

SREENIVASAINSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
(Autonomous)

3D PRINTING – Offered by MECH Branch

S.No	Course Code	Course Title	Scheme of Instructions Hours per Week				Scheme of Examination Maximum Marks		
			L	T	P	C	I	E	Total
1	23MR3DP1	Material Science & Engineering	3	-	-	3	30	70	100
2	23MR3DP2	Additive Manufacturing	3	-	-	3	30	70	100
3	23MR3DP3	Material Characterization Techniques	3	-	-	3	30	70	100
4	23MR3DP4	3D Printing Materials and Applications	3	-	-	3	30	70	100
5	23MR3DP5	CAD/CAM	3	-	-	3	30	70	100
6	23MR3DP6	Computer Aided Machine Drawing	-	-	3	1.5	30	70	100
7	23MR3DP7	3D Printing Lab	-	-	3	1.5	30	70	100

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Mechanical Department
Minor-3D Printing

23MR3DP1	Material Science & Engineering	L	T	P	C
		3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

1.

UNIT -1: STRUCTURE OF METALS & CONSTITUTION OF ALLOYS: (9)

Structure of Metals: Crystal Structures: Unit cells- Metallic crystal structures- Imperfection in solids: Point, Line, interstitial and volume defects; dislocation strengthening mechanisms and slip systems, critically resolved shear stress.

Constitution of Alloys: Necessity of Alloying, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, peritectoid and monotectic reactions. Iron-Iron-carbide diagram and microstructural aspects of ferrite, cementite, austenite, ledeburite, and cast iron.

UNIT -2: STEELS & CAST IRONS (9)

Steels: Plain carbon steels- use and limitations of plain carbon steels. AISI& BIS classification of steels. Classification of alloy steels. Microstructure- properties and applications of alloy steels- stainless steels and tool steels.

Cast irons: Microstructure- properties and applications of white cast iron- malleable cast iron- grey cast iron- nodular cast iron and alloy cast irons.

UNIT -3: HEAT TREATMENT OF STEELS: (9)

Annealing- tempering- normalizing and hardening- isothermal transformation diagrams for Fe-Fe₃C alloys and microstructure development. Continuous cooling curves and interpretation of final microstructures and properties- austempering- martempering- case hardening - carburizing- nitriding- cyaniding- carbo-nitriding- flame and induction hardening- and vacuum and plasma hardening

UNIT -4: NON-FERROUS METALS AND ALLOYS (9)

Microstructure- properties and applications of copper- aluminium- titanium- nickel and their alloys. Study of Al-Cu phase diagram

UNIT -5: CERAMICS- POLYMERS AND COMPOSITES (9)

Structure- properties and applications of ceramics- polymers and composites. Introduction to super alloys and nanomaterials.

Total Hours: 45

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TEXT BOOKS:

1. V.Raghavan- Material Science and Engineering- 5/e- Prentice Hall of India- 2004.
2. R.Balasubramaniam- Callister's Material Science and Engineering- 2/e- Wiley India- 2014.

REFERENCE BOOKS:

1. Y. Lakhtin- Engineering Physical Metallurgy- University Press of the Pacific- 2000.
2. S.H.Avner- Introduction to Physical Metallurgy- 2/e- Tata McGraw- Hill- 1997.
3. L.H.VanVlack- Elements of Material Science and Engineering- 6/e- Pearson Education- 2008.
4. George E.Dieter- Mechanical Metallurgy- 3/e- McGraw-Hill- 2013.

REFERENCE WEBSITE:

1. <https://nptel.ac.in/courses/113107078>
2. <https://nptel.ac.in/courses/112107767>
3. <https://nptel.ac.in/courses/113104073>

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23MR3DP2	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

1. Familiarize of additive manufacturing / rapid prototyping and its applications in various fields.
2. Impart reverse engineering technologies.
3. Explain different processes available in additive manufacturing.

UNIT –1: INTRODUCTION TO ADDITIVE MANUFACTURING (AM) SYSTEMS: (9)

History and Development of AM- Need of AM- Difference between AM and CNC- Classification of AM Processes: Based on Layering Techniques- Raw Materials and Energy Sources- AM Process Chain- Benefits and Applications of AM- Representation of 3D model in STL format- RP data formats: SLC- CLI- RPI- LEAF- IGES- CT- STEP- HP/GL.

UNIT –2: CAD & REVERSE ENGINEERING (9)

Basic Concept- Digitization techniques- Model Reconstruction- Data Processing for Additive Manufacturing Technology: CAD model preparation- Part Orientation and support generation- Model Slicing- Tool path Generation- Software's for Additive Manufacturing Technology: MIMICS- MAGICS. Reverse Engineering (RE) –Meaning- Use- RE – The Generic Process- Phase of RE Scanning- Contact Scanners- Noncontact Scanners- Point Processing- Application Geometric Model- Development.

UNIT –3: LIQUID BASED AM SYSTEMS (9)

Liquid Based AM Systems: Stereolithography (SLA): Principle- Process- Materials-Advantages- Limitations and Applications. Solid Ground Curing (SGC): Principle- Process- Materials- Advantages- Limitations- Applications. Fusion Deposition Modeling (FDM): Principle- Process- Materials- Advantages- Limitations- Applications. Laminated Object Manufacturing (LOM): Principle- Process- Materials- Advantages- Limitations- Applications.

UNIT –4: POWDER BASED AM SYSTEMS: (9)

Principle and Process of Selective Laser Sintering (SLS)- Advantages- Limitations and Applications of SLS- Principle and Process of Laser Engineered Net Shaping (LENS)- Advantages- Limitations and Applications of LENS- Principle and Process of Electron Beam Melting (EBM)- Advantages- Limitations and Applications of EBM.

UNIT –5: OTHER ADDITIVE MANUFACTURING SYSTEMS: (9)

Three Dimensional Printing (3DP): Principle- Process- Advantages- Limitations and Applications. Ballistic Particle Manufacturing (BPM): Principle- Process- Advantages- Limitations- Applications. Shape Deposition Manufacturing (SDM): Principle- Process- Advantages- Limitations- Applications.

Total Hours: 45

TEXT BOOKS:

1. Ian Gibson- David W. Rosen- Brent Stucker- “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing”- 1st edition- Springer- 2010.
2. Chua C.K.- Leong K.F. and Lim C.S.- “Rapid Prototyping: Principles and Applications”- 2nd edition- World Scientific Publishers- 2003.
3. Liou W. Liou- Frank W.- Liou- “Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development”- CRC Press- 2007.

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REFERENCE BOOKS:

1. Pham D.T. and Dimov S.S.- “Rapid Manufacturing; The Technologies and Application of RPT and Rapid Tooling”- Springer- London 2001.
2. Gebhardt A.- “Rapid prototyping” - Hanser Gardener Publications- 2003.
3. Hilton P.D. and Jacobs P.F.- “Rapid Tooling: Technologies and Industrial Applications”- CRC Press- 2005.
4. Rafiq Noorani- “Rapid Prototyping: Principles and Applications in Manufacturing”- John Wiley & Sons- 2006.

REFERENCE WEBSITE:

<https://nptel.ac.in/courses/112103306>

<https://nptel.ac.in/courses/112104312>

<https://nptel.ac.in/courses/112101623>

<https://nptel.ac.in/courses/113108632>

SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
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23MR3DP3	MATERIALS CHARACTERIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

UNIT –1: STRUCTURE ANALYSIS BY POWDER X-RAY DIFFRACTION: (9)

Introduction- Bragg's law of diffraction- Intensity of Diffracted beams —factors affecting Diffraction Intensities - structure of polycrystalline Aggregates- Determination of crystal structure- Crystallite size by Scherrer and WH Methods- Small angle X-ray scattering (SAXS) (in brief).

UNIT –2: MICROSCOPY TECHNIQUE -1—SCANNING ELECTRON MICROSCOPY (SEM) (9)

Introduction- Principle- Construction and working principle of Scanning Electron Microscope- Specimen preparation- Different types of modes used (Secondary Electron and Backscatter Electron)- Advantages- limitations and applications of SEM.

UNIT –3: MICROSCOPY TECHNIQUE -2 - TRANSMISSION ELECTRON MICROSCOPY (TEM) (9)

Construction and Working principle- Resolving power and Magnification- Bright and dark fields- Diffraction and image formation- Specimen preparation- Selected Area Diffraction- Applications of Transmission Electron Microscopy- Difference between SEM and TEM- Advantages and Limitations of Transmission Electron Microscopy.

UNIT –4: SPECTROSCOPY TECHNIQUES (9)

Principle- Experimental arrangement- Analysis and Advantages of the spectroscopic techniques — (i) UV-Visible spectroscopy (ii) Raman Spectroscopy- (iii) Fourier Transform infrared (FTIR) spectroscopy- (iv) X-ray photoelectron spectroscopy (XPS).

UNIT –5: ELECTRICAL & MAGNETIC CHARACTERIZATION TECHNIQUES (9)

Electrical Properties analysis techniques (DC conductivity- AC conductivity) Activation Energy- Effect of Magnetic field on the electrical properties (Hall Effect). Magnetization measurement by induction method- Vibrating sample Magnetometer (VSM) and SQUID (Superconducting Quantum Interference Device).

Total Hours: 45

TEXT BOOKS:

1. Material Characterization: Introduction to Microscopic and Spectroscopic Methods — **Yang Leng** — John Wiley & Sons (Asia) Pvt. Ltd. 2008
2. Micro structural Characterization of Materials - David Brandon- Wayne D Kalpan- **John Wiley & Sons Ltd.**- 2008

REFERENCE BOOKS:

1. Fundamentals of Molecular Spectroscopy — IV Ed. — Colin Neville Banwell and Elaine M. McCash- Tata McGraw-Hill- 2008.
2. Elements of X-ray diffraction — Bernard Dennis Cullity & Stuart R Stocks- Prentice Hall - 2001— Science

REFERENCE WEBSITE:

- <https://nptel.ac.in/courses/113105100> <https://nptel.ac.in/courses/113105100>
1. <https://nptel.ac.in/courses/112107767>

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23MR3DP4	3D PRINTING MATERIALS & APPLICATIONS	L	T	P	C
		3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

UNIT –1: INTRODUCTION TO 3D PRINTING

(9)

Introduction to Prototyping- Traditional Prototyping Vs. Rapid Prototyping (RP)- Need for time compression in product development- Usage of RP parts- Generic RP process- Distinction between RP and CNC- other related technologies- Classification of RP.

UNIT –2: SOLID AND LIQUID BASED RP SYSTEMS

(9)

Working Principle- Materials- Advantages- Limitations and Applications of Fusion Deposition Modelling (FDM)- Laminated Object Manufacturing (LOM)- Stereo lithography (SLA)- Direct Light Projection System (DLP) and Solid Ground Curing (SGC).

UNIT –3: POWDER BASED & OTHER RP SYSTEMS

(9)

Powder Based RP Systems: Working Principle- Materials- Advantages- Limitations and Applications of Selective Laser Sintering (SLS)- Direct Metal Laser Sintering (DMLS)- Laser Engineered Net Shaping (LENS) and Electron Beam Melting (EBM).

Other RP Systems: Working Principle- Materials- Advantages- Limitations and Applications of Three Dimensional Printing (3DP)- Ballistic Particle Manufacturing (BPM) and Shape Deposition Manufacturing (SDM).

UNIT –4: RAPID TOOLING & REVERSE ENGINEERING

(9)

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling- Classification of Rapid Tooling- Direct and Indirect Tooling Methods- Soft and Hard Tooling methods.

Reverse Engineering (RE): Meaning- Use- RE – The Generic Process- Phases of RE Scanning- Contact Scanners and Noncontact Scanners- Point Processing- Application Geometric Model- Development

UNIT –5: ERRORS IN 3D PRINTING AND APPLICATIONS:

(9)

Pre-processing- processing and post-processing errors- Part building errors in SLA- SLS- etc. Software: Need for software- MIMICS- Magics- SurgiGuide- 3-matic- 3D-Doctor- Simplant-Velocity2- VoXim- Solid View- 3DView- etc.- software- Preparation of CAD models- Problems with STL files- STL file manipulation- RP data formats: SLC- CLI- RPI- LEAF- IGES- HP/GL- CT- STEP. Applications: Design- Engineering Analysis and planning applications- Rapid Tooling- Reverse Engineering- Medical Applications of RP.

Total Hours: 45

TEXT BOOKS:

1. Chee Kai Chua and Kah Fai Leong- "3D Printing and Additive Manufacturing Principles and Applications" 5/e- World Scientific Publications- 2017.
2. Ian Gibson- David W Rosen- Brent Stucker- "Additive Manufacturing Technologies: 3D Printing- Rapid Prototyping- and Direct Digital Manufacturing"- Springer- 2/e- 2010.

REFERENCE BOOKS:

1. Frank W.Liou- "Rapid Prototyping & Engineering Applications"- CRC Press- Taylor & Francis Group- 2011.
2. RafiqNoorani- "Rapid Prototyping: Principles and Applications in Manufacturing"- John Wiley&Sons- 2006.

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REFERENCE WEBSITE:

- NPTEL Course on Rapid Manufacturing.
- <https://nptel.ac.in/courses/112/104/112104265/>
- <https://www.hubs.com/knowledge-base/introduction-fdm-3d-printing/>
- <https://slideplayer.com/slide/6927137/>
- <https://www.mdpi.com/2073-4360/12/6/1334>
- <https://www.centropiaggio.unipi.it/sites/default/files/course/material/2013-11-29%20-%20FDM.pdf>
- <https://lecturenotes.in/subject/197>
- https://www.cet.edu.in/noticefiles/258_Lecture%20Notes%20on%20RP-ilovepdfcompressed.pdf
- https://www.vssut.ac.in/lecture_notes/lecture1517967201.pdf
- <https://www.youtube.com/watch?v=NkC8TNts4B4>.

SREENIVASAINSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
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23MR3DP5	CAD/CAM	L	T	P	C
		3	0	0	3

PRE-REQUISITES:

COURSE EDUCATIONAL OBJECTIVES:

UNIT –1:

(9)

Overview of CAD/CAM: Product cycle- CAD- CAM and CIM. CAD Tools- CAM Tools- Utilization in an Industrial Environment- Evaluation criteria. CAD data structure- Data base management systems.

Computer Graphics: Co-ordinate systems- Graphics package functions- 2D and 3D transformations- clipping- hidden line / surface removal color- shading.

UNIT –2:

(9)

Geometric Modeling: Representation techniques- Parametric and non-parametric representation- various construction methods- wire frame modeling- synthetic curves and their representations- surface modeling- synthetics surfaces and their representations. Solid modeling- solid representation- fundamentals- introduction to boundary representations- constructive solid geometry representations

UNIT –3:

(9)

Numerical Control: NC- NC Modes- NC Elements- NC Machine tools and their structure- Machining center- types and features. Controls in NC- CNC systems- DNC systems. Adaptive control machining systems- types of adaptive control

CNC Part Programming: Fundamentals- NC word- NC Nodes- canned cycles- cutter radius compensation- length compensation- computed assisted part programming using APT: Geometry statements- motion statements- post process statements- auxiliary statements- macro statement program for simple components.

UNIT –4:

(9)

Group Technology & FMS: Part Family- Classification and Coding- advantages & limitations- Group technology machine cells- benefits. FMS: Introduction- components of FMS- material handling systems- Computer control systems- advantages. Computer Aided Quality Control: Terminology in Quality control- Inspection and testing- Contact inspection methods - optical and non-optical- integration of CAQC with CAD and CIM.

UNIT –5:

(9)

Computer Aided Processes Planning: Retrieval type and Generative type- benefits Machinability data systems- Computer generated time standards.

Computer integrated production planning: Capacity planning- shop floor control- MRP-I- MRP- II- CIMS benefits. Trends in manufacturing systems: Concepts of Reconfigurable manufacturing- Sustainable manufacturing and lean manufacturing.

Total Hours: 45

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TEXT BOOKS:

1. Mikell P. Groover- Emory W. Zimmers - CAD/CAM- 5/e- Pearson Prentice Hall of India- Delhi- 2008.
2. Ibrahim Zeid- R.Siva Subramanian- CAD/CAM: Theory and Practice- 2/e- Tata McGraw-Hill- Delhi- 2009

REFERENCE BOOKS:

1. P. N. Rao- CAD/CAM: Principles and applications- 3/e- Tata McGraw-Hill- Delhi- 2017.
2. P. Radhakrishnan- S. Subramanyan & V. Raju- CAD/CAM/CIM- 3/e- New Age International Publishers- 2008.
3. Computer Aided Manufacturing- 3/e- TienChien Chang- Pearson- 2008.

REFERENCE WEBSITE:

- https://onlinecourses.nptel.ac.in/noc20_me44/preview
- <https://www.youtube.com/watch?v=EgKc9L7cbKc>
- <https://www.youtube.com/watch?v=KXFpTb9cBpY>
- https://web.iitd.ac.in/~hegde/cad/lecture/L01_Introduction.pdf
- https://www.vssut.ac.in/lecture_notes/lecture1530947994.pdf
- [https://www.iare.ac.in/sites/default/files/lecture notes/CAD CAM LECTURE NOTES.pdf](https://www.iare.ac.in/sites/default/files/lecture%20notes/CAD%20CAM%20LECTURE%20NOTES.pdf)

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23MR3DP6	COMPUTER AIDED MACHINE DRAWING	L	T	P	C
		-	-	3	1.5

PRE-REQUISITES: Nil.

COURSE EDUCATIONAL OBJECTIVES:

1.

The following contents are to be done by any 2D software package

Conventional representation of materials and components:

Detachable joints: Drawing of thread profiles- hexagonal and square-headed bolts and nuts- bolted joint with washer and locknut- stud joint- screw joint and foundation bolts.

Riveted joints: Drawing of rivet- lap joint- butt joint with single strap- single riveted- double riveted double strap joints.

Welded joints: Lap joint and T joint with fillet- butt joint with conventions.

Keys: Taper key- sunk taper key- round key- saddle key- feather key- woodruff key.

Couplings: rigid – Muff- flange; flexible – bushed pin-type flange coupling- universal coupling- Oldhams' coupling.

II. The following contents to be done by any 3D software package

Sectional views

Creating solid models of complex machine parts and create sectional views.

Assembly drawings: (Any four of the following using solid model software)

Lathe tool post- tool head of shaping machine- tail stock- machine vice- gate valve- carburettor- piston- connecting rod- eccentric- screw jack- plumber block- axle bearing- pipe vice- clamping device- Geneva cam- universal coupling-

Manufacturing drawing:

Representation of limits- fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances.

TEXT BOOKS:

1. K.L.Narayana- P.Kannaiah and K.Venkat Reddy- Production Drawing- New Age International Publishers- 3/e- 2014
2. Software tools/packages- Auto CAD- Solid works or equivalent.

REFERENCE BOOKS:

1. Cecil Jensen- Jay Helsel and Donald D.Voisinet- Computer Aided Engineering Drawing- Tata McGraw-Hill- NY- 2000.
2. James Barclay- Brian Griffiths- Engineering Drawing for Manufacture- Kogan Page Science- 2003.
3. N.D.Bhatt- Machine Drawing- Charotar- 50/e- 2014

REFERENCE WEBSITE:

1. <https://eedocs.files.wordpress.com/2014/02/machinedrawing.pdf>

SREENIVASAINSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES
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23MR3DP7	3D PRINTING PRACTICE (Lab)	L	T	P	C
		-	-	3	1.5

PRE-REQUISITES: Nil.

COURSE EDUCATIONAL OBJECTIVES:

Students undergoing this course would

- Understand different methods of 3D Printing.
- Gain knowledge about simulation of FDM process
- Estimate time and material required for manufacturing a 3D component

Module 1:

Introduction to Prototyping- Working of 3D Printer- Types of 3D printing Machines:

Exp 1: Modelling of Engineering component and conversion of STL format.

Exp 2: Slicing of STL file and study of effect of process parameter like layer thickness- orientation- and infill on build time using software.

Exercise 1 : Component-1

Exercise 2 : Component-2

Module 2:

Exp1 : 3D Printing of modelled component by varying layer thickness.

Exp2 : 3D Printing of modelled component by varying orientation.

Exp 3: 3D Printing of modelled component by varying infill.

Module 3:

Study on effect of different materials like ABS- PLA- Resin etc- and dimensional accuracy.

Module 4:

Identifying the defects in 3D Printed components.

Module 5

Exp1: Modelling of component using 3D Scanner of real life object of unknown dimension in reverse engineering.

Exp 2: 3D Printing of above modelled component.

REFERENCE BOOKS:

1. Ian Gibson- David W. Rosen- Brent Stucker- Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing- 1/e- Springer- 2010.
2. Chua C.K.- Leong K.F. and Lim C.S.- Rapid Prototyping: Principles and Applications- 2/e- World Scientific Publishers- 2003

REFERENCE WEBSITE:

1. <https://www.hubs.com/knowledge-base/introduction-fdm-3d-printing/>
2. <https://slideplayer.com/slide/6927137/>
3. <https://www.mdpi.com/2073-4360/12/6/1334>
4. <https://www.centropiaggio.unipi.it/sites/default/files/course/material/2013-11-29%20-%20FDM.pdf>
5. <https://lecturenotes.in/subject/197>
6. https://www.cet.edu.in/noticefiles/258_Lecture%20Notes%20on%20RP-ilovepdf-compressed.pdf
7. https://www.vssut.ac.in/lecture_notes/lecture1517967201.pdf
8. <https://www.youtube.com/watch?v=NkC8TNts4B4>