CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY (A)
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COMMITTED TO RESEARCH, INNOVATION AND EDUCATION 44 years

MECHANICAL ENGINEERING

B.E: MINOR ENGINEERING (Mechatronics and Nanotechnology)

Sl. No.	Course Code	Title of the Course	Credits
1	M18ME 03/M20ME 03	Rapid Manufacturing	3
2	M18ME 05/M20ME 05	Introduction to Robotics	3
3	M18ME 06/M20ME 06	Fundamentals of electronic device fabrication	1
4	M18ME 10/M20ME 10	Computer Integrated Manufacturing	3
5	M18ME 11/M20ME 11	Principles of Industrial Engineering	3
6	M18ME 14/M20ME 14	Material Science and Engineering	2
7	M18ME 24/M20ME 24	Selection of Nano materials for Energy Harvesting and Storage Application	1
8	M18ME 25/M20ME 25	Engineering Metrology	3
9	M18ME 26/M20ME 26	Structural Analysis of Nano materials	1
10	M18ME 27/M20ME 27	Nano Technology, Science and Applications	2
11	M18ME 28/M20ME 28	Soft Nano Technology	2
12	M18ME 29/M20ME 29	Surface Engineering of Nano Materials	2
13	M18ME 30/M20ME 30	Automatic Control	2
14	M18ME 31/M20ME 31	Biomedical Nanotechnology	1
15	M18ME 32M20ME 32	Nanotechnology in Agriculture	2
16	H18ME 01/H20ME 01	Automation in Manufacturing	3
17	H18ME 02/H20ME 02	Advanced Materials and Processes	3
18	H18ME 03/H20ME 03	Industrial Safety Engineering	3
19	H18ME 18/H20ME 18	Mechanical Measurement Systems	2
20	H18ME 33/H20ME 33	Robotics and Control: Theory and Practice	2
21	H18ME 37/H20ME 37	Foundations of Cognitive Robotics	1

M18ME 03/ M20ME 03

RAPID MANUFACTURING

Instruction	3	Hours per week
Course Duration	12	Weeks
Credits	3	

Outcomes: At the end of the course, the students are able to

1. Define Rapid Manufacturing. (BL-1)
2. Understand Design for Modularity and the Reverse Engineering (BL-2)
3. Analyze and select a Rapid manufacturing technology for a given component. (BL- 4)
4. Describe the materials used and Post-processing techniques in Rapid Manufacturing. (BL-2)
5. Illustrate the significance of Rapid Product development. (BL-3)

UNIT- I
Introduction to Rapid Manufacturing (RM), Product Design Process

UNIT- II
Design for Modularity, Reverse Engineering, 3D measurement: laboratory demonstration

UNIT- III
Polymerization and Powder based RM processes, Liquid based, and Sheet stacking RM processes, 3D printing RM processes and laboratory demonstration

UNIT - IV
Beam Deposition RM processes, and materials in RM, Post-processing and costing in RM

UNIT –V
Rapid Product Development (CAD/CAE/CIM), Rapid Product Development (Software demonstration), and case studies on RM

Text Books:

1. Kamrani, A.K. and Nasr, E.A., 2010. Engineering design and rapid prototyping. Springer Science & Business Media. Groover, M. P., Automation, Production Systems, and Computer-Integrated Manufacturing, Prentice Hall, 2001.
2. Gebhardt, A., 2011. Understanding additive manufacturing.
3. Gibson, I., Rosen, D.W. and Stucker, B., 2014. Additive manufacturing technologies (Vol. 17). New York: Springer.

Suggested Reading:

1. Hopkinson, N., Hague, R. and Dickens, P. eds., 2006. Rapid manufacturing: an industrial revolution for the digital age. John Wiley & Sons.
2. Pham, D. and Dimov, S.S., 2012. Rapid manufacturing: the technologies and applications of rapid prototyping and rapid tooling. Springer Science & Business Media.

M18ME 05/M20ME 05

INTRODUCTION TO ROBOTICS

Instruction	3	Hours per week
Course Duration	12	Weeks
Credits	3	

Outcomes: At the end of the course, the students will be to

1. Describe the basic components, specifications and applications of the Robots (BL-1)
2. Understand transformations, direct and inverse kinematics of robots (BL-2)
3. Calculate forces in links and joints of a robot and find the singularities, Jacobian and trajectory planning of a robot for various tasks (BL-3)
4. Classify drives, sensors and grippers for various applications (BL-4)
5. Programme a robot for a given task with machine vision and sensors (BL-5)

Unit I
Introduction to robotics- History, growth; Robot applications- Manufacturing industry, defence, rehabilitation, medical etc., Laws of Robotics.

Unit II
Robot mechanisms; Kinematics- coordinate transformations, DH parameters Forward kinematics, Inverse Kinematics

Unit III
Jacobians, Statics, Trajectory Planning, Computed torque control, Actuators (electrical)- DC motors, BLDC servo motors.

Unit IV
Control – PWM, joint motion control, feedback control, Probabilistic robotics, Path planning, BFS; DFS; Dijkstra; A-star; D-star; Voronoi; Potential Field; Hybrid approaches

Unit V
Sensors , sensor integration. Perception, Localisation and mapping, Simultaneous Localization and Mapping. Introduction to Reinforcement Learning

Text Books:

1. Robert J Schilling, Fundamentals of Robotics, Prentice Hall India, 2000
2. John J Craig, Introduction to Robotics, Prentice Hall International, 2005
3. Groover, "Industrial Robotics", Mcgraw-Hill Publishing Company Ltd. 2003

Suggested Reading:

1. Asada and Slotine, "Robot analysis and Intelligence", Wiley Interscience, 1986
2. K.S. Fu Gon ZalezRC., lEEc.S.G., "Robotics, Control Sensing Vision and Intelligence", McGraw Hill, Int. Ed., 1987

M18ME 06/ M20ME 06

FUNDAMENTALS OF ELECTRONIC DEVICE FABRICATION

Instruction	1	Hours per week
Course Duration	4	Weeks
Credits	1	

Outcomes: At the end of the course, the students are able to

1. Recall the basic understanding of semiconductor devices. (BL-1)
2. Understand the current fabrication practices used in the semiconductor industry, along with the challenges and opportunities in device fabrication. (BL- 2)
3. Describe process evaluation, productivity and process yield. (BL- 2)
4. Understand the concept of clean room design and contamination in device fabrication. (BL-2)
5. Describe the integrated circuit fabrication and packaging along with practices and challenges. (BL- 2)

UNIT- I

Introduction and overview of semiconductor device fabrication

UNIT- II

Fabrication operations: Oxidation, doping, and lithography

UNIT- III

Fabrication processes: etching and growth. Process evaluation

UNIT - IV

Process yield, clean room design

UNIT –V

IC logic and packaging.

Text Books:

1. Parasuraman Swaminathan “Semiconductor Materials, Devices and Fabrication”, Wiley India, 2017
2. Peter Van Zant “Microchip Fabrication: A Practical Guide to Semiconductor Processing”, 6th Edition, McGraw-Hill, 2013
3. Stephen E. Saddow “Advances in Silicon Carbide Processing and Applications”, Anant Agarwal, 2004.

Suggested Reading:

1. “Fundamentals of Industrial Electronics” edited by Bogdan M. Wilamowski, J. David Irwin, 2016
2. “Fundamentals of Electronics: Electronic Devices and Circuit Applications”, By Thomas F. Schubert, Ernest M. Kim, 2015

M18ME 10/ M20ME 10

COMPUTER INTEGRATED MANUFACTURING

Instruction	3	Hours per week
Course Duration	12	Weeks
Credits	3	

Outcomes: At the end of the course, the students are able to
1. Understand the concepts of computer integrated manufacturing. (BL-2)
2. Apply various computer numerical control techniques. (BL-3)
3. Understand various CIM interface techniques. (BL-2)
4. Understand manufacturing systems in CIM. (BL-2)
5. Apply CIM concepts in additive manufacturing. (BL-3)

UNIT- I
Introduction: Computer integrated manufacturing, computer aided design and computer aided manufacturing.

UNIT- II
Computer Numerical Control: CNC machining, CNC tooling, CNC part programming.
Computer Aided Process Planning: Retrieval CAPP systems, generative CAPP systems.

UNIT- III
CIM Interfaces: Computer aided design versus computer aided manufacturing.
Data and Information in CIM: Automatic identification and data capture.

UNIT - IV
Manufacturing Systems: Manufacturing systems and their design, simulation of manufacturing systems.
Computer Aided Maintenance: Computer aided quality control, coordinate measuring machine.

UNIT –V
Computer Integrated Additive Manufacturing: Components of CIM, rapid manufacturing.
Advanced CIM techniques.

Text Books:
1. Chang, T.C. and Wysk, R.A., "Computer-aided manufacturing", Prentice Hall PTR, 1997
2. Xu, X., "Integrating Advanced Computer-Aided Design, Manufacturing, and Numerical Control", Information Science Reference, 2009.
3. Groover, M.P., "Automation, production systems, and computer-integrated manufacturing", Prentice Hall Press, 2007.

Suggested Reading:
1. S.Kant Vajpayee: "Principles of Computer Integrated Manufacturing", Prentice Hall India, 1998
2. Weatherall, A., Computer integrated manufacturing: from fundamentals to implementation. Butterworth-Heinemann, 2013.

M18ME 11/M20ME 11

PRINCIPLES OF INDUSTRIAL ENGINEERING

Instruction	3 Hours per week
Course Duration	12 weeks
Credits	3

Outcomes: At the end of the course, the students are able to

1. Understand the various concepts of organizational structure. (BL-2)
2. Analyze the process layout design. (BL-4)
3. Apply the network techniques in the project management. (BL-3)
4. Apply forecasting techniques for predicting demand. (BL-3)
5. Apply the quality control tools to improve performance of production system. (BL-3)

Unit -I
Introduction: Developments, objectives, functions and tools.
Organizational structure: Roles, Types, product strategies, principles, process and product organization.

Unit-II
Plant Location and Plant Layout: Selection of site, Factor Affecting Selection of Site, Purpose and Types of Layout, Process Layout Design, Product Layout Design.
Material Handling: Scope, Capacity Planning &Scheduling, Sequencing, Relative Performance of Priority Sequencing Rules.

Unit-III
Inventory: Fundamentals, Models I, Models II, Wilson Model, Gradual Replenishment Model.
Project Management & Network Modeling: Introduction, Network Modeling, Network Analysis.

Unit-IV
Forecasting: Introduction, Methods I, Methods II, Methods III, Methods IV, Methods V.

Unit -V
Quality Control: Introduction, Fundamentals, Control Charts for variables, Control Charts for Attributes, Productivity & Work Study.

Text Books:
1. Russel, R S, Taylor BW, "Operations Management", Pearson education, 2003.
2. Jocobs C A ,"Production and operations management", TMH, 1999.
3. Mitra, A "Fundamentals of Quality control and improvement", John Willey & Sons, 2008.

Suggested Reading:
1. Besterfield DH, "Total Quality Management", Pearson education, 1999.
2. S.N. Chary, "Production and Operations Management", 3rd edition, Tata McGraw Hill, 2006.

M18ME 14/ M20ME 14

MATERIALS SCIENCE AND ENGINEERING

Instruction	2	Hours per week
Course Duration	8	Weeks
Credits	2	

Outcomes: At the End of the course, students are able to

1. Understand the Crystallography (BL2)
2. Describes the Phase Diagram and Transformation (BL1)
3. Explain the Fe-C, TTT and CCT diagrams (BL2)
4. Categorize the Mechanical Properties (BL4)
5. Illustrate the different materials and NDT Techniques (BL3)

UNIT-1

Crystallography: Lattice, Crystal structures, Miller indices for planes and directions, Microscopes, microstructures and quantitative metallography, Defects, diffusion.

UNIT-2

Phase Diagrams and Transformations: Phase diagram, equilibrium phase diagram, lever rule, phase transformation

UNIT-3

Fe-C Phase Diagrams: Iron-carbon phase diagram, TTT and CCT curves, and heat treatments.

UNIT-4

Mechanical Behaviour: Introduction to mechanical properties, cold and hot working, strengthening mechanism Fracture, Fatigue and Creep

UNIT-5

Materials: Ceramics and plastic, NDT techniques, alloy designation

Text books and references

1. W. D. Callister, Jr., John Wiley and Sons, Materials Science and Engineering an Introduction, 2006.
2. V. Raghavan, Materials Science and Engineering, Prentice Hall of India Pvt. Ltd. 2015
3. S.H. Avener, Introduction to physical Metallurgy, Tata McGraw Hill, 2009

Suggested Readings:

1. E. Dieter, Mechanical Metallurgy, New Age Publications (P) Ltd. 2008
2. S.P. Nayak, Engineering Metallurgy and Material Science, Charoter Publishing house, 2005

M18ME 24/ M20ME 24

SELECTION OF NANO MATERIALS FOR ENERGY HARVESTING AND STORAGE APPLICATION

Instruction	1	Hours per week
Course Duration	4	Weeks
Credits	1	

Course Objectives:

1. To select Nanomaterials for Energy Harvesting and Storage Applications.
2. To understand working of Perovskite Solar Cells
3. To know the importance and need of hydrogen energy
4. To familiarize with concept of nanogenerators
5. To provide the knowlge of energy storage in present scenario

Course Outcomes: After completing this course, the students will be able to

1. Understand the importance of nanomaterials. (BL-2)
2. Apply Perovskite solar cell technology and its synthesis procedures. (BL-3)
3. Compare different methods to produce hydrogen energy. (BL-3)
4. Distinguish conventional energy generation techniques. (BL-4)
5. Solve key challenges for energy storage. (BL-3)

Unit-I

Introduction, Criteria for choosing the nanomaterials for energy harvesting and storage applications, Brief discussion about all types of energy harvesting and storage systems, Solar energy, Nanomaterials used for solar energy, Types of solar energy, Solar thermal and heat transfer fluids with example.

Unit-II

Perovskite Solar Cells: introduction, history, properties of perovskite materials, classification of perovskite structure, perovskite solar cell device structure, electron transport layer, hole transport layer, classification of synthesis procedures of the perovskite solar cells:solution process, one step spin coating,two step spin coating, vapor deposition process, advantages and applications.

Unit-III

Hydrogen energy: Introduction, Nanomaterials used for hydrogen energy generation, Methods to produce hydrogen energy,Hydrogen production from fossil fuels and biomass, thermo-chemical process, electrolysis, solar and biological, Key Challenges for hydrogen energy generation.

Unit-IV

Nanogenerators: Introduction, Types of Nanogenerators: Piezoelectric, Thermoelectric, Pyro-electric, Electromagnetic, and Triboelectric, Key challenges for choosing nanomaterials for nanogenerators, Other conventional energy generation techniques: Wind energy, Tidal, Thermal, hydro power generation, Nuclear and geothermal energy production.

Unit-V

Energy storage, Nanomaterials used for energy storage, key challenges for energy storage, Solution of key challenges, Type of energy storages: Electrochemical (Batteries), Supercapacitor, Hydrogen storage, Thermal energy storage.

Text Books:

1. Quan Li, Nanomaterials for sustainable energy, Springer, 2016.
2. Kathy Lu, Materials in energy conversion, harvesting and storage, John Wiley & Sons, Inc., 2014.
3. Alfred Rufer, Energy storage systems and components, CRC Press, 2017.

Suggested Reading:

1. S.A. Sherif, Handbook of Hydrogen energy, CRC Press, 2014.
2. SivaramArepalli, Nanomaterials for energy applications:Generation, Harvesting, Transmission and Storage, William Andrew Publishing, 2014.

M18ME 25/ M20ME 25

ENGINEERING METROLOGY

Instruction	3	Hours per week
Course Duration	12	Weeks
Credits	3	

Outcomes: At the end of the course, the students are able to

1. Understand the need, accuracy and associated concepts of measurements. (BL-2)
2. Demonstrate the knowledge of linear and angular measurements as per requirements. (BL-2)
3. Calculate surface roughness by using appropriate instruments. (BL-3)
4. Analyze and interpret the types of errors, strain measurement and instrument characteristics. (BL-4)
5. Identify measuring methods and devices for displacement, pressure & temperature. (BL-3)

UNIT- I

Introduction to Engineering Metrology: Instruments in measurement systems, general concepts in metrology, standards of measurements, Limits, fits and tolerances.

UNIT- II

Linear and Angular Measurements: Dial gauge, micrometer, vernier height gauge, surface plate, spirit level, combination set, slip gauges, sine bar. Comparators: Dial indicator, sigma mechanical comparator, pneumatic comparator, mechanical-optical comparator, Optical projector, Toolmaker's microscope. Optical flats, interferometer.

UNIT- III

Surface roughness measurement: Roughness and waviness, specification, Nano-metrology, importance of Nano dimension, atomic force microscopy, quality control, statistics in metrology, coordinate measuring machine.

UNIT - IV

Screw threads and gear tooth metrology: screw thread nomenclature, measurement of effective diameter, two wire method, best wire size, gear terminology, gear tooth thickness, errors in instrumentation,characteristics,strain measurements, gauge factor, strain gauge rosette, piezo elective transducer, load cells.

UNIT –V

Transducers; classification, Linear variable differential transformer, measurement,manometers,measurement of vacuum, pirani gauge, ionization gauge Pressure, thermocouples, resistance temperature detectors, thermistors.

Text Books:

1. Bewoor, A.K. and Kulkarni, V.A., 2009. Metrology and measurement. McGraw-Hill Education.
2. Venkateshan, S.P., 2015. Mechanical measurements. John Wiley & Sons.
3. Fridman, A.E., 2011. The quality of measurements: a metrological reference. Springer Science & Business Media.

Suggested Reading:

1. Doeblin, "Measurement Systems Application and Design", TMH, 5/e., 2004.
2. B.C. Nakra & K.K. Chaudhary , "Instrumentation Measurement and Analysis", 3/e., Mc Grawhill, 2014

M18ME 26/ M20ME 26

STRUCTURAL ANALYSIS OF NANO MATERIALS

Instruction	1	Hours per week
Course Duration	04	Weeks
Credits	1	

OUTCOMES: By the end of the course, students should able to

1. Recall the concepts of atomic structure and structure of materials. (BL 1)
2. Describe the phase diagrams (BL 1)
3. Understand the basic properties of metals, ceramics and polymers needed for nanomaterials (BL 2)
4. Analyze the characterization techniques by X-Ray based procedures (BL 4)
5. Apply the characterization procedures to nanomaterials (BL 3)

UNIT-I
Introduction: Fundamental concepts of atomic structure and interatomic bonding, Structure of materials, Defects in structure of materials

UNIT-II
Phase diagram: Determination of phases, Transformation of phases.

UNIT-III
Basic properties: Metals, Ceramics
Basic properties: Polymers, Selection of nanomaterials, Structure property relationship of advanced nanomaterials.
UNIT-IV
Characterization by X-Ray based procedures: Introduction to X-Ray Spectroscopy, Diffraction direction and methods of XRD, Determination of crystal structures by XRD Pattern, Precise parameter measurements, Orientation of single crystals.

UNIT V
Characterization by microscopy based techniques: Qualitative analysis by diffraction, Quantitative analysis by diffraction, Microscopic structural analysis of nanomaterials-I, Microscopic structural analysis of nanomaterials-II, Other characterization used.

Text Books:
1. Cullity, B.D., Stock, S.R. and Stock, S, “Elements of X-Ray diffraction”, Prentice Hall, 2001
2. Phillips, R., “Crystal defects and microstructures” ,Cambridge university press, 2001
3. Wang, Z.L., “Characterization of nanophase materials”, Wiley-VCH, 2001

Suggested Reading:
1. Allen, S.M., Thomas, E.L., “The structure of materials”, John Wiley & Sons, 1999
2. Guozhong Cao, “Nanostructures and Nano Materials, Synthesis properties and applications”, Imperial College Press, 2004

M18ME 27/ M20ME 27

NANOTECHNOLOGY, SCIENCE AND APPLICATIONS

Instruction	2	Hours per week
Course Duration	08	Weeks
Credits	2	

OUTCOME: At the end of the course, students are able to

1. Understand the synthesis procedure of nanomaterials. (BL 2)
2. Remember the experimental investigation of inverse Hall Petch relationship and optical effects (BL 1)
3. Understand nanoscale for superplasticity (BL 2)
4. Describe magnetic effects and ferroelectrics (BL 2)
5. Analyze the material behavior and synthesis of nanomaterials (BL 4)

UNIT-I
Introduction: History of nanomaterials Top down approach, bottom up approach to synthesize nanomaterials
Thermodynamic considerations: Impact of the nanoscale on the thermodynamic considerations, phase diagrams and stable phases, calorimetry

UNIT-II
Inverse Hall Petch relationship: Zirconia ZrO_2, Experimentally investigating the Hall-Petch relationship, Impact of the nanoscale on the Hall-Petch relationship
Optical effects: Impact of the nanoscale on optical properties and its measurements, Experimental approach to study impact of the nanoscale on optical properties

UNIT-III
Introduction to nanoscale: Impact of the nanoscale on mechanical properties,
Superplasticity and the nanoscale: Background, Experimental aspects

UNIT-IV
Magnetic effects: Nanocomposites, Effect of nanoscale on magnetic properties, Potential use of bio-materials, Effect of nanostructure on damping properties.
Ferroelectrics: Ferroelectric effects at nanoscale

UNIT V
Severe Plastic Deformation: Severe Plastic Deformation and the nanoscale, Experimental utility
Synthesis: An approach to prepare bulk nanostructures, Nanosized ferroelectrics
Special materials: Carbon, Carbon Nanotubes, Graphene, a 2D nanomaterial

Text Books:

1. Semiconductor Materials, Devices and Fabrication, Parasuraman Swaminathan, Wiley India, 2017.
2. Microchip Fabrication: A Practical Guide to Semiconductor Processing, 6th Edition, Peter Van Zant, McGraw-Hill, 2013
3. Dieter Vollath, "Nanomaterials: An introduction to Synthesis, properties and applications", Wiley, 2013

Suggested Reading:

1. Guozhong Cao, "Nanostructures and Nano Materials, Synthesis properties and applications", Imperial College Press, 2004
2. Carl C Koch, "Nano materials Synthesis , Properties and applications", Jaico Publishing House, 2008

M18ME 28/ M20ME 28

SOFT NANOTECHNOLOGY

Instruction	2	Hours per week
Course Duration	8	Weeks
Credits	2	

Outcomes: At the end of the course, the students are able to

1. Explain scientific and technical developments in nanotechnology (BL-2)
2. Understand methods of nanomaterial synthesis and nanofabrication as well as advanced characterization techniques (BL-2)
3. Differentiate nanomaterials based on their thermal, mechanical, optical and magnetic properties (BL-2)
4. Apply tool of nanotechnology (BL-3)
5. Categorize nanomaterials using atomic force microscopy. (BL-4)

UNIT- I

Introduction to patterning of thin films, application of nano patterned films and surfaces, basic concepts of wetting: cassie and wenzel regimes, basic concepts of surface tension.

UNIT- II

Different nano fabrication regimes including self assembly micelle formation.

UNIT- III

Introduction to photo lithography, discussion on photo lithography: photo resists, spin coating, exposuredevelopment.

UNIT - IV

Nano imprint lithography, soft lithography: introduction, soft lithography techniques.

UNIT –V

Basic concepts of atomic force microscopy, different imaging modes of atomic force microscopy.

Text Books:

1. B. S. Murty, Textbook of Nanoscience and Nanotechnology, Springer-Verlag Berlin Heidelberg, 2013.
2. K.T. Ramesh, Nanomaterials: Mechanics and Mechanisms, Springer US, 2009.
3. Xiaodong Chen, Soft Matter Nanotechnology, Wiley-VCH Verlag GmbH & Co, 2015.

Suggested Reading:

1. Ye Zhang, Soft Nanomaterials, World scientific series in nanoscience and nanotechnology Vol 19, 2019.
2. Sulabha K. Kulkarni, Nanotechnology : Principles and Practices, Cham : Springer, 2014.

M18ME 29/ M20ME 29

SURFACE ENGINEERING OF NANOMATERIALS

Instruction	2	Hours per week
Course Duration	8	Weeks
Credits	2	

Outcomes: At the end of the course, the students are able to

1. Understand the effect of tribology on surface of nanomaterials. (BL- 2)
2. Apply surface engineering principles and methods to modify and improve the properties of surfaces for structural and functional applications. (BL- 3)
3. Identify suitable processing methods to create surface engineering solutions. (BL- 1)
4. Apply various thin film techniques for surface modification. (BL- 3)
5. Understand the concept of microencapsulation. (BL- 2)

UNIT- I

Tribology: Tribology and its classification, friction tribology, wear and corrosion, lubrication, effect of tribology on surface of nanomaterials.

Surface Engineering: Conventional surface engineering, Types of surface modifications, physical modifications, Chemical modifications, Applications of surface engineering towards nanomaterials.

UNIT- II

Deposition and Surface Modification Methods: Physical vapor deposition, chemical vapor deposition, advanced surface modification practices, advantages of deposition for surface modification.

UNIT- III

Coatings: Synthesis, processing and characterization of nano-structured coatings, functional coatings, advanced coating practices, characterization of nano-coatings, applications of nano-coatings, need of advanced methods for surface and coating testings, size dependency in nanostructures of nano coatings, size effect in electrochemical properties of nanostructured coatings, size effect in mechanical properties of nanostructured coatings, size effect in physical and other properties of nanostructured coatings.

UNIT - IV

Thin films: Thin films for surface engineering of nanomaterials, sputtering techniques, evaporation processes, thin film deposition through gas phase techniques, liquid phase techniques.

Microencapsulation: Processes, kinetics of release, plating of nanocomposite coatings, advantages of microencapsulation over other conventional methods.

UNIT –V

Modified Nanomaterials: Current trends in surface modification of nanomaterials, modified Nanomaterials: In-use for consumer products, main problems in synthesis of modified nanomaterials.

Text Books:

1. Krishna Seshan, "Handbook of thin film deposition processes and techniques" William Andrew Publishing Norwich, New York, U.S.A, 2002.
2. Jamal Takadoum, John Wiley & Sons, "Nanomaterials and Surface Engineering", Inc., USA, 2013
3. Mahmood Aliofkhazrae "Nanocoatings: Size Effect in Nanostructured Films", Springer-Verlag, USA, 2011.

Suggested Reading:

1. Bharat Bhusan, "Introduction to Tribology" by John Wiley & Sons, USA, 2013.
2. S.K.Basu, S.N.Sengupta&B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd , New Delhi, 2005.

AUTOMATIC CONTROL

Instruction	2	Hours per week
Course Duration	8	Weeks
Credits	2	

Outcomes: At the end of the course, the students are able to

1. Understand control system, modeling and transfer functions of different systems. **[BL2]**
2Apply the concept of block diagram and signal flow graphs to different systems. **[BL3]**
3. Differentiate between time domain and frequency domain techniques. **[BL2]**
4. Examine the stability of a system using different approaches. **[BL3]**
5. Analyze the system in state space and to find out the controllability and observability. **[BL4]**

UNIT- I: Definition and Types, Performance Specifications, Design Process, Laplace Transform and Transfer Function, Translational Mechanical System, Rotational Mechanical System, Electrical System, Linearization of Nonlinear Systems, Numerical Problems.

Unit-II: Poles and Zeros, First Order System, Second Order System, Underdamped Second Order System-I, Underdamped Second Order System-II, Definition of Stability, Routh-Hurwitz Criterion, Routh-Hurwitz Criterion-Special Cases, Steady State Errors, Static Error Constants.

Unit-III: Define Root Locus, Sketching of Root Locus-I, Sketching of Root Locus-II, Sketching of Root Locus -III, Numerical Examples and Second Order Approximation, PI Controller Design, PD Controller Design, PID Controller Design, Lag Compensation, Lead and Lag-Lead Compensation.

Unit-IV: State Space Representation, Converting a Transfer Function to State Space, Converting From State Space to Transfer Function, Controller Design, Controller Design and Controllability, Transfer Function, Poles, Zeros, Response.

Unit-V: Steady State Error, Root Locus, Design via Root Locus, Compensation - I, Design via Root Locus, Compensation - II, State Space Method. Application of Matlab in automatic control systems.

Text Books:

1. Nise, N.S., Control Systems Engineering, 5th Ed., Willey, 2008.
2. Ogata, K., “Modern Control Engineering”, 5th Ed., Prentice Hall of India, 2013.
3. Kuo, B.C., “Automatic Control System”, 5th Ed., Prentice Hall of India, 1995.

Suggested Reading:

1. R.C. Dorf, “Modern Control systems”, 12^{th} edition Addison Wesley, 2011.
2. Raven, F.H., “Automatic Control Theory”, 5th Ed., McGraw Hill, 1995.

M18ME 31/ M20ME 31

BIOMEDICAL NANOTECHNOLOGY

Instruction	1	Hours per week
Course Duration	4	Weeks
Credits	1	

Outcomes: At the end of the course, the students are able to

1. Describe about variousSynthesis and characterization techniques of Nanomaterials. (BL- 1)
2. Explain the importance of Cell Behavior toward Nanostructured Surfaces and Bio – Applications. (BL- 2)
3. Understand the Nanomaterials and Nanotechnology for Cancer Diagnostics, Tissue Engineering and organ printing. (BL-2)
4. Diagnose the role of Nano structured materials and study various Nano pharmacology & Drug Targeting. (BL-3)
5. Understand the biomedical applications of nanomaterials. (BL-2)

UNIT- I

Introduction to nano, Nano-biomimicry, Synthesis of nanomaterials by physical and chemical methods, Synthesis of nanomaterials by biological methods, Characterisation of nanomaterials.

UNIT- II

DNA nanotechnology, Protein &glyco nanotechnology, Lipid nanotechnology, Bio-nanomachines, Carbon nanotube and its bio-applications.

UNIT- III

Nanomaterials for cancer diagnosis, Nanomaterials for cancer therapy, Nanotechnology in tissue engineering, Nano artificial cells, Nanotechnology in organ printing.

UNIT - IV

Nanotechnology in point-of-care diagnostics, Nano pharmacology & drug targeting, Cellular uptake mechanisms of Nanomaterials.

UNIT –V

In vitro methods to study antibacterial and anticancer properties of nanomaterials, Nanotoxicology.

Text Books:

1. Malsch, N.H., "Biomedical Nanotechnology", CRC Press. (2005).
2. Mirkin, C.A. and Niemeyer, C.M., "Nanobiotechnology II: More Concepts and Applications", Wiley-VCH. (2007).
3. Kumar, C. S. S. R., Hormes, J. and Leuschner C., "Nanofabrication Towards Biomedical Applications: Techniques, Tools, Applications, and Impact", WILEY -VCH Verlag GmbH & Co. (2005).

Suggested Reading:

1. Lamprecht, A., "Nanotherapeutics: Drug Delivery Concepts in Nanoscience", Pan Stanford Publishing Pte. Ltd. (2009).
2. Jain, K.K., "The Handbook of Nanomedicine", Humana press. (2008).

M18ME 32/ M20ME 32

NANOTECHNOLOGY IN AGRICULTURE

Instruction	2	Hours per week
Course Duration	8	Weeks
Credits	2	

Outcomes: At the end of the course, the students are able to

1. Identify role of chemicals in modern agriculture (BL- 1)
2. Explain about nanotechnology (BL- 2)
3. Illustrate the application of nanotechnology in modern day agriculture (BL- 3)
4. Discuss various Nanotechnologies for water quality and availability (BL- 2)
5. Describe Green nanotechnology, the role of good governance and policies (BL-2)

UNIT- I

History of agriculture and the role of chemicals in modern agriculture

UNIT- II

Overview of nanotechnology

UNIT- III

Application of nanotechnology in modern day agriculture practices I. Application of nanotechnology in modern day agriculture practices II. Application of nanotechnologies in animal production

UNIT - IV

Nanotechnology and shelf life of agricultural and food products. Nanotechnologies for water quality and availability

UNIT –V

Green nanotechnology and the role of good governance and policies for effective nanotechnology development

Text Books:

1. Introduction to Nano Technology by Charles. P. Poole Jr& Frank J. Owens.Wiley India Pvt.Ltd.
2. Jennifer Kuzma and Peter Ver Hage, "Nanotechnology in agriculture and food production", Woodrow Wilson International Center, 2006.
3. Lynn. J, Frewer, WillehmNorde. R. H, Fischer and Kampers. W. H "Nanotechnology in the Agri- food sector", Wiley-VCH Verlag, 2011.

Suggested Reading:

1. Nanotechnology in Agriculture and Food Science (Applications of Nanotechnology) by Monique A. V. Axelos, Marcel Van de Voorde, 2017.
2. Applied Nanotechnology in Agriculture. S.Choudary, 2011.

H18ME 01/ H20ME 01

AUTOMATION IN MANUFACTURING

Instruction	3	Hours per week
Course Duration	12	Weeks
Credits	3	

Outcomes: At the end of the course, the students are able to

1. Explain the design and development of automated systems in the manufacturing. (BL-2)
2. Describe working of various blocks of automated system. (BL-2)
3. Illustrate the principle of operation and construction details of sensors/transducers, actuators, drives and mechanisms, hydraulic and pneumatic systems for automation. (BL-3)
4. Summarize the microprocessor technology, programming and CNC technology. (BL-2)
5. Use automation principles for manufacturing industrial applications. (BL-3)

UNIT- I

Introduction: Importance of automation in the manufacturing industry. Use of mechatronics, systems required.
Design of an automated system: Building blocks of an automated system, working principle and examples.

UNIT- II

Fabrication: Fabrication or selection of various components of an automated system, specifications of various elements, use of design data books and catalogues.
Sensors: Study of various sensors required in a typical automated system for manufacturing, construction and principle of operation of sensors.

UNIT- III

Microprocessor Technology: Signal conditioning and data acquisition, use of microprocessor or micro controllers, Configurations, Working.
Drives: Electrical drives, types, selection criteria, construction and operating principle.

UNIT - IV

Mechanisms: Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, and transfer systems.
Hydraulic systems: Hydraulic power pack, pumps, valves, designing of hydraulic circuits.

UNIT –V

Pneumatic systems: Configurations, compressors, valves, distribution and conditioning.
CNC technology: Basic elements, interpolators and programming.

Text Books:

1. Boltan, W., “Mechatronics: electronic control systems in mechanical and electrical engineering”, Longman, Singapore, 1999.
2. Groover, M.P., “Automation, Production Systems, and Computer-Integrated Manufacturing”, Prentice Hall, 2001.
3. Gaonkar, R.S., “Microprocessor architecture, programming, and applications with the 8085”, Penram International Publishing (India), Delhi, 2000.

Suggested Reading:

1. Regtien, P. P. L., Sensors for mechatronics, Elsevier, USA, 2012.
2. Parr, A. A., Hydraulics and pneumatics, Elsevier, 1999.

Handbooks:

1. Smid, P., CNC Programming Handbook, Industrial Press, New York, USA, 2008.
2. Rothbart, H. A., CAM Design Handbook, McGraw-Hill, 2004.
3. Norton, R. L., Cam Design and Manufacturing Handbook, Industrial press Inc, 2002.

H18ME 02/ H20ME 02

ADVANCED MATERIALS AND PROCESSES

Instruction	3	Hours per week
Course Duration	12	Weeks
Credits	3	

Outcomes: At the end of the course, the students are able to

1. Understand the classification of structural and functional materials. (BL-2)
2. Learn the processing and applications of bulk metallic glasses. (BL-1)
3. Identify the use of various materials. (BL-2)
4. Design materials based on applications. (BL-3)
5. Understand the importance of Shape memory alloys and Super alloys. (BL-2)

UNIT – I
Introduction: Metastable and functional alloys
Bulk Metallic glasses: Fundamental concepts, mechanical and functional properties

UNIT - II
Shape memory alloys, Pseduelasticity, shape memory alloys applications and case studies.

UNIT - III
Introduction to high temperature materials
Super alloys: Alloy design, Microstructure and Properties

UNIT - IV
Nano-materials

UNIT - V
Soft and hard magnetic materials, Non-equilibrium Processes, Single Crystal Growth, Rapid Solidification, Inert Gas Condensation and Advanced Functional Alloys

Text Books:

1. Leonardo Lecce and Antonio Concilio, “Shape Memory Alloy Engineering: For Aerospace, Structural and Biomedical Applications”, Butterworth-Heinemann, 2014.
2. Helmi A. Youssef, “Machining of Stainless Steels and Super Alloys: Traditional and Nontraditional Techniques”, Wiley, 2016.
3. Guozhong Cao and Ying , “Nanostructures and Nanomaterials: Synthesis, Properties, and Applications”, World Scientific Publishing Company, 2010.

Suggested Reading:

1. Mark J. Mezger, Kay J. Tindle, “Energetic Materials: Advanced Processing Technologies for Next Generation Materials”, CRC Press, 2017.
2. C. Suryanarayana and A. Inoue, “Bulk Metallic Glasses”, CRC Press; 2 edition, 2017.

H18ME 03/H20ME 03

INDUSTRIAL SAFETY ENGINEERING

Instruction	3	Hours per week
Course Duration	12	Weeks
Credits	3	

Outcomes: At the end of the course, the students are able to

1. Identify the causes for industrial accidents and suggest preventive measures for safety (BL-2)
2. Use the concepts of engineering systems safety, dimensions of engineering systems safety.(BL-3)
3. Apply the principles of safety design and carry out analysis. (BL-3)
4. Design for engineering systems safety and control for safety. (BL-3)
5. Integrate safety with other operational goals such as quality and reliability. (BL-5)

UNIT - I

Introduction: key concepts, terminologies, and safety quantification, safety by design, Hazard identification techniques (e.g., HAZOP, FMEA, etc.)

UNIT - II

Fault tree and event tree analysis (qualitative & quantitative) and Bow-tie and quantitative risk assessment (QRA)

UNIT - III

Safety function deployment, safety vs reliability, quantification of basic events (repair to failure, repair-failure-repair, and combined processes).

UNIT - IV

Systems safety quantification (e.g., truth tables, structure functions, minimal cut sets), human error analysis and safety.

UNIT – V

Accident investigation and analysis, application of virtual reality, OSHAS 18001 and OSHMS

Text Books:

1. Komamoto and Henley, “Probabilistic Risk Assessment for Engineering and Scientists”, IEEE Press, 1995.
2. Heinrich et al., “Industrial Accident Prevention”, McGraw Hill, 1980.
3. Petersen D, “Techniques for safety management - A systems approach”, ASSE 1998.

Suggested Reading:

1. H. P. Garg, “Maintenance Engineering”, S. Chand and Company, Year 2010.
2. Tyler G. Hicks and T. W. Edwards, Pump Application Engineering, McGraw-Hill, 1971.

H18ME 18/ H20ME 18

MECHANICAL MEASUREMENT SYSTEMS

Instruction	2	Hours per week
Course Duration	8	Weeks
Credits	2	

Outcomes: At the end of the course, the students are able to
1. Understand the various characteristics of instrument. (BL-2)
2. Analyze the generalized model of a measuring system. (BL-4)
3. Understand the frequency response of a measuring system. (BL-2)
4. Evaluate measuring methods and devices for displacement, pressure and temperature measurement. (BL-5)
5. Understand the various thermophysical properties of measurement. (BL-2)

UNIT-I
Basic concepts of measurement, functional elements of instruments, classification of measuring instruments, methods of correction for interfering and modifying inputs.

UNIT-II
Static characteristics of measuring instruments, loading effect and impedance matching, statistical analysis, Chi-square test, least square method, uncertainty analysis, problem solving, generalized model of a measuring system, zero and first order system.

UNIT-III
First order system- ramp response, impulse response, frequency response. Second order system- step response, ramp response, impulse and frequency response. Higher order systems, compensation, transducers, flow measurement, temperature measurement.

UNIT-IV
Strain gauges, piezoelectric transducers pressure measurement, force and torque measurement, displacement and acceleration measurement.

UNIT-V
Sound measurement, thermophysical properties measurement, flow visualization, air pollution sampling and measurement, problem solving.

Text Books:

1. Venkateshan, S.P., “Mechanical measurements”, John Wiley & Sons, 2015.
2. Fridman, A.E., “The quality of measurements: a metrological reference”, Springer Science & Business Media, 2011.
3. Bewoor, A.K. and Kulkarni, V.A., “Metrology and measurement”, McGraw-Hill Education, 2009.

Suggested Reading:

1. R.K. Rajput, “Mechanical Measurements and Instrumentation”, S.K. Kataria & Sons, 2013.
2. Dr. D.S. Kumar, “Mechanical Measurements & Control”, Metropolitan Book Co. (P) Ltd, 2015.

H18ME 33/ H20ME 33

ROBOTICS AND CONTROL: THEORY AND PRACTICE

Instruction	2 hours per week
Course Duration	8 weeks
Credits	2

Course Outcomes: At the end of the course, students are able to

1. Understand the spatial transformations associated with rigid body motions. (BL2)
2. Develop skill in performing kinematics and dynamic analysis of robot systems. (BL3)
3. Analyze different robot manipulators (BL4)
4. Understand the concept of robot exosleleton (BL2)
5. Examine the Robot Assisted Percutaneous Interventions (BL4)

Unit 1

Introduction: Coordinate Frames and Homogeneous Transformations-I, Coordinate Frames and Homogeneous Frames-II, Differential Transformations, Transforming Differential Changes between Coordinate Frames

Unit 2

Robot Kinematics: Manipulator model, Direct Kinematics, Inverse Kinematics, Manipulator Jacobian
Robot Dynamics: Trajectory Planning, Dynamics of Manipulator, Manipulator Dynamics Multiple Degree of Freedom ,Stability of Dynamical System

Unit 3

Manipulator Control and Neural networks: Biped Robot Basics and Flat Foot Biped Model, Biped Robot Flat Foot and Toe Foot Model, Artificial Neural Network, Neural Network based control for Robot Manipulator

Unit 4

Robotic Exoskeletons: Introduction, Force Control of an Index Finger Exoskeleton, Neural Control of a Hand Exoskeleton, Neural Control of a Hand Exoskeleton Based on Human Subjects Intention.
Redundancy Resolution of Human Fingers using Robotic Principles, Manipulability Analysis of Human Fingers during Coordinated Object Rotation ,Kinematics of Flexible Link Robots

Unit 5

Robot Assisted Percutaneous Interventions : Experiments on Robot Assisted Percutaneous Interventions Sliding Mode Control, Higher Order Sliding Mode Control, Smart Needles for Percutaneous Interventions-I Smart Needles for Percutaneous Interventions-II

Textbooks and references

1. Mittal & Nagrath Robotics and Control, ata McGraw-Hill Education, 2003
2. Schilling Robert J, Fundamentals of Robotics: Analysis and Control, Prentice-Hall, 1990. (TJ211.S334)
3 Niku Saeed B, An Introduction to Robotics Analysis, Systems, Applications, Prentice-Hall, 2001

Suggested reading:

1 Niku Saeed B, An Introduction to Robotics Analysis, Systems, Applications, Prentice-Hall, 2001
2 K S Fu,Ralph Gonzalez,C S G Lee, Robotics: Control Sensing. Vision and Intelligence, Tata McGraw-Hill Education, 1987

H18ME 37/ H20ME 37 **FOUNDATION OF COGNITIVE ROBOTICS**

Instruction	1 hours per week
Course Duration	4weeks
Credits	1

Course Outcomes: At the end of the course students are able to

1. Understand importance of cognitive robot and smart materials (BL2)
2. Explain about intelligence, thinking (BL2)
3. Develop knowledge of artificial intelligence related to robots (BL3)
4. Design intelligent systems (BL6)
5. Apply AI based approach to various systems (BL3)

Unit 1
Introduction: Introduction to Cognitive robotics and Human Robot Interaction, Smart materials I, II, III

Unit 2
Intelligence Thinking: Thinking, Cognition, and Intelligence, Defining Intelligence - Embodiment and Its Implications.

Unit 3
Artificial Intelligence and Theory of Intelligence: Role of Neuroscience and Bio robotics, Synthetic Methodology for Intelligence

Unit 4
Intelligent System Design and Cognition Development: Properties of Complete Agents, Agent Design Principle, Developmental Robot Design, Matching brain and Body Dynamics

Unit 5
Control of Intelligent Systems- AI based Approach, Artificial Neural Networks (ANN), Fuzzy Logic, Genetic Algorithms and Other Nature Inspired Methods, Optimal Control using ANN

Textbooks:

1. Neuroscience, edited by Dale Purves, et al., published by Sinauer Associates.
2. How the body shapes the way we think-A New View of Intelligence, by Rolf Pfeifer and Josh Bongard, MIT Press.
3. Control Systems: Classical, Modern, and AI-Based Approaches, by Jitendra R. Raol, Ramakalyan Ayyagari, CRC Press.