B. Tech with

MINOR

in

3D PRINTING

Academic Regulations, Course Structure and Syllabus

Effective from 2023-24 admitted batches

Offered by

Department of Mechanical Engineering

KSRM College of Engineering (A) – Kadapa

(Approved by AICTE, Accredited by NAAC with A+ Grade and NBA and Affiliated to JNTUA, Anantapuramu)

ELIGIBILITY / REGISTRATION / AWARD OF MINOR

The primary objective of a minor degree is to provide students with a secondary area of study to broaden their knowledge, enhance their skill set, and potentially improve their career prospects. It allows students to explore interests beyond their major, potentially leading to a more well-rounded and competitive profile.

i) Minor degree is introduced by the respective departments offering B. Tech. programs and is applicable to all B.Tech (Regular and Lateral Entry) students admitted in Engineering & Technology.

ii) There is NO minimum CGPA requirement to register for Minor degree program. However, the student shouldn't have any course backlog **up to III Semester in the major degree.**

iii) A student shall earn **additional 18 credits for award of Minor degree** offered by the department other than parent department. This is in addition to 163 credits by a regular student and 123 Credits by a Lateral Entry student for the award of Major degree.

iv) A student is permitted to register for Minor in IV Semester after the results of III Semester are declared. Students shall register and pass in all the courses prescribed and being offered from V semester under the respective Minor degree.

v) Students have to attend classwork for courses under Minor degree beyond regular academic hours meant for major degree. Students can also undergo the courses under Minor through any proctored online platforms with the prior approval of the BoS Chairman and the HoD of the respective department offering Minor degree.

vi) The attendance for the registered courses under Minor and regular courses offered for Major degree in a Semester will be considered separately.

vii) A student shall have an aggregate of 75% attendance in all courses registered under Minor in that particular semester to become eligible for attending Semester-End examinations.

viii) The registration for the Minor will be cancelled, if the student is detained due to lack of attendance in Major.

ix) The registration for the Minor will be cancelled, if the student fails in any course of either Minor / Major in any semester from V to VIII Semester.

x) A student registered for Minor shall pass in all subjects that constitute the requirement for the Minor degree program. No class/division (i.e., second class, first class and distinction, etc.) will be awarded for Minor degree program.

xi) A separate grade sheet will be issued for the Minor degree courses semester-wise..

xii) If a student drops or is terminated from the Minor program, the additional credits so far earned cannot be converted into open or core electives; they will remain extra.

xiii) The Minor will be mentioned in the degree certificate as Bachelor of Technology in Civil Engineering with Minor in Mechanical Engineering.

xiv) There shall be a minimum enrolment of 20% OR 20 enrollments from the list of

eligible students to offer Minor program.

xv) There is no fee for registration of courses for Minor program offered.

xvi) A student can register for either Minor / Honor but not both.

xvii) Student shall submit an application for either Minor / Honor at least one week before the commencement of the V Semester.

MINOR PROGRAMS OFFERED

Offering Department	Title	Who can Register
Civil Engineering	Civil Engineering	B.Tech. EEE / ME / ECE / CSE / AIML / CSE(AIML) / CSE(DS)
Mechanical Engineering	3D Printing	B.Tech. CE / EEE / ECE / CSE / AIML / CSE(AIML) / CSE(DS)
	Industrial Engineering	B.Tech. CE / EEE / ECE / CSE / AIML / CSE(AIML) / CSE(DS)
Electrical and Electronics Engineering	Energy Systems	B.Tech. CE / ME / ECE / CSE / AIML / CSE(AIML) / CSE(DS)
Electronics and Communication Engineering	Embedded Systems	B.Tech. CE / EEE / ME / CSE / AIML / CSE(AIML) / CSE(DS)
Computer Science and Engineering	Computer Science and Engineering	B.Tech. CE / EEE / ME / ECE
	Data Science	B.Tech. CE / EEE / ME / ECE
	Computer Science and Engineering – Artificial Intelligence and Machine Learning	B.Tech. CE / EEE / ME / ECE

COURSE STRUCTURE

for

MINOR

in

3D PRINTING

S. No	COURSE CODE	COURSE TITLE	Semester Offered	L	T	P	IM	EM	CR
1	2303581M	Material Science and Engineering	V	3	0	0	30	70	3
2	2303582M	Additive Manufacturing	V	3	0	0	30	70	3
3	2303583M	Computer Aided Machine Drawing Lab	V	0	0	3	30	70	1.5
4	2303681M	Robotics	VI	3	0	0	30	70	3
5	2303682M	3D Printing Materials and Applications	VI	3	0	0	30	70	3
6	2303781M	Basic CAD/CAM	VII	3	0	0	30	70	3
7	2303782M	3D Printing Lab	VII	0	0	3	30	70	1.5
Total				**15**	**0**	**6**	**210**	**490**	**18**

2303581M	**MINOR IN 3D PRINTING** MATERIAL SCIENCE AND ENGINEERING (CE,EEE,ECE,CSE,CSE-DS,CSE-AIML,AIML)	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-Requisites: Engineering Chemistry

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Understand the concept of metallography in studying the microstructures of metals and alloys, Identify various invariant reactions in binary phase diagrams.

CO2. Classify, identify, compare steels and cast irons and their limitations and applications.

CO3. Understand the importance of iron – iron carbide phase diagram, Know the influence of heat treatment in modification of properties of steels.

CO4. Understand the importance of non-ferrous metals and alloys in engineering applications.

CO5. Demonstrate various properties and applications of Ceramics, polymers and Composites

SYLLABUS:

UNIT - I: STRUCTURE OF METALS & CONSTITUTION OF ALLOYS (12 Periods)

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 - II: STEELS & CAST IRONS (08 Periods)

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 (10 Periods)

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 (08 Periods)

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

UNIT - V: CERAMICS, POLYMERS AND COMPOSITES (07 Periods)

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

Total Periods: 45

TEXT BOOKS:

T1. Introduction to Physical Metallurgy, S.H. Avner, Tata McGraw- Hill, 1997, Second Edition.
T2. Metallurgy and Material science. Pakirappa, Durga Publications 2014, Fifth Edition.
T3. Principles of Engineering Metallurgy, Dr. L. Krishna Reddy, New Age International Publishers, 2015, Third Edition

REFERENCE BOOKS:

R1. Material Science and Engineering, R. Balasubramaniam, Callister's Wiley India, 2014, Second Edition.
R2. Engineering Physical Metallurgy, Y. Lakhtin, University Press of the Pacific, 2000, Fifth Edition.
R3. Material Science and Engineering, V. Raghavan, Prentice Hall of India, 2004, Fifth Edition.
R4. Elements of Material Science and Engineering, L.H. Van Vlack, Pearson Education, 2008, Sixth Edition.
R5. Mechanical Metallurgy, George E. Dieter , McGraw-Hill, , New York, USA, 2013, Third Edition

WEB RESOURCES:

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

2303582M	**MINOR IN 3D PRINTING** ADDITIVE MANUFACTURING (CE,EEE,ECE,CSE,CSE-DS,CSE-AIML,AIML)	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites: Nil

Course Outcomes:

On successful completion of the course, the student will be able to

CO1. Demonstrate various additive manufacturing and rapid prototyping techniques applications.
CO2. Apply various digitalization techniques.
CO3. Explain the principles, advantages, limitations and applications of solid and liquid based AM systems.
CO4. Use BPM and SDM 3D printing methods.
CO5. Explain principles and limitation of 3D printing using BPM and SDM

SYLLABUS:

UNIT - I: INTRODUCTION TO ADDITIVE MANUFACTURING SYSTEMS (08 Periods)

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 - II: CAD & REVERSE ENGINEERING (11 Periods)

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 - III: SOLID AND LIQUID BASED AM SYSTEMS (10 Periods)

Stereolithography (SLA): Principle, Process, Materials, Advantages, Limitations and Applications. Solid Ground Curing (SGC): Principle, Process, Materials, Advantages, Limitations, Applications. Fusion Deposition Modelling (FDM): Principle, Process, Materials, Advantages, Limitations, Applications. Laminated Object Manufacturing (LOM): Principle, Process, Materials, Advantages, Limitations, Applications.

UNIT - IV: POWDER BASED AM SYSTEMS (09 Periods)

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 - V: OTHER ADDITIVE MANUFACTURING SYSTEMS (07 Periods)

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 Periods: 45

TEXT BOOKS:

T1. Rapid Prototyping: Principles and Applications, Chua C.K., Leong K.F. and Lim C.S., World Scientific Publishers, 2003, Second Edition.

T2. Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development‖, Liou W. Liou, Frank W., Liou, CRC Press, 2007.First Edition.

REFERENCE BOOKS:

R1. Rapid Manufacturing; The Technologies and Application of RPT and Rapid Tooling, Pham D. T. and Dimov S.S., Springer, London 2001.First Edition

R2. Rapid Prototyping, Gebhardt A., Hanser Gardener Publications, 2003. First Edition

R3. Rapid Tooling: Technologies and Industrial Applications, Hilton P.D. and Jacobs P.F., CRC Press, 2005. First Edition

R4. Rapid Prototyping: Principles and Applications in Manufacturing ‖, Rafiq Noorani, John Wiley & Sons, 2006. First Edition

WEB RESOURCES:

1. https://nptel.ac.in/courses/112103306
2. https://nptel.ac.in/courses/112104312
3. https://nptel.ac.in/courses/112101623
4. https://nptel.ac.in/courses/113108632

2303583M	**MINOR IN 3D PRINTING** COMPUTER AIDED MACHINE DRAWING (CE,EEE,ECE,CSE,CSE-DS,CSE-AIML,AIML)	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1.5**

Pre-Requisites: Engineering Graphics.

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Produce accurate working drawings of hexagonal and square-headed bolts and nuts, bolted joints (with and without washers/locknuts), stud joints, and screw joints according to standard conventions.

CO2. Draft and detail lap joints, butt joints (single strap, single riveted; double strap, double riveted) in compliance with industry standards.

CO3. Create detailed drawings of fillet-welded lap and t-joints, butt joints, as well as taper keys, sunk-taper keys, round keys, woodruff keys, and bush-pin, universal,
and Oldham's couplings

CO4. Able to apply appropriate Tools and Techniques to understand and analyse the problems following professional ethics with focus on societal and environmental aspects.

CO5. Work as a team and communicate results in an effective way.

CO6. Make decisions as an individual or as team member to manage tasks and also engage in independent and life-long learning with ability to adapt to new and technological changes.

SYLLABUS:

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

Conventional representation of materials and components:

UNIT - I: DETACHABLE JOINTS

Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted joint, bolted joint with washer and locknut, stud joint, screw joint.

UNIT - II: RIVETED JOINTS

Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveted double strap joints.

UNIT - III: 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. Shaft coupling, bushed pin-type flange coupling, universal coupling, Oldham's' coupling.

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

UNIT - IV: SECTIONAL VIEWS

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

UNIT - V: 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.

List of Exercises/ List of Experiments:

Minimum Ten experiments are to be conducted.

1. Metric & BSW Thread Profiles
2. Hexagonal Bolt-Nut Joint with Washer & Lock-nut
3. Stud Joint & Machine Screw Joint
4. Single-Riveted Lap Joint
5. Double-Riveted Double-Strap Butt Joint
6. Fillet-Welded Lap & T Joints
7. Butt-Welded Joint with Conventional Symbols
8. Key Selection & Shaft-Hub Assembly
9. Bushed Pin-Type Flange Coupling
10. Sectional Modelling of an Eccentric
11. Screw Jack Assembly
12. Tail-stock Assembly (Lathe)

TEXT BOOKS:

T1. Machine Drawing, K.L. Narayana, P. Kannaiah New Age International Publications, 2019,Sixth Edition.

T2. A Text Book of Machine Drawing, Dr. R. K Dahwan S. Chand Publications,2018.Second Edition.

REFERENCE BOOKS:

R1. Computer Aided Engineering Drawing, Cecil Jensen, Jay Helsel and Donald D. Voisinet Tata McGraw-Hill, NY, 2016, Second Edition.

R2. Drawing for Manufacture, James Barclay, Brain Griffiths, Engineering, Kogan Page Science, 2016, First Edition.

WEB RESOURCES:

1. https://nptel.ac.in/courses/112/103/112103019/
2. https://www.coursera.org/learn/autodesk-fusion-360-mechanical-design
3. https://www.youtube.com/@MECADAcademy
4. https://www.linkedin.com/learning/solidworks-essential-training

2303681M	MINOR IN 3D PRINTING ROBOTICS (CE,EEE,ECE,CSE,CSE-DS,CSE-AIML,AIML)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Define and describe the fundamental concepts, scope, and historical development of robotics.
CO2. Formulate robot dynamics using Newton-Euler and Lagrangian mechanics.
CO3. Analyse SLAM techniques (EKF SLAM, Graph SLAM) and explain their applications in autonomous navigation.
CO4. Identify and evaluate the use of robotics in agriculture for tasks like autonomous navigation and spraying.
CO5. Evaluate the integration of robotics with emerging technologies like AI and IoT.

SYLLABUS:

UNIT - I: INTRODUCTION TO ROBOTICS (12 Periods)

Definition and Scope of robotics, Types of robots: mobile, manipulator, autonomous, humanoid, industrial, swarm, aerial (drones), Historical development and major milestones, Key robotic components: controller, sensors, actuators, end effectors, Degrees of Freedom (DOF) and coordinate frames.
Components of Robots**:** Mechanical Structure, Links and joints (prismatic, revolute) , Serial vs parallel manipulators, Actuators : Electric motors: DC, Servo, Stepper, Pneumatic and hydraulic actuators, Sensors: Internal sensors: encoders, gyroscopes, External sensors: ultrasonic, IR, lidar, force-torque, vision sensors, Power Systems: Battery types and power management End Effectors: Mechanical grippers, vacuum suckers, magnetic grippers, Tool changers.

UNIT - II: KINEMATICS AND DYNAMICS (09 Periods)

Kinematics: Coordinate transformations, Homogeneous transformation matrices, Forward and inverse kinematics, Denavit- Hartenberg (D-H) parameters
Dynamics: Newton-Euler formulation, Lagrangian mechanics, Inertia matrix, Coriolis and centrifugal forces.
Robot Control Systems Control Theory Basics: Open-loop and closed-loop systems, Error correction mechanisms, PID Control: Proportional, Integral, Derivative Tuning methods (Ziegler-Nichols), Trajectory Generation: Linear and joint-space trajectories, Time scaling, Motion Control: Point-to-point control, Continuous path control

UNIT - III: ARTIFICIAL INTELLIGENCE IN ROBOTICS (06 Periods)

Machine Learning in Robotics: Supervised and unsupervised learning, Applications in robot perception and decision-making.

Computer Vision: Object detection and recognition using OpenCV, Image processing for navigation (colour tracking, edge detection).
SLAM (Simultaneous Localization and Mapping): Techniques: EKF SLAM, Graph SLAM, Applications in autonomous vehicles and drones
Natural Interaction: Human-Robot Interaction (HRI), Speech recognition, gesture control

UNIT -IV: APPLICATIONS OF ROBOTICS (09 Periods)

Industrial Robotics: Automated assembly, welding, painting, Robotic arms in automotive production.
Medical Robotics: Surgical robots (e.g., Da Vinci), Rehabilitation and prosthetics.
Agricultural Robotics: Autonomous tractors, drone spraying
Military & Defence: Surveillance robots, bomb disposal units
Service and Domestic Robots: Cleaning robots (Roomba), Customer service (Pepper robot).

UNIT -V: ETHICS AND FUTURE OF ROBOTICS (09 Periods)

Ethical Considerations: Job displacement and automation, Privacy and surveillance, Lethal autonomous weapons.
Safety Standards: ISO standards in robotics, Human safety zones, fail-safes
Future Trends: Swarm robotics, soft robotics, Human enhancement and wearable robots, Integration with AI and IoT.

Total Periods: 45

TEXT BOOKS:

T1. Introduction to Robotics: Mechanics and Control, John J. Craig,Pearson Publications 2004,Third Edition.
T2. Robotics: Modelling, Planning and Control, Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo, Springer Nature, 2009, First Edition.
T3. Robot Modelling and Control, Mark W. Spong, Seth Hutchinson, and M. Vidyasagar, Wiley, 2020, Second Edition.

REFERENCE BOOKS:

R1. Handbook of Robotics, Bruno Siciliano and Oussama Khatib, Springer nature, 2016, Second Edition.
R2. Probabilistic Robotics, Sebastian Thrun, Wolfram Burgard, and Dieter Fox,MIT Press, 2005, Second Edition.

WEB RESOURCES:

1. http://www.cadcamfunda.com/cam_computer_aided_manufacturing
2. http://wings.buffalo.edu/eng/mae/courses/460-564/Course-Notes/cnc
3. http://nptel.iitm.ac.in/courses.php?branch=Mechanical
4. http://academicearth.org/courses/introduction-to-robotics
5. http://nptel.iitm.ac.in/video.php?courseId=1052

2303682M	**MINOR IN 3D PRINTING** 3D PRINTING MATERIALS AND ITS APPLICATIONS (CE,EEE,ECE,CSE,CSE-DS,CSE-AIML,AIML)	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Prerequisites: Nil

Course Outcomes:

On successful completion of the course, the student will be able to

CO1. Describe the principles, process categories (FDM, SLA, SLS, Binder Jetting, etc.), and material consolidation mechanisms used in major 3D printing methods.
CO2. Select suitable materials (polymers, metals, ceramics, photopolymers, bio-inks) for specified applications based on their properties and intended function.
CO3. Create CAD models, convert to STL/3MF, optimize orientation, generate toolpaths, and perform slicing for 3D printing workflows.
CO4. Perform post-processing (support removal, curing, annealing, sintering, polishing) and inspection to meet quality requirements.
CO5. Assess real-world industrial and biomedical applications, including customization, sustainability, regulatory, and safety considerations.

SYLLABUS:

UNIT –I :FUNDAMENTALS AND PROCESS CLASSIFICATION (10 Periods)

History of additive manufacturing and layered manufacturing principles. Overview of major 3D printing technologies: FDM/FFF, SLA/DLP, SLS/SLM, EBM, Binder Jetting, Material Jetting, LOM, LENS, DED — their capabilities, materials, costs, advantages, and limitations.

UNIT - II:MATERIALS AND CONSOLIDATION MECHANISM (10 Periods)

Basic Polymers: PLA, ABS, PETG, Nylon, PC, TPU — properties, melting behaviour, printing temperatures. Metals & ceramics: Ti-Alloys, stainless steel, ZrO_2 via binder-jet, DED, L-PBF. Photopolymers in SLA/DLP; powders in SLS/SLM; bio-inks in bioprinting

UNIT-III: CAD, SLICING AND PRE-PROCESSING (10 Periods)

CAD modelling, 3D scanning, file formats (STL, OBJ). Slicing strategies: uniform vs adaptive slicing, support generation, orientation optimization. Process-planning & toolpath generation.

UNIT-IV: POST-PROCESSING TECHNIQUES (07 Periods)

Surface finishing: sanding, chemical smoothing, curing. Thermal treatments: annealing, sintering; support removal. Specialized techniques for photopolymers, metals, ceramics.

UNIT-V: APPLICATIONS ACROSS INDUSTRIES (08 Periods)

Prototyping, industrial tooling, aerospace, automotive, biomedical, dental, maxillofacial surgery. Education & research: STEM, historical replicas, lab-on-chip devices. Emerging domains: 4D printing, bioprinting, food printing, energy storage, multi-material structures.

Total Periods: 45

TEXT BOOKS:

T1. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 1/e Springer, 2010,Second Edition.

T2. Chua C.K., Leong K.F. and Lim C.S., Rapid Prototyping: Principles and Applications, 2/e World Scientific Publishers, 2010.Third Edition.

T3. Liou W. Liou, Frank W., Liou, Rapid Prototyping and Engineering Applications: A Tool Box for Prototype Development, CRC Press, 2007, First Edition.

REFERENCE BOOKS:

R1. Rapid Manufacturing; The Technologies and Application of RPT and Rapid Tooling, Pham D.T. and Dimov S.S., Springer, London 2011, First Edition.

R2. Understanding Additive Manufacturing,Gebhardt A., Carl Hanser verlag GmgH & Co, 2011, First Edition.

R3. Rapid Tooling: Technologies and Industrial Applications, Hilton P.D. and Jacobs P.F., CRC Press, 2005

R4. Rapid Prototyping: Principles and Applications in Manufacturing, Rafiq Noorani, John Wiley & Sons, 2006, Second Edition.

WEB RESOURCES:

1. https://amt.mit.edu
2. https://www.hubs.com/knowledge-base
3. https://www.nist.gov/programs-projects/additive-manufacturing

2303781M	MINOR IN 3D PRINTING BASIC CAD/CAM (CE,EEE,ECE,CSE,CSE-DS,CSE-AIML,AIML)	L	T	P	C
		3	0	0	3

Pre-Requisites: Nil

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Describe the Fundamentals of CAD/CAM Systems and demonstrate basic 3D Modelling Skills.
CO2. Classify various 3D Printing technologies and explain their principles, advantages, and limitations.
CO3. Evaluate different materials used in 3D Printing based on their mechanical and physical properties.
CO4. Evaluate different materials used in 3D printing based on their mechanical and physical properties.
CO5. Design and Fabricate a functional product using 3D printing and demonstrate integration with CAM systems.

SYLLABUS:

UNIT - I: FUNDAMENTALS OF CAD/CAM AND DIGITAL DESIGN (09 Periods)

Introduction to CAD/CAM systems, 2D and 3D modelling basics, Parametric vs. non-parametric modelling, Sketching, constraints, and feature-based modelling, File formats: STL, OBJ, STEP, IGES, Design for Additive Manufacturing (DFAM) principles

UNIT - II: CURVES AND SURFACES MODELLING (09 Periods)

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermit cubic spline- Bezier curve and B-Spline curve – curve manipulations. Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermit bicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT - III: NURBS AND SOLID MODELING (09 Periods)

NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modelling.

UNIT - IV: APPLICATIONS AND INTEGRATION WITH CAM SYSTEMS

(09 Periods)

Integration of CAD with CAM for Additive Manufacturing, Reverse engineering using 3D scanning, Hybrid manufacturing (Additive + Subtractive), Industrial applications, Aerospace, Healthcare (bio-printing, prosthetics), Automotive and tooling, Capstone Project: Design and fabricate a product prototype

UNIT - V: INTRODUCTION TO 3D PRINTING TECHNOLOGIES

(09 Periods)

History and evolution of 3D printing, Additive Manufacturing vs. Traditional Manufacturing, Classification of 3D printing processes, FDM (Fused Deposition Modelling), SLA/DLP (Stereo lithography), SLS (Selective Laser Sintering), DMLS/SLM (Metal Printing), Printer components and mechanics, Material compatibility and limitations

Total Periods: 45

TEXT BOOKS:

T1. Introduction to CAD/CAM, P.N. Rao, Publisher: Tata McGraw-Hill Education, 2017, Third Edition

T2. Computer Aided Manufacturing, T. Kundra, P.N. Rao, N.K. Tewari, Publisher: Tata McGraw-Hill, 2017, First Edition

REFERENCE BOOKS:

R1. Production Technology: Manufacturing Processes, Technology and Automation, R.K. Jain, Khanna Publishers, 2018, Second Edition.

R2. Additive Manufacturing, Amit Bandyopadhyay & Susmita Bose (Indian-origin authors, book available in Indian editions), CRC Press, 2021, Second Edition.

R3. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Distributed by Springer India, 2016, Second Edition.

WEB RESOURCES:

1. https://nptel.ac.in
2. https://www.autodesk.com/education
3. https://ocw.mit.edu
4. https://academy.ultimaker.com
5. https://www.thingiverse.com

2303782M	MINOR IN 3D PRINTING 3D PRINTING LAB (CE,EEE,ECE,CSE,CSE-DS,CSE-AIML,AIML)	L	T	P	C
		0	0	3	1.5

Pre-Requisites: Nil

Course Outcomes:

On successful completion of the course, student will be able to

CO1. Model engineering components using CAD tools and prepare them for additive manufacturing by generating STL files and slicing with appropriate process parameters.

CO2. Perform 3D printing operations with different materials and machines by varying key process parameters and analyse their effect on build quality and efficiency.

CO3. Apply reverse engineering techniques using 3D scanning and evaluate printed components for dimensional accuracy and surface defects.

CO4. Able to apply appropriate Tools and Techniques to understand and analyze the problems following professional ethics with focus on societal and environmental aspects.

CO5. Work as a team and communicate results in an effective way.

CO6. Make decisions as an individual or as team member to manage tasks and also Engage in independent and life-long learning with ability to adapt to new and technological changes.

List of Exercises/ List of Experiments:

Minimum Ten experiments are to be conducted

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

2. Slicing of STL file and study of effect of process parameter like layer thickness, orientation, and infill on build time using software
    a. Exercise 1: Component-1
    b. Exercise 2: Component-2
3. 3D Printing of modelled component by varying layer thickness.
4. 3D Printing of modelled component by varying orientation.
5. 3D Printing of modelled component by varying infill.
6. Modelling of component using 3D Scanner of real-life object of unknown dimension in reverse engineering.
7. 3D Printing of above modelled component.
8. 3D printing the component using FGF large scale robotic 3D printer.
9. 3D printing the component using PETG material in large scale robotic 3D printer.
10. Identifying the defects in 3D Printed components

REFERENCE BOOKS/LABORATORY MANUALS:

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Ian Gibson, David W. Rosen, Brent Stucker, 1/e, Springer, 2010,

Web Resources:

1. https://www.hubs.com/knowledge-base/introduction-fdm-3d-printing/