CENTRE FOR ADVANCED STUDIES

Dr. APJ Abdul Kalam Technical University, Lucknow

SYLLABUS FOR M.TECH (Manufacturing Technology and Automation)

Effective from 2019-20

INDEX

MARKS DISTRIBUTION

Following is marks distribution for courses depending upon the credit of the courses:

(1 credit = 50 marks)

Credit	**Type of course**	**Max. Marks**	**Major (End semester examination)**	**Performance evaluation**		**Lab evaluation**
				Minor I & II	**Internal Assessments (Attendance, Quiz, Seminar & Assignments)**	
1	Lab course	50	25	25		-
2	Theory course	100	50	30 (15 each)	20	-
3	Theory course	150	75	40 (20 each)	35	-
4	Theory course with lab	200	75	40 (20 each)	35	50
4	Thesis / dissertation-I	350	200	150		-
5	Thesis / dissertation-II	650	400	250		-

Note: Maximum Marks is fixed for all the courses. Only internal assessments and lab evaluation marks distribution may vary as per the instructions communicated by the assigned Faculty. Refer to M.Tech Ordinance & Regulation for Assessment Procedures and Performance Evaluation.

SEMESTER-I

CORE COURSES

Course Code: MMTA-101,
Course Name: Advanced Engineering Mathematics
Credit: 3
Syllabus:
Prerequisite NIL

Linear Algebra: Matrix algebra; basis, dimension and fundamental subspaces; solvability of Ax = b by direct Methods; orthogonality and QR transformation; eigenvalues and eigenvectors, similarity transformation, singular value decomposition, Fourier series, Fourier Transformation, FFT.

Vector Algebra & Calculus: Basic vector algebra; curves; grad, div, curl; line, surface and volume integral, Green's theorem, Stokes's theorem, Gauss-divergence theorem.

Differential Equations: ODE: homogeneous and non-homogeneous equations, Wronskian, Laplace transform, series solutions, Frobenius method, Sturm-Liouville problems, Bessel and Legendre equations, integral transformations; PDE: separation of variables and solution by Fourier Series and Transformations, PDE with variable coefficient.

Numerical Technique: Numerical integration and differentiation; Methods for solution of Initial Value Problems, finite difference methods for ODE and PDE; iterative methods: Jacobi, Gauss-Siedel, and successive over-relaxation.

Complex Number Theory: Analytic function; Cauchy's integral theorem; residue integral method, conformal mapping. Statistical Methods: Descriptive statistics and data analysis, correlation and regression, probability distribution, analysis of variance, testing of hypothesis.

Texts / Reference Books:

1. H. Kreyszig, "Advanced Engineering Mathematics", Wiley, (2006).
2. Gilbert Strang, "Linear Algebra and Its Applications", 4th edition, Thomson Brooks/Cole, India (2006).
3. J. W. Brown and R. V. Churchill, "Complex Variables and Applications", McGraw-Hill Companies, Inc., New York (2004).
4. J. W. Brown and R. V. Churchill, "Fourier Series and Boundary Value Problems", McGraw-Hill Companies, Inc., New York (2009).
5. G. F. Simmons, "Differential Equations with Applications and Historical Notes", Tata McGraw-Hill Edition, India (2003).
6. S. L. Ross, "Differential Equations" 3rd edition, John Wiley & Sons, Inc., India (2004).
7. K. S. Rao, "Introduction to Partial Differential Equations", PHI Learning Pvt. Ltd (2005).
8. R. Courant and F. John, "Introduction to Calculus and Analysis, Volume I and II", Springer-Verlag, New York, Inc. (1989).
9. K. Atkinson and W. Han, "Elementary Numerical Analysis" 3rd edition, John Wiley & Sons, Inc., India
(2004).
10. R. A. Johnson and G. K. Bhattacharya, "Statistics, Principles and Methods", Wiley (2008).

Course Code: MMTA-102
Course Name: Metal Removal Processes
Credit: 3
Syllabus:
Prerequisite NIL

Introduction: Machining Process, Types of machining processes; Chip formation; Orthogonal and Oblique Cutting; Types of Chips; Built-up edge formation. Tool Geometry: Reference planes; Tool specification: American System (ASA), continental or Orthogonal System (ORS), International or Normal Rake system (NRS);
Mechanics of Metal Cutting: Cutting parameters; Orthogonal and Oblique cutting;
Mechanics of Metal Cutting: Chipping action Merchant's Circle Diagram; Co-efficient of Friction: Determination of stress, strain and strain rate; Measurement of shear angle; Thin Zone model: Lee and Shaffer's Relationship.
Friction in Metal Cutting: Nature of sliding friction; Friction in Metal Cutting: Sticking and Sliding Zones, Analysis of Stress.
Mechanism of Oblique cutting, Measurement of cutting Forces, Basic methods of measurement, Measurement of temperature; chip thickness ratio. Tool Material, Types of tool wear;
Mechanisms of wear: Abrasion, Adhesion and Diffusion. Progressive tool wear: flank and crater wear. Tool Life: variables affecting tool life - cutting conditions, tool geometry, Types of tool materials, fabrication of cutting inserts, coatings, work material and cutting fluid, Economic of Machining. Thermal Aspects of Machining.

Texts / Reference Books:

1. E.J.A. Armarego and R.H.Brown-The machining of Metals
2. G Boothroyd-Fundamentals of Metal Machining and Machine tools
3. A.Ghosh and Asok Mallik- Machining Science
4. G.K.Lal and S.K.Choudhury-Fundamental of Manufacturing Processes
5. M.C.Shaw-Metal Cuttting Principle
6. Materials and Processes in Manufacturing, Degarmo, J. T. Black, Prentice Hall Of India Pvt Ltd.
7. Manufacturing Processes for Engineering Materials, Kalpakjian and Schmid, Prentice Hall.
8. Principles of Machine Tools, G. C. Sen and A, Bhattacharya, New Central Book Agency
9. Theory of Metal Cutting, A. Bhattacharya.
10. Manufacturing Science: Ghosh and Mallick, East-West Press Private Limited
11. Machining and Metal Working Handbook, Ronal A Walsh and Denis Cormier McGraw Hill Publication.

Course Code: MMTA-103
Course Name: Materials Processing
Credit: 3
Syllabus:
Prerequisite NIL

Solidification processing: Plane front solidification, cellular solidification, cellular-dendritic transition, Theories of regular and irregular eutectic growth, Rheocasting, Thixocasting, casting of composites; Powder processing: preparation of metallic, ceramic and composite powders; Sintering and full density

processing; Metal forming processes: Deformation theories, Applications in rolling, forging, extrusion, machining; Processing of new materials: nanomaterials and biomaterial; Joining of materials: Fundamentals of liquid and solid state joining, friction stir welding, joining of similar and dissimilar materials; Processing of minerals, particulate materials; characterization of particles; crushing, grinding and classification; minerals separation using gravity techniques, electrical and magnetic methods, froth flotation, de-watering using thickening, filtration and drying operations; effluent processing and tailings disposal; Processing of ceramics: Crystal Systems, Amorphous Systems - Glass, Phase Equilibrium, Sintering of ceramics, Microstructure of Ceramics, Mechanical Properties, Thermal Properties, Optical Properties, Electrical and Magnetic Properties, Chemical Properties Traditional Ceramic Raw Materials, Non-Traditional and Special Ceramic Raw Materials, Glass ceramics, Bio implants, Advanced ceramics; Material processing from solid waste from metal industry and thermal power plants.

Texts / Reference Books:

1. Porter, Easterling and Sherif, Phase Transformation in metals and alloys
2. Randall M. German, Powder Metallurgy & Particulate Materials Processing
3. WD Kingery, HK Bowen, DR Uhlmann, Introduction to ceramics
4. B.A. Wills and T. Napier-Munn, Wills' Mineral Processing Technology
5. E.G. Kelly and D.J. Spottiswood, Introduction to Mineral Processing

Course Code: MMTA-104
Course Name: Sensors and Actuators
Credit: 3
Syllabus:
Prerequisite NIL

Brief overview of measurement systems, classification, characteristics and calibration of different sensors. Measurement of displacement, position, motion, force, torque, strain gauge, pressure flow, temperature sensor sensors, smart sensor. Optical encoder, tactile and proximity, ultrasonic transducers, opto-electrical sensor, gyroscope. Principles and structures of modern micro sensors, micro-fabrication technologies: bulk micromachining, surface micromachining, LIGA, assembly and packaging.
Pneumatic and hydraulic systems: actuators, definition, example, types, selection. Pneumatic actuator. Electro-pneumatic actuator. Hydraulic actuator, control valves, valve sizing valve selection. Electrical actuating systems: solid-state switches, solenoids, voice coil; electric motors; DC motors, AC motors, single phase motor; 3-phase motor; induction motor; synchronous motor; stepper motors. Piezoelectric actuator: characterization, operation, and fabrication; shape memory alloys.

Texts / Reference Books:

1. John G. Webster, Editor-in-chief, "Measurement, Instrumentation, and Sensors Handbook", CRC Press (1999).
2. Jacob Fraden, "Handbook of modern Sensors", AIP Press, Woodbury (1997).
3. Nadim Maluf, "An Introduction to Microelectromechanical Systems Engineering", Artech House Publishers, Boston (2000).
4. Marc Madou, "Fundamentals of Microfabrication", CRC Press, Boca Raton (1997).

5. Gregory Kovacs, “Micromachined Transducers Sourcebook”, McGraw-Hill, New York (1998).
6. E. O. Deobelin and D. Manik, “Measurement Systems – Application and Design”, Tata McGraw-Hill (2004).
7. D. Patranabis, “Principles of Industrial Instrumentation”, Tata McGraw-Hill, eleventh reprint (2004).
8. B. G. Liptak, “Instrument Engineers’ Handbook: Process Measurement and Analysis”, CRC (2003).

Elective- I

Course Code: MMTA-111
Course Name: Friction, wear and lubrication
Credit: 3
Syllabus:
Prerequisite NIL

Introduction: Fundamentals of Tribology
Engineering surfaces, nature of surface and surface measurements.
Friction: Origin of Friction; Friction theories; Measurement methods.
Wear: Types of wear - adhesive, abrasive, fatigue, corrosive etc.; testing methods; Wear debris analysis; Wear reduction methods.
Lubrication: Basic equations of the theory of lubrication, calculation of oil flow rate; Methods of lubrication; Types of industrial lubricants and their standard grades; Boundary, hydrostatic and hydrodynamic lubrication.

Texts / Reference Books:
1. Principles of Tribology J. Halling
2. Engineering Tribology Prasanth Sahoo
3. Friction & Wear B. Pugh
4. Fundamentals of Tribology Basu, Sengupta, Ahjua
5. Friction, Wear, Lubrication K. C Ludema

Course Code: MMTA-112
Course Name: Finite element method
Credit: 3
Syllabus:
Prerequisite NIL

Introduction to Finite Difference Method and Finite Element Method, Advantages and disadvantages, Mathematical formulation of FEM, Variational and Weighted residual approaches, Shape functions, Natural co-ordinate system, Element and global stiffness matrix, Boundary conditions, Errors, Convergence and patch test, Higher order elements. Application to plane stress and plane strain problems, Axi-symmetric and 3D bodies, Plate bending problems with isotropic and anisotropic materials, Structural stability, other applications e.g., Heat conduction and fluid flow problems. Idealisation of stiffness of beam elements in beam-slab problems, Applications of the method to materially non-linear problems, Organisation of the Finite Element programmes, Data preparation and mesh generation through computer

graphics, Numerical techniques, 3D problems, FEM an essential component of CAD, Use of commercial FEM packages, Finite element solution of existing complete designs, Comparison with conventional analysis.

Texts / Reference Books:

1. Introduction to Finite Elements in Engineering, T. R. Chandrupatla & A. D. Belegundu, 2nd Ed., PHI, 2001.
2. An Introduction to the Finite Element Method, Reddy, J. N., 2005.
3. The Finite Element Method, O. C. Zienkiewicz, 3rd Ed., McGraw-Hill, 1997.
4. The Finite Element Method in Engineering, S. S. Rao, 2nd Ed., Elmsford, Pergamon, 1989.
5. Introduction to the Finite Element Method: A Numerical Method for Engineering Analysis, Desai, C. S. and Abel, J. F., 1972
6. The Finite Element Method O.C. Zienkiewicz and R.L. Taylor McGraw Hill
7. Finite Element Procedure in Engineering Analysis K.J. Bathe McGraw Hill
8. Finite Element Analysis C.S. Krishnamoorthy Tata McGraw Hill
9. Concepts and Application of Finite Element Analysis R.D. Cook, D.S. Malcus and M.E. Plesha John Wiley
10. Finite Element and Approximation O.C. Zenkiewicy & Morgan

Course Code: MMTA-113
Course Name: Precision Engineering
Credit: 3
Syllabus:
Prerequisite NIL

Introduction to precision engineering for manufacturing. Emphasis on design and performance of precision machinery for manufacturing. machine tool elements and structure, sources of error: thermal, static, dynamic and process related; precision machining processes and process model: diamond turning, fixed and free abrasive processes, sensors for process monitoring and control, metrology, actuators, examples of precision component manufacture, role of CAD/CAM in precision manufacturing, and aspects of sustainable manufacturing and design for sustainability.

Texts / Reference Books:

1. Precision Manufacturing, by David Dornfeld and Dae-Eun Lee, Springer, 2008.
2. Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer.
A. H. Slocum, Precision Machine Design, 1992, Prentice-Hall.
3. H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
4. P. Seyfried, H. Kuntzmann, P. McKeown and M. Weck, eds., Progress in Precision Engineering, Springer-Verlag, 1991.
5. C. Evans, Precision Engineering; An Evolutionary View, Cranfield Press, 1989.
6. Tlusty, J., Manufacturing Processes and Equipment, Prentice-Hall, Upper Saddle River NJ, 2000.
7. Thomas, T. Rough Surfaces, 2nd ed., Imperial College Press, London, 1999.
8. Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.

Course Code: MMTA-114
Course Name: Composite Materials
Credit: 3
Syllabus:
Prerequisite NIL

Introduction to composites: Basic concepts, Structural applications, Classification, Strength and stiffness advantages, manufacturing aspects of composites.

Micro-mechanics : Mechanics of materials method, Bounding methods, Semiemperical methods, Longitudinal and Transverse elastic properties, Inplane Shear modulus, Stress – strain relations for General anisotropic, Specially orthotropic and Transversely isotropic Materials, 2D Transformation of Stress – strain, Elastic parameters, Engineering constants, 3D Transformation of Stress – strain, and Elastic parameters.

Macro-mechanics: Strength analysis of Unidirectional Lamina under various loading conditions, Failure theories, Computational procedure for determination of Lamina strength – Tsai – Wu criterion.

Elastic behavior of Multidirectional laminates – symmetric and asymmetric laminates, Computational procedure for determination of engineering elastic properties, Carpet plots for multidirectional laminates.

Stress and failure analysis of multidirectional laminates, Hygrothermal effects, Experimental methods for characterization and testing of Composite materials. design of laminates.

Texts / Reference Books:

1. Mechanics of composite materials, R. M. Jones, 2nd Edn. Ttaylor & Francis, 1999.
2. Engineering mechanics of composite materials, I. M. Daniel & O. Ishai, 2nd Edn., Oxford University Press, 2006.
3. Principles of composite material mechanics, R. F. Gibson, 2nd Edn. CRC Press, 2007

MME 52107 Micro-Electro-Mechanical-Systems (MEMS) (3-0-0)

Introduction to MEMS & materials, fabrication processes, MEMS sensors and actuators, scaling issues in MEMS, electro mechanics, modelling and design techniques, packaging and reliability, measurement techniques for MEMS.

References:

1. MEMS: Introduction and Fundamentals by Mohamed Gad-el-Hak –
2. MEMS mechanical sensors by Stephen Beeby
3. Microsensors, MEMS, and smart devices by Julian W. Gardner, V. K. Varadan, Osama O. Awadelkarim
4. MEMS and microsystems: design, manufacture, and nanoscale engineering- Tai-Ran Hsu –
5. MEMS by N P Mahalik

Course Code: MMTA-115
Course Name: Automation and Control
Credit: 3
Syllabus:
Prerequisite NIL

Introduction; Mathematical models of physical system; Feedback characteristics of control systems; Control systems and components; Time response analysis, design specifications and performance indices; Concepts of stability and algebraic criteria; Root locus technique; Frequency response analysis; Stability in frequency domain; State variable analysis and design; Controllability and Observability; Optimal

control; Adaptive control; Open loop control and closed loop control, Positive and negative feedback, Stepper motor and servo motor, PTP and Continuous control, PID Control Introduction to digital control systems; 8085/8080A Microprocessor architecture and programming.

Texts / Reference Books:

1. Automatic Control Engineering by F.H.Raven, 5th ed., McGrawHill International.
2. Modern Control Engineering by K.Ogata, Prentice Hall.
3. Digital Control Systems by B.C.Kuo, Prentice Hall.
4. Microprocessor architecture, programming, and applications with the 8085/8080A by Ramesh S. Gaonkar, Wiley Eastern Ltd.
5. Fundamentals of Linear State Space Systems by John S. Bay, WCB/McGraw-Hill

Course Code: MMTA-116
Course Name: Thermo Production Processes
Credit: 3
Syllabus:
Prerequisite NIL

INTRODUCTION: Need and Classifications of Thermo-production Processes; METAL CASTING: Need and Limitations; Classification of Casting Processes; Sand Mould Casting: Classification of foundry sands; Composition, Properties and Testing of Moulding Sand; Design of Pattern and Core; Parting Line Design; Gating System Design-Types of gating systems; Design of pouring basin, sprue, runner and ingate; Mould filling velocity and time including friction and velocity distribution in the conduit; Determination of solidification time of castings; Riser design and Placement; Description of Precision Sand Mould Casting Processes; Metal Mould Casting: Preparation of metal mould; Determination of solidification time of castings; Description of Die Casting, Centrifugal casting and Continuous Casting;

METAL WELDING: Need and Limitations; Classification of Welding Processes; Arc Welding-Characteristics of arc and mode of metal transfer; Welding fluxes and coatings; welding machine characteristics-conventional and pulsed power sources, inverter type; Working and Modeling of arc welding processes; Resistance Welding-Principles and technology; power sources; Modeling of resistance welding processes; Beam Welding– Working and modeling of Laser Beam Welding and Electron Beam Welding; Solid Welding– Modeling and analysis of Friction Stir Welding, Explosive welding and Ultra-sonic welding, Weldability of cast iron, plain carbon and low alloy steels, stainless steels, Defects and Inspection of welds; Weld cracking and prevention;

POWDER METALLURGY: Production of metal powders; Blending and Mixing; Compacting and Sintering; Densification and Sizing; Impregnation and Infiltration; Advances in powder metallurgy-Isostatic pressing, Hot pressing and Spark sintering.

References:

1. Materials and Processes in Manufacturing, Degarmo, J. T. Black, Prentice Hall Of India Pvt Ltd.
2. Manufacturing Processes for Engineering Materials, Kalpakjian and Schmid, Prentice Hall.
3. Fundamentals of modern manufacturing processes, M. P. Groover.
4. Manufacturing Science : Ghosh and Mallick, East-West Press Private Limited

5. Machining and Metal Working Handbook, Ronal A Walsh and Denis Cormier McGraw Hill Publication.

SEMESTER-II

CORE COURSES

Course Code: MMTA-201
Course Name: Fundamental of Robotics & Automation
Credit: 3
Syllabus:
Prerequisite NIL

Introduction: Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Production Economics. Automated Flow lines, Methods of Work part Transport, Transfer Mechanism, and Buffer Storage.
Material handling and Identification Technologies: Types of Material Handling Equipment, Conveyor Systems, Automated Guided Vehicle Systems. Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Product identification system: Barcode, RFID etc.
Automated Assembly Systems: Types of Automated Assembly Systems. Different control technologies in automation. Automated Inspection and Testing, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Machine Vision, Other optical Inspection Methods.
Fundamentals of robotics. Introduction, construction and applications. The robot and its peripherals, Control systems and components, robot motion analysis and control, end effectors, feedback systems. Jacobian, work envelopes. Trajectory planning, Joint Interpolated Trajectory, Link joints and their Manipulator dynamics and force control.
Sensors in Robotics: Developments in sensor technology, sensory control Vision, ranging, laser, acoustic, tactile.
Programming Language: Different programming languages. Mobile robots, walking devices. Robot reasoning.
Robot applications: Application of robots in surgery, Manufacturing industries, space and underwater. Humanoid robots, Micro robots, Social issues and Future of robotics.

Texts / Reference Books:
1. "Automation, Production Systems and Computer Integrated Manufacturing"- M. P. Grover, Pearson Education.
2. "Computer Based Industrial Control" – Krishna Kant, EEE-PHI
3. Principles and Applications of PLC – Webb John, Mcmillan 1992
4. "An Introduction to Automated Process Planning Systems" – Tiess Chiu Chang & Richard A. Wysk
5. "Anatomy of Automation" – Amber G.H & P.S. Amber, Prentice Hall.

6. K.S Fu, R.C. Gonzalez, C.S.G. Lee, Robotics, McGraw Hill, 1987.
7. Y. Koren, Robotics for Engineers, McGraw Hill, 1985.
8. J.J. Craig, Robotics, Addison-Wesley, 1986.
9. Saeed B. Niku, "Introduction to Robotics – Analysis, Systems and Application": PHI 2006.
10. Richard D, Klafter, Thomason A Chmiel Owski, Michel Nagin "Robotics Engg-an Integrated Approach" PHI 2005.
11. R.K. Mittal & I.J. Nagrath, "Robotics & Control" TMH-2007.
12. Groover. M.P. Industrial Robotics, technology, programming and application Mc-Graw Hill 2012.
13. S. K. Saha, "Introduction to Robotics", Tata McGraw-Hill Publishing Company Ltd. (2008).

Course Code: MMTA-202
Course Name: Micro Manufacturing Processes
Credit: 3
Syllabus:
Prerequisite NIL

Introduction to Advanced Manufacturing Processes: Overview of non-conventional machining processes with (AJM, USM, ECM, EDM, EBM, LBM, AFM, MRF, MAF, MFP and MRAFF etc.)
Introduction to use of non-conventional processes for micro-machining.
Abrasive Jet Machining (AJM): Introduction to abrasive jet machining (AJM), Mechanics of AJM, AJM process parameters Components of AJM (Abrasive, Gas, Setup), Mixing and Mass ratio and Material Removal Rate (MRR).
Ultrasonic Machining (USM): Basics of USM processes, Mechanics of USM, Process parameters of USM, Dependence of process parameters in estimation of MRR, Ultrasonic machining setup, Design of acoustic ultrasonic head and feed mechanism in USM.
Water Abrasive jet machining (WAJM): Introduction to WAJM, Basic principle and MRR estimation.
Introduction to nano finishing and need of nano finishing,
Basic Principle of Electrochemical Machining, Estimation of MRR in ECM, MRR in multiphase alloys, Surface Finish in ECM of alloys, Basics of Electrochemical drilling, Basics of Electrochemical Grinding , Electro stream drilling and Electrochemical Grinding, Allied Processes, Electrochemical turning, Electrochemical Milling, Electrochemical deburring, Electrocemical boring etc.
Electro-discharge machining (EDM), Process parameters of EDM, Mechanics of EDM, Theoretical estimation of MRR in EDM, Role of cavitation in material removal in EDM, Role of melting temperature of the work-piece material, EDM circuits and operating principles, Electrode and dielectric fluid, EDM turning, Wire EDM. Comparison of EBM machining with other thermal processes, Setup for EBM, Mechanics of EBM process, Types of lasers and feedback mechanisms in Lasers, Mechanics of material removal in Laser machining.

Texts / Reference Books:

1. Advanced manufacturing processes, Hassan Abdel, Gabad El Hoffy, McGraw Hill.
2. V.K. Jain, Advance Machining Processes, Allied Publisher Bombay.
3. Ghosh and Mallik, Manufacturing Science, EWP Private Ltd.
4. Pandey P.C., Shan H.S., Modern machining processes, Tata McGraw-Hill Education.

5. Weller E.J., Non-traditional machining processes, Society of Manufacturing Engineers, Publications.
6. The Science and Engineering of Micro-fabrication, Stephen P. Campbell, Oxford University press.

Course Code: MMTA-203
Course Name: Advanced Characterization Techniques
Credit: 3
Syllabus:
Prerequisite NIL

Principles, instrumentation, design and application of UV, visible and IR spectroscopy, mass spectrometry, Mossbauer and NMR spectroscopy, X-ray methods of analysis including powder diffraction, wavelength and energy dispersive x-ray fluorescence. Electron microscopy and microprobe. ESCA and Auger techniques, photo electron spectroscopic methods, scanning tunnelling and atomic force microscopy. Chromatography, thermal analysis including DTA, DSC and TGA. Hands on training on preparation of fine particles, growth of single crystals and thin films and their thermal analysis, magnetic measurement, X-ray diffraction, SEM and TEM analyses, electrical and dielectric measurements.

Texts / Reference Books:

1. George M. Crankovic (Ed.), ASM Handbook: Volume 10: Materials Characterization, ASM International, 1986
2. Robert Cahn (Ed.), Concise Encyclopaedia of Materials Characterization, 2nd Edition, Elsevier, 2004
3. Charles Evans, Richard Brundle and Shaun Wilson, Encyclopaedia of Materials Characterization: Surfaces, Interfaces, Thin Films, Elsevier, 1992
4. Tantra, Ratna, Nanomaterial Characterization: An Introduction, Wiley (2016)

ELECTIVE- (II-II1)

Course Code: MMTA-211
Course Name: Additive Manufacturing
Credit: 3
Syllabus:
Prerequisite NIL

Introduction: Historical developments, Fundamentals of RP/AM Systems and its Classification, Rapid prototyping process chains, 3D modelling and mesh generation, Data conversion and transmission.
Introduction to reverse engineering Traditional manufacturing via AM, Computer aided design (CAD) and manufacturing (CAM) and AM Different AM processes and relevant process physics AM process chain, Application level: Direct processes – Rapid Prototyping, Rapid Tooling. Rapid Manufacturing; Indirect Processes - Indirect Prototyping. Indirect Tooling, Indirect Manufacturing. Comparison between RP processes and CNC Machining.
RP Database: Rapid prototyping data formats, STL format, STL file problems, STL file repair, Network based operations, Digital inspection, Data warehousing and learning from process data.

Selection of AM technologies using decision methods, Additive manufacturing process plan: strategies and post processing. Monitoring and control of defects, transformation

Different Rapid Prototyping Processes – namely Stereolithography (STL), Laser Sintering; Fused Deposition Modelling (FDM), Solid Ground Curing (SGC); Laminated Object Manufacturing (LOM) , Ballistic Particle Manufacturing (BPM), Three Dimensional Printing (3DP), numerical Examples. **Materials of RP Technology -** Photo Sensitive Resin, Wax etc.

RP interfacing with Manufacturing processes - Investment Casting, Vacuum Casting, and Laser Additive Manufacturing. Rapid manufacturing processes like - Vacuum Casting Processes via RP Processes, Electroplated Prototypes, RTV Silicon Moulds, Direct Inkjet SL Tooling, Electron Beam Melting.

Texts / Reference Books:

1. Rapid Manufacturing: An Industrial Revolution for the Digital Age. Neil Hopkinson, Richard Hague, Philip Dickens (Editors); Wiley; Jan., 2006; ISBN: 10: 0470016132; 13: 978-0470016138.
2. Additive Manufacturing Technologies; Rapid Prototyping to Direct Digital Manufacturing. Ian Gibson, David W. Rosen, Brent Stucker; Springer; January, 2010; ISBN: 978-1-4419-1119-3.
3. Rapid Prototyping: Principles and Applications. Rafiq I. Noorani; Wiley; Oct., 2005; ISBN: 10: 0471730017; 13: 978-0471730019.
4. User's Guide to Rapid Prototyping. Todd Grimm; Society of Manufacturing Engineers; February, 2004; ISBN: 0-87263-697-6.
5. Rapid Prototyping - Laser-based and Other Technologies. Patri K. Venuvinod and Weiyin Ma; Kluwer Academic Publishers; October, 2003; ISBN: 1-4020-7577-4.
6. Rapid Prototyping. Andreas Gebhardt; Hanser Gardner Publications; 1st ed., June 1, 2003; (Originally published in German, 1995); ISBN: 156990281X.
7. Rapid Prototyping: Principles and Applications. Chua Chee Kai, Leong Kah Fai, Lim Chu-Sing; World Scientific Pub Co; March, 2003; ISBN: 9812381171.
8. Rapid Prototyping: Theory and Practice. Ali Kamrani, Emad Abouel Nasr (Editors); Springer; 1st ed., Jan., 2006; ISBN:10: 0387232907; 13: 978-0387232904.
9. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, D.T. Pham, S.S. Dimov.
10. Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing By Andreas Gebhardt. Hanser Publishers, 2011.
11. Rapid Prototyping, Tooling and Manufacturing By R. J. M. Hague, P. E. Reeves, Paperback, 2002.
12. Rapid Prototyping Technology: Selection and Application By Kenneth Cooper, CRC, 2001.
13. Rapid Prototyping: Theory and Practice By Kamrani A., Nasr E. A., Springer, 2006
14. Laser assisted fabrication of materials By J.D. Majumdar and I. Manna. Springer Series in Material Science, 2013.
15. Rapid Prototyping: Laser-Based and Other Technologies By Patri K. Venuvinod, Weiyin Ma, Springer, 2004.
16. Rapid Prototyping By Andreas Gebhardt, Hanser, 1996.
17. Rapid Prototyping and Engineering Applications: A Toolbox for Prototype ... By Frank W. Liou, CRC Press, 2007.

Course Code: MMTA-212

Course Name: Theory of Metal Forming
Credit: 3
Syllabus:
Prerequisite NIL

INTRODUCTION: Need and Classification of Forming Processes, Theory and practice of Forming Processes;
CONVENTIONAL FORMING PROCESSES: Massive metal and Sheet metal forming-Comparisons; Fundamentals of Plastic Deformations: Elastic and Plastic Deformation, Yielding Criterion and Flow Rules; Plastic Anisotropy and Viscoplasticity; Concept of solid and flow formulations; Plastic Deformation Analysis Techniques-Slab Method, Upper Bound Method and Slip Line Method; Analysis (using Slab, Upper Bound and Slip Line Method) of: Plain strain Problems: Drawing of Sheet and Extrusion of Plate, Rolling of Plate and Forging of Strip; Axisymmetric Problems: Drawing of Wire and Extrusion of bar and tube, Forging of Solid and Hallow Disc; Bending and Deep Drawing;
UNCONVENTIONAL FORMING PROCESSES: Classification; Process Principle, Applications, Equipment, Process Analysis and Die Design of Explosive Forming; Electro-Magnetic Forming ; Electro-Hydraulic Forming; Laser Beam Bending and Laser Assisted Deep Drawing;
MICRO FORMING PROCESSES: Classification; Process Principle and Applications of Conventional Micro-Forming Processes and Unconventional Micro-Forming Processes.

Texts / Reference Books:
1. Materials and Processes in Manufacturing, Degarmo, J. T. Black, Prentice Hall of India Pvt Ltd.
2. Manufacturing Processes for Engineering Materials, Kalpakjian and Schmid, Prentice Hall.
3. Fundamentals of modern manufacturing processes, M. P. Groover.
4. Manufacturing Science: Ghosh and Mallick, East-West Press Private Limited
5. Machining and Metal Working Handbook, Ronal A Walsh and Denis Cormier McGraw Hill Publication.

Course Code: MMTA-213
Course Name: Machine tool control and condition monitoring
Credit: 3
Syllabus:
Prerequisite NIL

Overview of automatic control in machine tools
Open loop and closed loop system in machine tools- process model formulation-transfer function control actions-block diagram representation of mechanical pneumatic and electrical systems.
Drive systems and feedback devices in machine tools
Hydraulic and Pneumatic drives, Electrical drives, A.C. Motor, D.C. Motor, Servo motor and Stepper motor. Feedback devices- Syncro, resolver, diffraction gratings, potentiometer, Inductosyn and encoders-application in machine tools.
Adaptive control and PLC: Types– ACC, ACO, Real time parameter estimation, Applications- adaptive control for turning, milling, grinding and EDM. Programmable logic controller-Functions-Applications in machine tools.

Vibration, acoustic emission / sound: Primary & Secondary signals, Online and Off-line monitoring. Fundamentals of Vibration, Sound, Acoustic Emission. Machine Tool Condition Monitoring through Vibration, Sound, Acoustic Emission, Case Studies.
Condition monitoring, through other techniques: Visual & temperature monitoring, Leakage monitoring, Lubricant monitoring, condition monitoring of Lube and Hydraulic systems, Thickness monitoring, Image processing techniques in condition monitoring.

Texts / Reference Books:

1. MikellP.Groover, "Automation Production system and Computer Integrated Manufacturing", Prentice Hall of India Pvt. Ltd., 2010
2. Sushil Kumar Srivstava, "Industrial Maintenance Management" S.Chand & Company Ltd., New Delhi, 1998.
3. Manfred Weck, "Hand Book of Machine Tools" – Vol.3, John Wiley & Sons, 1995.

Course Code: MMTA-214
Course Name: Laser Processing of Materials
Credit: 3
Syllabus:
Prerequisite NIL

Main industrial lasers: He-Ne, CO2, Excimer, Nd:YAG, Diode, Fiber and Ultra-short pulse lasers and their output beam characteristics; laser beam delivery systems. Overview of Industrial & Scientific Applications of laser: Metrological applications, Holography, Laser Isotope Separation, Laser fusion. Laser processing fundamentals: Laser beam interaction with metal, semiconductor and insulator, Ultra-short laser pulse interaction, heat flow theory and metallurgical considerations. Laser Material Processing Applications: Laser cutting and drilling: Process characteristics, material removal modes, practical performances. Laser welding: Process mechanisms like keyhole and plasma effect, operating characteristics and process variation. Laser surface modifications: Heat treatment, surface re-melting, surface alloying and cladding, surface texturing, LCVD and LPVD. Laser rapid manufacturing. Laser metal forming: Mechanisms involved including thermal temperature gradient, buckling, upsetting. Laser peening: Fundamentals of Laser Shock Processing, Effects of various laser and process parameters, Mechanical effects and microstructure modification during laser shock processing. Theoretical modelling of laser material processing. On-line Process monitoring & control: Laser and process parameters, and workpiece characteristics. Economics of Laser Applications in Manufacturing. Laser Safety: Laser safety standards and safety procedures.

Texts / Reference Books:

Course Code: MMTA-215
Course Name: Biomaterials Processing and Applications
Credit: 3
Syllabus:
Prerequisite NIL

Surface chemistry and physics of selected metals, polymers, and ceramics, surface characterization methodology, modification of biomaterials' surfaces, biosensors and microarrays, bulk properties of implants, acute and chronic responses to implanted biomaterials, drug delivery and tissue engineering; Property requirement of biomaterials; Concept of biocompatibility; Cell-material interactions and foreign body response; Assessment of biocompatibility of biomaterials, important biometallic alloys; Ti-based, stainless steels, Co-Cr-Mo alloys; Bio-inert, bio-active and bio-resorbable ceramics; Processing and properties of different bio-ceramic materials with emphasize on hydroxyapatite; Synthesis of biocompatible coatings on structural implant materials; Microstructure and properties of glass ceramics; Biodegradable polymers; Design concept of developing new materials for bio-implant applications.

Texts / Reference Books:

1. TeohSwee Hin Engineering Materials For Biomedical Applications (Biomaterials Engineering and Processing Series
2.

Course Code: MMTA-216
Course Name: Surface Engineering
Credit: 3
Syllabus:
Prerequisite NIL

Concept and Importance, Classification of surface modification techniques, Advantages and their Limitations.
Causes, types and consequences of surface degradation, Forms of wear – Adhesive, Abrasive, Surface fatigue, Corrosive, Fretting and erosive wear, Classical governing laws related to wear, Techniques to evaluate the wear damage.
Materials characteristics, their importance in surface engineering, Wear resistant materials, Selection of materials for engineering the surfaces for specific applications; New coating concepts including multi-layer structures, Functionally gradient materials (FGMs), Intermetallic barrier coatings and Thermal barrier coating;
Principles and application of weld surfacing: SMAW, SAW, GMAW, Thermal spraying – Flame spraying, Electric arc spraying, Plasma spraying, Detonation gun spraying and High velocity oxy fuel spraying.
Ion implantation, Chemical Vapour Deposition (CVD) and Physical Vapour Deposition (PVD), Carburizing, Nitriding, Plasma nitriding, Cyaniding.
Laser cladding, Alloying, Glazing, Laser and Induction hardening, Heat treatment of steel and re-melting by Laser / TIG.
Microwave glazing;
Importance of Different characterisation techniques – Physical, Mechanical and Functional characterisations, Surface finish, Micro hardness, Strength and Tribological characterizations; Electro deposition and Electroless coatings; and Pulsed Laser Deposition.

Texts / Reference Books:

1. Surface Engineering of Metals: Principles, Equipment, Technologies By T.Burakowski and Wierzchoń T., CRC Press, Boca Raton, Florida, 1999.

2. Surface Engineering Casebook By J.S. Burnell-Gray and P.K.Datta (eds.), Woodhead Publishing Limited, Cambridge, England, 1996.
3. Engineering coatings - design and application By S. Grainger and J. Blunt (eds.), Abington Publishing, Cambridge, England, 1998.
4. Advanced Surface Coatings: a Handbook of Surface Engineering By D. S. Rickerby and A. Matthews (eds), Blackie, London,1991.
5. Coatings Tribology: Properties, Techniques and Applications in Surface Engineering By K.
6. Holmberg and A. Matthews, Elsevier Science B.V., Amsterdam, 1994.

Course Code: MMTA-217
Course Name: Modelling and Simulation of Materials
Credit: 3
Syllabus:
Prerequisite NIL

Basics of modelling and simulations, Empirical and phenomenological modelling, Population balance models, Kinetic models, Stochastic models, Matrix models, Discrete size discrete time models, Discrete size continuous time models, Continuous size continuous time models, Modelling of flotation networks and simulation of complex flotation circuits, Material balance over complex minerals flow sheets, Physical modelling, Mathematical modelling; Data modelling as a new type of modelling, Reverse Monte-Carlo Analysis (RMCA): Reconstruction of 3-D atomic ensemble from diffraction data, Discrete Element Modelling (DEM), Finite Element Method (FEM) and its application in materials science, Ab-initio simulations, Phase-field modelling.

Texts / Reference Books:

1. K. Janssens, G. Frans, D. Rabbe, B. Nestler, E. Kozeschnik, M, Miodownik, Computational Materials Engineering- An Introduction to Microstructure Evolution.
2. K. KesavaRao, Prabhu R. Nott, An Introduction to Granular Flow.
3. Dominik Marx, JürgHutter, Ab Initio Molecular Dynamics: Basic Theory and Advanced Methods.

Course Code: MMTA-218
Course Name: Optimization Theory
Credit: 3
Syllabus:
Prerequisite NIL

Basic Concepts: optimal problem formulation.
Single variable optimization algorithms: bracketing, region elimination, point estimation, and gradient based methods, root finding.
Multivariable optimization algorithms: unidirectional search, direct search methods, simplex search and gradient based methods.
Constrained optimization algorithms: penalty function method, method of multipliers, sensitivity analysis, and direct search for constrained minimization, linearized search techniques, feasible direction method, generalized reduced gradient method, and gradient projection method.

Non-traditional optimization algorithms: Genetic algorithms, simulated annealing, and global optimization. Computer programming practice for general design applications.

Texts / Reference Books:

1. Deb, K. Optimization for engineering design: algorithms and examples. Prentice Hall of India, New Delhi.
2. Rao, S.S.. Engineering Optimization: Theory and Practice. Wiley.
3. Bradley, S.; Hax, A.; Magnanti, T. Applied mathematical programming. Addison Wesley.
4. Rardin, Ronald L. Optimization in operations research. Prentice Hall.
5. Strang, Gilbert. Introduction to applied mathematics. Wellesley-Cambridge Press.

Course Code: MMTA-219
Course Name: MEMS and NEMS
Credit: 3
Syllabus:
Prerequisite NIL

Micro and nano mechanics – principles, methods and strain analysis, an introduction to microsensors and MEMS, Evolution of Microsensors & MEMS, Microsensors & MEMS applications, Microelectronic technologies for MEMS, Micromachining Technology – Surface and Bulk Micromachining, Micromachined Microsensors, Mechanical, Inertial, Biological, Chemical, Acoustic, Microsystems Technology, Integrated Smart Sensors and MEMS, Interface Electronics for MEMS, MEMS Simulators, MEMS for RF Applications, Bonding & Packaging of MEMS, Conclusions & Future Trends. Nanoelectromechanical systems (NEMS) – a journey from MEMS to NEMS, MEMS vs. NEMS, MEMS based nanotechnology – fabrication, film formation and micromachining, NEMS physics – manifestation of charge discreteness, quantum electrodynamical (QED) forces, quantum entanglement and teleportation, quantum interference, quantum resonant tunneling and quantum transport, Wave phenomena in periodic and aperiodic media – electronic and photonic band gap crystals and their applications, NEMS architecture, Surface Plasmon effects and NEMS fabrication for nanophotonics and nanoelectronics, Surface Plasmon detection – NSOM/SNOM.

References:

1. Electromechanical Sensors and Actuators, Ilene J. Busch-Vishniac, Springer, 2008
2. Introduction to Microelectronics Fabrication, Vol. V, G. W. Neudeck and R. F. Pierret (eds.), Addison, Wesley, 1988
3. Introduction to Microelectromechanical Microwave Systems, H. J. De Loss Santos, 2nd edition, Norwood, MA: Artech, 2004
4. Microsystems Design, S. D. Senturia, Kluwer – Academic Publishers, Boston MA, 2001.
5. Principles and Applications of Nano-MEMS Physics, H. J. Delos Santos, Springer, 2008.
6. Materials and Process Integration for MEMS Microsystems, Vol. 9, Francis E. H. Tay, Springer, 2002.
7. MEMS: Introduction and Fundamentals by Mohamed Gad-el-Hak –
8. MEMS mechanical sensors by Stephen Beeby
9. Microsensors, MEMS, and smart devices by Julian W. Gardner, V. K. Varadan, Osama O. Awadelkarim.
10. MEMS and microsystems: design, manufacture, and nanoscale engineering- Tai-Ran Hsu.
11. MEMS by N P Mahalik.

Course Code: MMTA-220
Course Name: Digital Manufacturing
Credit: 3
Syllabus:
Prerequisite NIL

Digital design: Geometrical design of curves, Surfaces and solids, Introduction to computer aided engineering analysis and optimum design. Consideration of manufacturing and assembly aspects in design.
Shape digitization: 3D object scanning, Solid reconstruction from point cloud and tessellated data, Downstream applications; Digital manufacturing: Subtractive manufacturing: Basic architecture, Control hardware and software details, Tooling, Sculptured surface machining;
Additive Manufacturing: Basics, Hardware details and capabilities of commercial systems, planning of material addition, Rapid tooling solutions;
Computer Aided Process Planning: CAPP and route sheet development, CAPP system, Computer aided plant layout, Computer Aided Production Planning and Control, Algorithms for CAPP;
Product Database Management Systems: Types, Management Information System, Manufacturing data preparation, Shop-floor control, automatic identification systems (sensors, trackers), Product life cycle management; and Introduction of Industry 4.0.

Texts / Reference Books:

1. Fundamentals of Digital Manufacturing Science, by Z.Zhou,S.Xie, D. Chen, Springer, 2012.
2. Rapid Prototyping: Principles and Applications By C.K. Chua, K.F. Leong, C.S. Lim, John Wiley, 2010.
3. Mastering CAD CAM By Ibrahim Zeid, McGraw Hill, 2005.
4. Automation, production systems, and computer-aided manufacturing By M P Groover, Pearson, 2016.

Course Code: MMTA-221
Course Name: Computer Aided Manufacturing
Credit: 3
Syllabus:
Prerequisite NIL

Basic principles of automation; Extending the capabilities of conventional machines through improved devices and manipulators; Basic principles of numerical control; CNC, DNC and Machining Centres; Manual part programming(industrial controller like Fanuc/Siemens); APT programming; System devices; Adaptive control; Economics of numerical control. Introduction to Robotics: Synthesis of elements with movability constraints; Elements of robot anatomy; Hydraulic, pneumatic and electrical manipulators; End-effectors and their design; Controllers with microprocessors; Robot Sensors; Applications of industrial robots; Economics of robotics.

Texts / Reference Books:

1. CAD/CAM Theory and Practice, Ibrahim Zeid, Tata McGraw Hill Publication
2. CAD/CAM Principle and Application, P. N. Rao, Tata McGrawHill Publication.

3. Users guides to Rapid Prototyping, Todd Frimm, Society of Manufacturing Engineers
4. Computer control of Manufacturing system, Yoram koren, McGraw Hill Publication.
5. Machining and Metal Working Handbook, Ronal A Walsh and Denis Cormier McGraw Hill Publication.
6. Machining and CNC Technology, M. Fitzpatrick, McGraw-Hill Publication.
7. Journey from Rapid Prototyping to Rapid Manufacturing, S Chattopadhyaya, Lambert Publication.

Course Code: MMTA-222
Course Name: Inspection and Testing in Manufacturing
Credit: 3
Syllabus:
Prerequisite NIL

Types and purposes of testing of manufactured components, Precautions in inspections, Accuracy of measurement and important terms.
Destructive Physical Analysis (DPA): Suitability and purpose; Review of Mechanical testing Methods.
Tensile Testing (TT); Compression test, Charpy Impact test, Hardness Testing (HT) - Micro and Nano-hardness test, Stress Rupture Testing (SRT); Toughness, Fatigue and Fracture toughness test, Bend test, Creep test, Chemical tests, Macrographs study.
ASTM standard test methods : Tensile test, Charpy Impact test, Micro-hardness evaluation, Fracture toughness test, Crack growth rate study, Flexural strength of beam; Introduction to NDT,Visual Optical methods, Dye penetrant testing, Methods of application, Developer.
Magnetic particle testing, Magnetization methods, Field indicators, Particle application, Inspection; Eddy current testing, Faraday's law, Inductance, Lenz's law, Self and Mutual Inductance, Impedance plane, Inspection system.
Ultrasonic testing: Basics of ultrasonic waves, Pulse and beam shapes, Ultrasonic transducers, Distance and Area calibration, Weld inspection by UT.
Acoustic emission testing: Sources of acoustic emission, Source parameters, Kaiser-Felicity theory, Equipment and Data analysis.
Radiography: X-rays and their properties, X-ray generation, X-ray absorption and atomic scattering. Image formation, Image quality, Digital Radiography, Image interpretation, Radiation Shielding.
ASTM standard test method for NTD tests, like Radiographic, Ultrasonic, Electromagnetic (eddy current), X-ray, Acoustic and Tomographic techniques; and Comparison and selection of NDT methods.

Texts / Reference Books:

1. Non-destructive Testing, Louis Cartz, ASM International
2. Non-destructive Evaluation and Quality Control, ASM Handbook, Vol. 17.
3. Non-Destructive Test and Evaluation of Materials By J Prasad, McGraw Hill, 2017
4. Welding Inspection, American Welding Society,3rdEd.,2000
5. The Mechanical Testing of Metals and Alloys By foster, P. Field, Cousens Press , 2007
6. Metals Handbook: Mechanical testing, American Society for Metals, 1978
7. ASTM standards for mechanical test, such as: ASTM E8/E8M (Tension test for metals), ASTM
8. D6110-10 (Charpy impact test), ASTM E9-09 (Compression test), ASTM E139-11 (Creep test)
9. ASTM standards for various non-destructive tests

Course Code: MMTA-223
Course Name: Flexible Manufacturing System
Credit: 3
Syllabus:
Prerequisite NIL

FMS concept, Components of FMS, FMS Layouts, FMS planning and implementation. Tool Management systems-Tool monitoring, Work holding devices Modular fixturing, flexible fixturing,, flexibility, quantitative analysis of flexibility, application and benefits of FMS, automated material handling system ,AGVs, Guidance methods, AS/RS.

Automated process planning: Group Technology ,Part families, Part classification and coding, Production flow analysis, Machine cell design, Applications and Benefits of Group Technology, Structure of a Process Planning, Process Planning function, CAPP - Methods of CAPP, CAD based Process **Planning, Inventory management:** Materials requirements planning - basics of JIT.

Monitoring and quality control: Types of production monitoring system, process control & strategies, direct digital control - Supervisory computer control - computer aided quality control - objectives of CAQC, QC and CIM, contact, non-contact inspection methods, CMM and Flexible Inspection systems. Integration of CAQC with CIM.

Texts / Reference Books:

1. Kant Vajpayee. S., "Principles of Computer Integrated Manufacturing", Prentice Hall of India, 1999.
2. Radhakrishnan.P, Subramanyan. S, "CAD/CAM/CIM", New Age International publishers, 2000.
3. Scheer.A.W., "CIM- Towards the factory of the future" Springer - Verlag, 1994.
4. Daniel Hunt.V., "Computer Integrated Manufacturing Hand Book", Chapman & Hall, 1989.
5. Groover M.P, "Computer Aided Design and Manufacturing", Prentice Hall of India, 1987.
6. Yorem Koren, "Computer Control of Manufacturing System", McGraw Hill, 1986.
7. Ranky Paul. G., "Computer Integrated Manufacturing", Prentice Hall International, 198681.
8. Automation Production System & CIM, M. P. Groover.
9. Materials & processes in Manufacturing, Degarmo, J. T. Black.
10. Lean Manufacturing System & Cell Design, J. T. Black.

Course Code: MMTA-224
Course Name: Modelling and Simulation
Credit: 3
Syllabus:
Prerequisite NIL

Physical Modelling: Mechanical and electrical systems, physical laws, continuity equations, compatibility equations, system engineering concept, system modelling with structured analysis, modelling paradigms for mechatronic system, block diagrams, mathematical models, systems of differential-algebraic equations, response analysis of electrical systems, thermal systems, fluid systems, mechanical rotational system, electrical-mechanical coupling.

Simulation Techniques: Solution of model equations and their interpretation, zeroth, first and second order system, solution of 2nd order electro-mechanical equation by finite element method, transfer function and frequency response, non-parametric methods, transient, correlation, frequency, Fourier and spectra analysis, design of identification experiments, choice of model structure, scaling, numeric

methods, validation, methods of lumped element simulation, modelling of sensors and actuators, hardware in the loop simulation (HIL), rapid controller prototyping, coupling of simulation tools, simulation of systems in software (MATLAB, LabVIEW) environment.

Texts / Reference Books:

1. L. Ljung, T. Glad, "Modeling of Dynamical Systems", Prentice Hall Inc. (1994).
2. D.C. Karnopp, D.L. Margolis and R.C. Rosenberg, "System Dynamics: A Unified Approach", 2nd Edition, Wiley-Interscience (1990).
3. G. Gordon, "System Simulation", 2nd Edition, PHI Learning (2009).
4. V. Giurgiutiu and S. E. Lyshevski, "Micromechatronics, Modeling, Analysis, and Design with MATLAB", 2nd Edition, CRC Press (2009).

Course Code: MMTA-225
Course Name: Computational fluid dynamics
Credit: 3
Syllabus:
Prerequisite NIL

Concept of Computational Fluid Dynamics: Different techniques of solving fluid dynamics problems, their merits and demerits, governing equations of fluid dynamics and boundary conditions, classification of partial differential equations and their physical behavior, Navier-Stokes equations for Newtonian fluid flow, computational fluid dynamics (CFD) techniques, different steps in CFD techniques, criteria and essentialities of good CFD techniques.
Finite Difference Method (FDM): Application of FDM to model problems, steady and unsteady problems, implicit and explicit approaches, errors and stability analysis, direct and iterative solvers. Finite Volume
Method (FVM): FVM for diffusion, convection-diffusion problem, different discretization schemes, FVM for unsteady problems.
Prediction of Viscous Flows: Pressure Poisson and pressure correction methods for solving Navier-Stokes equation, SIMPLE family FVM for solving Navier-Stokes equation, modelling turbulence.
CFD for Complex Geometry: Structured and unstructured, uniform and non-uniform grids, different techniques of grid generations, curvilinear grid and transformed equations. Lattice Boltzman and **Molecular Dynamics:** Boltzman equation, Lattice Boltzman equation, Lattice Boltzman methods for turbulence and multiphase flows, Molecular interaction, potential and force calculation, introduction to Molecular Dynamics algorithms.

Texts / Reference Books:

1. J. D. Anderson, "Computational Fluid Dynamics", McGraw-Hill Inc. (1995).
2. S. V. Patankar, "Numerical Heat Transfer and Fluid Flow", Hemisphere Pub. (1980).
3. K. Muralidhar, and T. Sundarajan, "Computational Fluid Flow and Heat Transfer", Narosa (2003).
4. D. A. Anderson, J. C. Tannehill and R. H. Pletcher, "Computational Fluid Mechanics and Heat Transfer", Hemisphere Pub. (1984).
5. M. Peric and J. H. Ferziger, "Computational Methods for Fluid Dynamics", Springer (2001).
6. H. K. Versteeg and W. Malalaskera, "An Introduction to Computational Fluid Dynamics", Dorling Kindersley (India) Pvt. Ltd. (2008).

7. C. Hirsch, “Numerical Computation of Internal and External Flows”, Butterworth-Heinemann, (2007).
8. J. M. Jaile, “Molecular Dynamics Simulation: Elementary Methods”, Willey Professional, 1997.
9. A. A. Mohamad, “Lattice Boltzman Method: Fundamentals and Engineering Applications with Computer Codes”, Springer (2011).

SEMESTER-III

CORE COURSES

Course Code: MMTA-301
Course Name: Research Methodology and Technical Writing,
Credit: 3
Syllabus:

Prerequisite- NIL

Research Methodology:

Research process, types of research, problem identification and hypothesis formulation, Research design, methods of data collection, reliability and validity, data presentation, and report preparation.

Introduction to Research Communication:

Grammar and Rhetoric: Sentential and supra sentential structure, Narrative and structuring argument, common error in composition. Reading skills for literature review: Previewing techniques, understanding the gist of an argument, identifying the topic sentence.

Writing skills (Part-I)

Sentence formation, Use of appropriate diction, paragraph and essay writing, coherence and cohesion. Summarizing, paraphrasing, outlining, Non-linear description, Narrative, Instruction and reporting. Descriptive and explanatory, analytical and argumentative writing, enhancing editing skills, punctuation.

Writing skills (Part-II)

Introduction to terminology, concept of research. Preparing research proposal/ Synopsis. Formulating thesis statement. Referencing (all style sheet). Writing Introduction, Footnotes/ Endnotes, Conclusion. Preparing Appendix, Bibliography (all style sheets), and Abstract. Writing acknowledgement. Concept of Keywords, preparing content page/ list of Tables and Figures. Use of classified materials, Plagiarism and copyright materials.

Texts / Reference Books:

1. Ranjit Kumar, research methodology: a step-by-step guide for beginners, SAGE Publications India Pvt Ltd.
2. C.R. Kothari, Research Methodology: Methods and Techniques, New Age International, 2004.
3. Michael H. Markel. Handbook of technical writing. Bedford/St Martins, 2012
4. Technical Writing and Professional Communication: For Nonnative Speakers of English. Thomas N. Huckin. McGraw Hill 1991.
5. Michael H. Markel. Technical Writing Essentials. St. Martin's Press, 01-May-1988.

6. Sharon J Gerson, Steven M Gerson. Technical writing: Process and product. Fifth edition, Pearson Education.

SEMESTER-IV

Course Code: MMTA-451
Course Name: Thesis/Dissertation,
Credit: 13

The students will continue to work on the problem identified in "Thesis/Dissertation-I" (in Semester III) as per the work plan. The work is continued until all stated objectives and deliverables are met. Student will prepare a comprehensive report containing introduction to the problem, literature review, methodology, results and discussion and conclusion.
Research Progress Seminar will be held twice a month for continuous evaluation.