and limitations, Permanent magnet and switched reluctance motors BATTERIES: Battery: lead, acid battery, cell discharge and charge operation, construction, advantages of lead, acid battery, Battery parameters: battery capacity, discharge

rate, state of charge, state of discharge, depth of discharge, Technical characteristics, Ragone plots. **Hybrid Vechiles:** Configurations of hybrids, Series and Parallel, advantages and limitations, Hybrid drive trains, sizing of components Initial acceleration, rated vehicle velocity, Maximum velocity and maximum grade ability, Hydrogen: Production, Hydrogen storage systems, reformers.

Fuel Cell Vechiles: Introduction, Fuel cell characteristics, Thermodynamics of fuel cells, Fuel cell types: emphasis on PEM fuel cell.

Suggested Readings

1. J.B. Heywood Internal Combustion Engine Fundamentals, McGraw Hill Co.1988
2. Seth Leitman and Bob Brant Build your own electric vehicle McGraw Hill Co.2009.
3. F. Barbir PEM Fuel Cells-Theory and Practice Elsevier Academic Press,2005.
4. W.W. Pulkrabek Engineering Fundamentals of IC Engine, PHI Pvt. Ltd 2002

1MEMME2-08: Maintenance Engineering

Failure data analysis, Reliability, availability and maintainability analysis, Approaches to determine and improve system reliability, Fault tree analysis, FMECA.

Objectives and functions of maintenance, Classification of maintenance systems, Maintenance planning and scheduling.

Maintenance of production equipments, Replacement versus reconditioning assessment, Individual and group replacement decisions, Spare parts inventory control.

Suggested Readings:

1. W. Grant Ireson, F Clyde, Hand Book of Reliability, Mc Graw Hill.
2. Anthony Kelley, Maintenance Planing and Control, East-west press.
3. S. K. Srivastava, Industrial Maintenance Management, S Chand & Co.
4. L. R. Higgins, Maintenance Engineering Handbook, Mc Graw Hill.
5. K. Venkataramana, Maintenance Engineering and management, P H I Learning Pvt. Ltd.

1MEMME2-09: Operation Management

Introduction: The objective of the course is to develop familiarity with the concepts of production systems their constraints, and their linkages with the overall business strategy; planning and control of operations; optimal utilization of resources and interfaces of operations management with other managerial areas.

Operations Management and its scope, Historical Evolution, Competitiveness, Strategy and Productivity, improving productivity. Motion and Time Study, Problem solving process, Work Method Design, Process analysis, Work measurement: Time Study, Rating, Allowances, Stopwatch time study, predetermined time standards, standard data, Work sampling, Applications. Introduction to Human Factors.

Demand Management and Forecasting; Strategic Importance, Approaches to Forecasting, Qualitative and, Quantitative Methods, Accuracy and monitoring the forecast.

Capacity Planning: Introduction to capacity, Capacity Strategy, Measures of capacity, factors

determining effective capacity, developing capacity strategies, and evaluating alternatives.

Facilities Planning: Strategic Facilities Planning; Facilities Location: Facility Location Problems; Single Facility Location Problem; Multi facility Location Problem; Process Selection, Layout Planning: Basic Layout types, Designing Product Layout: Line balancing, Systematic Layout planning procedure, Flow, Space and Activity Relationships, Computer-Aided Layout Planning; Materials Handling (MH): MH System design, Unit Loads, MH Equipment's, Principles of MH. ASRS, AGV; Introduction to Warehouse Layout planning; Storage and Retrieval Systems; Warehouse Management.

Aggregate Planning and Master Scheduling: Planning and Scheduling, Objectives of Aggregate Planning, Strategies of Aggregate Planning, Master Scheduling

Materials Management: Scope, Purchasing Process, Make or Buy decisions, Inventory Management: Classification, Functions of inventories, Dependent and independent demand, Inventory costs. Economic Order Quantity Models: Basic EOQ Model, Economic Run Length Model, Quantity discount Model. Reorder Point Models, Service levels and safety stock, Fixed Order Interval Model. Single Period Model: Continuous and discrete stocking levels. Selective Inventory Control. Materials and Capacity requirements planning(MRP/CRP): MRP inputs and outputs, Bill of Materials (BOM), System parameters and Lot sizing techniques, MRP Logic. CRP activities. Basic concept of MRP II & ERP

Operations Scheduling and Control: Functions and objectives, Scheduling in High volume and Low volume systems, Order Release. Loading and Assignment: Gantt Charts, Infinite and finite loading, Sequencing: Priority rules: SPT, FCFS, EDD, CR, S/O, RUSH. Johnson's Rule, Scheduling in Services

Project Management Introduction, Difference between PERT and CPM, PERT/CPM Network Components and Precedence Relationship, Project Management – PERT

Lean Manufacturing and Agile Manufacturing, Just-In-Time: Introduction, Characteristics of JIT, Key Processes to Eliminate Waste, Implementation of JIT, Pre-requisites for implementation, JIT Inventory and Supply Chains.

Suggested Readings:

1. Operations Management, (Latest Edition), William J. Stevenson, Tata McGraw Hill education Private Limited.
2. Operations & Supply Management, (Latest Edition), Chase, R. B. Aquilano, N. J. Jacobs, F. R. Boston, McGraw-Hill.
3. Operations Management: Processes and Supply Chains, (latest Edition), Krajewski, Ritzman, L. P. and Malhorta, M.J., Pearson.
4. Operations Management, (Latest Edition), Heizer, Jay; Render, Barry, Upper Saddle River, N.J.: Prentice-Hall.
5. Introduction to Work Study: International Labor Office (ILO), Geneva.
6. Motion and Time Study Design and Measurement of Work: Ralph M. Barnes, Wiley, The University of California

1MEMME2-10: Manufacturing Strategies

Manufacturing and operations strategy, relevance and concepts, strategic issues in

manufacturing and operations, Linkage of manufacturing strategy with financial and marketing strategies, Push and pull manufacturing strategies.

Focused manufacturing strategies such as lean and agile, Concept of reconfigurable manufacturing and seru production, Manufacturing competitiveness.

Evaluation of manufacturing strategies based on cost, quality, delivery time and mass customization attributes, Sustainable and smart manufacturing, IOT in manufacturing.

Suggested Readings:

1. Terry Hills, Manufacturing Strategy, McGraw-Hill/Irwin.
2. John. Milten Burg, Manufacturing Strategy, CRC Press.
3. Per Lindberg, Christopher A. Voss, Kathryn L. Blackmon, International Manufacturing Strategies: Context, Content and Change, Springer Science.
4. C. A . Voss, Manufacturing Strategy, Chapman and Hall. 5. Steve Brown, Manufacturing the Future, Prentice Hall.

1MEMME2-11: Fabrication Techniques of Smart and Composite Materials

Introduction: Objective, scope and outcome of the course.
Polymers - molding of thermoplastics - plastic sheet forming process - machining of thermoplastics - Thermosetting plastics - properties, molding processes and machining - other processing methods for plastics - plastic component design.
Rubber: Manufacturing process - Manufacturing techniques, materials design, sizing, components, building, moulding and vulcanising of tyres - Belting – manufacture and types of hose.
Types, processing and manufacturing techniques of Glass vessels
Ceramic materials - Processing of ceramic products
Composite materials, Fiber, particulate, whisker reinforced ceramics, properties of reinforcements and matrix. Manufacturing Techniques and applications of different Composites namely PMC, MMC and CMC.

Suggested Readings:

1. E. P. DeGarmo, J. T Black, R. A. Kohser, Materials and Processes in Manufacturing, Prentice Hall of India
2. Blow C M,, "Rubber Technology and Manufacturing", Newman Butterworths, 1977
3. Vanviack L.H, "Physical Ceramics for Engineers", Addision Wesley Publicxation

1MEMMM3-12: HUMAN VALUES AND PROFESSIONAL ETHICS

Need, Basic Guidelines, Content And Process For Value Education:

Understanding the need, basic guidelines, Self Exploration - its content and process; 'Natural Acceptance' and Experiential Validation, Continuous Happiness and Prosperity- Human Aspirations, Right understanding, Relationship and Physical Facilities, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfill the above human aspirations: understanding and living in harmony at various levels

Understanding Harmony in the Human Being - Harmony in Myself:

Understanding human being as a co-existence of the sentient 'I' and the material 'Body' Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha Understanding the Body as an instrument of 'I', Understanding the characteristics and activities of 'I' and harmony in 'I' Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship: Understanding harmony in the Family, Understanding values in human- human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay- tripti; Trust (Vishwas) and Respect (Samman) , meaning of Vishwas; Difference between intention and competence, meaning of Samman, Difference between respect and differentiation; the other salient values in relationship, harmony in the society , Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals, Visualizing a

universal harmonious order in society- Undivided Society (AkhandSamaj), Universal Order (SarvabhaumVyawastha)- from family to world family.

Understanding Harmony in the Nature and Existence - Whole Existence as Coexistence: Understanding the harmony in the Nature. Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature. Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all pervasive Space. Holistic perception of harmony at all levels of existence

Implications of the Above Holistic Understanding of Harmony on Professional Ethics - Natural Acceptance of Human Values:

Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in Professional Ethics: a) Ability to utilize the professional competence for augmenting universal human order, b) Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies and management models. Strategy for transition from the present state to Universal Human Order: At the level of individual: as socially and ecologically responsible engineers, technologists and managers. Case studies related to values in professional life and individual life.

Suggested Readings:

1. R. R. Gaur, R Sangal, G P Bagaria, A Foundation Course in Human Values and Professional Ethics, Excel Books.
2. R. Subramanian, Professional Ethics includes Human Values, Oxford Univ. Press.
3. A. N. Tripathy, Human Values, New Age International Publishers.
4. M. Govindrajran, S. Natrajan, V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
5. B. P. Banerjee, Foundations of Ethics and Management, Excel Books.
6. B. L. Bajpai, Indian Ethos and Modern Management, New Royal Book Co

1MEMTE1-13: Thermal & I C Engine Lab

Practicals:-

1. Performance test on Spark Ignition engines.
2. Emission measurement in Spark Ignition and Compression Ignition Engines.
3. Performance test on variable compression ratio petrol and diesel engines.
4. Performance study in a cooling tower
5. Performance study in a refrigeration and heat pump systems
6. Performance Study in a solar water heater
7. Properties of fuel oils, biomass, biogas
8. Solar Radiation measurement
9. Performance of Hybrid vehicles
10. Performance of Heat Exchangers
11. Study on Fuel Cell Systems
12. Study on Thermal Storage Systems

1MEMMM4-14: FIELD WORK

Student is required to work in the organization/industry concerned with his/her course.

1MEMMM5-15: HUMAN VALUES PRACTICE SCHOOL

This practice school in first semester will have two parts -

I. Industry Interaction

In this, students will start his industry interaction in the very first semester of the M.Tech. Course. He/ She have to visit an organization for 3 hours /week in any industry finalized/selected by competent authority. This interaction will give him feel and insight to the real time working.

A. This 3 hours /work will be after the classroom studies

B. Selection criteria of organisation-
   1. Have turnover more than 20 lakhs
   2. Have more than 20 employees

C. During these hours, student will observe following points in the organisation:
   1. Organisational structure and hierarchy
   2. Different kind of jobs/works done by the employees at all levels in the company
   3. Working of different departments
   4. Types of skills require to work in an organisation
   5. Ways of internal and external communication
   6. Formal dressing and attitude
   7. Coordination and team work

II. Social Responsibility

To make students understand his role and responsibility in society & nature and co-existence as whole, student has to take an initiative towards contribution in any relevant social and environmental issue.

A. This work will be performed after the time of regular classes

B. Student will perform one or more of the following activities after the approval of mentor and HOD:

1. Making contribution in increasing the income of any street vender or any needy person from under privileged section.
2. Cleanliness Campaign
3. Donation of his/her belongings which is of no use to him/her to needy ones
4. Plantation and care for nature (soil, natural resources, plants and animals)
5. Girl child and women safety, education and empowerment.
6. Blood donations and help of needy people at hospitals
7. Helping the under – privileged section of the society
8. Educating the street children or in schools when and where needed.
9. Nukkad Natak on any topic of social or environmental concern.
10. Any other relevant activities.

SEMESTER- II

2MEMME1-01: FINITE ELEMENT METHOD

Introduction to Finite Element Method: Basic Steps in Finite Element Method to solve mechanical engineering (Solid, Fluid and Heat Transfer) problems, Functional approach and Galerkin approach, Displacement Approach, Admissible Functions, Convergence Criteria, Conforming and Non Conforming elements, Continuity Elements, Basic Equations, Element Characteristic Equations, Assembly Procedure, Boundary and Constraint Conditions.

Solid Mechanics : One-Dimensional Finite Element Formulations and Analysis, uniform, varying and stepped cross section- Basic(Linear) and Higher Order Elements Formulations for Axial, Torsional and Temperature Loads with problems, Beams- Basic (Linear) Element Formulation-for uniform, varying and stepped cross section- for different loading and boundary conditions with problems, Trusses, Plane Frames and Space Frame Basic (Linear) Elements Formulations for different boundary condition -Axial, Bending, Torsional and Temperature Loads with problems. **Two Dimensional Finite Element Formulations for Solid Mechanics Problems:** Triangular Membrane (TRIA 3, TRIA 6, TRIA 10) Element, Four-Noded Quadrilateral Membrane (QUAD 4, QUAD 8) Element Formulations for in-plane loading with sample problems. Triangular and Quadrilateral Axi-symmetric basic and higher order Elements formulation for axi-symmetric loading only with sample problems Three Dimensional Finite Element Formulations for Solid Mechanics Problems: Finite Element Formulation of Tetrahedral Element (TET 4, TET 10), Hexahedral Element (HEXA 8, HEXA 20), for different loading conditions, Serendipity and Lagrange family Elements.

Finite Element Formulations for Structural Mechanics Problems: Basics of plates and shell theories: Classical thin plate Theory, Shear deformation Theory and Thick Plate Theory, Finite Element Formulations for triangular and quadrilateral Plate elements, Finite element formulation of flat, curved, cylindrical and conical Shell elements.

Dynamic Analysis: Finite Element Formulation for point/lumped mass and distributed masses system, Finite Element Formulation of one dimensional dynamic analysis: bar, truss, frame and beam element. Finite Element Formulation of Two dimensional dynamic analysis: triangular membrane and axisymmetric element, quadrilateral membrane and axisymmetric element, Evaluation of eigen values and eigen vectors applicable to bars, shaft, beams, plane and space frame.

Suggested Readings:

1. T. R. Chandrupatla, A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall.
2. H. V. Lakshminarayana, Finite Elements Analysis – Procedures in Engineering, Universities Press.
3. S. S. Rao, Finite Elements Method in Engineering, Elsevier.
4. P. Seshu, Textbook of Finite Element Analysis, PHI.
5. J. N. Reddy, Introduction to Finite Element Method, McGraw –Hill.
6. K. J. Bathe, Finite Element Procedures, Prentice-Hall.
7. R. D. Cook, Finite Element Modeling for Stress Analysis, Wiley.

2MEMME1-02: Industrial Automation and Robotics

Introduction to Automation: Automation production system, Mechanization and automation, Types of automation, Automation strategies, Mechanical, electrical, hydraulic and Pneumatic automation devices and controls, Economics of automation.

High Volume Manufacturing Automation: Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multimodel and mixed model production lines.

Programmable Manufacturing Automation: CNC machine tools, Machining centers, Programmable robots, Robot time estimation in manufacturing operations.

Flexible Manufacturing Automation: Introduction to Group Technology, Grouping methods, Cell Design, Flexible manufacturing system.

Assembly Automation: Assembly systems, Automatic transfer, feeding and orienting devices, Flexible assembly systems, Performance evaluation and economics of assembly systems.

Robotics: Review of robotic technology and applications, Laws of robotics, Robot systems and anatomy, Robot classification, End Effectors, Robot kinematics, Object location, Homogeneous transformation, Direct and inverse kinematics, Manipulator motions, Robot drives, actuators and control, Drive systems, Hydraulic, Pneumatic Electrical DC and AC servo motors and stepped motors, Mechanical transmission method- Rotary-to-rotary motion conversion, Robot motion and path planning control and Controllers, Robot sensing, Range sensing, Proximity sensing, touch sensing, Force and torque sensing etc., Robot vision, Image representation, Image recognition approaches.

Robot Applications: Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference, Economics and social aspects of robotics, Future applications.

Suggested Readings:

1. Groover, Weiss, Nagel, Industrial Robotics, McGraw Hill International.
2. YoramKoren, Robotics for Engineers , McGraw Hill International.
3. R. K Mittal, I. J. Nagrath, Robotics and Control, tata Mc-Graw Hill.
4. K. S Fu, R. C. Gonzalex, Robotics Control and Sensing, Vision and Intelligence, Mc-Graw Hill Book Co.

2MEMME1-03: Analysis of Newer Machining Methods

Introduction to Non-traditional machining processes: Classifications of material removal processes, need for non-conventional or non-traditional processes, characteristics of non-traditional material removal (machining) processes.

Non-traditional machining processes (Chemical & Electrochemical): Chemical and photo-chemical machining, electrochemical machining, electrochemical grinding their working principles, equipment, process parameters, advantages, disadvantages and applications.

Non-traditional machining processes (Mechanical): Ultrasonic machining, Abrasive jet machining, Water jet machining, Abrasive water jet machining, their working principles, equipment, process parameters, advantages, disadvantages and applications.

Non-traditional machining processes (Thermal): Electric discharge machining, Laser beam machining, Electron beam machining, Plasma machining their working principles, equipment,

process parameters, advantages, disadvantages and applications.

Suggested Readings:

1. G.F. Benedict, Non-traditional Manufacturing Processes, Marcel Dekker, Inc. New York.

2. Vijay K. Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd., New Delhi.

3. S. Kalpakjian, Manufacturing Engineering & Technology, Pearson Education Asia.

4. E. P. DeGarmo, J. T Black, R. A. Kohser, Materials and Processes in Manufacturing, , Prentice Hall of India, New Delhi

5. A. Ghosh, and A. K. Mallik, Manufacturing Science, Affiliated East-West Press Pvt. Ltd. New Delhi.

6. P.C. Pandey, H. S. Shan, Modern Machining Processes, Tata McGraw-Hill, New Delhi

1MEMMD2-04: Tribology

Introduction: Tribology, Historical background, practical importance and subsequent use in the field.

Lubricants: Types and specific field of applications, Requisite properties of lubricants, Viscosity; its measurement, effect of temperature and pressure on viscosity, standard grades of lubricants, selection of lubricants, Lubricant Rheology, Lubrication Types, Basic equation of lubrication. **Friction:** Origin, Friction Theories, measurement methods, friction of metals and non-metals. **Wear:** Classification and Mechanisms of Wear, Delamination theory, Debris analysis, testing methods and standards, wear mechanism maps and approach to wear reduction, Related Case Studies.

Surface Roughness: Standardization, measurement with contacting and non-contacting instruments, Statistical analysis of surface, characteristics of the surface, tribological behaviour of asperities contact.

Behaviour of Tribological Components: Plain & Antifriction Bearings: selection, effect of frictional torque, factors affecting performance, failure modes, bearing lubrication. **Hydrodynamic Bearings:** Mechanism of pressure development, classification, Idealized Journal Bearing, oil film thickness, pressure distribution, load carrying capacity, Failure Case Studies. **Elasto-Hydrodynamic Lubrication:** Theoretical considerations, line and point contacts, film thickness equations, different regimes in EHL contact.

Antifriction Bearings: Ball and roller bearings, geometry of ball bearings, radial load distribution, stresses and deformations, lubrication of ball bearings, Failure Case Studies. **Monitoring of Equipment's Condition:** Condition monitoring techniques, lubricant, corrosion, temperature & surface roughness monitoring, Nano/Micro Tribology, Green Tribology.

Suggested Readings:

1. Prasanta Sahoo, Engineering Tribology, Prentice Hall of India Pvt. Ltd.

2. S.K. Basu, S.N. Sengupta, B.B. Ahuja, Fundamentals of Tribology, PHI Learning Pvt. Ltd.

3. S.K. Shrivastava, Tribology in Industries, S. Chand & Company Ltd.

4. A. Harnoy, Bearing Design in Machinery, Engineering Tribology and Lubrication, Marcel Dekker Inc.

5. G.W. Stachowiak, A.W. Batchelor, Engineering Tribology, Elsevier India Pvt. Ltd.

6. B.C. Majumdar, Introduction to Tribology of Bearings, S. Chand & Company Ltd.

7. T.A. Harris, Rolling Bearing Analysis, John Wiley & Sons, Inc.

8. J. Williams, Engineering Tribology, Cambridge University Press.

2MEMME2-05: Additive Manufacturing

Additive Manufacturing Process: Basic Principles of the Additive Manufacturing Process, Generation of Layer Information, Physical Principles for Layer Generation. Elements for Generating the Physical Layer, Classification of Additive Manufacturing Processes, Evaluation of the Theoretical Potentials of Rapid Prototyping Processes.

Machines for Rapid Prototyping: Overview of Polymerization: Stereolithography (SL), Sintering/Selective Sintering: Melting in the Powder Bed, Layer Laminate Manufacturing (LLM) and Three-Dimensional Printing (3DP).

Rapid Prototyping: Classification and Definition, Strategic Aspects for the Use of Prototypes, Applications of Rapid Prototyping in Industrial Product Development. Rapid Tooling: Classification and Definition of Terms, Properties of Additive Manufactured Tools, Indirect Rapid **Tooling Processes:** Molding Processes and Follow-up Processes, Indirect Methods for the Manufacture of Tools for Plastic Components, Indirect Methods for the Manufacture of Metal Components.

Direct Rapid Tooling Processes: Prototype Tooling: Tools Based on Plastic Rapid Prototyping Models and Methods, Metal Tools Based on Multilevel AM Processes, Direct Tooling: Tools Based on Metal Rapid Prototype Processes.

Suggested Readings

1. Andreas Gebhardt Jan-Steffen Hötter, Additive Manufacturing: 3D Printing for Prototyping and Manufacturing, Hanser Publications, 6915 Valley Avenue, Cincinnati, Ohio.
2. Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies:
3. 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Second Edition, Springer New York Heidelberg Dordrecht London.
4. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2007.
5. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. 3. Hilton P.D. and Jacobs P.F., "Rapid
6. Tooling: Technologies and Industrial Applications", CRC press, 2000.

2MEMME2-06: Computer Aided Design and Manufacturing

Introduction: Definition and scope of CAD/CAM, Introduction to design process and role of computers in the design process.
Transformations: 2D and 3D transformations.
Curves and Surfaces: Analytical, Synthetic curves with advantages, Disadvantages, Comparison with parametric curves, Geometric modeling curves and surfaces, Representation, Wire frame models, Parametric representations, Parametric curves and surfaces.
Solid modeling: Solid models, Fundamentals of solid modeling, Different solid representation schemes, Half -spaces, Boundary representation (B-rep), Constructive solid geometry (CSG).
CAD/CAM Data Exchange Formats: Types of file formats & their exchange, Graphics standards.
Simulation: Need of simulation , concept of a system, Model and its purpose , Types of simulation approaches-Event Scheduling Approach (ESA) , Activity Scanning Approach (ASA), Process Interaction Approach (PI A), Steps in a simulation study , advantage s disadvantages and pitfalls of simulation ,Simulation Languages.
Computer Aided Manufacturing : CNC machine tools, principle of operation of CNC, Steps in manufacturing , construction features including structure and drives, Direct numerical control (DNC) and its application, advantages and limitations of CNC systems.
Computer Assisted Part Programming: CNC part programming, axes of CNC machines, manual part

programming using G code, use of subroutines, computer aided part programming using APT or any other language, Automatic NC program generation from CAD models, Machining of surfaces, Mould, Casting and Die design and manufacture using CAD/CAM software.

Suggested Readings

1. Zeid, I., "CAD/CAM", McGraw Hill, 2008.
2. Rogers, D. F. and Adams, J. A., "Mathematical Elements for Computer Graphics", McGraw Hill 2nd edition, 1989.
3. Radhakrishnan, P. and Kothandaraman, C. P., "Computer Graphics & Design", Dhanpat Rai Publication", 2nd edition, 2005.
4. Krishnamoorathy, C. S. and Rajeev, J. S., "Computer Aided Design (Software and Analysis Tools)",Narosa Publication House, 2nd edition, 2005.

2MEMME2-07: Fracture Mechanics

History of Failure by Fracture: failure of structures, bridges, pressure vessels and ships, brittle fracture, development of testing for failure, identification of reasons for failure, existence of crack, Griffith crack and experiment, energy release rate and stress for failure in presence of crack.

Stress Field Around Crack Tip: revision of theory of elasticity, conformal mapping, Airy's stress function for crack tip stress field with crack emanating from straight boundary, stress state in crack tip vicinity, modes of crack face deformation, stress intensity factor and Irwin's failure criterion, fracture toughness.

Determination of Stress Intensity Factor, different specimen configuration, numerical techniquesboundary collocation and boundary integral, finite element method, experimental method-reflection and refraction polariscopy, Determination of fracture toughness.

Energy Consideration; potential energy, surface energy, plastic deformation around crack tip, energy release rate, compliance and correlation with fracture toughness, crack opening displacement (COD), COD as fracture criterion, experimental determination of COD, use of fracture toughness and COD as design criteria.

Crack Propagation; law of fatigue crack propagation, life calculation when a crack is present and loaded, microscopic aspects of crack propagation, elastic crack and plastic relaxation at crack tip.

Suggested Readings:

1. David and Bruck, Elementary Engineering Fracture Mechanics, Norelco.
2. S.T. Rolfe, J.M. Barson, Fracture and Fatigue Control in Structure, Prentice Hall.
3. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, CRC Press.
4. A.S. Tetelman, A.J. McEvily, Fracture of Structural Materials, John Wiley and sons.
5. Abdul Mubeen, Machine Design, Khanna Publishers.

2MEMME2-08: Signal Analysis and Condition Monitoring

Introduction, Basic concepts.Fourier analysis.Bandwidth. Signal types. Convolution. Signal analysis: Filter response time. Detectors.Recorders.Analog analyzer types.

Analysis of Stationary Signals: Stepped filter analysis. Swept filter analysis. High speed analysis.Real-time analysis.

Analysis of Continuous Non-Stationary Signals: Choice of window type. Choice of window length.Choice of incremental step.Practical details.Scaling of the results.

Analysis of Transients: Analysis as a periodic signal. Analysis by repeated playback (constant bandwidth).Analysis by repeated playback (variable bandwidth).

Condition Monitoring in Real Systems: Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan.Sugar centrifugal.Cooling tower fan.Air separator.Preheater fan.Field balancing of rotors. ISO standards on vibrations, active, passive hybrid methods of condition monitoring

Suggested Readings

1. Condition Monitoring of Mechanical Systems / Colcote.
2. Frequency Analysis /R.B.Randall.
3. Mechanical Vibrations Practice with Basic Theory / V. Ramamurti/ Narosa Publishing House.
4. Theory of Machines and Mechanisms/ Amitabh Ghosh& AK Malik/ E

2MEMME2-09: Forming Processes and Analysis

Metal Forming: Classification of forming processes, mechanism of metal forming, temperature of metal working, hot working, cold working, friction and lubricants, forming defects.

Rolling: Rolling processes, forces and geometrical relationship in rolling, simplified analysis, rolling load, rolling variables, theories of cold and hot rolling, defects in rolling, torque and power calculations.

Forging: Classification of forging processes, forging of plate, forging of circular disc, open die and closed die forging, forging defects and powder metallurgy.

Extrusion: Classification, hot and cold extrusion, analysis of extrusion process, defects in extrusion, extrusion of tubes, and production of seamless pipes.

Drawing: Drawing of rods and wires, tube drawing process, and deep drawing.

Sheet Metal Forming: Forming methods, bending, stretch forming, spinning, and advanced techniques of sheet metal forming, forming limit criteria, defect in formed parts.

Advanced Metal Forming Processes: High energy rate forming, electro-magnetic forming, explosive forming, electro hydraulic forming, stretch forming, and contour roll forming.

Introduction to Press Tool Design: Design of various press tools and dies like piercing dies, blanking dies, compound dies and progressive blanking dies, design of bending, forming, and drawing dies.

Suggested Readings:

1 G. E. Dieter, Mechanical Metallurgy, Tata McGraw Hill.

2 Sunder Kumar, Principles of Metal Working, Oxford & IBH Publishing Company.

3 G.W. Rowe, Principles of Metal Working Processes, CBS Publishers & Distributors

4 Roy A. Lindberg, Processes & Materials of Manufacture, Prentice Hall India Learning Private Limited.

5 S. Dalela, Manufacturing Science & Technology Vol- I , S Chand & Company Pvt Ltd

6 S. Kalpajian, Schmit, Manufacturing Processes for Engineering Materials, Pearson Publications.

7 A. Ghosh, A. K. Mallik, Manufacturing science, East-West Press Pvt Ltd

2MEMME2-10: Intelligent Manufacturing Systems

Computer Integrated Manufacturing Systems: structure and functional areas of cim system- CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

Components Of Knowledge Based Systems - Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference

Engine, Knowledge Acquisition.

Machine Learning - Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

Automated Process Planning - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) - Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KRSES.

Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) — Data Base, Knowledge Base, Clustering Algorithm.

Suggested Readings:

1. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
2. Artificial Neural Networks/ Yagna Narayana/PHI/2006
3. Automation, Production Systems and CIM / Groover M.P./PHI/2007

1MEMMD2-11: Reverse Engineering

Introduction: Scope and tasks of RE - Domain analysis process of duplicating

Tools for Reverse Engineering: Functionality- dimensional- developing technical data, digitizing techniques, construction of surface model, solid-part material, characteristics evaluation, software and application, prototyping verification

Concepts: History of Reverse Engineering, Preserving and preparation for the four stage process, Evaluation and Verification, Technical Data Generation, Data Verification, Project Implementation.

Data Management: Data Reverse Engineering, Three data Reverse engineering strategies, Definition organization data issues, Software application, Finding reusable software components, Recycling real time embedded software, Design experiments to evaluate a Reverse Engineering tool, Rule based detection for reverse Engineering user interfaces, Reverse Engineering of assembly programs: A model based approach and its logical basics.

Integration: Cognitive approach to program understated - Integrating formal and structured methods in reverse engineering, integrating reverse engineering, reuse and specification tool environments to reverse engineering, coordinate measurement, feature capturing, surface and solid members

Suggested Readings:

1. T. J. Biggerstaff, Design Recovery for Maintenance and Reuse, IEEE Corpn.
2. S. Rugaban, White paper on RE, Technical Report, Georgia Instt. of Technology.
3. Katheryn, A. Ingle, Reverse Engineering, McGraw-Hill.
4. Peter H. Aiken, Data Reverse Engineering, McGraw-Hill.
5. Linda Wills, Reverse Engineering, Kluiver Academic Publishers.

2MEMME3-12: Research Methodology

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to

the society in general. Defining the Research Problem, Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. Literature Review, Need of Review, Guidelines for Review, Record of Research Review.

Research Design: Meaning of Research Design, Need of Research Design, and Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software. Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, student's t- test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids, Intellectual property, Plagiarism. Research Proposal Preparation: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Suggested Readings:

1. C.R Kothari, Research Methodology, Methods & Technique, New Age International Publishers, 2004.
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011.
3. Ratan Khananabis and Suvasis Saha, Research Methodology, Universities Press, Hyderabad, 2015.
4. Y. P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004.
5. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009.
6. G. Nageswara Rao, Research Methodology and Quantitative methods, BS Publications, Hyderabad, 2012.
7. Naval Bajjai, Business Research Methods, Pearson 2011. 8. Prahalad Mishra, Business Research Methods, Oxford 2016.

2MEMME1-13: CAD/ CAM LAB

1. Manual part programming using G and M codes for Turning, step turning, taper turning, thread cutting and radius turning on cylindrical components.
2. Given a component drawing to write the manual part programming and execute on CNC lathe and milling machine.
3. Programming and simulation of machining using the following features.(i) Linear and Circular interpolation(ii) Pocket milling, slotting, peck drilling and other fixed canned cycles.

4. Design and developing a CAD model for a product/part and generating automatically a program for CNC machine.
5. Exercises on robot with programming.

List of facilities required 1. CNC Lathe with Fanuc® / Siemens® Control.
2. CNC Milling Machine with Fanuc® / Siemens® control.
3. Master CAM® / Machining module of Hyperworks® software or any other with similar features.
4. Computer Workstations with Robot.

2MEMME4-14: FIELD WORK

Student is required to work in the organization/industry concerned with his/her course.