Curriculum for M.Sc. Manufacturing Engineering

(Effective from Session-2021 and Onwards)

Sr. No	Core Courses (Compulsory)		Credit Hours
1	MF-501	Concurrent Product and Process Design	(3,0)
2	MF-502	Production Planning and Control	(3,0)
3	MF-503	Advanced Topics in Manufacturing	(3,0)
4	MF-504	Lean Manufacturing	(3,0)
Sr. No	**Elective Courses (Any four of the following)**		
1	MF-505	Manufacturing Strategy	(3,0)
2	MF-506	CAD/CAM	(3,0)
3	MF-507	CIM and Industry 4.0	(3,0)
4	MF-508	Tool Design	(3,0)
5	MF-509	Manufacturing Systems Analysis	(3,0)
6	MF-510	Research Methodology in Manufacturing	(3,0)
7	EM-504	Total Quality Management	(3,0)
8	EM-506	Economic Decisions in Engineering	(3,0)
9	EM-507	Environmental Management and Safety	(3,0)
10	EM-502	Operations Management	(3,0)
11	EM-514	Sustainability in Operations	(3,0)
12	MF-601	Trends in Manufacturing Processes	(3,0)
13	MF-598	Thesis	(3,0)

Note: Non-thesis option students will have to take additional courses and design project as per university policy.

CORE COURSES (COMPULSORY)

MF-501 Concurrent Product and Process Design (3)

Theory and Philosophy of Concurrent Engineering, Planning the Transition and Reducing the Organizational Barriers, Product Cycle Time, Customer Satisfaction, Reduction in Engineering Change Orders and Reworks Case Study, Strategies for Selecting, Staffing and Managing Multidisciplinary Functional Project Teams, Design for Manufacture and Assembly, Design for Manual and Automatic Assembly, Design for Machining, Design for Molding, Design for Casting, Design for Sheet Metalworking, Design for Hot Forming

Recommended Books:

1. Carter, D.E. and Baker, B.S., "CE Concurrent Engineering: The Product Development Environment for the 1990s",Addison-Wesley Publishers, 1992
2. Prasad, B., "Concurrent Engineering Fundamentals" Prentice Hall, 1996
3. Boothroyd, Dewhurst and Knight, "Product Design for Manufacture and Assembly", Marcel Dekker Inc., 2002

MF-502 Production Planning and Control (3)

Objectives of Production Planning and Control, Forecasting, Capacity Planning, Allocation of Resources, Resource Scheduling, Material and Inventory Management, Materials Requirement Planning, Manufacturing Resource Planning, Enterprise Resource Planning, Just-in-Time Manufacturing

Recommended Books:

1. Manufacturing Planning and Control Systems by Thomas E. Vollmann, William L. Berry, D. Clay Whybark (2^{nd} Edition)
2. Operations Management by Jay Heizer (12^{th} Edition)

MF-503 Advanced Topics in Manufacturing (3)

Conventional machining & Non-conventional machining: High speed machining, electric discharge machining, electrochemical machining, ultrasonic machining, plasma arc cutting, laser beam machining, water jet cutting.
Forming processes: Defects in typical metal forming processes (forging, rolling, extrusion etc, their implications and their remedies, high energy rate forming

Adhesive Bonding: Overview, applications and surface considerations for various bonding applications.

Coatings: Coating processes and its control, various types of novel PVD and CVD coatings and their benefits (DLC coatings, superlattice coating etc.)

Casting: Important process parameters & concepts for expendable and permanent mold processes (e.g. sand and die casting etc.), casting defects, their implications and control measures, non-traditional casting processes e.g. squeeze casting, cosworth process, single crystal casting etc.,

Additive manufacturing: Concept of 3D and beyond, key distinctive features, application perspective of additive manufacturing, various research domains of 3D printing

Recent research trends in select processes:

Recommended Books:

1. Castings by John Campbell (2^{nd} Edition)
2. Materials and Processes in Manufacturing by J.T. Black, Ronald A. Kohser (11^{th} Edition)
3. Manufacturing Processes for Engineering Materials by Serope Kalpakjian, Steven R. Schmid (5^{th} Edition)
4. Machining Fundamentals: From Basic to Advanced Techniques by John R. Walker

MF-504 Lean Manufacturing (3)

Introduction to lean, origin of lean manufacturing and evolution, lean, just in time and Toyota production system, lean tools and techniques, House of lean and Hoshin kanri planning,inventory and variations, lean implementation strategies, deployment approaches for lean tools, managing lean organizations, barriers and reasons of failure to lean implementation, lean product development, lean supply chains, process improvement case studies

Recommended Book:

1. How to implement lean manufacturing Lonnie Wilson McGraw Hill 2009
2. The Machine That Changed the World by James P. Womack, Daniel T. Jones, Daniel Roos The Free Press 2007
3. Essentials of Lean Six Sigma, Butterworth-Heinemann Salman Taghizadegan © 2010

ELECTIVE COURSES (Any Four)

MF-505 Manufacturing Strategy (3)

International Comparisons, Manufacturing Implications of Corporate Marketing Decisions, Order-winners and Qualifiers, Choice of Process Focused Manufacturing Process Positioning Manufacturing Infrastructure Development, Accounting and Financial Perspectives and Manufacturing Strategy

Recommended Book:

1. Hill, T., "Manufacturing Strategy: The Strategic Management of the Manufacturing Function", Macmillan Press Ltd, 1993

MF-506 CAD/CAM (3)

Computer methods in industrial design, Advanced computer geometric modeling, Transformation and projection, CAD/CAM databases, Introduction to automated machine tools and cutting tools, Tool path planning, Management of cutting tools, Numerical control, Motion control, Robotics, CNC machine tools programming, Use of modeling software, Part programming with respect to various tool compensation (nose radius, wire compensation, multi-pass strategy)

Recommended Book:

1. CAD/CAM Principles and Applications by P.N. Rao, 6th Edition, Mcgraw Hill

MF-507 CIM and Industry 4.0 (3)

CIM Strategy, Components of CIM, Group Technology and Cellular Systems, FMS, Robotic Systems, Systems Integration, Selection of CIM systems, Design and Implementation of computer integrated manufacturing (CIM). Future trends in CIM.
Industry 4.0: Conceptual framework, concept of smart factories, Industry 4.0 case studies in manufacturing, role of enabling technologies in Industry 4.0 readiness, implementation and maturity, Industry 4.0 case studies in manufacturing

Recommended Book:

1. Automation, Production Systems & Computer Integrated Manufacturing by Mikell P. Groover, 4th Edition, Pearson Education, 2014.
2. Computer Integrated Manufacturing by James A. Rehg, Henry W. Kraebber, Pearson Education, 2002

3. Industry 4.0: Managing the Digital Transformation by Ustundag, Alp | Cevikcan, Emre: Springer, 201

MF-508 Tool Design (3)

Design of cutting tools for turning, milling, drilling, boring and broaching, Design of circular and flat form tools, Cams and quick-return mechanisms for automatic machine tools, Tool layout for automatic, semi-automatic and multi-spindle machines, Design of plastic molding dies, Design of molds for ferrous and nonferrous metals Advanced problems in jigs and fixtures design with scope of standardization and optimization, Materials for cutting tools, Economic considerations in tool selection

Recommended Books:

1. Parsons, S.A.J., "Production Tooling Equipment", Macmillan and Company Limited, 3rd Ed.
2. Donaldson, Lecain and Goold, "Tool Design", Tata McGraw Hill, 3rd Edition
3. "Tool Engineer's Handbook", American Society of Tool and Manufacturing Engineers

MF-509 Manufacturing Systems Analysis (3)

Manufacturing systems and components, classification of manufacturing systems (manual, automated, single station, multi stations), basic probability review and important distributions, basics of factory models (definitions, system parameters, deterministic vs. stochastic models), single workstation model (diagram method for balance equations, Kendall notations, various case models e.g. finite and infinite capacity models etc.), multiple workstation/stage (single & multiple products) models (system parameters, characteristics, building blocks and performance measures), models of various forms of batching (e.g. batch move model, batch model for setup reduction, batch server model etc.), WIP limiting control strategies

Recommended Books:

1. "Manufacturing Systems Modeling and Analysis" by Guy L. Curry and Richard M. Feldman (Springer)
2. "Modeling and Analysis of Manufacturing Systems" by Ronald G. Askin and Charles R. Standridge (John Wiley and Sons, Inc.)
3. "Automation, Production Systems and Computer Integrated Manufacturing" by Mikell P. Groover (Prentice Hall, Inc.)

MF-510 Research Methodology in Manufacturing (3)

Introduction to research, definition and objectives of research, Types of research, Building blocks or research, Formulation and statement of problem, Theoretical framework, Hypothesis development, Elements of research design, ANOVA, Regression, DOE, Taguchi Techniques, Main Effect Plots, Signal to Noise Ratio, Preparation of research report and presentation, Use of Minitab, MS Excel or some other software for analysis, Reference styles used in research paper writing, Use of reference management software e.g. Endnote or Mendeley

Recommended Book:

1. Research Methodology: Methods and Techniques by C. R. Kothari, 2nd Edition

EM-504 Total Quality Management (3)

Introduction to quality management, quality control, quality assurance, TQM concepts and philosophies, leadership, customer satisfaction, employee involvement and team work, continuous process improvement, typical performance measures, quality costs, quality control tools, quality management systems, quality function deployment, quality by design, failure mode and effect analysis, total productive maintenance, future trends in TQM, TQM case studies.

Recommended Books:

1. TQM: Text with Cases by Jhon S. Oakland, 3rd Edition
2. Out of Crisis by W. Edward Deming
3. Total Quality Management by Besterfields, 3rd Edition

EM-506 Economic Decisions in Engineering (3)

Concept of economic analysis, cost concepts, economic life cycle, supply and demand relationship, return to capital, interest and interest formulae, contemporary methods for economic analysis, comparing mutually exclusive alternatives, depreciation of assets, effect of taxes, replacement analysis, economic decision-making under risk and uncertainty, sensitivity analysis, benefit/cost ratio method, case studies, international trade and balance of payments.

Recommended Books:

1. Engineering Economy by William G. Sullivan, Elin M. Wicks (16th Edition)
2. Engineering Economy by Leland Blank, Anthony Tarquin (7th Edition)

EM-507 Environmental Management and Safety (3)

Introduction to environment and industrial systems, overview of hazardous wastes and regulatory agencies, Characteristics of hazardous substances, associated hazards (toxicity, corrosiveness, reactiveness, ignitability, radioactivity), concept of industrial hygiene, in-plant management & disposal of hazardous materials, work place safety (layout, material handling, pressure vessels, points of operation and maintenance, personal protection& means of controlling industrial fires), environmental protocols, air pollutants (terminology and definitions, control and treatment methods), water pollutants (terminology and definitions, control and treatment methods), soil pollutants (terminology and definitions, control and treatment methods), environment impact assessment, economic aspects of environment & safety management, overview of environmental management systems

Recommended Books:

1. "Handbook of Industrial and Hazardous Wastes Treatment" edited by Lawrence K. Wang, Yung-Tse Hung, Howard H. Lo, Constantine Yapijakis(CRC Press)
2. "Safety Management" by John V. Grimaldi and Rollin H. Simonds (Richard D. Irwin, Inc.)

EM-502 Operations Management (3)

The production/operations function and the organization, production/operations management as a strategic competitive weapon, social responsibility and sustainability, product design (goods and services, life cycle), process strategy, plant location and layout, variety and value, forecasting, inventory management, scheduling techniques, capacity planning, aggregate planning, supply chain management, case studies/research trends in operations management

Recommended Book:

1. "Operations Management: Sustainability and Supply Chain Management by Jay Heizer, Barry Render, Chuck Munson and Amit Sachan Twelfth Edition, Pearson © 2020

EM-514 Sustainability in Operations (3)

Fundamental concepts of sustainability, triple bottom line, UN sustainable development goals and relevant frameworks, design for sustainability aspects, life cycle assessment, end of life phases, 3Rs (reduce, reuse a

nd recycle), logistics and reverse logistics, regulations and industry standards, research domains/case studies of sustainability in operations/manufacturing

Recommended Books:

1. Sustainable Manufacturing J P Davim Wiley 2010

2. Green Manufacturing: Fundamental and Applications. David Dornfeld Springer-Verlag, New York, US, 2013
3. Green Design and Manufacturing for Sustainability Nand K Jha CRC Press 2016

MF-601 Trends in Manufacturing Processes (3)

Developments in conventional machining: Challenges of conventional machining, evolving research areas in conventional machining, high feed machining, novel inserts and their role for productivity improvement, minimum quantity lubrication (MQL) and cryogenic machining, sustainable and green conventional machining concepts, insight into the roles of process parameters and their relevance with physical phenomenon

Developments in non-conventional machining: EDM/WEDM and process variants (such as electric discharge coating, electric discharge turning, slot milling and drilling), an in-depth into the role of process variables, the influence of electrode geometry on the cutting performance, novel coated wires in WEDM, evolving research trends in electric discharge machining domain, recent trends in water jet cutting and plasma arc cutting

Casting: Solidification theory and microstructure evolution, non-traditional casting approaches (e.g composite casting etc.), role of key process variables

Casting and Semi-solid processing: Rationale and background, Thixocasting, Rheocasting

Recent research trends in select processes:

Recommended Books:

1. Castings by John Campbell (2nd Edition)
2. Materials and Processes in Manufacturing by J.T. Black, Ronald A. Kohser (11th Edition)
3. Manufacturing Processes for Engineering Materials by Serope Kalpakjian, Steven R. Schmid (5th Edition)
4. Machining Fundamentals: From Basic to Advanced Techniques by John R. Walker