BMS COLLEGE OF ENGINEERING, BENGALURU

Autonomous College under VTU

VISION	MISSION
Promoting Prosperity of mankind by augmenting human resource capital through Quality Technical Education & Training	Accomplish excellence in the field of Technical Education through Education, Research and Service needs of society

DEPARTMENT OF MECHANICAL ENGINEERING

DEPARTMENT VISION	DEPARTMENT MISSION
To become a center of excellence in educating students to become successful Mechanical Engineers	• To empower the students with the fundamentals for a successful career in the field of Mechanical engineering. • To continue their education through post-graduation, Research & Development. • To provide service to the society.

Scheme and Syllabus for
M.Tech-Manufacturing Science and Engineering
With effect from A. Y-2018 – 19

Program Educational Objectives

PEO1-Graduates will have knowledge in the discipline of Materials and Manufacturing processes with hands on practice in using advanced material characterisation and advanced manufacturing technology to address real world engineering problems.

PEO2–Graduates will be successful in their career independently or in a group as materials and manufacturing professionals in an Industry/Research /Academia.

PEO3–Graduates will be proficient in their communication, presentation skills and will be prepared to engage in the process of life-long learning through professional development and research.

Programme Outcomes

PO No.	Program Outcomes (PO)
PO1	An ability to independently carry out research /investigation and development work to solve practical problems
PO2	An ability to write and present a substantial technical report/document
PO3	An ability to demonstrate mastery in the domain of the program

Scheme of Teaching for 2018-19

I Semester **CREDIT BASED**

Sl. No	Subject Code	Course Title	Credits				CREDITS	Mapping with POs
			L	T	P	S		
1	18MEMSPCMS	Machining Science & Technology	3				3	PO1-2, PO2-1, PO3-3
2	18MEMSPCMC	Material Characterization	3				3	PO1-3, PO2-1, PO3-2
3	18MEMSPCPM	Plasticity and Metal Forming	3				3	PO1-2, PO2-1, PO3-3
4	18MEMSPCCM	Composite materials	3		1		4	PO1-3, PO2-1, PO3-2
5	18MEMSPEZZ	Elective -1	3				3	PO1-3, PO2-1, PO3-2
6	18MEMSPEZZ	Elective - 2	3				3	PO1-3, PO2-1, PO3-3
7	18MEMSPCMM	Material characterization and Manufacturing Technology lab			1		1	PO1-2, PO2-2, PO3-3
8	18ALLPICRM	Research Methodology	2				2	PO1-1, PO2-1, PO3-2
		Total	**20**		**2**		**22**	

Note: Two electives to be chosen from the list below:
Elective will be offered for a minimum strength of six candidates (out of 18) / eight Candidates (out of 24)

Course Elective – 1	
18MEMSPENT	Nanotechnology
18MEMSPETQ	Total Quality management
18MEMSPECS	Corrosion and Surface Engineering

Course Elective – 2	
18MEMSPEAJ	Advanced Joining process
18MEMSPEAT	Additive Manufacturing Technology
18MEMSPEAM	Advanced Manufacturing Processes

Scheme of Teaching for 2018-19

II Semester **CREDIT BASED**

Sl. No	Subject Code	Course Title	Credits				CREDITS	Mapping with POs
			L	T	P	S		
1	18MEMSPCTD	Tool Engineering Design	3	1			4	PO1-2, PO2-1, PO3-2
2	18MEMSPCIR	Industrial Robotics	3				3	PO1-2, PO2-1, PO3-2
3	18MEMSPCFM	Finite Element Modeling	3		1		4	PO1-2, PO2-1, PO3-3
4	18MEMSPEZZ	Elective -3	3				3	PO1-2, PO2-1, PO3-3
5	18MEMSPEZZ	Elective -4	3				3	PO1-2, PO2-1, PO3-3
6	18MEMSOEZZ	Institution Engineering Elective	4				4	PO1-3, PO2-3, PO3-3
7	18MEMSPCCR	CNC and Robotics lab			1		1	PO1-2, PO2-1, PO3-2
		Total	**19**		**2**	**1**	**22**	

Note: Two electives to be chosen from the list below:

Elective will be offered for a minimum strength of six candidates (out of 18) / eight Candidates (out of 24)

Course Elective – 3	
18MEMSPECC	Computer control of Manufacturing systems
18MEMSPEDM	Design for Manufacture
18MEMSPEID	Industrial Design and Ergonomics

Course Elective – 4	
18MEMSPEAE	Advanced Engineering Materials
18MEMSPEND	Nondestructive Testing
18MEMSPEME	Micro Electro - Mechanical Systems (MEMS)

Institution Engineering Elective	
18MEMSOECE	Computational methods in Engineering analysis
18MEMSOEDE	Design of Experiments

Scheme of Teaching for 2018-19

III Semester **CREDIT BASED**

Scheme of Instruction for Third Semester M. Tech. (Manufacturing Science and Engineering) 2018-2019

Sl. No	Course type	Subject Code	Course Title	Credits				CREDITS	Marks		
				L	T	P	S		CIE	SEE	Total
1	Program Core 6	18MEMSPCPJ-1	Project work Phase-I	0	0	08		08	50	50	100
2.	Program Core 7	18MEMSPCNT	Internship			10		10	50	50	100
3	(**Program Core**/Elective - Domain/ Management)	18MEMSPCPL	Product Lifecycle Management	02		01		03	50	50	100
4	Program core	18MEMSPCSR	Technical Seminar				01	01	50	--	50
5	Audit -1 Non Credit Mandatory Course							0			P/NP
			Total	**02**		**19**	**01**	**22**			

AUDIT COURSES
a. Online courses- MOOCs
b Professional English for research paper and proposal writing
c. Yoga and meditation for stress management
d. Personality development

Scheme of Teaching for 2018-19

IV Semester **CREDIT BASED**

Scheme of Instruction for IV Semester M. Tech. (Manufacturing Science and Engineering) 2018-2019

Sl. No	Course Type	Subject Code	Course Title	Credits				CREDITS	Marks		
				L	T	P	S		CIE	SEE	Total
1	Program Core 8	18MEMSPCPJ-2	Project work Phase-II			20		20	50	50	100
2	**Program Elective** (Domain/**Management Stream)**	18MEMDOEBA	Business Analytics	02					50	50	100
		18MEMDOECM	Cost Management of Engineering Projects								
3	Audit -2 Non Credit Mandatory Course							0			P/NP
		Total		**02**		**20**		**22**			

AUDIT COURSES
a. Online courses- MOOCs
b Professional English for research paper and proposal writing
c. Yoga and meditation for stress management
d. Personality development

Typical structure of the curriculum

Semester	Institute Core	Program Core	Program Elective	Open Elective	Project Work	Seminar	Industrial Internship	Non-credit Mandatory Course	Total Credits
I	**02**	**14**	**06**	**-**		**-**	**-**	**-**	**22**
II	**-**	**12**	**06**	**04**		**-**	**-**	**-**	**22**
III			**08**	**-**	**12**	**02**	**-**	**02 Units**	**22**
IV				**-**	**12**		**10**	**02 Units**	**22**
Total: Credits	**02**	**26**	**20**	**04**	**24**	**02**	**10**	**--**	**88**

Credits through courses = 52/88 = 60%

Credits through Project/Seminar/Internship = 36/88 = 40%

Manufacturing Subjects	Materials subjects	Management subjects
Machining Science & Technology	Material Characterization	Total Quality management
Plasticity and Metal Forming	Composite materials	Advanced Operations Research
Advanced Joining process	Nanotechnology	Planning, Analysis & Financing Of Projects
Additive Manufacturing Technology	Corrosion and Surface Engineering	Product Lifecycle Management
Advanced Manufacturing Processes	Advanced Engineering Materials	Industrial Design and Ergonomics
Tool Engineering Design	Nondestructive Testing	
Industrial Robotics	Micro Electro - Mechanical Systems (MEMS)	
Finite Element Modeling		
Computer control of Manufacturing systems		
Design for Manufacture		
Experiments and research based --- Design of Experiments, Research Methodology		

I SEMESTER

SYLLABUS

MACHINING SCIENCE & TECHNOLOGY

Subject Code	**18MEMSPCMS**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Mechanics of Metal Cutting: Mechanism of chip formation, Orthogonal & Oblique cutting, types of chips, built-up edge, Determination of shear plane angle, forces on the chips, forces in orthogonal cutting, Merchant circle diagram and analysis, theory of Ernst and Merchant, comments on shear plane angle, theory of Lee & Shaffer, friction in metal cutting, power & energy relationship, specific cutting energy, velocity relationship, shear-strain, factors affecting forces and power, Problems. **11 Hours**

Unit-2

Geometry of Cutting Tools: Single point and multi point cutting tools, tool angle specifications– ISO and ASA systems, effect of cutting parameters on tool geometry.

Tool Materials and Their Properties: Characteristics of tool materials, types of tool materials, recommended cutting speeds for the above tools and tool inserts

Tool Wear, Tool Life: Mechanisms of tool wear, Sudden & gradual wear, crater wear, flank wear, tool failure criteria-direct and indirect, tool life equations, tool life tests-conventional & accelerated, effect of process parameters on tool life, tool wear measurement, machinability index, Problems. **6 Hours**

Unit-3

Measurement of Cutting Forces: Reasons for measuring cutting forces, dynamometer requirements, Classification of cutting force dynamometers – mechanical, hydraulic, pneumatic, optical, inductance, piezoelectric, and strain gage type dynamometers, Dynamometers for lathe, drilling and milling

Economics of Machining: Introduction, elements of total production cost, optimum cutting speed and tool life for minimum cost, optimum cutting speed and tool life for maximum production, Problems. **5 Hours**

Unit-4

Thermal Aspects in Metal Cutting: Heat sources in metal cutting, temperature in chip formation, temperature distribution, experimental determination of tool temperatures, Problems.

Cutting fluids: Basic actions of cutting fluids, properties of cutting fluids, selection of cutting fluids, application of cutting fluids, filtration of fluids, recommended cutting fluids.

Surface finish and surface integrity: Surface finish, Effect of machining parameters on surface finish, Expression for surface roughness in machining with single point tool and Problems **6 Hours**

Unit-5

Introduction to modern machining- History, need, classification

Process description, mechanism of metal removal, effect of parameters, and modeling of i) Ultrasonic Machining (USM), ii) Abrasive Water Jet Machining (AWJM), iii) Electrical Discharge Machining (EDM) and iv) Laser Beam Machining (LBM)

Modeling – Empirical and Analytical models

Recent Developments: Hot machining, Cryogenic machining, High speed machining, Hard machining, Micromachining, Turning of composites and Hybrid Machining **11 Hours**

TEXT BOOK:

1. **Fundamentals of metal cutting & Machine Tools** - by B.L.Juneja & G.S – Sekhar - Wiley Eastern.

2. **Advanced machining process** - Vijay K. Jain, Allied Publishers PVT. Limited

REFRENCE BOOKS:

1. **Metal Cutting Principles** - M.C. Shaw - Oxford Publication

2. **Metal Cutting** - Dr. B.J.Ranganath -Vikas Publications.

3. **Fundamentals of machining and machine tools -** Boothroyd and Knight – Taylor and Francis

4. **Production Technology** - HMT - Tata Mc Graw Hill

5. **Modern Machining Process** - P.C Pandy & H.S. Shan - Tata McGraw Hill

E-BOOKS:

1.**http://ceb.ac.in/knowledgecenter/EBOOKS/Metal%20Machining%20%20Theory%20and% 20Applications%20-%20Thomas%20Childs.pdf**

2. http://www.download4referencebook.com/journals/nontraditional-machining-processes

MOOCS:

1. **http://nptel.ac.in/downloads/112105127/**

2. **http://fmcet.in/MECH/ME6402_uw.pdf**

3. **http://www.gitam.edu/eresource/images/Mechanics_of_Metal_Cutting.pdf**

4. **http://nptel.ac.in/courses/112105126/36**

Course Out comes

CO1	Analyze cutting forces in turning and learn problem solving skills in both analytical and graphical methods. Categorize cutting force measuring instruments and choose them for a particular application. Outline tool wear, tool geometry, tool temperature and parameters influencing tool life. Estimate machining costs
CO2	Summarize nontraditional machining techniques and highlight the importance of NTM. Illustrate mechanism of material removal describe the process parameters, advantages & limitations, applications and model for material removal rate for industrially relevent NTM techniques. Describe advanced machining techniques
CO3	Make oral presentations and prepare report on analytical and simulation models

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 2, 3 and 4 and two questions each from units 1 and 5.

MATERIALS CHARACTERISATION

Subject Code	**18MEMSPCMC**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Introduction to the course: Relevance of advanced characterization to materials development, Optical microscopy-principle, types and applications. **06 Hours**

Unit-2

Advanced Diffraction Techniques: Introduction; X-Ray, their production & properties Review of basic diffraction theory; XRD; Various SAXS techniques and its applications in characterizing material SAXS,GISAXS LEED and RHEED, EXAFS, SEXAFS/NEXAFS

10 Hours

Unit-3

Neutron radiation; Neutron sources; Small angle neutron scattering; Instrumentation

Advanced Surface Characterization Techniques: XPS, AES & SIMS; Importance of surface characterization techniques; Physical principles of XPS, Photoelectric effects; Instrumentation, XPS patterns; Spin orbital Splitting; Quantitative analysis; XPS imaging Auger electron generation; Principle, Chemical effect, Quantitative analysis, Depth profiling, Applications

10 Hours

Unit-4

Advanced Spectroscopic Techniques: Introduction; Electromagnetic spectroscopy; UV-Visible Spectroscopy; Photo-luminescence spectroscopy; Infrared spectroscopy; Raman; STEM; EELS

06 Hours

Unit-5

Advanced Microscopic Techniques: Introduction; Electron-materials interactions; TEM: HR, HAADF, STEM, In-situ TEM; SEM, EBSD, In-situ SEM; AFM, STM; Laser Confocal Microscopy **07 Hours**

REFERENCES

1. Materials Characterization Techniques Sam Zhang, Lin Li, Ashok Kumar; CRC press, (2008)

2. Transmission Electron Microscopy; D.B. Williams and C.B. Carter, Plenum Press (2004)
3. Modern ESCA The Principles and Practice of X-Ray Photoelectron Spectroscopy, Terry L.Barr, CRC press, (1994)
4. Scanning Electron Microscopy and X-ray Microanalysis by Joseph Goldstein, Dale E. Newbury, David C. Joy, and Charles E.; Springer Science (2003)
5. Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series) A. K. Tyagi, Mainak Roy, S. K. Kulshreshtha and S. Banerjee;, Volumes 49 – 51 (2009)
6. L. Yang, Materials Characterization: Introduction to microscopic and spectroscopic, Wiley.
7. ASM Handbook, Vol. 9, Metallography and Microstructures, ASM International, USA.
8. Goodhew, Humphreys and Beanland, Electron Microscopy and Microanalysis, Taylor and Francis.
9. Hatekayama and Quinn, Thermal analysis techniques, Wiley.

MOOCS:

1. http://nptel.ac.in/courses/113104004/
2. http://nptel.ac.in/course.php?disciplineId=112
3. http://nptel.ac.in/courses/113106032/
4. http://nptel.ac.in/syllabus/syllabus.php?subjectId=113107033

Course Out comes

CO1	Analyze qualitatively and quantitatively different materials structure using advanced diffraction techniques, XPS instrumentation and patterns
CO2	Explain and analyse materials using advanced spectroscopy techniques
CO3	Select appropriate characterization methods to the analysis and characterization of materials
CO4	Read and Write technical report/document regarding material characterization

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 1, 4 and 5 and two questions each from units 2 and 3.

PLASTICITY AND METAL FORMING

Subject Code	**18MEMSPCPM**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Brief review of elastic and Plastic behavior of metals:

Continuous, homogeneous and isotropic bodies, Concept of stress and strain, types of stresses and strains, description of stress at a point, plane stress, state of stress in three dimensions, Principal Stresses, Description of strain at a point, hydrostatic and deviator components of stress and strain energy.

Flow curves for different materials, true stress and strain, yield criteria for ductile metals - Vonmise criterion, Tresca criterion, yield locus, anisotropy in yielding, yield surface, octahedral sheer stress and shear strain, invariants of stress and strain, plastic stress-strain relations, Levy-Mises equations for ideal plastic solid, problems on yield criteria and true stress and strain **11 Hours**

Unit-2

Fundamentals of Metal Working:

Classification of forming processes, Hot working, Cold Working, Warm Working, Mechanics of Metal Working, flow stress determination - plain strain compression test, Temperature in metal working, Strain-rate effects, Metallurgical Structure, friction and lubrication-sticking and sliding friction, Deformation – Zone Geometry, hydrostatic pressure, Workability limit diagram and residual stresses **6 Hours**

Unit-3

Forging: Classification, forging equipment, determination of compressive stress for plate and disc, open and closed die forging, residual stresses in forgings, forging defects and problems

6 Hours

Unit-4

Rolling of metals: Classification of Rolling mills, forces and geometrical relationships in rolling, simplified analysis of rolling load, theories of cold and hot rolling, roll separating force, Power loss in bearings, torque and power, front and back tensions, defects in rolled products and problems

5 Hours

Unit-5

Extrusion: Classification, extrusion equipment, Process variables, Analysis of extrusion processes, tube extrusion, production of seamless pipe and tubing, extrusion defects and problems.

Drawing: Analysis of wire drawing, Rod and wire drawing, dies in drawing, tube drawing, analysis of tube drawing, Residual stresses, redundant work and estimation, optimal cone angle and dead zone formation, defects and problems. **11 Hours**

TEXT BOOK:

1. Mechanical Metallurgy - Dieter G.E. - Mc Graw Hill Publications.

REFRENCE BOOKS:

1. **Metals Handbook** – ASM - Volume II - ASM
2. **Fundamentals of working of Metals -** Sach G. - Pergamon Press.

E BOOKS:

1.http://staff.uny.ac.id/sites/default/files/pendidikan/aan-ardian-mpd/3c-handbook-metal-forming.pdf

2. http://killerwall.net/USA/survman/Manuals/Metal-Forming(2).pdf

MOOCS:

1. http://web.iitd.ac.in/~pmpandey/MEL120_html/Metal%20Forming%20Processes.pdf

2. http://nptel.ac.in/courses/112106153/

3. http://nptel.ac.in/downloads/112106153/

Course Out comes

CO1	Describe elastic and plastic behavior of metals. Differentiate metal working techniques and describe parameters influencing metal working
CO2	Estimation of forming loads in forging, rolling, extrusion and drawing. Analyze process variables
CO3	Make oral presentations and prepare report on analytical and simulation models

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 2, 3 and 4 and two questions each from units 1 and 5.

COMPOSITE MATERIALS

Subject Code	**18MEMSPCCM**	CIE Marks	50
L-T-P-S	3-0-1-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Introduction: Definition, Reason for composites, Types, constituents, interface, Role of interface, bonding mechanisms and bond strength.

Production of composites: Production of MMC's by Spray (Osprey) Process, Dispersion Processes - Stir-casting & Compo-casting, Liquid-metal impregnation technique - Squeeze casting, Pressure infiltration, Rheo-casting FRP's by Hand Layup, Pressure and Vacuum bag processes, CMC's by Vapour deposition technique cold and hot isostatic pressing techniques, Fabrication of nano-composites**.** **6 Hours**

Unit-2

Fabrication of Composites: Cutting, machining, drilling, mechanical fasteners & adhesive bonding, joining, computer aided design manufacturing, tooling, fabrication equipment

Testing of Composites; Destructive (Tensile, Compression, Flexural, ILSS, Impact strength, HDT) & non-destructive (ultrasonic, thermography, shearography & X-ray radiography)

Application Developments –Aerospace, Automobile, electrical and electronics, marine, Bridge and other Civil Engineering Structures, recreational and sports equipment-future potential of composites **6 Hours**

Unit-3

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli by Strength of Materials Approach, Ultimate strengths of unidirectional lamina, Longitudinal Tensile Strength, Longitudinal Compressive Strength ,Transverse Tensile Strength ,Transverse Compressive Strength ,In-Plane Shear Strength, Numerical problems.

Macro Mechanics of a Lamina: Introduction**,** Hooke's law for different types of materials, Number of elastic constants, relationship of compliance and stiffness matrix. **10 Hours**

Unit-4

Macro Mechanics of a Lamina Hooke's law for two-dimensional–unidirectional lamina, angle lamina, engineering constants for an angle lamina -Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

Biaxial Strength Theories: Macro mechanical Failure Theories: - Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai, Wu tensor theory, Comparison of Failure Theories, Numerical problems. **10 Hours**

Unit-5

Laminated Composites: Introduction, laminate code, Kirchhoff's Plate Theory ,Classical Laminated Plate Theory, Kirchhoff's Hypothesis ,Stress-resultants in a Laminate, Laminate forces and moments, Laminate Stiffness and ABD Matrices (Detailed derivation.

Failure Analysis and Design of Laminates: Introduction , Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite and Other Mechanical Design Issues . **7 Hours**

Lab component

1. Manufacturing of FRP composites using hand layup / Vacuum bag process.
2. Manufacturing of Metal matrix composites using stir casting process.
3. Manufacturing of Metal matrix composites using Squeeze casting. **26 Hours**

Reference Books:

1. **Composite Science and Engineering** by K. K. Chawla Springer Verlag 1998.
2. MECHANICS OF Composite Materials BY Autar K. Kaw SECOND EDITION 2006
3. **Introduction to composite materials** by Hull and Clyne, Cambridge University.
4. **Fiber Reinforced Composites** by P. K. Mallick, Marcel Dekker,Inc
5. **Mechanics of Composite Materials**, Robert M. Jones, McGraw Hill Kogakusha Ltd.1998
6. Engineering Mechanics of Composite Materials, I. M. Daniel and O. Ishai, 1994 Oxford University Press.

E-BOOKS

1. www.ae.iitkgp.ernet.in/**ebooks**/
2. www.rjafari.iut.ac.ir/sites/.../1mechanics_of_**composite_materials**.pdf

MOOCS:

1. nptel.ac.in/courses/112104168/, ***nptel****.ac.in/courses/101104010/,*

2. nptel.ac.in/courses/.../IISc.../**Composite**%20**Materials**/New_index1.html

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 1, 2 and 5 and two questions each from units 3 and 4.

Course Out comes

CO1	Identify the different reinforcement and matrix materials to synthesis components which find its innovative applications and service conditions.
CO2	Develop mathematical models for evaluating mechanical properties and failure criteria laminates. Failure analysis and design considerations of laminates
CO3	Analyze the current research and present case studies with technical reports.

NANO TECHNOLOGY

Subject Code	**18MEMSPENT**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours	39	Exam Hours	03

Course Content:

Unit-1

Metal based nanocomposites – Necessity of nano-composites (limitations of micon-composites), Classification of metal matrix nano composites (MMNCs) & types of fillers used , Different preparation techniques of MMNCs (Liquid, Semi-Solid and Solid route), Limitations of MMNCs, Wettability & agglomeration, Examples of improvement in mechanical, Electrical and magnetic properties

Design of Super hard materials – Introduction, Examples, Brief overview of their fabrication techniques, Mechanical properties **11 hours**

Unit-2

Polymer based nanocomposites – Classification (types of fillers and polymers), Applications with examples of improvement in mechanical, Electrical and magnetic, Fabrication methods using liquid moulding, compression moulding and filament winding techniques (for both thermoset and thermoplastic based nanocomposites), Types of hardeners and its necessity

Polymer based -carbon nanocomposites – Types of carbon reinforced polymer nano composites (GO, GNP, carbon black, diamond) applications, improvement in mechanical properties, Introduction to hybrid nano-composites

11 hours

Unit-3

Mechanics of polymer nanocomposites – Polymer – filler interphase, Interface adhesion, debonding and its characterization, pull-out strength, factors influencing the performance of nanocomposites, failure mechanics, mechanical behaviour & stress transfer, characterization using SEM, TEM and XRD **06 hours**

Unit-4

Carbon Nanotubes based polymer composites – Types of carbon nano tubes, mechanical, electrical, thermal & electro-magnetic shielding properties of composites and their applications,

Mechanics of fracture in CNT-Polymer composites, directional properties of CNT/Polymer composites **05 hours**

Unit-5

Testing of nanocomposites – Principle of working of Dynamic Mechanical Thermal Anlyzer (DMTA), Thermal Mechanical Analyzer (TMA), Differential Scanning Calorimeter (DSC), Thermogravimetric analyzer (TGA), nanocomposite characterization using DMA, TGA, DSC, TMA, Overview of mechanical tests and ASTM standards **06 hours**

Text Books:

1. **Text Book of Polymer Science** - Fred W. Billimeyer, Jr - Wiley Interscience Publication - third edition, 1994.

2. **Polymer Science and Technology** - Joel R. Fried - Prentice- Hall, Inc. Englewood Cliffs, N. J., USA - 2000.

REFERENCE BOOKS:

1. **New Developments and Technology** -Hand book of Elastomers - (Eds. A. K. Bhowmic and H. C. Stephense), Marcel - Dekker Inc., New York - 1995.

2. **Polymer Blends** - D. R. Paul and S. Newman - Academic Press, New York - 1978.

3. **Short Fibre Reinforced Thermoplastics** - M. J. Folkes - John Wiley, New York - 1982.

4. **Nanocomposites Science and Technology** Physical Properties of Carbon Nanotubes - P. M. Ajayan, L.S. Schadler, P. V. Braun , R. Saito, Carbon Nanotubes (Carbon, Vol 33) - M. Endo, S. Iijima, M.S. Dresselhaus

E-BOOKS:

1.**Carbon Nanotubes – A scientometric study** *by Werner Marx and Andreas Barth*

nptel.ac.in/courses/118102003/

2. http://www.zums.ac.ir/files/research/site/ebooks/nanotechnology/nano-technology.pdf

3. http://web.pdx.edu/~pmoeck/phy381/workbook%20nanoscience.pdf

MOOCS:

1. https://www.coursera.org/learn/nanotechnology1

2. https://www.coursera.org/learn/nanotechnology2

3. https://www.edx.org/course/nanotechnology-fundamentals-purduex-nano530x

4. http://nptel.ac.in/courses/118102003/

5. **nptel**.ac.in/courses/118104008/

6. http://nptel.ac.in/course.php?disciplineId=112

Course Outcomes

CO1	Understand the classification and fabrication of nano-composites, identify their applications
CO2	Analyze physical, mechanical and thermal properties of nano composites properties using modern tools such as SEM, XRD, DMTA, TGA, DSC
CO3	Present case studies with technical reports on current research in the relevant field

Scheme of Examination:

Answer five full questions selecting one from each unit.

To set one question each from units 3, 4 and 5 and two questions each from units 1 and 2.

TOTAL QUALITY MANAGEMENT

Subject Code	**18MEMSPETQ**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

INTRODUCTION: Basic, concepts of Total Quality Management, Principles of TQM, Quality in Manufacturing and Service Systems, Leadership Concepts, Benchmarking - Re-engineering - Concurrent Engineering. **6 Hours**

Unit-2

PRINCIPLES OF TOTAL QUALITY MANAGEMENT: Elements of Total Quality Management– A Customer Focus – Fact-Based Management– Continuous Improvement – Teamwork and Participation. Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement, Malcolm Baldrige National Quality Award, Award Criteria. Benefits of TQM. The Deming Management Philosophy – Profound Knowledge –The Impact of Profound Knowledge – Deming's 14 Points for Management- PDCA Cycle, The Juran Philosophy – The Juran Quality Trilogy. The Crosby Philosophy. The Taguchi Loss Function, 5S, Kaizen, Performance Measures **11 Hours**

Unit-3

TQM TOOLS

Ishikawa 's Seven Quality Tools, Ishikawa Fish bone diagram –Nominal Group Technique – Quality Circles – Flow Charts – Pareto Analysis– Poka Yoke (Mistake Proofing),Process, Quality Function Deployment (QFD), House of Quality, QFD Process, Benefits, Total Productive Maintenance (TPM) Concept, Improvement Needs, FMEA, Stages of FMEA, cybernetic Analysis **11 Hours**

Unit-4

QUALITY BY DESIGN:

Introduction – Rationale for implementation – Benefits– Teams – Communication models – Implementation – Tools – Misconceptions and Pitfalls **6 Hours**

Unit-5

QUALITY MANAGEMENT STANDARDS Introductory aspects only) **5 Hours**

a. The ISO 9001:2000 Quality Management System Standard

b. The ISO 14001:2004 Environmental Management System Standard

c. ISO 27001:2005 Information Security Management System

d. ISO / TS16949:2002 for Automobile Industry

e. CMMI Fundamentals and Concepts

TEXT BOOKS:

1. A New American TQM Four Practical Revolutions in Management" –Shoji Shiba, Alan Graham and David Walden,– Productivity Press, Portlans (USA) , 1993

2. Management for Total Quality" –N Logothetis- Prentice Hall of India, New Delhi, 1994.

REFERENCE BOOK:

1. The Quality Improvement Hand Book, -Roger C Swanson, Publisher Vanity Books International, New Delhi, 1995.

2. Total Quality Management – Kesavan R – I K International Publishing house Pvt. Ltd, 2008

E BOOKS:

1. http://psbm.org/Ebooks/Total%20Quality.pdf
2. http://www.mescenter.ru/images/abook_file/Total_Quality_Management_and_Six_Sigma.pdf

MOOCs:

1. https://www.mooc-list.com/course/fundamentals-six-sigma-quality-engineering-and-management-edx?static=true
2. https://www.mooc-list.com/course/quality-management-uninettuno?static=true

Course Out comes

CO1	Describe management policies of quality control and implementation of quality standards. Develop an understanding on the necessary information and skills needed to manage, control and improve quality practices in the organization through TQM Philosophy
CO2	Apply the reactive and proactive improvement methodologies for problem solving in organizations. Demonstrate the importance of team work in problem solving processes. Analyze implementation of quality by design
CO3	Present case studies with technical reports on current research in the relevant field

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 1, 4 and 5 and two questions each from units 2 and 3.

CORROSION AND SURFACE ENGINEERING

Subject Code	**18MEMSPECS**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

CORROSION

Definition, classification, forms of corrosion, expressions for corrosion rate. Emf and galvanic series - merits and demerits, Forms of corrosion - Uniform, pitting, intergranular, stress corrosion, corrosion fatigue, dezincification, erosion corrosion, crevice corrosion - Cause and remedial measures

CORROSION IN INDUSTRIES**:** Boiler water - corrosion by carbon di oxide and unstable salts - corrosion prevention methods by treatment. Cooling water - specification, types of scales and causes - use of antiscalant - water treatments. Maintenance of boilers - protection of boilers during off loading, high temperature corrosion, turbine corrosion **11 Hours**

Unit-2

CORROSION TESTING

Corrosion failure – Inspection and analysis of corrosion damage. Purpose of corrosion testing, Susceptibility tests for intergranular corrosion- Stress corrosion test. salt spray test humidity and porosity tests, accelerated weathering tests. ASTM standards for corrosion testing. Atomic Scale Machining of Surfaces. **06 Hours**

Unit-3

CORROSION BEHAVIOR OF MATERIALS:

Selection of material for various corrosive environments - Corrosion of Steels, Stainless Steel, Aluminum alloys, Copper alloys, Nickel and Titanium alloys – Corrosion of Polymers, Ceramics and Composite materials. **06 Hours**

Unit-4

INTRODUCTION TO SURFACE ENGINEERING AND SURFACE ENGINEERING METHODS

Definition of surface engineering, diffusion techniques, deposition methods**,** Electroless plating and Anodizing - Cathodic protection, metallic, organic and inorganic coatings, corrosion

inhibitors, surface preparation, Coating Characterization: Measurement of coatings thickness. porosity & adhesion of surface coatings . Measurement of residual stress & stability, Surface microscopy & topography by scanning probe microscopy **10 Hours**

Unit-5

SPECIAL SURFACING PROCESSES - CVD and PVD processes, sputter coating. Laser and ion implantation. Arc spray. Plasma spray. Flame spray. HVOF. **06 Hours**

REFERENCE BOOKS:

1. Fontana and Greene."Corrosion Engineering". McGraw Hill Book Co. New York. USA 1983.
2. Raj Narayan. "An Introduction to Metallic Corrosion and its prevention". Oxford & 1BH. New Delhi. 1983.
3. Kenneth G Budinski."Surface Engineering for Wear Resistance". Prentice Hall Inc.. Engelwood Cliff. New Jersey. USA 1988
4. Uhlig. H.H . "Corrosion and Corrosion Control". John Wilcy & Sons. New York. USA. 1985.
5. ASM Metals Handbook. Vol.5. "Surface Engineering". ASM Metals Park. Ohio. USA. 1994.
6. ASM Metals Handbook. Vol.l3,"Corrosion".ASM Metals Park. Ohio. USA. 1994

E-BOOKS:

1.https://app.knovel.com/web/toc.v/cid:kpHCDE000D/viewerType:toc/root_slug:handbook-corrosion-data

2. http://uotechnology.edu.iq/dep-materials/lecture/fourthclass/SurfaceEng2.pdf

MOOCS

1. http://nptel.ac.in/courses/112105053/

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 2,3, and 5 and two questions each from units 1and 4.

2.

Course Out comes

CO1	Analyze different forms of corrosion, corrosion mechanisms in industries and selection of different corrosion resistance materials by conducting various corrosion tests to minimize industrial corrosion.
CO2	Corrosion control using conventional & special coating techniques and coating characterization.
CO3	Present case studies with technical reports on current research in the relevant field

ADVANCED JOINING PROCESS

Subject Code	**18MEMSPEAJ**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Distortion- Methods to avoid distortion. Stresses in Joint Design

Welding and Cladding of dissimilar materials - overlaying and surfacing

Advanced welding techniques: TIG and MIG welding, Electro Slag, Welding Electron Beam Welding, Plasma arc Welding, Laser Beam Welding, Explosion Welding, Diffusion Welding, Ultrasonic Welding, Friction welding, friction stir welding, linear friction welding, thermit welding and under water welding. **11 Hours**

Unit-2

Inspection of Welds: Destructive techniques like Tensile, Bend, Nick break, Impact & Hardness. Non-Destructive techniques like 'X' rays, Ultrasonic, Magnetic particle, Dye Penetrant, Gamma ray inspection. **6 Hours**

Unit-3

Welding Symbols- Need for symbols representing the welds, Basic weld symbols, Location of Weld, Supplementary symbols, Dimensions of welds, Examples

Welding Design - Introduction, Principles of sound welding design, Welding joint design, Welding positions, Allowable strengths of welds- static/steady loads and dynamic loads, Design welds subjected to combined loads, Weld throat thickness, Problems

Quality Control in Welding - Introduction, Quality assurance v/s Quality control, Weld quality, Discontinuities in welds, their causes and remedies and Quality conflicts. **11 Hours**

Unit-4

Computer-Aided Welding Design – Design in broad sense, narrow sense, Welding analysis, Engineering design and welding design, Perspectives in welding design, Solution to welding design problems, Computer aided welding analysis, Computer aided welding design and at least two case stud **5 Hours**

Unit-5

Welding of composites - Special challenges posed to joining by composites, mechanic joining versus adhesive bonding of composites, Joining of Polymer Matrix composites, Joining of Metal Matrix Composites, Joining of Dissimilar material combinations – The need and challenges of joining dissimilar materials, Logical and Illogical combinations of material

6 Hours

REFERENCE BOOKS:

1. **Welding Engineering Handbook** - A.W.S.
2. **Welding Engineering** - Rossi - McGraw Hill.
3. **Welding Technology** - O.P. Khanna
4. **Welding for Engineers** - Udin, Funk & Wulf

E-BOOKS:

1.https://www.wilhelmsen.com/globalassets/marine-products/welding/documents/wilhelmsen-ships-service---unitor-welding-handbook.pdf

2. https://pubs.aws.org/Download_PDFS/WHB-1.9PV.pdf

MOOCS:

1. http://nptel.ac.in/courses/112107090/

2. http://nptel.ac.in/courses/112107089/

Course Out comes

CO1	Classify various welding processes according to their importance and evaluate best method of inspection of welds
CO2	Identify weld symbols and their need, Design the welded joints with conventional and computer aided procedures. Challenges in welding of composites and dissimilar metals
CO3	Analyze the current research and present case studies with technical reports

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 2, 4 and 5 and two questions each from units 1 and 3.

ADDITIVE MANUFACTURING TECHNOLOGY

Subject Code	**18MEMSPEAT**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

UNIT-I

Definition of Additive Manufacturing, Direct Processes, Indirect Processes, Nomenclature of AM machines, Generic AM Process, Comparison of CNC with AM, Reverse engineering, haptic based CAD. **04 Hours**

UNIT-2

Polymerization- Laser Stereolithography, Polymer Printing and Jetting, Digital Light Processing, Microstereolithography.

Sintering and Melting- Laser Sintering, Laser Melting, Electron Beam Melting, Extrusion Machines- Fused Layer Modeling, Powder Binding Drop on Powder Process- Three Dimensional Printing, Laminated layer manufacturing, Aerosol and Bio Printer. **12 Hours**

UNIT-3

Applications of Additive Manufacturing

Data Processing and Application Workflow, STL Data Structure, Errors and Repair, Applications of AM in Aerospace, Foundry, Medical, Architecture and Consumer Goods Industry **05 Hours**

UNIT-4

Additve Manufacturing Design and Strategies

Potential of AM, Complex Geometries, Integrated Geometry, Multi-material Parts, Customized mass production, Personal Fabrication and Self Customization, Distributed Customized Production

AM Unique capabilities, Design for Additive Manufacturing, DFAM Concept and Objectives, Exploring Design freedoms, CAD Tools for AM, Synthesis Methods. **12 Hours**

UNIT-5

Materials, Design and Quality Aspects in AM

Materials of AM- Anisotropic materials, Isentropic Materials, Graded Composite materials Engineering Design rules in AM-Tolerances, Design Freedom, Relative Fit, Flexures, Hinges and snap fits, Orientation and Clamping, Drillings, Gaps, Pins and Walls, AM properties, selection, build management. **06 Hours**

Textbooks and References:

1. Understanding Additive Manufacturing by Andreas Gebhart, Hanser Publication Munich 2011.

2. Additive Manufacturing Technologies by Ian Gibson, David Rosen and Brent Strucker 2nd Edition, Springer 2015

REFERENCE BOOKS:

1.Additive Manufacturing by Amith Bandopadhyay and Susmitha Bose CRC Press Florida 2016.

2.Terry Wohler's ―Wohler's Report 2000- Wohler's Association 2000

MOOCS:

1.https://www.coursera.org/specializations/3d-printing

2.http://nptel.ac.in/courses/112104204/47

E-Books:

1.http://home.iitk.ac.in/~nsinha/Additive_Manufacturing%20I.pdf

2.https://www.sculpteo.com/en/ebooks/

Course Outcomes: At the end of the course the student is expected to:

CO1	Analyze additive manufacturing systems for new product development and give a detailed technical report on current research
CO2	Evaluate the best additive manufacturing method for product development make use of current software tools
CO3	Give a detail presentation of current additive manufacturing systems used in various industries with some case studies

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 1, 3 and 5 and two questions each from units 2 and 4.

ADVANCED MANUFACTURING PROCESSES

Subject Code	**18MEMSPEAM**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Injection moulding

Elements of plastic moulding tools – injection moulds (initial considerations) – shot capacity, number of cycles per minute, clamping force, number of impressions. Types of injection moulding tools – 2 plate and 3 plate moulding tools.

Design considerations: position of gate, type of gate runners, parting surface, ejection system, core, cavity , Mould shrinkage, taper and tolerances,

Tool construction: Side cores, methods of actuating side cores, split moulds, methods of actuating, split moulds, moulds of threaded components. Internal under-cuts, external under-cuts, moulds with under-feed system. Ejection methods - pin, sleeve, and stripper – plate ejection, blade ejection, air ejector, double ejection, delayed action ejection etc.

Multi – colour moulding tools. Defects in moulded components and their remedies. **11 Hours**

Unit-2

Metal Injection Moulding (MIM) Metal Injection Moulding: Introduction, Steps in MIM, Advantages, Requirements, Materials Processed by MIM.

Plastic moulding techniques: Compression moulding tool, transfer moulding tool, Design principles of compression and transfer moulding tools**.** **06 Hours**

Unit-3

Plastic processing techniques: Extrusion, blow moulding, forming, calendaring etc.

Self-Propagating high temperature synthesis (SHS) Process: Introduction, Advantages, Process, Parameters to be considered, Types of products and Applications

High Velocity Forming Process: introduction - comparison of conventional and high velocity forming methods - Types of high velocity forming methods- explosion forming process-elector hydraulics forming magnetic pulse **06 Hours**

UNIT 4

Powder Metallurgy Processes Introduction to powder metallurgy, Benefits of Powder Metallurgy, Limitations and Applications, Production of Powders, Powder Treatment, Powder Characteristics, Compaction of powders, High temperature compaction, Pre Sintering and Post Sintering operations,

Mechanical Alloying: Introduction, Process, Milling parameters, Process Control Agents, Process Variables, Mechanism of Alloying, Powder Contamination, Consolidation, Types of Mills, Oxide dispersion strengthened alloys, Reactive milling, Applications. **11 Hours**

UNIT 5

Ceramic Materials Processing: Properties and applications of ceramics. Processing of ceramics, Ceramic shell casting, Forming – Pressing, dry-pressing, isostatic pressing, hot pressing, slip casting, extrusion, thermal treatment, vitrification. **5 Hours**

REFERENCE BOOKS:

1. Dominic v. Rosato, Injection molding handbook, CBS publishers
2. Rao, P.N, 'Manufacturing Technology', Tata McGraw Hill, 1996.
4. Kalpakjian, S, 'Manufacturing Engineering and Technology', Addison-Wesly, 1995.
5. Suryanarayana, Mechanical Alloying an Introduction.
6. P. C. Angelo and R. Subramanian, Powder Metallurgy – Science , Technology and Applications, PHI Publications, 2009.

MOOCS:

1. https://www.ielm.ust.hk/dfaculty/ajay/courses/ieem215/lecs/6_plastics.pdf
2. http://www.m-ep.co.jp/en/pdf/product/novaduran/molding.pdf

Course Out comes

CO1	Describe plastic injection molding and metal injection molding techniques to synthesize various components. Application of Plastic forming techniques and High velocity forming techniques for modern materials
CO2	Illustrate mechanical alloying and powder metallurgy processes for ceramic materials.
CO3	Present case studies with technical reports on current research in the relevant field

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 2,3 and 5 and two questions each from units 1 and 4.

MATERIAL CHARACTERIZATION AND MANUFACTURING TECHNOLOGY LAB

Subject Code	**18MEMSPCMM**	CIE Marks	50
L-T-P-S	0-0-1-0	SEE Marks	50
Total no. of practical classes	13	Exam Hours	03

Pre-requisites: Basic knowledge on Advanced materials characterization techniques, Non-traditional machining and Additive manufacturing is the primary requirement for this course.

Lab Experiments:

1. Specimen preparation and microstructure studies using Optical Microscope and Scanning electron Microscope
2. Material analysis using XRD
3. Exercises on Abrasive waterjet Cutting and Wire EDM
4. Demonstration of 3D Scanning and 3D printing of simple components
5. Surface roughness measurement

Course Out comes:

CO1	Analyse microstructure and characterize elements, compounds of materials
CO2	Estimate Process capabilities for different materials using abrasive water jet and wire EDM
CO3	Understand 3D Scanning and 3D printing of simple components

II SEMESTER

SYLLABUS

TOOL ENGINEERING DESIGN

Subject Code	**18MEMSPCTD**	CIE Marks	50
L-T-P-S	3-1-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Use of Tool Design Data Handbook is permitted in the examination

Course Content:

Unit-1

INTRODUCTION: Tool design procedure, drafting practice and drawing layout, abbreviations and shortcuts in tool drawings, tools of the tool maker, EDM application in tool manufacturing, ferrous and non-ferrous tooling materials, non-metallic tooling materials, factors affecting heat treatment, heat treatment and tool design **05 Hours**

Unit-2

DESIGN OF SINGLE POINT CUTTING TOOLS: Force and power requirement in turning, Types of single point tools, design of shank dimensions based on strength and rigidity, numerical problems on shank dimensions, tool signature (ASA), selection of tool geometry, influence of tool geometry on tool life, inserts and chip breakers.

DESIGN OF DRILL: Force and power requirement in drilling, Types of drills, tool angles, design of twist drill, numerical problems on design of twist drill, influence of tool geometry on tool life.

DESIGN OF MILLING CUTTER: Force and power requirement in milling, Types of milling cutters, tool angles, design of plain milling cutter, numerical problems on design of plain milling cutter, influence of tool geometry on tool life.

DESIGN OF TOOLS FOR INSPECTION AND GAUGING: Introduction, work piece quality criteria, principles of gauging, types of gages and their applications, amplification and magnification of error, gage tolerances, selection of material for gages, indicating gages, automatic gages, gauging positionally tolerance parts, problems. **11 Hours**

Unit-3

JIGS AND FIXTURES: Differences between jigs and fixtures, Design principles, Economic analysis, Principles of location: 3-2-1 and 4-1-1 types of location, types of locators, redundant location, **Clamping:** clamping principles, types of clamps - mechanical, hydraulic, vacuum and magnetic.

DRILL JIGS: Drill bushes, Template, plate, channel, diameter, leaf, box, pot, angular, turnover, indexing jigs.

FIXTURES: Turning and milling fixtures, indexing type of fixtures. **6 Hours**

Unit-4

PRESS TOOLS: Sheet metal operations, Classification, components of simple die, drive mechanisms, die accessories, press features, press working dies- simple, progressive, compound, and combination, punch and die clearances, shear action**.** **6 Hours**

Unit-5

PRESS TOOLS DESIGN: Center of pressure. Scrap strip layout, Computation of capacities/tonnage requirements, Design of blanking die and progressive die

Bending-bend allowance, spring back, edge bending die design

Drawing-Single, double and triple action dies, factors affecting drawing, drawing die design, forming limit criteria, deep drawing & redrawing methods, defects in formed parts **11 Hours**

Self study topics:

A. Drawing of single point tool, drill bit and milling cutter as per the design

B. Drawing of few jigs and fixtures as per the design

C. Drawing of cutting, bending, drawing dies as per the design

TEXT BOOKS:

1. **Tools Design** - Cyril Donaldson, George H.LeCain, V C Goold and Joyjeet Ghose, McGraw Hill Education (India) Private Limited, New Delhi, 2015.

2. **Metal Cutting and Tool design** - Dr. B.J. Ranganath, Vikas Publishing house, 1993.

REFERENCE BOOKS:

1. **Metal cutting theory and Tool Design**- Arshinav MIR Publications

2. **Press Tools Design and Construction** - P. H. Joshi, S. Chand Publisher, 2010

3. **Introduction to Jigs & Fixtures**- Kempster. ELBS, Edn. 1974.

4. **Fundamentals of Tools Design**- ASTME – Prentice Hall India Publications – 1983.

5. **Jigs and Fixtures** - Prakash Hiralal Joshi, Tata McGraw-Hill Education, 2010

MOOCS:

http://nptel.ac.in/courses/112105126/35

Course Out comes

CO1	Analyze tool design procedure, forces in turning, milling & drilling and design of tools for the same. Choose inspection tools and design them
CO2	Design of jigs and fixtures and press tools for blanking, bending and drawing operations. Construct tool drawings.
CO3	Make oral presentations and prepare report on advancements in tooling

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 1, 3 and 4 and two questions each from units 2 and 5.

INDUSTRIAL ROBOTICS

Subject Code	**18MEMSPCIR**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

FUNDAMENTAL CONCEPTS OF ROBOTICS: Historical evolution of robotics, Automation and robotics, Definition of robots, Laws of robots, Robot anatomy, Basic features of the manipulator and manipulator arm configurations, Specification of Robots, Resolution, Repeatability and Accuracy of a Manipulator, Economic and Social aspects of robotics.

05 Hours

Unit-2

ROBOT POWER SYATEMS AND END EFFECTORS:

Types of Robot drives – Basic components of Pneumatic, hydraulic and electrical drive systems. Pneumatic and hydraulic actuators, AC, DC and stepper motors. Mechanical transmission methods – Rotary-to-Rotary motion conversion. Rotary-to-linear motion conversion

End effectors – types- Mechanical - Slider crank mechanism, Screw type, Rotary actuators, cam type, Magnetic -Vacuum – Adhesive, gripping problems, Remote-Cantered compliance devices.

SENSORY DEVICES: Non optical and optical position sensors - Velocity and Acceleration sensors, Range sensors, Proximity sensors, touch sensor, Slip sensor, Force –Torque sensor.

Robot vision - Functions, sensing and digitizing-imaging, devices, lighting techniques, analogue to digital signal conversion, image storage, image processing and analysis-image data reduction, segmentation, feature, extraction, object recognition. AI and Robotics.

11 Hours

Unit-3

ROBOT ARM KINEMATIC ANALYSIS AND COORDINATE TRANSFORMATIONS: Direct coordinate problems, Rotation Matrices, Composite Rotation matrices, Rotation matrices with Euler angle representation- Homogeneous coordinates and transformations, Composite homogeneous transformations , Links Joints and their parameters, The DH representation and applications, Geometry based Direct Kinematic analysis, Inverse kinematic solution.

11 Hours

Unit-4

TRAJECTORY PLANNING AND GENERATION: Introduction, Joint space schemes (Example-A cubic Trajectory), Joint space schemes with via points (Example-A cubic Trajectory with via points). Cartesian space schemes, Straight line and circular motion.

ROBOT PROGRAMMING AND LANGUAGES: Manual teaching, lead through teaching, Programming Languages, Programing with graphics, Storing and operating task programs.

06 Hours

Unit-5

APPLICATIONS OF ROBOTS: Present and future of robotics –Material handling – Manufacturing Processes – Welding, Machining, Assembly and Inspection, CIM and hostile environments - safety considerations.

Robot cell design: Robot cell layouts-robot cantered cell, inline robot cell, mobile robot cell **MICRO/NANO ROBOTICS SYSTEM**: Future trends, Micro/Nano robotics overview-Scaling effect-Actuators of Micro/Nano robotics system-Micro/nano grippers-Wall climbing micro robot working principles-Biomimetic robot- Nanorobot in targeted drug delivery system.

06 Hours

TEXT BOOKS:

1. **Robotics Engineering An integrated approach -** Richard D Klafter, Thomas A Chmielewski, Michael Negin – Prentice Hall of India Pvt. Ltd. - Eastern Economy Edition, 1989.

2. **Robotics: Control Sensing, Vision, intelligence** - Fu KS Gomaler R C, Lee C S G - McGraw Hill Book Co.- 1987.

REFERENCE BOOKS:

1. **Handbook of Industrial Robotics** - Shuman Y. Nof - John Wiley & Sons, New York - 1985.
2. **Robotics Technology and Flexible Automation** - Deb SR - McGraw Hill BookCo. - 1994.

3 Robotics for Engineers , Yoram Koren, McGraw Hill International.

4 **Robot Technology Fundaments**"- Keramas, Thomson Vikas Publication House.

5 **Company Fundamentals of Robotics Analysis and Control**" -Schilling, PHI.

6 **Introduction to Robotics"**-Niku, Pearson Education, Asia.

7 Bharat Bhushan., "Springer Handbook of Nanotechnology", Springer, 2004. 11.

8 Julian W. Gardner. "Micro sensor MEMS and Smart Devices", John Wiley & Sons, 2001

MOOCS:

https://www.edx.org/course/robot-mechanics-control-part-i-snux-snu446-345-1x

https://www.edx.org/course/robot-mechanics-control-part-ii-snux-snu446-345-2x

Course Out comes

CO1	Analyze the manipulator design including actuator, drive and sensor issues
CO2	Students will be familiarized with the kinematics of robot, trajectory plan and document the motion diagrams for Industrial robots
CO3	Students will be familiarized with Micro and Nano robotics and its applications

Scheme of Examination:
Answer five full questions selecting one from each unit. To set one question each from units 1, 4 and 5 and two questions each from units 2 and 3.

FINITE ELEMENT MODELING

Subject Code	**18MEMSPCFM**	CIE Marks	50
L-T-P-S	3-0-1-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit - 1

Fundamental concepts: Principles of Elasticity: stresses-principal, maximum shear and Vonmises stresses, Equilibrium equations, strain displacement relationships in matrix form – Constitutive relationships for plane stress, plane strain , Axi-symmetric and 3D. Boundary conditions.

Potential energy and equilibrium, Rayleigh-Ritz method and Galerkin method-applied to simple problems on axially loaded members, cantilever, simply supported beams, with point loads and distributed loads.

Introduction to FEM, basic concept, historical background, general applicability, engineering applications, general description ,comparison with other methods of analysis, commercial packages-preprocessor, solver and post processor**.** **05 Hours**

Unit - 2

Solid Mechanics: One-Dimensional Finite Element Formulations and Analysis –

Bars- Introduction; Finite Element Modeling – Element Division; Numbering Scheme; Coordinate and Shape Functions; The Potential Energy Approach; Assembly of Global Stiffness Matrix and Load Vector; Treatment of Boundary Conditions; Temperature Effects; Numericals.

Truss-Local and Global co-ordinate systems, Trusses – assumptions, formulation of Truss element, Numericals

Beam- Hermite functions, formulation of beam. Numericals **12 Hours**

Unit - 3

Two Dimensional Finite Element Formulations for Solid Mechanics Problems:

Formulation of triangular and quadrilateral elements. Formulation of axis symmetric triangular elements. Numericals

Convergence criteria-requirements of convergence of a displacement model, Displacement models and shape functions for Higher order elements in triangular ,quadrilateral elements. Lagrangian and serendipity elements. Iso parametric, sub parametric and super parametric elements. **12 Hours**

Unit - 4

Three Dimensional Finite Element Formulations for Solid Mechanics Problems: Finite Element Formulation of 4 noded Tetrahedral Element, 8 noded Hexahedral Element, Shape functions for Higher order elements. **5 Hours**

Unit - 5

Finite Element in Manufacturing Processes: Types of Non Linearity, Plasticity Fundamentals, Material Behavior Models, Yielding Criteria, Governing Equations, Finite Element Formulation for Large Deformation Processes. **5 Hours**

Simulation (Lab) Exercises:

1. Linear and Non Linear Analysis of Bars and Beams
2. Stress analysis in Curved beam in 2D, rectangular plate with circular hole under Uniform Tension
3. Simulation of bending pipe process
4. Analysis of Welded Joints: FE Modeling and Failure Analysis
5. Melting Using Element Death
6. Metal Forming analysis. Solving metal rolling problem **26 hours**

TEXT BOOKS:

1.T. R. Chandrupatla and A. D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 3rd Ed, 2002.

2.Lakshminarayana H. V., Finite Elements Analysis– Procedures in Engineering, Universities Press, 2004.

3. G. W. Rowe , C. E. N. Sturgess , P. Hartley and I. Pillinger, Finite-Element Plasticity and Metal forming Analysis,Cambridge University Press, 1991

REFERENCE BOOKS:

1.Rao S. S. , Finite Elements Method in Engineering- 4th Edition, Elsevier, 2006

2.P. Seshu, Textbook of Finite Element Analysis, PHI, 2004.

3.J. N. Reddy, Introduction to Finite Element Method, McGraw -Hill, 2006.

4.Bathe K. J., Finite Element Procedures, Prentice-Hall, 2006.

5.Cook R. D., Finite Element Modeling for Stress Analysis, Wiley, 1995.

E-Books / Web References
http://nptel.ac.in/courses/112104115/

MOOCs

1. Finite Element Method (FEM) Analysis and Applications
   https://www.edx.org/course/finite-element-method-fem-analysis-tsinghuax-70120073x

2. A Hands-on Introduction to Engineering Simulations
   https://www.edx.org/course/hands-introduction-engineering-cornellx-engr2000x

3. https://www.mooc-list.com/course/finite-element-method-fem-analysis-and-applications-edx?static=true

4. https://www.coursetalk.com/providers/mit/courses/finite-element-analysis-of-solids-and-fluids-i

5. https://online-learning.tudelft.nl/courses/linear-modeling-fem/

Course Out comes

At the end of Course, Student will be able to

CO1	FORMULATE finite elements like bar, truss, beam, 2D ,axisymmetric and Solid elements for linear static structural analysis & Solve problems of limited complexity in structural domain
CO2	IDENTIFY issues associated with application of Finite Element modelling in Manufacturing Processes
CO3	UTILIZE finite element software to simulate practical problems related to Manufacturing, Prepare report and present them

Scheme of Examination::
Answer Five Full questions selecting one from each unit.
To set One question each from unit 1, 4, 5 and Two questions each from units 2 & 3.

COMPUTER CONTROL OF MANUFACTURING SYSTEMS

Subject Code	**18MEMSPECC**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Introduction: Basic concepts in Manufacturing Systems, Fundamentals of numerical control, advantages limitations of N.C systems-classification of N.C systems, design consideration of N.C machine tools — increasing productivity with N.C machines, Machining center and tooling for CNC machines. **System devices:** Drives, feedback devices, counting devices digital to analog converters. **11 Hours**

Unit-2

Interpolators for manufacturing systems: DDA Integrator, DDA Hardware Interpolator, CNC software Interpolators, Reference word CNC interpolators, the concept of reference word interpolators. Tustin Method

Control Loops of CNC Systems: Introduction, Control of Point-to-point Systems, Control loops in Contouring Systems, Mathematical Analysis, operation of a two axis system.

11 Hours

Unit-3

Computerized numerical control: CNC Concepts, Advantages, The Digital Computer, Reference Pulse Technique, Sampled-Data Technique, Design Principles, Optimization for Circular Motion, summary of design considerations, micro computers in CNC. **5 Hours**

Unit-4

Adaptive control systems: Introduction, Adaptive control with optimization, Adaptive control with Constraints. ACC for turning, Variable Gain AC systems Adaptive control for grinding, Cost analysis in machining **5 Hours**

Unit-5

C**NC part programming:** Introduction, manual part programming computer aided programming, Post processors, APT programming, Examples. **7 Hours**

Text Books:

1. **Computer control of manufacturing systems -** Yorem Koren, Tata McGraw-Hill edition, 2005.

Reference Books:

2. **Computer Aided Design and Manufacturing -** Dr.Sadhusingh, Khanna Publishers, 2002

Reference Books

1. **Simulation modeling and Analysis -** Avverill M Law, TMH, 2008.

2. Martin J. Numerical control of machine tools

MOOCS:

1. http://nptel.ac.in/courses/112102103/
2. http://nptel.ac.in/courses/112102101/

Course Out comes

CO1	Illustrate NC and CNC machining centers and categorize the interpolators, control loops and feedback devises used in manufacturing systems and give a detailed technical report on current research trends
CO2	Compose Part programming using Manual and APT for deferent machining operations
CO3	Describe design principles and optimize controller motion for a modern machining scenario and give a detailed technical report

Scheme of Examination:
Answer five full questions selecting one from each unit. To set one question each from units 3, 4 and 5 and two questions each from units 1 and 2.

DESIGN FOR MANUFACTURE

Subject Code	**18MEMSPEDM**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Material and process selection – Introduction, Advantages of applying DFMA, General requirements of early materials and process selection, Selection of Manufacturing processes, Process capabilities, Selection of materials, Primary process/ materials selection, Systematic selection of processes and materials. Case studies on machining sequence **05 Hours**

Unit-2

Engineering Design features – Dimensioning, Tolerances, General Tolerance, Geometric Tolerances, Assembly limits, achieving larger machining tolerances, Screw threads, Ground surfaces, holes. Examples

Datum features – Functional datum, machining sequence, manufacturing datum, changing the datum. Examples

Component design – Machining Considerations – Drills, Milling cutters, Drilling, Keyways, Dowels, Screws, Reduction in machining areas, Simplification by separation and amalgamation, work piece holding, surface grinding, Examples **11 Hours**

Unit-3

Component design – Casting Considerations – Pattern, Mould, parting line, cast holes, machined holes, identifying parting line, special sand cores, designing to obviate sand cores. Examples

Design for Injection molding and Sheet metal working – Injection molding materials, Molding cycle, Systems, molds, machine size, cycle time, Cost estimation, Insert molding, Design guidelines, Introduction to sheet metalworking, Dedicated Dies and Press working, Press selections, Design Rules. **11 Hours**

Unit-4

Design for Die casting and Powder metal processing – Die casting alloys, cycle, machines, dies, finishing, Assembly techniques, Design principles, Powder metallurgy processing, stages, compaction characteristics, Tooling, Sintering, Design guidelines. **05 Hours**

Unit-5

Geometric Tolerance – Symbols, Three datum concept of dimensioning, Straightness, concentricity, Run-out, Location Tolerance, Assembly of parts having concentric cylinders, Control of feature location by true position, Body of revolution, Roundness, Profile dimensioning, Tapers, Shaft of two diameters. Examples. **07 Hours**

TEXT BOOKS:

1. Product Design for Manufacture and Assembly – Geoffrey Boothroyd - Peter Dewhurst - Winston Knight – Marcel Dekker, Inc. – Newyork - Second Revison, ISBN 0-8247-0584-X.

2. Designing for Manufacturing – Harry Peck - Pitman Publications – 1983.

3. Dimensioning and Tolerancing for Quantity Production – Merhyle F Spotts –Inc. Englewood Cliffs - New Jersey - Prentice Hall, 5th edition.

E-BOOKS:

1. http://nptel.ac.in/courses/112101005/

2. http://nptel.ac.in/courses/112101005/11

Course Out comes

CO1	Selection of materials and processes for designed component
CO2	Design of inspection, cutting tools & fasteners, casting, injection moulding & die casting, sheet metal operation and powder metallurgy tools
CO3	Make oral presentations and prepare report on current research on product design

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 1, 4 and 5 and two questions each from units 2 and 3.

INDUSTRIAL DESIGN AND ERGONOMICS

Subject Code	**18MEMSPEID**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Introduction: An approach to industrial design - elements of design structure for industrial design in engineering application in modem manufacturing systems.

Ergonomics and Industrial Design: Introduction - general approach to the man-machine relationship-workstation design-working position. **06 Hours**

Unit-2

Control and Displays: shapes and sizes of various controls and displays-multiple displays and control situations - design of major controls in automobiles, machine tools etc., - design of furniture design of instruments.

Ergonomics and Production: Ergonomics and product design ergonomics in automated systems-expert systems for ergonomic design, Anthropomorphic data and its applications in ergonomic design limitations of anthropomorphic data - use of computerized database.

11 Hours

Unit-3

Visual Effects of Line and Form: The mechanics of seeing psychology of seeing, general influences of lined and form.

Colour: colour and light - colour and objects - colour and the eye colour consistency - colour terms - reactions to colour and colour continuation - colour on engineering equipments.

11 Hours

Unit-4

Aesthetic Concepts: Concept of unity - concept of order with variety - concept of purpose style and environment - Aesthetic expressions. Style-components of style - house style, observations style in capital goods. **06 Hours**

Unit-5

Industrial Design in Practice: General design - specifying design equipments - rating the importance of industrial design – industrial design in the design process. **05 Hours**

TEXT BOOKS:

1. **Industrial design for Engineers** - Mayall W.H. - London Cliffee Books Ltd. - 1988.
2. **Applied Ergonomics Hand Book** - Brien Shakel (Edited) - Butterworth Scientific, London – 1988.

E-BOOKS:

1. http://textofvideo.nptel.iitm.ac.in/107103004/lec40.pdf

MOOCS:

1. http://nptel.ac.in/courses/107103004/

Course Out comes

CO1	Illustrate general approaches to the man- machine relationship and design of work station and analyze various control and displays in various industries give a oral presentation
CO2	Design and develop an effective expert systems for ergonomic design and Identify visual effects of line & form and analyze mechanics of seeing psychology with some case studies
CO3	Design an industrial equipment in perspective of ergonomics and give a detailed technical reports on ergonomic standards used in industries

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 1, 4 and 5 and two questions each from units 2 and 3.

ADVANCED ENGINEERING MATERIALS

Subject Code	**18MEMSPEAE**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Ferrous Materials: Fe-C phase diagram, Composition Properties and applications **of**: low carbon steel, dual phase steels, micro-alloyed steels, weathering steels, free cutting steels, medium carbon steels, high strength structural steels, ausformed steels, martensitic stainless steels, austenitic stainless steels.

Tool Materials – Classification, properties, heat treatment of high speed steel, medium duty tools, tools for cold and hot forming, tools for high speed cutting.

Cast Iron, Gray C I, White C I, Malleable C I, Nodular C I or Ductile Iron, Vermicular Graphite Iron, properties and applications **11 Hours**

Unit-2

Polymeric Materials: Thermoplastics, thermosetting plastics, industrial polymerization methods, Processing and forming techniques. Elastomers, material preparation

Ceramic Materials: Classification ,properties and applications. Processing of ceramics, – Pressing, dry-pressing, isostatic pressing, hot pressing, slip casting, extrusion, thermal treatment, verification, properties and applications.

Engineering Ceramics – Alumina, silicon nitride, silicon carbide **11 hours**

Unit-3

Super alloys: Ni, Fe and Co based super alloys, properties and applications.

Bio-Materials, Bio compatibility, Applications, properties and applications.

Magnetic Materials: Magnetic fields, types of magnetism, soft magnetic materials, hard magnetic materials, properties and applications. **6 Hours**

Unit-4

Semi-conducting Materials: Intrinsic and extrinsic semiconduction, The Hall effect, semiconductor devices, properties and applications.

Superconducting Materials: Meissner effect, current flow and magnetic fields in superconductors, high critical temperature superconducting oxides **6 Hours**

Unit-5

High Temperature Materials Inconel steels, Titanium super alloys – structure, properties and applications **Nano Materials** Nanostructures: Carbon Nanotubes, Fullerenes, Nanowires, Quantum Dots. Applications of nanostructures, Thermodynamic of nano materials. **5 hours**

Text Book:

1. W.F. Smith, Principles of Materials Science and Engineering, Mc Graw Hill, New York (1994)

References:

1. W.D. Callister, An Introduction to Materials Science & Engineering, John Wiley & Sons (2007)
2. V. Raghavan, Material Science and Engineering, Prentice Hall of India, 2004.
3. R. Sharma, Heat Treatment: Principles and Techniques, Prentice Hall of India (2004)

E-BOOKS:

1. http://nptel.ac.in/courses/113108051/
2. http://nptel.ac.in/courses/112104122/

Course Out comes

CO1	Describe different types of advanced ferrous, nonferrous, semi & super conducting materials with properties and applications in engineering components
CO2	Categorize polymeric materials and ceramic materials with various processing techniques
CO3	Present case studies with technical reports on current research in the relevant field

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 3, 4 and 5 and two questions each from units 1 and 2.

NONDESTRUCTIVE TESTING

Subject Code	**18MEMSPEND**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Introduction to ND Testing: Selection of ND methods, visual inspection (Boroscopes, Image sensors, Magnifying Systems) leak testing: Method of leak testing systems at pressure or at vacuum, liquid penetration inspection, its advantages and limitation.

Magnetic Particle Inspection: Methods of generating magnetic field, types of magnetic particles and suspension liquids steps in inspection – application and limitations. **11 Hours**

Unit-2

Ultrasonic inspection: Basic equipment, advantages and disadvantages, applicability, characteristics of ultrasonic waves, variables inspection, attenuation of ultrasonic beams, inspection methods:- pulse echo, A,B,C scans transmission.

Transducer elements couplets, search units, contact types and immersion types, inspection standards-standard reference blocks, Indian standards for NDT. **11Hours**

Unit-3

Eddy Current Inspection: principles, operation variables, procedure, inspection coils, and detectable discounts by the method. **5 Hours**

Unit-4

Radiography Inspection: principles, radiation source X-rays and gamma rays, X-ray-tube, radio graphic films, neutron radiography, Thermal inspection principles, equipment inspection methods applications**.** **6 Hours**

Unit-5

Optical Holography: Basics of Holography, recording and reconstruction - Acoustical Holography: systems & techniques applications. Microwave holography: Technique, applications and limitations. **6 Hours**

REFERENCE BOOKS:

1. Non Destructive Testing - Mc Gonnagle JJ – Garden and reach New York.

2. Non Destructive Evolution and Quality Control - volume 17 of metals hand book 9 edition Asia internal 1989.

3. The Testing instruction of Engineering materials - Davis H.E Troxel G.E wiskovil C.T - **McGraw hill.**

E-BOOKS:

1.https://www.asnt.org/Store/ProductDetail?productKey=f3f52371-81eb-4cd3-b463-179a55ec36a5.

MOOCS:

1. https://onlinecourses.nptel.ac.in/noc16_mm07/preview

2. http://nptel.ac.in/courses/114106035/1

Course Out comes

CO1	Describe various NDT techniques, equipment, applications and limitations
CO2	Selection, application of appropriate NDT method for various components using NDT standards and interpretation of defects
CO3	Present case studies with technical reports on current research in the relevant field

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 3, 4 and 5 and two questions each from units 1 and 2.

MICRO ELECTRO - MECHANICAL SYSTEMS (MEMS)

Subject Code	**18MEMSPEME**	CIE Marks	50
L-T-P-S	3-0-0-0	SEE Marks	50
Total no. of Lecture Hours.	39	Exam Hours	03

Course Content:

Unit-1

Introduction: Concepts of MEMS (Micro Electro mechanical system)- Principles, application and design**.**

Classification: & Consideration: Mechanical systems, Fludic systems; example & MEMS Architecture, Introduction to Micro-fabrication & Micromachining.

Devising & Synthesis: Micro Accelerometers as Micro Electro Mechanical Micro-devices

11 Hours

Unit-2

Modeling of Micro Electro Mechanical System& Devices: Model developments of micro electromagnetic, mechanics and its application to MEMS. **6 Hours**

Unit-3

Modeling of Micro Electro Mechanical Devices: Direct current Micro machines induction micro machine synchronous micro machine, permanent-magnet stepper micro motors.

Controls of MEMS: Analog control of MEMS, Sliding mode control of MEMS, Digital control of MEMS. **11 Hours**

Unit-4

Materials for MEMS: Substrate and wafers, Active substrate material, silicon, Silicon compound, Silico pezoresisters, Gallium arsenide, Quartz, piezoelectric crystals, Polymers.

5 Hours

Unit-5

Micro System Packaging: Over view of mechanical packaging of microelectronics micro system packaging, Interfaces in micro system packaging, Packaging technologies. **6 Hours**

TEXT BOOKS:

1. Max J. Madou: **"Fundamentals of Micro Fabrication"-** The science of miniaturization-, Nanogen corporation, USA, CRC press, March 2002.

2. Sergey Edward Lyshevski: **"Nano-And Micro Electro Mechanical Systems**" – Second edition, CRC press, Boca Ratron London.

REFERENCE BOOKS:

1. Sherif sedky: **"Integrated MEMS"-** Artech House, Boston London.
2. N. Maluf **: "Introduction To Micro Mechanical Systems Engineering**" –, Artech House, Norwood, MA, 2000.
3. Tai – Ran Hsu**: "MEMS And Micro Systems: Design And Manufacture"** – Tata Mc Graw Hill, 2002.

E-BOOKS:

1. http://textofvideo.nptel.iitm.ac.in/117105082/lec1.pdf

MOOCS:

1. http://nptel.ac.in/courses/117105082/
2. http://nptel.ac.in/courses/117105082/

Course Out comes

CO1	Classify and apply the concepts of MEMS based on its applications. Synthesize the designed MEMS for pre defined application.
CO2	Modeling of MEMS to evaluate better performance. Identify control mechanisms of MEMS. Select a system packaging based on its performance
CO3	Present case studies with technical reports on current research in the relevant field

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 2, 4 and 5 and two questions each from units 1 and 3.

CNC AND ROBOTICS Lab

Subject Code	**18MEMSPCCR**	CIE Marks	50
L-T-P-S	0-0-1-0	SEE Marks	50
Total no. of Lecture Hours.	13	Exam Hours	03

- Part programming in CNC turning and milling
- Exercises in Programing of Industrial Robot for Pick and place, Continuous path applications, Simulation and practical exercises.

Course Out comes

CO1	Write and simulate CNC program for Turning and Milling
CO2	Document and report programs for CNC and Robot
CO3	Hands on programming and execution of Milling and Turning operations

III SEMESTER

INTERNSHIP

Subject Code	**18MEMSPCNT**	CIE Marks	100
L-T-P-S	0-0-10-0	SEE Marks	100
Total no. of Lecture Hours.	-	Exam Hours	3

Course objectives for Internship

CO1	Understand the structure, culture, various industrial practices, professional ethics and working of an industry and gain awareness of possible careers
CO2	Apply critical thinking in identification and solution of problems by integrating knowledge and skills. Perform efficiently in taking up assigned responsibilities. Communicate effectively and professionally
CO3	Prepare technical reports and make oral presentation

PROJECT WORK (I PHASE)

Subject Code	**18MEMSPCPJ-1**	CIE Marks	100
L-T-P-S	0-0-08-0	SEE Marks	100
Total no. of Lecture Hours.	-	Exam Hours	3

Course objectives for Project Work **(I PHASE)**

CO1	Choose a problem applying relevant knowledge and skills acquired during the course in the domain. Formulate the specifications of the project work, identify a set of feasible solutions and prepare and execute project plan considering professional, cultural and societal factors. Conclude problem solving methodology using literature survey and present the same
CO2	Develop experimental planning and use appropriate techniques and tools to conduct experiments. Evaluate and critically examine the outcomes. Conclude the results and identify relevant applications.

TECHNICAL SEMINAR

Subject Code	**18MEMSPCSR**	CIE Marks	50
L-T-P-S	0-0-0-1	SEE Marks	-
Total no. of Lecture Hours.	-	Exam Hours	-

Course objectives for Technical Seminar

CO1	Identify and select a research/journal paper related to materials, characterization, manufacturing or analysis
CO2	Understand the content of the selected research/journal paper
CO3	Prepare a technical seminar report and communicate effectively through oral presentation using multimedia tools

PRODUCT LIFECYCLE MANAGEMENT

Subject Code	18MEMSPCPL	CIE Marks	50
L-T-P-S	2-0-1-0	SEE Marks	50
Total no. of Lecture Hours.	26	Exam Hours	03

Course Content:

UNIT-1

Introduction to PLM, Definition, Corporate Challenges, System Architecture, Information models and product structures, Reasons for deployment of PLM Systems **02 Hours**

UNIT-2

Product Lifecycle Management Systems, Product development and Engineering, Production, After Sales, sales and marketing, Sub-contracting, Sourcing and Procurement. Product Structure case studies, with examples of ship, cellular phones, structure of customizable products.

Integration of PLM with other applications, Database integration, System Roles, ERP, CAD, Configurators, EAI. **07 Hours**

UNIT-3

Deployment of PLM system, Stages of deployment, Leading a PLM project, Need for change understanding, PLM Maturity model, Choosing system, Realization stage of project, Accomplishing change in organization. Business benefits, Costs of Quality, PLM Software licenses, Database licenses, Maintenance of Equipment, licenses **04 Hours**

UNIT-4

Challenges of PLM in manufacturing and engineering industry, Life cycle thinking, Value added services and after sales, Traceability, Case studies of High tech and Engineering product, Product Management, Capital goods manufacturing customer specific variable product.

Role of Product management in Collaborative business development, CIM, Concurrent engineering, Tools for collaboration, International Standardization organizations, CPC, cPDM.

07 Hours

UNIT-5

Basic behavior of product and lifecycles, metrics for performance review, Data management view, PLM as business strategy tool, Time to Market, time to react, Time to volume, time to service, Significance of product management, collaboration and electronic business for manufacturing industry. **06 Hours**

Textbooks and References:

1. Product Lifecycle Management, Antti Saaksvuori, Anselmi Immonen, 2nd Edition, Springer, Berlin.
2. Product Lifecycle Management, 21st Century paradigm for product realization, 2nd Edition, Springer, Berlin.

REFERENCE BOOKS:

1. Product Lifecycle Management driving the next generation, Michael Grieves, Tata Mc Graw Hill
2. Configuration management metrics, Frank B Watts, Elsevier
3. Product Lifecycle Management Geometric Variations, Max Giordano, Luc Mathieu, Francois Villeneuve, Wiley publications USA

MOOCS:

1. https://academy.3ds.com/en/learn-online

E-Books:

1. **https://s3-eu-west-1.amazonaws.com/gxmedia.galileo-press.de/leseproben/3030/sappress_product_lifecycle_management.pdf**

Course Outcomes: At the end of the course the student is expected to:

CO1	Analyze product lifecycle management systems for new product development and give a detailed technical report on current research
CO2	Evaluate and make use of the best tools and practices for product development make use of current software tools and evaluation models
CO3	Give a detail presentation of current PLM based systems and architecture for manufacturing and allied industries with some case studies

Lab Component: 1 Hour workload/week (for 2 hours) (13 classes)

Module 1: Development of conceptual model using Sketching and idea presentation

Module2: Use of CAD tools such as CATIA/Solidworks to develop the model

Module 3: Analysis of the CAD model for developing engineering connections

Module 4: Use of Analysis software for analyzing the developed model

Module 5: 3D printing the model for realization of the concept into prototypes for form and fit conformance

Module 6: Use of Product Lifecycle Management Tool to create manuals and product service manuals**.**

Module 7: e-commerce platforms for product launch and tracking.

CIE 1	20 marks
CIE 2	20 marks
Lab	10 marks

Scheme of Examination:

Answer five full questions selecting one from each unit. To set one question each from units 1, 3 and 5 and two questions each from units 2 and 4.

IV SEMESTER

PROJECT WORK (PHASE-II)

Subject Code	**18MEMSPCPJ-2**	CIE Marks	100
L-T-P-S	0-0-20-0	SEE Marks	100
Total no. of Lecture Hours.		Exam Hours	3

Course objectives for Project Work (PHASE-II)

CO3	Document the findings and write a report in the prescribed format. Demonstrate working knowledge of ethics and professional responsibility at different stages such as problem formulation, designing the experiments, implementation and presentation. Present and publish the outcomes of the project work in a journal/conference

2	**Program Elective** (Domain/**Management Stream)**	18MEMDOEBA	Business Analytics	02					50	50	100
		18MEMDOECM	Cost Management of Engineering Projects								
3	Audit -2 Non Credit Mandatory Course							0			P/NP