Outcome Based Education (OBE) Document

M.Tech. (Manufacturing Science and Engineering)

School of Engineering Sciences and Technology

Vision Statement

To be a centre of excellence for learning, training, research and development and entrepreneurial attitude in engineering sciences and technology.

Mission Statements (MS)

- To produce scientists, engineers and technologists through training programs in Materials Engineering, Nano Science and Technology, Manufacturing Science and Technology and other current areas of Engineering Sciences and Technology.

- To create a culture of addressing and solving the short-term and long-term pertinent problems in the society through engineering interventions.

- To encourage inter-disciplinary and collaborative research both at national and international levels.

- To carry out sponsored research and consultancy projects funded by national and international agencies and industries.

Program Educational Objectives (PEOs)

PEO1. To attain world-class quality in learning (theory and practical) and research related to engineering sciences and technology.
PEO2. To provide comprehensive and interdisciplinary knowledge on analyses, design, and creation of novel and environmentally benign engineering solutions for short-term and long-term pertinent problems in the society.
PEO3. To give a comprehensive hands-on training in the theory and experiments related to processing, characterization, testing of advanced materials and engineering components.
PEO4. To produce high quality and industrially relevant human resource for possible employment in industries, and academic and research organizations.

Mapping Program Educational Objectives (PEOs) with MS

	MS-1	MS-2	MS-3	MS-4
PEO-1	3	3	3	2
PEO-2	3	3	3	2
PEO-3	2	3	2	2
PEO-4	3	2	2	2

‘3’ – ‘high-level’ mapping; ‘2’ – ‘Medium-level’ mapping; ‘1’ – ‘Low-level’ mapping;

Program Outcomes (POs)

On completion of the M.Tech. (Materials Engineering) program at School of Engineering Sciences and Technology, the students will be able to:

PO-1. apply the basic science and engineering knowledge and course-specific engineering fundamentals to solve the problems in the society

PO-2. identify or formulate complex engineering problems and design specific and generic solutions for the same

PO-3. analyze the identified (or formulated) problems and conduct systematic and interdisciplinary research to solve them and/or to provide valid conclusions

PO-4. select and apply appropriate resources, and contemporary techniques and tools while solving the identified (or formulated) problems with a complete understanding of the limitations

PO-5. illustrate the complete cognizance of public health and safety, environmental safety, and cultural, societal and legal implications while solving the identified (or formulated) problems

PO-6. evaluate the sustainability, impact and implications of their work on solving the identified (or formulated) problems

PO-7. summarize effectively and explain the identified (or formulated) problems and their solutions and the methodology followed to solve the problems to the appropriate professional community as well as to the general public

PO-8. perform effectively as an individual and as a member (or a leader) of a team under inter-disciplinary national and international contexts.

PO-9. apply the project management skills under inter-disciplinary scenarios

PO-10. demonstrate professional responsibility and ethics

PO-11. recognize the need to develop interest in life-long learning to keep-up with the contemporary science and engineering

PO-12. To impart approaches in general problem solving, professional and ethical values, principles of team work and written and oral communication skills

PO-13. To provide an environment that fosters the culture of life-long learning

Program Specific Outcomes (PSOs)

PSO-1 demonstrate comprehensive knowledge on engineering materials processing, characterization and testing
PSO-2 apply knowledge on modelling and designing new engineering materials
PSO-3 conduct systematic experimentation to produce new engineering materials and products
PSO-4 select appropriate technologies leading to new engineering products and processes for different applications

Mapping of POs and PSOs with PEOs

	PEO-1	PEO-2	PEO-3	PEO-4
PO-1	3	3	3	3
PO-2	3	3	3	3
PO-3	3	3	3	3
PO-4	3	3	3	3
PO-5	2	2	2	1
PO-6	2	2	2	1
PO-7	3	2	2	2
PO-8	2	2	2	2
PO-9	2	2	2	2
PO-10	2	2	2	1
PO-11	2	2	2	1
PO-12	2	2	2	2
PO-13	3	2	2	2
PSO-1	3	3	3	3
PSO-2	3	3	2	2
PSO-3	3	3	3	3
PSO-4	3	3	3	2

‘3’ – ‘high-level’ mapping; ‘2’ – ‘Medium-level’ mapping; ‘1’ – ‘Low-level’ mapping;

Course Structure

Semester I

Subject Type	Subject Code	Subject Name	L-T-P	Credits
Core	MF401	Tool Design in Manufacturing	3-0-0	3
Core	MF402	Machining: Theory and Practice	2-0-1	3
Core	MF403	Plasticity and Metal Forming	3-0-0	3
Core	MF 404	CAD: Theory and Practice	1-0-2	3
Core	MF405	Advanced Casting and Welding: Science and Technology	3-0-0	3
Core	MF406	Conventional Manufacturing Laboratory	0-0-4	4
Core	MT407	Near Net shape Technology	0-0-3	3
		Total		**22**

L-Lecture; T-Tutorial; P-Practical;

Semester II

Subject Type	Subject Code	Subject Name	L-T-P	Credits
Core	MF451	Additive Manufacturing	3-0-0	3
Core	MF452	Automation and AI in Manufacturing	3-0-0	3
Core	MF453	NDT for Manufacturing	3-0-0	3
Core	MF454	Industrial Management	3-0-0	3
Core	MF455	Advanced Manufacturing Laboratory	0-0-4	4

Elective	MF651	Elective I Precision Machining/Surface Engineering/Manufacturing of small and ultra-small systems	3-0-0	3
Elective	MF652	Elective II Systems Engineering/Selection and Design of Engineering Materials/Case Studies in Industrial Manufacturing	3-0-0	3
		Total		**22**

L-Lecture; T-Tutorial; P-Practical;

Semester III

Subject Code	Subject Name	L	T	P	Credits
MF498	Project Part-I	0	0	12	12
MF496	Project Seminar-I	0	0	8	8
	Total				**20**

L-Lecture; T-Tutorial; P-Practical;

Semester-IV

Subject Code	Subject Name	L	T	P	Credits
MF499	Project Part-II	0	0	12	12
MF497	Project Seminar-II	0	0	8	8
	Total				**20**

L-Lecture; T-Tutorial; P-Practical;

Total Credits (I+II+III+IV semesters) = 22+22+20+20 = **84**

List of Electives (Semester II)

{Any two (2) from the following list of subjects and those (relevant and) offered in other MTech courses}

MF651 Precision Machining
MF652 Surface Engineering
MF653 Manufacturing of small and ultra-small systems
MF654 Systems Engineering
MF655 Selection and Design of Engineering Materials
MF656 Case Studies in Industrial Manufacturing Mechanical Systems

Subject Code: **MF401**
Title of the Course: Tool Designing in Manufacturing
L-T-P: 3-0-0 Credits: 3
Prerequisite Course/Knowledge (If any): General mechanical engineering, materials science and technology at bachelors level

After completion of this subject successfully, the students will be able to:

CO-1: apply the principles of materials selection for designing tools
CO-2: apply the knowledge of tooling for machining, forming, casting and joining
CO-3: select and conduct appropriate inspection and gauging procedures
CO-4: design an intended tool using the available software and validate the design
CO-5. validate and finalize the tool design idea for an intended application

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	2	1	1	1	1	1	1	1	1	1	2	2	2	2
CO2	3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO5	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

‘3’–‘high-level’ mapping; ‘2’–‘Medium-level’ mapping; ‘1’–‘Low-level’ mapping;

Detailed Syllabus:

Unit 1: Tools: Role of materials in tooling and tool engineering; Analysis of various manufacturing processes w.r.t the tools required;

Unit 2: Tooling for machining and forming: Traditional and advanced machining processes; Automats and NC machining; CNC machining; Tooling for forming processes (die, punch etc.,);

Unit 3: Tooling for casting and joining: Tooling for casting (molds, patterns etc.,); Tooling for welding and mechanical joining (welding fixtures, squaring tools etc.,)

Unit 3: Inspection and gauging: Tolerances and allowances; Gage tolerances; Gage types; Magnifying or amplifying dimensions;

Unit 4: Tool designing using CMM and CAD; One example in machining, forming, casting and joining;

Suggested Books:

1. Fundamentals of Tool Design, John G. Nee
2. Tool Engineering and Design, G. R. Nagpal
3. Machine Tool Design and Numerical Control, N. K. Mehta
4. Tool Design, C. Donaldson and G. H. Lecain

Subject Code: **MF402**
Title of the Course: **Machining: Theory and Practice**
L-T-P: 2-0-1 Credits: 3
Prerequisite Course/Knowledge (If any):

After completion of this subject successfully, the students will be able to:

CO-1: Develop interrelations among ASA, ORS and NRS systems of tool geometry
CO-2: Analyse cutting forces, temperature, power and specific energy along the shear and rake planes
CO-3: Evaluate shear angle relationships and coefficient of friction in natural and controlled contact cutting
CO-4: Select cutting fluids, cutting tool materials and tool geometry for improving machinability and tool life
CO-5: Analyse the frequency response function and stability lobe to perform condition monitoring of various machine tools

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3	PSO4
CO1																	
CO2																	
CO3																	
CO4																	

'3'–'high-level' mapping; '2'–'Medium-level' mapping; '1'–'Low-level' mapping;

Detailed Syllabus:

UNIT-1:

Introduction: Classification of Manufacturing Processes, History of Machining, Scope and Significance of Machining

Geometry of Cutting Tools: Geometry of single-point cutting tool: Tool-in hand system, ASA system, Significance of various angles of single point cutting tools, Orthogonal Rake System (ORS), Conversions between ASA and ORS systems – Graphical and Analytical Methods, Normal Rake System (NRS) & relation with ORS.

UNIT-2:

Mechanics of Machining Processes: Orthogonal and Oblique cutting, Mechanics of Chip formation: Types of chips, chip-breakers, Chip reduction coefficient, shear angle, shear strain, Built-Up-Edge and its effect in metal cutting, Merchant's analysis of metal cutting process, Theories of Metal Cutting: Ernst & Merchant, theory, Modified Merchant's theory, Lee & Shaffer Theory, Chip-tool Natural Contact Length – Hahn's Analysis, Stress distribution at Chip-Tool Interface – Zorev's Analysis, Machining with controlled contact cutting, Chip breakers and its design

UNIT-3:

Thermal aspects in machining: Sources of heat generation, Effects of temperature, Determination of cutting temperature using analytical methods, Determination of cutting temperature using experimental methods, Methods of Controlling Cutting Temperature.

Tool wear, Tool life and Machinability: Wear Mechanisms, Types of tool wear, Tool Life and Machinability, Evaluation of Tool Life and Machinability

Cutting Tool Materials: Desirable Properties of tool materials, Characteristics of Cutting Tool Materials, indexable inserts, coated tools

Cutting Fluids: Functions, characteristics and types, selection of cutting fluids

UNIT-4:

Mechanics of Multipoint Machining processes: Drill geometry & Mechanics of drilling process, Geometry of milling cutters and Mechanics of milling process, Mechanics of grinding (plunge grinding and surface grinding), Grinding wheel wear

Oblique Cutting: Inclination Angle, Chip Flow angle, Mechanics of oblique cutting.

UNIT-5:

Machining Dynamics: Machining tool vibrations, analysis methods (Chatter prediction) and vibration control; Frequency response functions and stability lobe plots; tool condition monitoring; Dynamics in high speed machining, thin-wall machining and high-performance machining; Optimization and economics.

Suggested Books:

1. Winston A. Knight and Geoffrey Boothroyd, Fundamentals of Machining and Machine Tools, 3/e, Taylor and Francis Group, 2005.
2. M. C. Shaw, Metal Cutting - Principles and Practices, Cambridge University Press, 2005
3. P. N. Rao, Manufacturing Technology - Metal Cutting and Machine Tools, TMH, 2013.
4. A. Bhattacharya, Metal Cutting: Theory and Practice, New Central Book Agency, 2007
5. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 2010
6. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2009.
7. D. K Pal, S. K. Basu, “Design of Machine Tools”, 5th Edition. Oxford IBH, 2008.

Subject Code: **MF403**
Title of the Course: Plasticity and Metal forming
L-T-P: 2-0-1 Credits: 3
Prerequisite Course/Knowledge (If any):

After completion of this subject successfully, the students will be able to:

CO-1: Determine the active slip systems for a material
CO-2: Analyse the stress strain curve and determine the yield point, ultimate tensile strength and fracture strength of a material
CO-3: Evaluate the critical resolved shear stress for a material
CO-4: Select appropriate forming operation and loading direction for ease of deformation
CO-5: Correlate the strain hardening behaviour to its microstructure

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3	PSO4
CO1																	
CO2																	
CO3																	
CO4																	

‘3’–‘high-level’ mapping; ‘2’–‘Medium-level’ mapping; ‘1’–‘Low-level’ mapping;

Detailed Syllabus:

Unit 1: Metallurgical aspects in plasticity: Slip and twinning mechanics; Temperature, strain rate, microstructure and friction effects; Stress-strain relations; Yielding and its importance; Flow stresses; Deformation mechanisms; Classification of forming processes; Examples;

Unit 2: Metal working: Hot and cold working processes; Controlling mechanical properties by working; Mechanics of metal working; Determination of flow stress; Influence of temperature, strain-rate, crystal structure, friction and lubrication in metal working processes; Working defects; Examples;

Unit 3: Rolling: Hot and cold rolling processes; Forces and geometry in rolling; Rolling load, variables, limitations and defects; Examples;

Unit 4: Forging, Extrusion and Drawing: Plane strain forging; Estimation of forging loads; Forging defects; Fundamentals of extrusion (deformation, lubrication etc.,); Extrusion defects; Drawing operation and mechanisms of rods, wires and tubes; Drawing defects (especially residual stress); Examples;

Unit 5: Sheet metal forming: Shearing, bending, stretch forming, deep drawing, and blanking operations and mechanisms therein; Forming limit criteria; Forming defects;

Suggested Books:

1. Theory of Metal Forming Plasticity by Andrzej Sluzalec, Springer Publisher.
2. Mechanical Metallurgy by G. E. Dieter, Metric edition, McGraw-Hill Book Company.

Subject Code: **MF404**
Title of the Course: **CAD: Theory and Practice**
L-T-P: 2-0-1 Credits: 3
Prerequisite Course/Knowledge (If any): -

After completion of this subject successfully, the students will be able to:

CO-1: Apply geometric transformations and projection methods in CAD

CO-2: Develop geometric models to represent curves

CO-3: Design surface models for engineering design

CO-4: Model engineering components using solid modelling techniques for design

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3	PSO4
CO1																	
CO2																	
CO3																	
CO4																	

‘3’–‘high-level’ mapping; ‘2’–‘Medium-level’ mapping; ‘1’–‘Low-level’ mapping;

Detailed Syllabus:

Introduction: Introduction to CAE, CAD. Role of CAD in Mechanical Engineering, Design process, software tools for CAD, Geometric modelling.

Transformations in Geometric Modelling: Introduction, Translation, Scaling, Reflection, Rotation in 2D and 3D. Homogeneous representation of transformation, Concatenation of transformations. Computer-Aided assembly of rigid bodies, Applications of transformations in design and analysis of mechanisms, etc. Implementation of the transformations using computer codes.

Introduction to Geometric Modelling for Design: Introduction to CAGD, CAD input devices, CAD output devices, CAD Software, Display Visualization Aids, and Requirements of Modelling.

Curves in Geometric Modelling for Design: Differential geometry of curves, Analytic Curves, PC curve, Ferguson’s Cubic Curve, Composite Ferguson, Curve Trimming and Blending. Bezier segments, de Casteljau's algorithm, Bernstein polynomials, Bezier-subdivision, Degree elevation, Composite Bezier. B-spline basis functions, Properties of basic functions, Knot Vector generation, NURBS, Conversion of one form of curve to other. Implementation of the all the curve models using computer codes in an interactive manner. Use of CAD software for modelling of curves

Surfaces in Geometric Modelling for Design: Differential geometry of surfaces, parametric representation, Curvatures, Developable surfaces. Surfaces entities (planar, surface of revolution, lofted etc). Free-for surface models (Hermite, Bezier, B-spline surface). Boundary interpolating surfaces (Coon's). Implementation of the all the surface models using computer codes. Use of CAD software for modelling of surfaces

Solids in Geometric Modelling for Design: Solid entities, Boolean operations, Topological aspects, Invariants. Write-frame modeling, B-rep of Solid Modelling, CSG approach of solid modelling. Popular modelling methods in CAD software. Data Exchange Formats and CAD Applications. Use of CAD software for modelling of Solid Modelling

Text Books:

1. Michael E. Mortenson, Geometric Modelling, Tata McGraw Hill, 2013.
2. A. Saxena and B. Sahay, Computer-Aided Engineering Design, Anamaya Publishers, New Delhi, 2005.

Reference Books:

1. Rogers, David F., An introduction to NURBS: with historical perspective, Morgan Kaufmann Publishers, USA, 2001.
2. David F. Rogers, J. A. Adams, Mathematical Elements for Computer Graphics, TMH, 2008.

Subject Code: **MF405**
Title of the Course: **Advanced Casting and Welding: Science and Technology**
L-T-P: 3-0-0 Credits: 3
Prerequisite Course/Knowledge (If any): General Materials Engineering, Mechanical Engineering at bachelors level

After completion of this subject successfully, the students will be able to:

CO-1: apply the fundamentals of casting and welding for various applications
CO-2: apply the principles of casting and welding processes
CO-3: analyze the advantages and limitations of the casting and welding processes based on the intended application
CO-4: compare different casting/welding methods for an intended application
CO-5. select a suitable casting/welding method for any given application

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	1	1	1	1	1	1	1	1	2	2	2	2
CO2	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO3	3	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO5	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

'3'–'high-level' mapping; '2'–'Medium-level' mapping; '1'–'Low-level' mapping;

Detailed Syllabus:

Unit 1: Science in Casting: Traditional casting processes (Sand, investment, plaster and die casting processes); Fluid flow and heat transfer in casting solidification; Heat transfer models for casting processes; Prediction of casting defects;

Unit 2: Advanced casting processes: Low pressure gravity die-, counter gravity sand-, and squeeze- casting processes; Thixo- and rheo- casting processes; Directional solidification of single crystal and columnar-grained castings; Metal infiltration; Casting of composites; Casting defects; Case studies;

Unit 3: Science in Welding 1: Traditional welding processes; Modelling of heat flow and distribution (stationary and moving heat sources, heat flow during welding, prediction of thermal history (steady state, transient and pseudo-steady state heat conductions), prediction of cooling rate and its effects on microstructure and mechanical properties);

Unit 3: Science in Welding 2: Solidification in fusion welding (weld pool shape and columnar grain structures, solidification microstructures, solute redistribution and peritectic solidification); Grain growth in welds; Solid-state transformations in welds; Weldability of Al, Fe, Cu, Ti based alloys;

Unit 4: Advanced welding processes: Electron beam welding, brazing (diffusion- brazing and bonding, ceramic to metal seals, vacuum brazing, controlled atmosphere brazing, laser brazing), Friction welding and friction stir welding; Ultrasonic and magnetostrictive welding;

Unit 5: Welding defects: Residual stress and distortion analysis and control in welding; Other welding defects;

Suggested Books:

1. Compiled lecture notes will be given to students after each class

Subject Code: **MF406**
Title of the Course: **Conventional Manufacturing Laboratory**
L-T-P: 0-0-4 Credits: 4
Prerequisite Course/Knowledge (If any): Basic concepts of materials processing and characterization

After completion of this subject successfully, the students will be able to:

CO-1: compare the different machining operations and their parameters
CO-2: Apply the fundamentals of melting processes
CO-3: Analyze the metal powder characteristics
CO-4: Compare the different metal forming operations
CO-5: Compare the surface coating technologies
CO-6: Compare the metal joining technologies

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3	PSO4
CO1																	
CO2																	
CO3																	
CO4																	

‘3’–‘high-level’ mapping; ‘2’–‘Medium-level’ mapping; ‘1’–‘Low-level’ mapping;

Detailed Syllabus:
Experiment 1: Determination of forces in milling, grinding, drilling, and turning operations.
Experiment 2: Determination of process parameters in small scale vacuum arc melting of an alloy .
Experiment 3: Science of producing metal powders and making finished /semifinished objects from mixed or alloyed powders with or without the addition of non-metallic constituents.
Experiment 4: Metal forming like Rolling, Forging and Extrusion.
Experiment 5: Surface engineering of Coating and surface modification.
Experiment 6: Metal joining /welding of components.

Suggested Books:

1. Kalpakjian S, Manufacturing Processes for Engineering Materials, 5th ed, Prentice Hall, 2007.
2. William D.Callister And David G. Rethwisch, “Materials Science and Engineering”, 9th edition, Wiley
3. Surface Engineering: An Introduction, J. B. Hudson.
4. Engineering Coatings, S. Grainger, J. Blunt.

Subject Code: **MF407**
Title of the Course: **Near Net Shape Technology**
L-T-P: 3-0-0 Credits: 3
Prerequisite Course/Knowledge (If any): BE/BTech level mathematics knowledge

After completion of this subject successfully, the students will be able to:

CO-1: Analyze the near net shape worthiness of different casting process
CO-2: Able to differentiate between the different type of near net shape process
CO-3: Able to select the near net shape process for different type of design in manufacturing
CO-4: Understand and compare the defining parameter of near net shape technology

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3	PSO4
CO1																	
CO2																	
CO3																	
CO4																	

'3'–'high-level' mapping; '2'–'Medium-level' mapping; '1'–'Low-level' mapping;

Detailed Syllabus:

Unit 1: Concept of Shape, size, accuracy, tolerances and surface roughness. Economic and technological factors; improved material and energy efficiency, dimensional accuracy, product integrity and reduced manufacturing cost through near net processing.

Unit 2: Foundry Casting processes: Shell process, investment casting, ceramic moulding, plaster mould process, V-process, squeeze casting, rheo-casting, permanent mould casting, low pressure die casting and pressure die casting processes.

Unit 3: Plastic deformation processes: warm forging, flashless forging, cold forging. Super plastic forming, powder metal forging, liquid forging, rheo-forging and isothermal forging processes.

Unit 4: Electro forming; principles of electro deposition, production of dies and moulds by electro-forming.

Suggested Books:

1. Menges G et al., How to make injection moulds, 3rd ed, 2001, Hanser Publishers, 2001
2. Kalpakjian S, Manufacturing Processes for Engineering Materials, 5th ed, Prentice Hall, 2007.
3. William D.Callister And David G. Rethwisch, "Materials Science and Engineering", 9th edition, Wiley

Subject Code: **MT655/MF652**
Title of the Course: **Surface Engineering**
L-T-P: 3-0-0 Credits: 3
Prerequisite Course/Knowledge (If any): General materials science and technology at masters level

After completion of this subject successfully, the students will be able to:

CO-1: apply the fundamentals of surface engineering and related matters for functional and protection applications
CO-2: apply the principles of thin film deposition and coating methods
CO-3: analyze the advantages and limitations of different surface engineering approaches for functional and protection applications and repair
CO-4: compare different surface engineering technologies from different applications' perspectives
CO-5. select a suitable surface engineering technology for any given application

Mapping of COs with POs and PSOs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	2	1	1	1	1	1	1	1	1	1	2	2	2	2
CO2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO3	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO4	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO5	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

'3'–'high-level' mapping; '2'–'Medium-level' mapping; '1'–'Low-level' mapping;

Detailed Syllabus:

Unit 1: Introduction: Definitions and Application Examples; Surface Cleaning and Surface Degradation;

Unit 2: Vacuum Science and Technology: Gas Kinetics, Gas Pumping and Transport; Thin Film Deposition: Physical Vapor Deposition: Evaporation: Thermal evaporation, Evaporation of alloy and compound films, Reactive evaporation, Activated evaporation and other modern evaporation techniques: Sputtering: Basic principles, sputtering of alloys, reactive sputtering and setting up sputtering units, Ion and ionized cluster assisted deposition; Chemical Vapor Deposition: Basic principles, Conventional CVD methods and Plasma enhanced CVD;

Unit 3: Thin film nucleation and growth: Volmer-Weber, Frank Van der Merwe and SK growth modes; Zone Model; Evolutionary selection principle;

Unit 4: Chemical conversion coatings and plating processes; Thermo chemical surface treatments; Thermal Barrier Coatings; Hardfacing & Cladding, Thermal and Plasma Spray Processes; Post synthesis processing and surface modification/functionalization;

Unit 5: Characterization and Performance evaluation of Coatings;

Suggested Books:

1. Surface Engineering, H. Dimigen.
2. Surface Engineering: An Introduction, J. B. Hudson.
3. Engineering Coatings, S. Grainger, J. Blunt.
4. The Materials Science of Thin Films, M. Ohring.
5. Thin Film Deposition, Principles and Practice, D. L. Smith.
6. ASM Handbook, Volume 5, "Surface Engineering", ASM International.