Walchand Institute of Technology, Solapur

(An Autonomous Institute)

Affiliated to

Punyashlok Ahilyadevi Holkar Solapur University, Solapur

Choice Based Credit System (CBCS)

Structure and Syllabus

for

Multidisciplinary Minor Program in
Mechanical and Automation Engineering
offered by
Department of Mechanical Engineering
for Batch Admitted in
2024-25

Multidisciplinary Minor Program in Mechanical and Automation Engineering	
Legends Used	
L	Lecture Hours / week
T	Tutorial Hours / week
P	Practical Hours / week
FA	Formative Assessment
SA	Summative Assessment
ESE	End Semester Examination
ISE	In Semester Evaluation
ICA	Internal Continuous Assessment
POE	Practical and Oral Exam
OE	Oral Exam
MOOC	Massive Open Online Course
HSS	Humanity and Social Science
NPTEL	National Programme on Technology Enhanced Learning
F.Y.	First Year
S.Y.	Second Year
T.Y.	Third Year
B.Tech.	Bachelor of Technology

Multidisciplinary Minor Program in Mechanical and Automation Engineering

Course Code Format

2	4	M	A	U/P	2	C	C	1	T/L
Year of syllabus revision		Program Code		U-Under Graduate, P-Post Graduate	Semester No./ Year1/2/3/…8	Course Type		Course Serial No. 1-9	T-Theory, L-Lab session A-Tutorial P-Programming / Design

| Program Code	
MA	Mechanical and Automation Engineering
Course Type	
BS	Basic Science
ES	Engineering Science
HU	Humanities & Social Science
MC	Mandatory Course
CC	Programme Core Compulsory Course
SN*	Self-Learning (**N*** *indicates the serial number of electives offered in the respective category*)
EN*	Programme Core Elective Course (**N*** *indicates the serial number of electives offered in the respective category*)
SK	Skill-Based Course
SM	Seminar
MP	Mini project
PR	Project
IN	Internship
ON*	Open Elective (**N*** *indicates the serial number of electives offered in the respective category*)
MD	Multidisciplinary Minor
EM	Entrepreneurship/Economics/Management Courses
FP	Community Engagement Project / Field Project
AE	Ability Enhancement Course

VE	Value Education Course
IK	Indian Knowledge System
VS	Vocational & Skill Enhancement Course
RM	Research Methodology
HN	Honors' Degree Course
HR	Honors Research

Sample Course Code	
24MAU3MD6T	Manufacturing Processes and Mechanisms

Semester	Course Code	Name of Course	Engagement Hours L	T	P	Credits	SA Theory	OE/POE	FA ISE	ICA	Total
		Multidisciplinary Minor Program in Mechanical and Automation Engineering									
III	24MAU3MD6T	Manufacturing Processes and Mechanisms	2			2	60		40		**100**
IV	24MAU4MD6T	Machine Drawing and 3D Modeling	1			1			50		**50**
V	23MAU5MD6T	Automobile Engineering and Robotics	3			3	60		40		**100**
VI	23MAU6MD6T	Additive Manufacturing	2			2	60		40		**100**
VII	23MAU7MD5T	Thermal Engineering	3			3	60		40		**100**
VII	23MAU7MD5A	Thermal Engineering		1		1				25	25
		Subtotal	11	1		12	240		210	25	475
		Laboratory Courses									
IV	24MAU4MD6L	Machine Drawing and 3D Modeling			2	1				25	25
VI	23MAU6MD6L	Additive Manufacturing			2	1				25	25
		Subtotal			4	2				50	50
		Grand Total	11	1	4	14	240		210	75	525
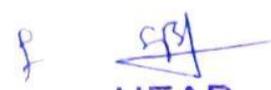
HEAD
Mechanical Engineering Deptt.
Walchand Institute of Technology,
Solapur.

Dr.Mrs.M.A.Nirgude
Dean, Academics

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR

(An Autonomous Institute)

Second Year B.Tech. (Mechanical and Automation), Semester-III

24MAU3MD6T: Multidisciplinary Minor I - Manufacturing Processes and Mechanisms

Teaching Scheme		Examination Scheme	
Lectures	2 Hours/week	**ESE**	60 Marks
Practical	----	**ISE**	40 Marks
Credits	2	**ICA**	----

Introduction:

This course introduces the foundational and advanced manufacturing processes including casting, forming, traditional and non-traditional machining, CNC technology, and machine tool mechanisms. It emphasizes both theoretical concepts and industrial applications to enhance problem-solving and analytical skills. The course integrates numerical problem-solving, mechanism understanding, and exposure to modern production methods. Students will learn to select appropriate manufacturing processes for different engineering applications. This multidisciplinary knowledge equips mechanical engineers with skills for designing and optimizing production systems.

Course Prerequisite:

Not required

Course Objectives:

1. To provide knowledge of various manufacturing techniques including casting, forming, and machining processes.
2. To explain the working principles and mechanisms of traditional and modern machine tools.
3. To develop an understanding of unconventional and CNC-based manufacturing technologies.
4. To impart knowledge of basic CNC programming concepts and industrial manufacturing requirements.

Course Outcomes:

After completing the course, students will be able to

1. Identify and describe various casting, molding, and forming processes used in industry.
2. Analyze the construction, operations, and applications of traditional machine tools like lathe, milling, and drilling machines.
3. Evaluate the principles and suitability of unconventional and CNC machining processes for different manufacturing tasks.
4. Develop basic CNC part programs for machining operations using standard programming formats and cycles.

Unit – I	Casting and Molding Processes	5 Hours
Casting fundamentals: definition, basic steps, advantages, limitations, and applications, patterns: types, materials used, allowances, cores and core boxes: types and functions, molding materials: properties and applications, gating system and risers: types, functions, design, efficiency improvement, molding techniques: green sand molding (hand and machine), shell molding, investment casting, casting methods: centrifugal casting, gravity casting, pressure die casting, melting furnaces: construction and working of cupola and induction furnaces		

Unit – II	Metal Forming and Advanced Forming Processes	4 Hours
Forming process classification, forging: types, numerical on upset forging, extrusion and wire drawing: types and applications, rolling: types, rolling operation numerical, advanced forming, high energy rate forming, explosive and magnetic pulse forming, hydrostatic pressure forming, hydro-forming process		

Unit – III	Traditional Machining Processes	6 Hours
Centre lathe: parts, specifications, accessories, attachments, operations, drilling machines: pillar and radial types – classification, construction, job/tool holding, operations, milling machines: classification, column and knee type construction, up/down milling, operations, gear cutting		

Unit – IV	Unconventional and CNC Machining Technologies	5 Hours
Unconventional machining: introduction, classification, significance, Electrical Discharge Machining (EDM), Electrochemical Machining (ECM), Ultrasonic Machining (USM), Abrasive Water Jet Machining (AWJM), working principles, applications, advantages, limitations, CNC technology and tooling: elements of NC manufacturing systems, work zero vs. machine zero, CNC machine tool classification, controllers, adaptive control and direct numerical control (DNC), tool magazines and automatic tool changers		

Unit – V	CNC Part Programming and Applications	3 Hours
Basics of CNC programming: principles and structure, word address format (WAF), tool length and cutter diameter compensation, canned cycles and sub programming, industrial applications of CNC programming		

Unit – VI	Machine Tool Mechanisms and Motion Systems	5 Hours
Definition and purpose of mechanisms in machine tools, concept of motion transmission: rotary, reciprocating, intermittent, and compound motion, types of mechanical drives used in machine tools: belt, gear, lead screw, and cam-based systems, mechanisms in centre lathe- eg. headstock and gear train mechanism for speed variation, threading mechanism, mechanisms in drilling machines- rack and pinion mechanism for feed, mechanisms in milling machines- column and knee-type construction: vertical motion mechanism, role of machine mechanisms in precision, productivity, and tool control		

Textbooks

1. P.N. Rao, Manufacturing Technology: Foundry, Forming and Welding.
2. P.C. Sharma, Production Technology, S. Chand & Co. Ltd.
3. Grover M.P, Automation, Production Systems, and CIM - Prentice Hall of India
4. Kundra, Rao, Tiwari, Numerical Control-Computer Aided Manufacturing, T.M. Hill Pub.Co.
5. B.S. Raghuvanshi, Workshop Technology (Volume II), Dhanpat Rai Publication
6. P. N. Rao, Manufacturing Technology, Vol. II., McGraw Hill Publication

Reference Books

1. J. S. Campbell, Principles of Manufacturing Material and Processes, Tata Mc Graw Hill.
2. S. Kalpakjian, S. R. Scsimid, Manufacturing Engineering and Technology, Pearson Education.
3. D. D. Bedworth, M. R. Henderson & P. M. Wolfe, Computer Integrated Design and Manufacturing, Tata McGraw Hill Pub. Co.
4. Yoram Koren, Computer control of manufacturing systems, Tata McGraw Hill Publication
5. Asfahl C. R., "Robots and Manufacturing Automation" John Wiley & Sons.

e-Resources

1. https://archive.nptel.ac.in/courses/112/107/112107219/
2. https://web.mit.edu/course/me/2/2.78/www/lectures/forming.pdf
3. https://nptel.ac.in/courses/112/105/112105233
4. https://www.tutorialspoint.com/unconventional-machining-processes-and-cnc-programming/index.htm
5. https://www.cnccookbook.com/cnc-programming/

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR

(An Autonomous Institute)

Second Year B.Tech. (Mechanical and Automation), Semester-IV

24MAU4MD6T: Multidisciplinary Minor II - Machine Drawing and 3D Modeling

Teaching Scheme		Examination Scheme	
Lectures	1 Hour/week	**ISE**	50 Marks
Practical	2 Hours/week	**ICA**	25 Marks
Credits	2		

Introduction:

This course contains different BIS conventions free hand sketching, production drawings, assembly and detail drawings. It also includes 2D & 3D drawings using drafting software. It also includes geometric dimensioning & tolerances used for production drawing.

Course Prerequisite:

Basics of mechanical drawing, isometric & orthographic drawings.

Course Objectives:

1. To use various BIS conventions.
2. To understand geometric dimensions, tolerances & symbols.
3. To draw parts and assembly drawing.
4. To operate drafting and modelling software.

Course Outcomes:

After completing the course, students will be able to
1. Apply the BIS conventions in component drawings & assembly drawings.
2. Use geometrical dimensions, tolerances, and symbols in part-assembly drawings
3. Draw part and assembly drawing of mechanical components
4. Prepare 2D and 3D drawing pf machine components using drafting software.

Unit – I	**Study of B.I.S. (Bureau of Indian Standards) Conventions**	**1 Hour**

BIS conventions-significance and importance and use in drawings

Unit – II	**Free Hand Sketching of machine component**	**2 Hours**

Importance of sketching, sketching/drafting of various machine elements

Unit – III	Production Drawing: Limits, Fits, & Tolerances	2 Hours

Dimensional tolerances: introduction to the system of limits and fits. basic concepts, terminology, tolerances, various types, necessity of limit system, unilateral, and bilateral tolerances, selection of tolerances based on fits

Geometrical tolerances: need of geometrical tolerances, terminology, and tolerances for single features such as straightness, flatness, circularity, and cylindricity, tolerances for related features such as parallelism, perpendicularity, angularity, concentricity, tolerance symbol, and value, indicating geometrical tolerances on drawings, Surface finish: surface texture, surface roughness number, roughness symbols, and range of roughness obtainable with different manufacturing processes

Unit – IV	Details and Assembly Drawing	2 Hours

Assembly drawing from given detail drawing and vice versa with tolerances and fits

Unit – V	Isometric Drafting	1 Hours

Isometric drawing, isometric scale, isometric projection, isometric drawing, circles in isometric view, isometric views of simple object from given orthographic views

Unit – VI	Computer aided drafting (2D)	2 Hours

The treatment on 2D drawing with- basic commands to draw 2D objects like line, circle, arc, ellipse, polygon etc edit & modify commands: erase, extension, break, fillet, chamfer, trim, scale, hatching etc., dimensioning & text commands, viewing and other: zoom, pan, block etc., computer aided drafting for isometric drawing

Unit – VII	Computer aided drafting (3D)	3 Hours

Introduction to computer aided drafting (3D), introduction to modeling: wireframe, solid, surface modeling, 3-dimensional drawing: UCS & 3-dimensional co-ordinates, solid modeling commands: primitive solids, extrude, revolve, sweep, loft, press pull, etc, solid editing commands: 3D-rotate, 3D-move. 3D-scale, boolean operations, slice, sections

ICA consists of minimum 8 from the below list
1. Sheet on BIS Conventions
2. Sheet on free hand sketches
3. Sheet on production drawing
4. 2-D sketching with geometrical and dimensional constraints using CAD software-I
5. 2-D sketching with geometrical and dimensional constraints using CAD software -II
6. 3D CAD modeling of the parts-I
7. 3D CAD modeling of the parts-II
8. Sheet on details to assembly
9. Sheet on assembly to details

Textbooks

1. P.S. Gill, Machine Drawing. S.K. Kataria and Sons , Delhi.
2. N. D. Bhatt. Machine Drawing, Charotor Publication House, Bombay.
3. N. Sidheshwar. P. Kannaiah and V.V. S. Sastry. Machine Drawing, Tata McGraw Hill, New Delhi.
4. George Omura, Mastering Auto CAD, BPB Publications.
5. K. L. Narayana, P. Kanniah, & K.V. Reddy, "Machine Drawing" SciTech Publications (India Pvt. Ltd.) Chennai

Reference Books

1. IS: SP46- Engineering drawing practice for schools and colleges, B.I.S. Publications.
2. IS: 696- Code of practice for general engineering drawings B.I.S. Publications.
3. IS : 2709-Guide for selection of fits, B.I.S. Publications.
4. IS:919-Recommendation for limits and fits for Engineering, B.I.S. Publications
5. IS: 8000- Part I, II. III. IV, Geometrical tolerancing of technical drawings -- B.I.S. Publications.

e-Resources

1. https://archive.nptel.ac.in/courses/112/102/112102102/
2. https://www.me.iitb.ac.in/~ramesh/courses/ME338/ssp1

23MAU5MD6T: Multidisciplinary Minor III - Automotive Engineering and Robotics

Teaching Scheme		Examination Scheme	
Lectures	3 Hours/week	**ESE**	60 Marks
Practical	----	**ISE**	40 Marks
Credits	3	**ICA**	----

Introduction:

This course covers vehicle systems and industrial robotics, focusing on powertrains, electronics, dynamics, and robot design to prepare students for innovation in automotive and automation fields.

Course Prerequisite:

Basic Mechanical Engineering, Manufacturing processes and Mechanism

Course Objectives:

1. To provide fundamental knowledge of automobile systems including layout, components, and the integration of various automotive subsystems.
2. To familiarize students with modern automotive technologies, including hybrid and electric vehicles, ADAS, and control systems.
3. To understand robotic fundamentals and kinematics, covering robot anatomy, sensors, actuators, and manipulators.
4. To enable students to apply kinematic modeling and control concepts in analyzing and designing robotic arms

Course Outcomes:

After completing the course, students will be able to
1. Demonstrate the fundamental structure and function of various automobile subsystems such as transmission, electrical systems, and safety devices.
2. Identify the operation and applications of electric and hybrid vehicle components, including advanced driver assistance systems.
3. Illustrate the structure and working principles of industrial robots
4. Analyze forward and inverse kinematics of planar and articulated robot arms using transformation matrices and Jacobian concepts.

Unit – I	Introduction to Automobiles	4 Hours

Broad classification of automobiles, major components and their functions, types of vehicle layouts, types of bodies and their materials, safety devices

Unit – II	Automotive Electrical Systems	6 Hours

Automotive batteries, types of battery in automotive (hybrids & EV) with their principal operation and application, automotive lighting system, starting system, charging system, electric horn, electric fuel gauge- thermostatic & balancing coil type, wiper & side indicator circuit, electric speedometer

Unit – III	Transmission System and Final drives	6 Hours

Requirements of transmission system, automobile clutches- requirements, types & functions, types of automotive gearboxes, overdrive, principle of operation of automatic transmission, continuously variable transmission (CVT), dual clutch transmission (DCT), direct shift gearbox (DSG), torque converter, propeller shaft, hotch- kiss and torque tube drive

Unit – IV	Modern trends in Automobiles	4 Hours

Introduction to sensors and actuators used in automobile controls, electronic control unit, traction control unit, fuel cells electric & hybrid vehicles and its major components, ADAS (Advance Driver Assisted System) etc

Unit – V	Introduction to Robotics	4 Hours

History and fundamentals of industrial robots, definitions of robot, classification and applications, laws of robotics, flexible automation vs robotics technology, robot anatomy and configurations: cartesian, cylindrical, polar, articulated, SCARA, pendulum arm, multiple joint arm, parallel manipulator, work envelope/volume, degree of freedom associated with robot arm & wrist, joints & joint notification scheme

Unit – VI	Actuators, Sensors & End Effectors	4 Hours

Actuators: classification, working and selection of electric, hydraulic and pneumatic actuators, sensors: classification, working, selection and design considerations of internal sensors: position sensors, velocity sensors, acceleration sensors & force sensors; external sensors: contact and non-contact type- proximity sensor, end effectors: classification, construction, working, applications, design, and selection criteria for end effectors

Unit – VII	Forward Kinematics	6 Hours

Robot architecture-links and joints, kinematic chain, degrees of freedom, pose of a rigid body, homogeneous transformations, introduction to D-H parameters, forward kinematics of planar arms (2 DOF and 3 DOF), SCARA robot, puma robot, KUKA KR-5 robot

Unit – VIII	Inverse Kinematics	6 Hours

Difference between forward and inverse kinematics, inverse kinematics of planar arm (2 DOF and 3 DOF), Jacobian matrix of a two-link and three-link revolute arm

Text Books
1. Groover, M. P (2016) - Automation, Production Systems, and Computer-integrated Manufacturing, Pearson Education.
2. Kripal Singh - Automobile Engineering – Standard publisher.
3. N. K. Giri - Automobile Mechanics, Khanna Publication
4. P. S. Kohali - Automobile Electrical Equipment Mc Graw Hill
5. Deb, S. R., Deb, S., (2017) - Robotics Technology and Flexible Automation, McGraw Hill Education.
6. Sandler, B. Z., (1999) - Robotics: Designing the Mechanisms for Automated Machinery, Academic Press/Prentice Hall
7. Nagarajan, R., (2016) - Introduction to Industrial Robotics, Pearson Education India

Reference Books
1. Saha, S. K., (2017) - Introduction to Robotics, McGraw-Hill Education,
2. Ashitava, G. (2006), Robotics: Fundamental Concepts and Analysis, Oxford Press
3. K. Newton and W. Seeds, T.K. Garrett, Motor Vehicle, Elsevier publications
4. Hans Hermann Braess, Ulrich Seiffen, handbook of Automotive Engineering, SAE Publications
5. William H. Crouse. Automotive Mechanics - Tata McGraw Hill Publishing House
6. Joseph Heitner, Automotive Mechanics -C.B.S Publishers And Distributors
7. SAE Manuals and Standard
8. Niku, S. B., (2020) - Introduction to Robotics, Analysis, Control, Applications, Wiley publication
9. Schilling, R. J. (1996), Fundamentals of Robotics: Analysis and Control, Prentice Hall India

e-Resources
1. https://www.youtube.com/watch?v=HWQ_xWnQU0A&t=1s
2. https://www.youtube.com/watch?v=xrwz9IxpMJg&list=PLbRMhDVUMngcdUbBySzyzcPiFTYWr4rV_&index=2

23MAU6MD6T: Multidisciplinary Minor IV - Additive Manufacturing

Teaching Scheme		Examination Scheme	
Lectures	2 Hours/week	**ESE**	60 Marks
Practical	2 Hours/week	**ISE**	40 Marks
Credits	3	**ICA**	25 Marks

Introduction:

Additive Manufacturing (AM), also known as 3D Printing, is a transformative approach to industrial production that enables the creation of lighter, stronger parts and systems. This course provides an in-depth understanding of AM processes, materials, 3D modeling tools, scanning technologies, and real-world applications across industries such as aerospace, medical, and automotive. It emphasizes design thinking, process selection, and digital fabrication skills aligned with Industry 4.0 trends.

Course Prerequisite:

Manufacturing Processes and Mechanisms, Machine Drawing and 3D Modeling

Course Objectives:

Students will be able to:
1. Understand the fundamental principles, classifications, and industrial applications of additive manufacturing technologies.
2. Get familiar with 3D printable models using software tools.
3. Study the materials used in AM processes and their implications on manufacturing quality.
4. Understand the integration of 3D scanning techniques and their role in real-world AM applications.

Course Outcomes:

After completing the course, students will be able to
1. Create printable 3D CAD models using appropriate modeling tools and file formats.
2. Select materials used in additive manufacturing for performance and quality.
3. Develop mechanical components using 3D printing technology by selecting suitable additive manufacturing processes.
4. Integrate 3D scanning technologies with additive manufacturing in industrial applications.

Unit – I	Introduction to Additive Manufacturing	5 Hours

Industry 4.0 and additive manufacturing, need for additive manufacturing, additive manufacturing vs subtractive manufacturing, classification of additive manufacturing processes, applications of additive manufacturing

Unit – II	Additive Manufacturing Processes	5 Hours
Stereo Lithography (SLA), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), Digital Light Processing (DLP), Multi Jet Fusion (MJF), Direct Metal Laser Sintering (DMLS), Electron Beam Melting (ebm), binder jetting, Laminated Object Manufacturing (LOM)		
Unit – III	3D Modeling Software Used in Additive Manufacturing	5 Hours
introduction to CAD, geometric modeling and its types, schemes of solid modeling, feature based modeling, introduction to modelling software, features, and basic operations, overview, key features, and advanced modeling capabilities		
Unit – IV	Materials Used in Additive Manufacturing	5 Hours
Classification of materials by technology, forms of raw materials: overview of different material forms (liquid, solid, wire, powder) used in AM polymers in am, metals in am: common metals used, their properties, and applications, composites in AM: advantages of composite materials, typical applications, overview of techniques used for powder preparation, atomization process and its types.		
Unit – V	Introduction to 3D Scanning	5 Hours
Overview of 3D scanning, types of 3D scanning technologies, working principles of 3D scanners, integration of 3D scanning with additive manufacturing, applications in additive manufacturing, challenges and limitations		
Unit – VI	Applications of Additive Manufacturing Processes	5 Hours
Applications of 3D printing in aerospace, automotive, manufacturing, medical and architectural engineering		
ICA consists of minimum 8 practical/assignment from the below list 1. Feature-Based Parametric Modeling in CATIA 2. Basics of Additive Manufacturing 3. Types of additive manufacturing Processes 4. Types of additive manufacturing Machines 5. Application of Additive Manufacturing (AM) 6. Techniques of Powder Preparation for AM. 7. Virtual Lab Experiment – I 8. Virtual Lab Experiment – II 9. Development of prototype using FDM Technology 10. Demonstration of a scanning-to-print process		
Text Books		
1. Gebhardt A., Rapid prototyping, Hanser Gardener Publications, 2003 2. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, Third Edition, World Scientific Publishers, 2010 3. Liou L.W. and Liou F.W., Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2007		

Reference Books
1. Kamrani A.K. and Nasr E.A., Rapid Prototyping: Theory and practice, Springer, 2006
2. Hilton P.D. and Jacobs P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2000
3. Dougles Bryden, CAD and Prototyping for Product Design, 2014

e-Resources

1. https://additive-manufacturing-training.com/process-categories/
2. https://www.tinkercad.com/fusion
3. https://www.sciencedirect.com/science/article/pii/S2238785422015526
4. https://iamrapid.com/knowledge-hub/introduction-to-3D-scanning-and-different-technologies/
5. https://www.creaform3d.com/en/solutions/3d-scanning-improve-quality-control-additive-manufacturing-processes-large-parts-0
6. https://amfg.ai/industrial-applications-of-3d-printing-the-ultimate-guide/