CURRICULUM & SYLLABUS

(2024 SCHEME)

Minor *in*

MATERIALS AND MANUFACTURING (MECHANICAL ENGINEERING)

OFFERED BY : Department of Mechanical Engineering (ME)

ELIGIBLE DEPARTMENTS : AD, CA, CC, CE, CS, EC, ER, EE

Minor

MATERIALS AND MANUFACTURING

MECHANICAL ENGINEERING

COURSES

CURRICULUM

COURSES												
Sl. No:	Semester	Course Code	Course Title (Course Name)	Credit Structure				SS	Total Marks		Credits	Hrs./ Week
				L	T	P	R		CIE	ESE		
1	3	24SJMNMET309	Material Science and Technology*/MOOC#	4	0	0	0	5	40	60	4	4
2	4	24SJMNMET409	Manufacturing Technology*/MOOC#	3	1	0	0	5	40	60	4	4
3	5	24SJMNMET509	Machine Tools Engineering/MOOC	3	1	0	0	5	40	60	4	4
4	6	24SJMNMET609	Industrial Engineering/MOOC	3	0	0	0	5	40	60	3	3
Total								**20**			**15**	**15**

** Students must register for theory courses in the 3rd and 4th semesters of the Minor curriculum.*

 # Students who fail a theory course listed in the Minor curriculum are permitted to register for an alternate MOOC course specified in the Minor curriculum.

SEMESTER 3

MATERIAL SCIENCE AND TECHNOLOGY

Course Code	24SJMNMET309	CIE Marks	40
Teaching Hours/Week (L:T:P:R)	4:0:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Pre-requisites (if any)	Nil	Course Type	Theory

Course Objectives:

- To provide the students with basic knowledge of materials science, so that they would be able to understand and distinguish between variety of materials based on their structure and properties
- To impart basic knowledge on the response of the materials under static/dynamic loading at different temperatures
- To introduce the materials characterization techniques to the students.
- To provide the students with the basic physics of semiconductor materials, device fundamentals with emphasis on their electronic characteristics.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic chemical bonds, crystal structures, and their relationship with material properties.	K2
CO2	Understand the interaction of materials at the nanoscale and differentiate engineering materials based on structure and properties for engineering applications.	K2
CO3	Understand the failure mechanisms of materials and able to identify the ideal method of analysis to draw the required information.	K2
CO4	Provide fundamental understanding of the materials used in the semiconductor industry, problems in electronic materials and propose viable engineering solutions.	K2

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	-	-	1	-	1	-	-	1
CO2	3	-	-	-	-	1	-	1	-	-	1
CO3	3	-	-	2	-	1	-	1	-	-	1
CO4	3	1	-	-	-	1	-	1	-	-	1

SYLLABUS

Module	Syllabus Description	Contact Hours	CO
1	Earlier and present development of atomic structure- primary bonds: - secondary bonds - earlier and present development of atomic structure- primary bonds: - secondary bonds - classification of engineering materials- levels of structure- crystallography- structure–property relationships in materials - Miller indices	**10**	**1**
2	Structure determination by X-ray diffraction- Classification of crystal Imperfections- Modes of plastic deformation Diffusion in solids, Fick's laws -Dislocation density-mechanism of crystallization: homogeneous and heterogeneous nuclei formation-Hall - Petch theory. Phase diagrams: - Limitations of pure metals and need of alloying - classification of alloys, solid solutions, Hume Rothery`s rule - strengthening mechanisms- introduction to super alloys.	**12**	**2**
3	Mechanical properties: Tensile properties, Hardness and hardness measurement, Impact properties, Super plasticity. Fatigue: - Stress cycles – fatigue tests, SN curve - Ductile to brittle transition temperature (DBTT) in steels - Creep: Creep curves – creep tests Spectroscopic methods- UV-visible and vibrational spectroscopy- Infrared and Raman, Optical microscopy, Electron microscopy- SEM, TEM; Scanning Probe Microscopies: STM, AFM; Thermal analysis- TGA, DTA,DSC	**12**	**3**
4	Electronic Materials-Introduction: Semiconductors-Introduction- Band Formation in Semiconductors-Classification of Semiconductors: Intrinsic Semiconductors-Introduction-Intrinsic Silicon-Conductivity Equation-Carrier Concentration in Semiconductors: Extrinsic Semiconductors: dielectric materials- conductors - resistor materials. Introduction-Doping Types-Compensation Doping-Dopant Materials: LASERs- Photodetectors and Solar Cells: Superconducting phenomenon	**10**	**4**

Course Assessment Method (CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 2 marks **(8x3 = 24 marks)**	Each question carries 9 marks. Two questions will be given from each module, out of which one question should be answered. Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Material Science and Engineering	Callister William D.	John Wiley	2014
2	Material Science and Engineering	Raghavan V.	Prentice Hall	2004

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Introduction to Physical Metallurgy	Avner H. Sidney	Tata McGraw Hill	2009
2	Material Science for Engineers	Anderson J. C.	Chapman and Hall	1990
3	Mechanical Metallurgy	Dieter George	Tata McGraw Hill	1976
4	Semiconductor Materials, Devices, and Fabrication	Parasuraman Swaminathan	John Wiley	2019

Video Links (NPTEL, SWAYAM…)		
Module No.	**Topic**	**Link ID**
1 to 2	Material Science and Technology	https://archive.nptel.ac.in/courses/113/102/113102080/
3	Material Characterization	https://archive.nptel.ac.in/courses/113/106/113106034/
4	Fundamentals Of Electronic Materials	https://onlinecourses.nptel.ac.in/noc21_mm03/preview

SEMESTER 4

MANUFACTURING TECHNOLOGY

Course Code	24SJMNMET409	CIE Marks	40
Teaching Hours/Week (L:T:P:R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Pre-requisites (if any)	Material Science and Technology (Minor)	Course Type	Theory

Course Objectives:

- To understand basic manufacturing processes of casting and welding
- Provide a detailed discussion on the welding process and the physics of welding.
- To understand mechanisms of material removal in LBM and EBM process
- To introduce the different forming process of forging, extrusion and drawing.
- To introduce the different fabrication of microelectronic devices

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Illustrate the basic principles of metal shaping processes such as casting process, special casting processes, forging process, extrusion process and drawing process their advantages, limitations and applications.	K2
CO2	Categorize welding processes according to welding principle and material.	K2
CO3	Understand the working principles of powder metallurgy method and categorize the various non-traditional material removal process based on energy sources and mechanism employed.	K2
CO4	Understand the principles of the basic microelectronic processing technologies.	K2

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	-	-	1	1	1	-	-	1
CO2	3	-	-	-	-	1	1	1	-	-	1
CO3	3	-	-	-	-	1	1	1	-	-	1
CO4	3	-	-	-	-	1	1	1	-	-	1

SYLLABUS

Module	Syllabus Description	Contact Hours	CO
1	Metal casting: -sand casting: - shell moulding, evaporative pattern casting, investment casting, permanent mould casting, vacuum casting, slush casting, pressure casting, die casting, centrifugal casting, squeeze casting, semi solid metal forming, casting for single crystal, casting defects, Metal forging: quality, defects -Metal extrusion: process, defects, applications - Metal drawing process, drawing practice, defects, applications	**11**	**1**
2	Welding: arc welding: non consumable electrodes; heat affected zone; quality; case study and weldability of metals-Consumable electrodes; heat affected zone; power density; weld quality. Resistance welding: HAZ, process and correlation of process parameters with welded joints of spot, seam, projection, stud arc, percussion welding- applications of each welding process –simple problems. (Kalpakjian). Arc welding: -HAZ, process and correlation of process parameters with welded joints of shielded metal arc, submerged, gas metal, flux cored, electrogas, electroslag, gas tungsten, plasma arc, electron beam, laser beam –simple problems - Thermit welding, friction welding- applications of each welding process-Oxyacetylene welding: -chemistry, types of flame and its applications -brazing- soldering - adhesive bonding.	**11**	**2**
3	Powder metallurgy: -powder production methods; powder characteristics; blending, mixing; compaction of metal powders; sintering fundamentals and mechanisms; infiltration and impregnation. Non Traditional machining processes: - Electric Discharge Machining (EDM): - Mechanism of metal removal, dielectric fluid, spark generation, and attributes of process characteristics on MRR, accuracy, HAZ etc. Ultrasonic Machining (USM): -mechanics of cutting, effects of parameters on amplitude, frequency of vibration, grain diameter, slurry, tool material attributes and hardness of work material, applications. Laser Beam Machining (LBM), Electron Beam Machining (EBM), Ion beam Machining(IBM) – Mechanism of metal removal, attributes of process characteristics on MRR, accuracy etc. and structure of HAZ. Abrasive Jet Machining (AJM), Abrasive Water Jet Machining (AWJM)-Working principle, Mechanism of metal removal, Influence of process parameters, Applications, Advantages & disadvantages.	**12**	**3**
4	Fabrication of microelectronic devices – crystal growing and wafer preparation - Film deposition - oxidation - Photo lithography. Different lithography methods - Etching, wet etching, dry etching- diffusion and Ion implantation metallization and testing - wire bonding and packing - yield and reliability - fabrication of micro electro mechanical devices.	**10**	**4**

Course Assessment Method (CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 2 marks **(8x3 = 24 marks)**	Each question carries 9 marks. Two questions will be given from each module, out of which one question should be answered. Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Manufacturing Engineering and Technology	Serope Kalpakjian, Steven R. Schmid	Pearson	7th edition

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Metal Casting	Hine and Rosenthal	Tata McGraw-Hill	1976
2	DeGarmo's Materials and Processes in Manufacturing, 13th Edition	J. T. Black, Ronald A. Kohser	Wiley	2019
3	Manufacturing Technology Foundry, Forming and Welding	P. N. Rao	McGraw Hill Education (India) Private Limited	2018

Video Links (NPTEL, SWAYAM…)

Module No.	Topic	Link ID
1	Manufacturing Technology	https://onlinecourses.nptel.ac.in/noc24_me108/preview
2	Welding Technology	https://archive.nptel.ac.in/courses/112/103/112103263/
3	Powder Metallurgy Non-conventional Machining	https://archive.nptel.ac.in/courses/113/106/113106098/ https://onlinecourses.nptel.ac.in/noc24_me72/preview
4	Microfabrication	https://nptel.ac.in/courses/103106075/

SEMESTER 5

MACHINE TOOLS ENGINEERING

Course Code	**24SJMNMET509**	**CIE Marks**	40
Teaching Hours/Week (L:T:P:R)	3:1:0:0	**ESE Marks**	60
Credits	4	**Exam Hours**	2 Hrs. 30 Min.
Pre-requisites (if any)	Material Science and Technology (Minor)	**Course Type**	Theory

Course Objectives:

- To provide students with a comprehensive understanding of various machine tools and the operations performed on them.
- To equip learners with the theoretical foundation necessary for appropriate selection of machine tools.
- To develop supervisory skills and enhance decision-making abilities for efficient shop floor management.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		**Bloom's Knowledge Level (KL)**
CO1	Understand the basic concepts involved in metal cutting.	**K2**
CO2	Differentiate between machine tools, their components, operations carried out and their unique metal removing mechanisms.	**K2**
CO3	Understand how to specify machine tools and cutting tools and also calculate the time required for machining.	**K3**
CO4	Understand the basics of machine tools with Computer Numeric Control and understand the processes and evaluate the role of different micro machining and nano finishing processes used	**K2**

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	-	-	1	1	-	-	-	1
CO2	3	-	1	-	-	1	1	-	-	1	1
CO3	3	-	-	2	-	1	1	-	-	1	1
CO4	3	2	1	-	-	1	1	-	-	-	1

SYLLABUS

Module	Syllabus Description	Contact Hours	CO
1	Definition of machining–brief history of machining–role of machining in society. Introduction to metal cutting: Elements of cutting process–orthogonal cutting– mechanism of chip formation–machining variables - types of chips–chip breaker– geometry of single point cutting tool– tool nomenclature- speed, feed, depth of cut – cutting fluids- effect of machining variables on surface roughness- Cutting tool materials–types–application. Machinability–tool life and wear.	**11**	**1**
2	General purpose machine tools – Lathe: principle of operation of lathe–construction details of lathe–work holding and tool holding parts of lathe– types of lathe and specification–machining time calculation on lathe–main operations. Drilling Machines: principle of operation construction details- work holding and tool holding devices– types of drilling machine and specification. Twist drill geometry–specification–calculation of machining time in drilling.	**11**	**2**
3	Milling machines: Principle of operation of milling machine-types and specifications–principal parts-work holding devices–types of milling cutters-elemental milling motions-up milling, down milling calculation of machining time. Grinding machines: classification –operations– surface, cylindrical and centreless grinding–grinding wheels–specification–types of abrasives, grain size. Dressing and truing of grinding wheels–selection of grinding wheels.	**11**	**3**
4	Machine tools with Computer Numeric Control: Principle of operation of CNC system–basic components of CNC system– classification of CNC systems– open loop control and closed loop control– point to point and continuous path control– absolute positioning and incremental positioning–CNC lathe–construction and operation – CNC milling machine–construction and operation (elementary treatment only). Micromachining: Diamond turn mechanism, Advanced finishing processes: Abrasive Flow Machining, Magnetic Abrasive Finishing. - Magnetorheological Finishing, Magnetorheological Abrasive Flow Finishing, Magnetic Float Polishing, Elastic Emission Machining.	**11**	**4**

Course Assessment Method (CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 2 marks **(8x3 = 24 marks)**	Each question carries 9 marks. Two questions will be given from each module, out of which one question should be answered. Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of thePublisher	Edition and Year
1	Production Technology	R.K. Jain	Khanna publishers	17th ed., 2013
2	Elements of Workshop Technology Vol. II	Hajra Choudhary	Media Promoters & Publishers Pvt. Ltd	2010

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Manufacturing Engineering and Technology	Serope Kalpakjian, Steven R. Schmid	Pearson.	8th ed.
2	Workshop Technology	Chapman W.A.J.	Viva books (P) Ltd	1998
3	Precision Machining Technology	Peter J. Hoffman, Eric S. Hopewell et al	Cengage Learning	2008
4	Grinding Technology: Theory and application of Machining with Abrasives	Malkin Stephen	Industrial press	2008
5	Advances in Abrasive Based Machining and Finishing Processes	S. Das, G. Kibria, B. Doloi, B. Bhattacharyya	Springer	2020
6	CNC Programming for Machining	Kaushik Kumar; Chikesh Ranjan; J. Paulo Davim	Springer	2020

Video Links (NPTEL, SWAYAM…)

Module No.	Topic	Link ID
1 to 4	Machine Tool Engineering	https://archive.nptel.ac.in/courses/112/105/112105233/

SEMESTER 6

INDUSTRIAL ENGINEERING

Course Code	24SJMNMET609	CIE Marks	40
Teaching Hours/Week (L:T:P:R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Pre-requisites (if any)	Nil	Course Type	Theory

Course Objectives:

- To introduce students to the core functions and techniques of Industrial Engineering, including productivity improvement, work study, method study, and time study.
- To enable students to analyze the economic aspects of business decisions and apply human factors in engineering design.
- To familiarize students with industrial engineering tools and techniques for effective plant management, including plant layout, material handling, and production planning and control.
- To provide knowledge of quality practices, project management, and replacement techniques relevant to industrial operations and decision-making.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's KnowledgeLevel (KL)
CO1	Understand the functions of Industrial Engineering, Economic aspects of business and Human factors in design	K2
CO2	Apply Principles of Work study, Method study and Work measurement techniques.	K3
CO3	Develop layout for a manufacturing/service system and apply plant management and material handling techniques.	K3
CO4	Apply and analyse Production Planning and Control techniques, Inventory control, Quality practices and Project Management.	K3

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	2	-	3	-	-	-	-	-	-	2	-
CO2	3	-	3	-	-	-	-	-	-	2	-
CO3	3	-	3	3	3	-	-	-	-	3	-
CO4	3	-	3	3	3	-	-	-	-	3	-

SYLLABUS

Module	Syllabus Description	Contact Hours	CO
1	Introduction to Industrial Engineering - Evolution of modern Concepts in Industrial Engineering - Functions of Industrial Engineering. Productivity- productivity measures- dynamics of productivity change- Techniques for improving productivity. Production costs concepts – Manufacturing Vs Purchase- problems- Economic aspects- C-V-P analysis – simple problems. Ergonomics Man-Machine Systems-Anthropometry Work place design and ergonomics – Value Engineering	**9**	**1**
2	Work study-procedure-concept of work content- techniques to reduce work content. Method Study-steps-recording techniques-operation process chart-flow process chart-two hand process chart-multiple activity chart. Diagrams- Flow Diagrams-String diagrams. Micro-motion study-SIMO chart- critical examination. Principle of motion economy. Work measurement- techniques of work measurement - Time Study- - Steps in time study calculation of standard time (problems)- allowances.	**9**	**2**
3	Plant location, plant layout and material handling- Type of layouts and characteristics –Tools and techniques for plant layout- travel chart – REL chart- Computer algorithms for layout design CRAFT-ALDEP (methods only)- Systematic layout planning -Line balancing–RPW (problem). Principles of material handling-selection and type of material handling equipment- Unit load concept- Automated Material Handling Systems-AGVs.	**9**	**3**
4	Production Planning and control -Types of Production systems. Demand forecasting- Forecasting methods, Aggregate planning- methods- Master Production Schedule - Material Requirement Planning-bill of material- product structure diagram- Inventory Control, Inventory models – Basic model -price discounts -problems – determination of safety stock - Selective inventory control techniques. Quality control - Statistical quality control –causes of variation in quality- control charts for X and R (problems). Project management- Critical Path Method, PERT.	**9**	**4**

Course Assessment Method (CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 2 marks **(8x3 = 24 marks)**	Each question carries 9 marks. Two questions will be given from each module, out of which one question should be answered. Each question can have a maximum of 3 sub divisions. **(4x9 = 36 marks)**	**60**

Text Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Industrial Engineering & Production Management,	Martand Telsang,	S. Chand	Third revised Edition, 2018.
2	Industrial Engineering	B. Kumar	Khanna Publishers	Tenth Edition, 2015
3	Manufacturing Planning and Control for Supply Chain Management	Thomas E Vollmann, William L Berry, D Clay Whybark, F Robert Jacobs,	McGraw Hill Education (India) Private Limited,	Fifth Edition, 2017
4	Industrial Engineering & Production Management	M. Mahajan	Dhanpat Rai	First Edition, 2015
5	Industrial Engineering and Management	O. P. Khanna	Dhanpat Rai	2018

Reference Books

Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Production management	E. S. Buffa	John Wiley	Eighth Edition, 2007
2	Statistical Quality Control	Grant and Leaven Worth	McGraw Hill	Seventh Edition, 2017
3	Motion and Time Study	Ralph M Barnes	Wiley	Seventh Edition, 1980
4	Facility Layout and Location: An Analytical Approach	Richard L. Francis, F. McGinnis Jr., John A. White	Pearson	Second Edition, 2015

Video Links (NPTEL, SWAYAM…)

Module No.	Topic	Link ID
1 to 4	Industrial Engineering	https://nptel.ac.in/courses/112107292