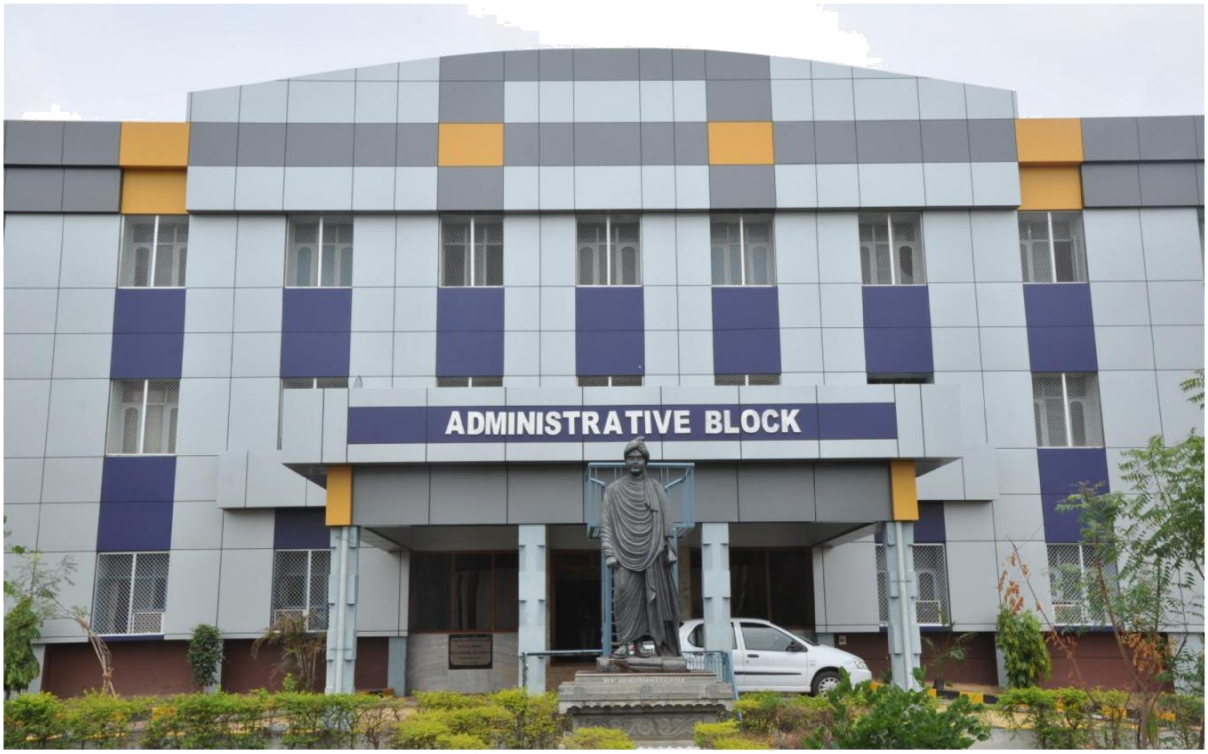

Scheme – 2023

Department of Mechanical Engineering

G. Pulla Reddy Engineering College
(Autonomous): Kurnool

Accredited by NBA of AICTE and NAAC of UGC

Affiliated to JNTUA, Anantapuramu

Scheme and Syllabus for

Minor in 3D Printing

(For Non Mechanical Engineering students)

(With Effect from the Batch Admitted in 2023-24)

G**. PULLA REDDY ENGINEERING COLLEGE (Autonomous): KURNOOL**

DEPARTMENT OF MECHANICAL ENGINEERING

Minor in 3D PRINTING (For Non Mechanical Engineering students)

SCHEME OF INSTRUCTION AND EXAMINATION

S. No.	Course Code	Title	L	T	P	Credits
1	M3D01	Material Science & Engineering	3	0	0	3
2	M3D02	Additive Manufacturing	3	0	0	3
3	M3D03	Material Characterization Techniques	3	0	0	3
4	M3D04	3D Printing Materials and Applications	3	0	0	3
5	M3D05	CAD/CAM	3	0	0	3
6	M3D06	Computer Aided Machine Drawing	0	0	3	1.5
7	M3D07	3D Printing Lab	0	0	3	1.5
Total			**15**	**0**	**6**	**18**

MATERIAL SCIENCE & ENGINEERING (MSE)								
Minor: 3D Printing						**Scheme: 2023**		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
M3D01	**PC**	**3**	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration: 2 Hrs						**End Exam Duration: 3 Hrs**		

Course Outcomes: At the end of the course the student will be able to	
CO1:	Understand the structure of metals and importance of iron - iron carbide phase diagram and identify invariant reactions in binary phase diagrams
CO2:	Distinguish steels and cast irons and their limitations in applications.
CO3:	Understand heat treatment processes and interpret their final microstructures and properties. .
CO4:	Outline the properties of non-ferrous alloys and metals and categorize their applications
CO5:	Discuss and analyse the properties and applications of ceramic, polymers, composites and nano-scale materials.

UNIT – I

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.

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 – II

Steels: Plain carbon steels, use and limitations of plain carbon steels. AISI& BIS classification of steels. Classification of alloys 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 – III

Heat Treatment of Steels: 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 – IV

Non-ferrous Metals and Alloys: Properties and applications of copper, aluminium, titanium, nickel, Lead, Tin and their alloys.

UNIT – V

Ceramics, Polymers and Composites: Structure, properties and applications of ceramics, polymers and composites.

Introduction to super alloys and nanomaterials.

Text Books:

1. Callister's Materials Science and Engineering, adopted by R. Balasubramaniam, Wiley.
2. V Raghavan, Material Science and Engineering, Prentice Hall of India.
3. Vijendra Singh, Physical metallurgy , Standard publishers distributors

Reference Books:

1. William F. Smith, Javad Hashemi, Ravi Prakash, Material Science and Engineering, McGraw Hill Education.

2. Van vlack, Elements of Material Science and Engineering, Pearson Education India.

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

ADDITIVE MANUFACTURING TECHNOLOGY (ADMT)

Minor: 3D Printing | **Scheme: 2023**

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
M3D02	PC	3	0	0	3	30	70	100

Sessional Exam Duration : 2 Hrs | **End Exam Duration : 3 Hrs**

Course Outcomes: At the end of the course the student will be able to

CO1:	Differentiate additive manufacturing from traditional machining and classify various AM processes and material types.
CO2:	Illustrate the principles and process parameters of Vat Photo-polymerization, Material Jetting, and Extrusion-based AM technologies.
CO3:	Illustrate the working mechanisms, material compatibility, and applications of Sheet Lamination, 3D Printing, and Powder Bed Fusion methods.
CO4:	Describe Direct Energy Deposition and Wire Arc AM processes and analyze critical parameters, challenges, and benefits using case studies.
CO5:	Implement post-processing techniques to enhance AM part quality and compare direct and indirect tooling methods for functional prototyping.

UNIT – I

Introduction to Additive Manufacturing: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Steps in AM, Classification of AM processes, Advantages of AM and Types of materials for AM.

Vat Photo-polymerization AM Processes: Stereolithography (SL), Materials, Process Modeling, SL resin curing process, SL scan patterns, Micro-Stereolithography, Mask Projection Processes, Process Benefits and Drawbacks, Applications of Vat Photo-polymerization, case studies.

UNIT – II

Material Jetting AM Processes: Evolution of Printing as an Additive Manufacturing Process, Materials, Process Benefits and Drawbacks, Applications of Material Jetting Processes.

Binder Jetting AM Processes: Materials, Process Benefits and Drawbacks, Research achievements in printing deposition, Technical challenges in printing, Applications of Binder Jetting Processes.

Extrusion-Based AM Processes: Fused Deposition Modelling (FDM), Principles, Materials, Process Modelling, Plotting and path control, Bio-Extrusion, Contour Crafting, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes, case studies.

UNIT – III

Sheet Lamination AM Processes: Bonding Mechanisms, Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications, case studies.

Three Dimensional Printing (3DP): Principle, Process, Applications, advantages and disadvantages of 3DP

Powder Bed Fusion AM Processes: Selective laser Sintering (SLS), Materials, Powder fusion mechanism and powder handling, Process Modelling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes, case studies.

UNIT – IV

Direct Energy Deposition AM Processes: Process Description, Material Delivery, Laser

Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Benefits and drawbacks, Applications of Directed Energy Deposition Processes.

Wire Arc Additive Manufacturing: Process, parameters, applications, advantages and disadvantages, case studies.

UNIT – V

Post Processing of AM Parts: Support Material Removal, Surface Texture Improvement, Accuracy Improvement, Aesthetic Improvement, Property Enhancements using Non-thermal and Thermal Techniques.

Direct methods of rapid tooling: AIM tooling, SLS rapid steel, Direct Laser Metal Sintering (DMLS), Laminate tooling.

Indirect methods of rapid Tooling: RTV silicon rubber moulds, Vacuum casting, Reaction injection Moulding(RIM),Wax Injection moulding, Spray metal tooling, 3D kelt tool

Text Books:

1. Chua C.K., Leong. K.F, and Lim C, C.S., Rapid Prototyping Principles and Applications, World Scientific Publishing Co. Pte. Ltd
2. D.T.Pham and S.S.Dimov, Rapid manufacturing The technologies and applications of rapid Prototyping and rapid tooling. Springer Publications

Reference Books:

1. Terry Wholers, Wholers report, Wholers Associates
2. I. Gibson D. W. Rosen and B. Stucker., Additive manufacturing technologies, Springer Publication

Online Resources:

1. https://www.nist.gov/additive-manufacturing
2. https://www.metal-am.com/
3. http://additivemanufacturing.com/basics/
4. https://www.3dprintingindustry.com/
5. https://www.thingiverse.com/
6. https://reprap.org/wiki/RepRap

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

MATERIAL CHARACTERIZATION TECHNIQUES (MCT)

Minor: 3D Printing						**Scheme: 2023**		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
M3D03	**PC**	**3**	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration: 2 Hrs						**End Exam Duration: 3 Hrs**		

Course Outcomes: At the end of the course the student will be able to

CO1:	Explain Bragg's law and XRD mechanism. Determine crystal structure and crystallite size using Scherrer and WH Methods
CO2:	Understand the construction and principle of SEM and differentiate types of modes.
CO3:	Outline the working principle of TEM and extrapolate the differences between TEM and SEM
CO4:	Explain the principle and analysis of spectroscopy techniques.
CO5:	Describe electrical and magnetic properties analysis techniques like VSM, SQUID.

UNIT – I

Structure analysis by powder x-ray diffraction: 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 – II

Microscopy technique -1—Scanning Electron Microscopy (SEM): 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 – III

Microscopy technique -2 - Transmission Electron Microscopy (TEM): 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 – IV

Spectroscopy Techniques: 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 – V

Electrical & *M*agnetic Characterization Techniques: 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)

Text Books:

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

Reference Books:

1. Colin Neville Banwell and Elaine M. Mc Cash, Fundamentals of Molecular Spectroscopy, Tata McGraw-Hill.

2. Bernard Dennis, Cullity & Stuart R Stocks ,Elements of X-ray diffraction, Prentice Hall.

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

3D PRINTING MATERIALS AND APPLICATIONS (3DPMA)

Minor: 3D Printing | **Scheme: 2023**

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
M3D04	PC	3	0	0	3	30	70	100

Sessional Exam Duration: 2 Hrs | **End Exam Duration: 3 Hrs**

Course Outcomes: At the end of the course the student will be able to

CO1:	Understand material categories and selection criteria for additive manufacturing.
CO2:	Explain properties and processing of polymers used in AM.
CO3:	Analyze metal materials, processing methods, and applications in AM.
CO4:	Describe ceramic and composite materials, techniques, and challenges in AM.
CO5:	Identify emerging and sustainable materials for future AM applications

UNIT – I

Introduction to 3D Printing Materials: Categories and general properties.

Material Selection Criteria for AM processes: Factors influencing the choice of materials for AM, Comparison of AM materials with those used in traditional manufacturing.

Material Properties Relevant to AM: Mechanical, thermal, electrical, and chemical properties relevant to AM.

UNIT – II

Polymers for Additive Manufacturing, Thermoplastics: Common types (ABS, PLA, Nylon), properties, and applications.

Thermosets: Properties, preparation methods, and applications.

Elastomers: Characteristics and challenges.

Polymer Blends and Composites: Enhancing properties for specific applications.

Processing Techniques: Extrusion, curing, and sintering of polymers.

UNIT – III

Metals for Additive Manufacturing, Metallic Materials: Common metals such as Titanium alloys, Aluminum alloys, Stainless steels Nickel-based super alloys alloys, and their properties (Mechanical properties, Thermal properties, Corrosion resistance).

Powder Metallurgy in AM: Powder production, characterization, and handling,

Processing Techniques for Metals: Powder Bed Fusion (PBF), Directed Energy Deposition (DED), Binder Jetting, Electron Beam Melting (EBM).

Post-Processing: Heat treatment, machining, and surface finishing of metal AM parts.

Applications of Metal AM: Aerospace, Automotive, Medical implants.

UNIT – IV

Ceramics and Composite Materials for Additive Manufacturing: Types, Properties and Characteristics of Ceramics, Mechanical properties, Thermal stability, Electrical insulation, and applications.

Processing Techniques for Ceramics: Binder Jetting, Stereolithography(SLA) for ceramics

Challenges in Ceramic AM: Cracking, sintering, and densification.

Composite Materials: Definition, types, and significance in AM.

Processing Techniques for Composites: Fused Deposition Modeling (FDM) with fiber reinforcement, Continuous Fiber Reinforcement (CFR),Selective Laser Sintering (SLS) for composites and challenges in processing composite materials for AM.

Applications of Ceramics and Composites in AM: High-temperature applications, Wear-resistant parts, Biomedical applications.

UNIT – V

Future Trends and Emerging Materials in Additive Manufacturing: Smart Materials in AM: Shape memory alloys, Self-healing materials, Conductive polymers,

Biomaterials in AM: Biocompatible polymers, Hydroxyapatite for bone scaffolds, Bio-printing techniques, Nano materials in AM, Nano composites, Graphene and carbon nano tubes.

Sustainable Materials and Green Manufacturing: Recyclable materials, Bio-based polymers, Energy-efficient AM processes.

Text Books:

1. Chua C.K., Leong.K.F, and Lim C, C.S., Rapid Prototyping Principles and Applications, World Scientific Publishing Co. Pte. Ltd
2. D.T.Pham and S.S.Dimov, Rapid manufacturing The technologies and applications of rapid Prototyping and rapid tooling. Springer Publications
3. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications.

Reference Books:

1. Terry Wholers, Wholers report, Wholers Associates
2. I. Gibson D. W. Rosen and B. Stucker., Additive manufacturing technologies, Springer Publication
3. Bártolo, P. J. Stereolithography: Materials, Processes and Applications. Springer.

Online Resources:

1. https://www.nist.gov/additive-manufacturing
2. https://www.metal-am.com/
3. http://additivemanufacturing.com/basics/
4. https://www.3dprintingindustry.com/
5. https://www.thingiverse.com/
6. https://reprap.org/wiki/RepRap

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

CAD/CAM (CADM)								
Minor: 3D Printing						**Scheme: 2023**		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
M3D05	**PC**	**3**	**0**	**0**	**3**	**30**	**70**	**100**
Sessional Exam Duration: 2 Hrs						**End Exam Duration: 3 Hrs**		

Course Outcomes: At the end of the course the student will be able to	
CO1:	Understand the need for CAD/CAM, 3D modelling, Geometric modelling and Computer Graphics.
CO2:	Understand the wireframe models, solid and surface models, parametric representation of cubic spline, Bezier and B-spline curves, B-rep, Constructive Solid Geometry and sweep representation.
CO3:	Understand Numerical Control, classification of NC machines, part programming, CNC, DNC and adaptive control and Write computer assisted part programs, APT Programs for machining operations.
CO4:	Understand group technology, parts classification, flexible manufacturing systems, its Components and layouts
CO5:	Understand material handling systems, automated guided vehicles, Computer integrated manufacturing, Computer integrated production planning systems and Computer aided process planning.

UNIT – I

Fundamentals of CAD: The design process, applications of computers for design, benefits of CAD, Computer configuration for CAD application, Computer peripherals for CAD, Design of work station and Graphic terminal. CAD software: Definition of system software and application software. CAD database and structure

Geometric modelling: 3-D wire frame modelling, wire frame entities and their definitions, Interpolation and approximation of curves, concept of parametric and non-parametric representation of curves

UNIT – II

Curve and Surface Modelling: Generation of plane and space curves. Wire frame models and curve representation - parametric representation of curved shapes - cubic spline, Bezier, B-spline curves. Curve manipulations, Introduction to surface modelling.

Solid Modelling: Solid models and entities, solid representation, fundamentals of solid modelling, Boundary representation (B-rep), Constructive Solid Geometry (CSG) and sweep representation, Solid manipulations

UNIT – III

Numerical Control of Manufacturing: Numerical control (NC) definition, Classification of NC machines, Open loop, Closed loop, Absolute, Incremental system, Advantages of NC machines, Machining Centre, Method of NC part programming, computer assisted programming, APT language, APT statements, geometric statement, Motion statement, Post processing statement, Auxiliary statements, Structure of APT programming, simple problems using APT language. CNC, DNC, Adaptive control.

UNIT – IV

Group Technology (GT): Group technology fundamentals, Part classification methods, coding systems, advantages of GT, applications of GT

Flexible Manufacturing Systems (FMS): Introduction to FMS, components of FMS, computer system configuration, FMS layouts, FMS compared to other types of manufacturing systems, Types of FMS, benefits of FMS, applications of FMS

UNIT – V

Material Handling: Types of material handling equipment, Automated guided vehicles (AGVs), Vehicle guidance and routing; Traffic control, Benefits of AGV

Computer Integrated manufacturing (CIM): Computerized elements of CIM, Computer integrated production planning systems, Computer aided process planning (CAPP), Retrieval type CAPP system, Generative type CAPP system

Text Books:

1. Ibrahim Zeid, CAD/CAM Theory and Practice, TMH Publishers, New Delhi.
2. M.P.Groover and E.W.Zimmers, CAD/CAM, PHI Publishers, New Delhi.
3. Mikell P. Groover, Automation of Production Systems and Computer Integrated Manufacturing, PHI Publishers, New Delhi.

Reference Books:

1. P. N. Rao CAD/CAM principles and operations, Tata McGraw Hill.
2. Joe Rooney and Philip, Principles of CAD, EWP Publishers, New Delhi.
3. K. Lalith Narayan, K. Mallikarjuna Rao, M.M.M. Sarcar, Computer Aided Design and Manufacturing, PHI Private Limited, New Delhi.

Question Paper Pattern:

Sessional Exam: The question paper for Sessional Examination shall be for 40 marks. The question paper shall consist of Four questions and all questions are compulsory. Question No.1 shall contain Five compulsory short answer questions for a total of Ten marks. Question No.2 to 4 shall be EITHER/OR Type for Ten marks each. Student shall Answer any one of them. Each of these questions may contain sub-questions.

End Examination: The question paper for End Examination shall be for 70 marks. The Question paper shall contain Six Questions and all questions are compulsory. Question No.1 shall contain Ten compulsory short answer questions for a total of Twenty marks (with Two short answer questions from each unit). Question No.2 to 6 shall be EITHER/OR Type for Ten marks each and shall cover one Unit of the Syllabus for each question. Student shall Answer any one of them. Each of these questions may contain sub-questions.

COMPUTER AIDED MACHINE DRAWING (CAMD (P))

Minor: 3D Printing | **Scheme:** 2023

Course Code	Category	Hours/Week			Credits	Maximum Marks		
		L	T	P	C	Continuous Internal Assessment	End Exam	TOTAL
M3D06	PC	0	0	3	1.5	30	70	100

End Exam Duration: 3 Hrs

Course Outcomes: At the end of the course, students will be able to

CO1:	Demonstrate the conventional representations of materials and machine components.
CO2:	Model riveted, couplings and key joints using CAD system.
CO3:	Create solid models and sectional views of machine components.
CO4:	Generate solid models of machine parts and assemble them.
CO5:	Translate 3D assemblies into 2D drawings.

LIST OF EXPERIMENTS

The following 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, wood ruffkey.

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

The following exercises are to be done by any 3D software package

Sectional views:

Creating solid models of complex machine parts and sectional views.

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

Steam Engine parts – Stuffing box, Cross head eccentric, carburetor, piston, connecting rod

Machine Tool Parts - Lathe tool post, tool head of shaping machine, tail-stock,

Other parts - machine vice, gate valve, screw jack, plumber block, axle bearing, pipe vice, clamping device, Geneva cam, universal coupling.

Production 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. Machine Drawing by K.L.Narayana, P. Kannaiah and K. Venkat Reddy, New Age International Publishers, 3/e, 2014
2. Machine drawing by N.Sideshwar, P.Kannaiah, V.V.S.Sastry, TMH Publishers. 2014.
3. Machine drawing with Auto CAD, Goutham Pohit & Goutham Ghosh 1st Indian Printing Pearson Education, 2005

4.	Computer Aided Machine Drawing, by S. Trymbaka Murthy, CBS Publishers, New Delhi – 2008.
5.	Machine Drawing includes AutoCAD , Ajeet Singh, TMH Publishers, 2017.
Reference Books:	
1.	Cecil Jensen, Jay Helsel and Donald D.Voisinet, Computer Aided Engineering Drawing, Tata McGraw-Hill, NY, 2000.
2.	James Barclay, Brain Griffiths, Engineering Drawing for Manufacture, Kogan Page Science, 2003.
3.	N. D. Bhatt, Machine Drawing, Charotar Publishers, 50/e, 2014.
Online Resources:	
1.	https://eeedocs.wordpress.com/wp-content/uploads/2014/02/machinedrawing.pdf
2.	https://archive.nptel.ac.in/courses/112/105/112105294/

3D PRINTING LAB (3DP(P))								
Minor: 3D Printing						**Scheme:** 2023		
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**Continuous Internal Assessment**	**End Exam**	**TOTAL**
M3D07	**PC**	**0**	**0**	**3**	**1.5**	**30**	**70**	**100**
End Exam Duration: 3 Hrs								
Course Outcomes: At the end of the course, students will be able to								
CO1:	Develop 3D CAD models and convert them into STL files suitable for additive manufacturing.							
CO2:	Process CAD data using open-source slicing software to generate G-code and operate 3D printers for part fabrication.							
CO3:	Perform post-processing operations and evaluate printed parts for surface finish, dimensional accuracy, and application suitability.							
CO4:	Apply reverse engineering techniques by using 3D scanning to model and reproduce real-life components with unknown dimensions.							
LIST OF EXPERIMENTS								
1.	Introduction to Additive Manufacturing							
2.	Generating STL files from the CAD Models & Working on STL files							
3.	Modeling Creative Designs in CAD Software							
4.	Processing the CAD data using open source software							
5.	Generating G-code for the part model.							
6.	Sending the tool path data for fabricating the physical part on RP machine.							
7.	Removing the supports & post processing (cleaning the surfaces).							
8.	Evaluating the quality of the fabricated part in terms of surface finish and dimensional accuracy.							
9.	Evaluating the fabricated part for its suitability to a given application.							
10.	Producing a simple component on SLA printer.							
11.	Assembling and testing a basic desktop 3D printer. (demo)							
12.	Modelling of component using 3D Scanner of real life object of unknown dimension in reverse engineering and Printing. (demo)							
Virtual lab:								
1.	https://3dp-dei.vlabs.ac.in/List%20of%20experiments.html							