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
T. Y. B.Tech. Mechanical and Automation Engineering

W.E.F. 2025-26

HEAD
Mechanical Engineering Deptt.
Walchand Institute of Technology,
Solapur.

WIT SOLAPUR

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

Department of Mechanical Engineering

Vision

- To produce world class globally competent distinguished graduates/ post graduates/ doctoral, Mechanical Engineers on the basis of their capabilities, dedication and work ethic and continuously strive towards societal development.

Mission

- **M1:** To impart quality Mechanical Engineering education in accordance with the needs of the society.
- **M2:** To produce globally competent Mechanical Engineers through research, industry institute interaction.
- **M3:** To help Mechanical Engineering graduates to implement their acquired engineering knowledge for society and community development.

Mechanical and Automation Engineering

Program Educational Objectives (PEOs)

- Graduate will excel in professional career in the field of Mechanical and Automation Engineering.
- Graduate will exhibit strong fundamentals required to pursue higher education and continue professional development in emerging technology in Mechanical and Automation Engineering.
- Graduate will adhere to ethics develop team spirit and effective communication skills to be successful leaders with a holistic approach to societal and environmental issues with professional conduct.

Knowledge and Attitude Profile (WK)

WK1	A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.
WK2	Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.
WK3	A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.
WK4	Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.
WK5	Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.
WK6	Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.
WK7	Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.
WK8	Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.
WK9	Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Program Outcomes (POs)	
PO 1	**Engineering Knowledge:** Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.
PO 2	**Problem Analysis:** Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)
PO 3	**Design/Development of Solutions:** Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)
PO 4	**Conduct Investigations of Complex Problems:** Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).
PO 5	**Engineering Tool Usage:** Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)
PO 6	**The Engineer and The World:** Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).
PO 7	**Ethics:** Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)
PO 8	**Individual and Collaborative Team work:** Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.
PO 9	**Communication:** Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning difference
PO 10	**Project Management and Finance:** Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO 11	**Life-long Learning:** Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)
Program Specific Outcomes (PSOs)	
1. Design high quality mechanical and automation engineering equipments for the modern industry and society. 2. Implement manufacturing processes for mechanical and automation engineering equipment.	

Department of Mechanical 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

Mechanical and Automation Engineering

Course Code Format

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

Program Code	
MA	Mechanical and Automation Engineering
Course Type	
BS	Basic Science
ES	Engineering Science
HU	Humanities & Social Science
MC	Mandatory Course
CC	Core Compulsory Course
SN*	Self-Learning **N*** *indicates the serial number of electives offered in the respective category*
EN*	Core Elective **N*** *indicates the serial number of electives offered in the respective category*
ON*	Open Elective **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

Sample Course Code	
23MAU5CC1T	Industrial Hydraulics & Pneumatics

Mechanical and Automation Engineering

B. Tech. Semester V

Course Code	Name of Course	Engagement Hours			Credits	SA		FA		Total
		L	T	P		Theory	OE/ POE	ISE	ICA	
23MAU5CC1T	Industrial Hydraulics & Pneumatics	2			2	60		40		100
23MAU5CC2T	Design of Machine Elements	3			3	60		40		100
23MAU5CC2A	Design of Machine Elements (Tutorial)		1		1				25	25
23MAU5CC3T	Material Science & Metallurgy	2			2	60		40		100
23MAU5EN*4T	Programme Elective Course I	3			3	60		40		100
23MAU5IK5T	Indian Knowledge System II - Measurement in Ancient India	2			2			50		50
23##U5MD6T	Multidisciplinary Minor III	3			3	60		40		100
23MCU5OE7T	Open Elective III (MOOC)				2	50				50
	Subtotal	15	1		18	350		250	25	625
	Laboratory Courses									
23MAU5CC1L	Industrial Hydraulics & Pneumatics Lab			2	1				25	25
23MAU5CC3L	Material Science & Metallurgy Lab			2	1		25		25	50
23MAU5EN*4L	Programme Elective Course I Lab			2	1				25	25
23MAU5CC8P	Programming in Python	1		2	2		50	25	25	100
	Subtotal	**1**		**8**	**5**		**75**	**25**	**100**	**200**
	Grand Total	16	1	8	23	**350**	**75**	**275**	**125**	**825**

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Mechanical and Automation Engineering

B. Tech. Semester VI

Course Code	Name of Course	Engagement Hours			Credits	SA		FA		Total
		L	T	P		Theory	OE/ POE	ISE	ICA	
23MAU6CC1T	Heat Transfer	3			3	60		40		100
23MAU6CC2T	Metrology & Quality Control	3			3	60		40		100
23MAU6CC2A	Metrology & Quality Control (Tutorial)		1		1				25	25
23MAU6EN*3T	Programme Elective Course - II	3			3	60		40		100
23MAU6EN*3A	Programme Elective Course - II (Tutorial)		1		1				25	25
23MAU6EN*4T	Programme Elective Course - III	3			3	60		40		100
23##U6MD6T	Multidisciplinary Minor IV	2			2	60		40		100
	Subtotal	**14**	**2**		**16**	300		200	50	550
	Laboratory Courses									
23MAU6CC1L	Heat Transfer Lab			2	1		25		25	50
23MAU6EN*4L	Programme Elective Course - III Lab			2	1				25	25
23##U6MD6L	Multidisciplinary Minor IV Lab			2	1				25	25
23MAU6CC5P	Programming in Java	1		2	2		50	25	25	100
23MAU6VS7L	Advanced Manufacturing Technology	1		2	2				50	50
	Subtotal	**2**		**10**	**7**		**75**	**25**	**150**	**250**
	Grand Total	**16**	**2**	**10**	**23**	**300**	**75**	**225**	**200**	**800**

Note: - N* indicates the serial number of electives offered in the respective category
indicates program code of offering Programme

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Programme Elective Course –I (Semester –V)

Course Code	Course Name
23MAU5E14T	Additive Manufacturing
23MAU5E24T	Internal Combustion Engines
23MAU5E34T	Material Handling Systems

Programme Elective Course –II (Semester –VI)

Course Code	Course Name
23MAU6E13T	Computational Fluid Dynamics
23MAU6E23T	Tool Design
23MAU6E33T	Design of Transmission Systems

Programme Elective Course –III (Semester –VI)

Course Code	Course Name
23MAU6E14T	Instrumentation & Control Engineering
23MAU6E24T	Finite Element Analysis
23MAU6E34T	Mechanical Vibrations

- **For 23MCU5OE7T: Open Elective III (MOOC) in Semester V:**

1. Students are required to enroll in one of the courses of a minimum duration of 8 weeks offered on the SWAYAM/NPTEL platform. The list of courses will be finalized and released by Board of Studies each year.
2. List of MOOCs will be provided by the department depending on the availability of the courses in that semester under NPTEL / Swayam or Other recognized MOOC Platforms as per suggestions by the BoS.
3. Students may enroll for the course in Semester IV or V. They must complete all assignments and appear for the certification examination conducted by SWAYAM/NPTEL.
4. Students must pass the examination by the end of Semester V. The marks earned by the student in final assessment of this MOOC will be appropriately scaled and transferred to Open Elective III (MOOC) in Semester V.

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- **For courses offered during Semester VIII for A.Y. 2026-27**

Sr. No	***Course Code***	***Option I***	***Option -II***
1	23MAU8CC1T	MOOC Certification*	‘Power Plant Engineering’ course offered by the department during Semester VIII in Self Learning / Online mode and successfully passing ESE for the same.
2	23MAU8EN*2T	MOOC Certification*	‘Program Elective VI’ course offered by the department during Semester VIII in Self Learning / Online mode and successfully passing ESE for the same. Program Elective VI options: Welding Application Technology Advances in Welding and Joining Technologies

* Student has to complete this MOOC in any semester of – V, VI, VII or VIII. In semester VIII, the marks earned by the student in final assessment of this MOOC will be appropriately scaled and transferred for 23MAU8CC1T and / or 23MAU8E32T along with the required credits.
The list of approved MOOCs will be finalized and released by Board of Studies each year.

- **Multidisciplinary Minor (MDM) Courses**

Sr. No.	**MDM Program**	**MDM I (Sem III)**	**MDM II (Sem IV)**	**MDM III (Sem V)**	**MDM IV (Sem VI)**	**MDM V (Sem VII)**
1	Computer Science and Engineering	Operating System	UI Technologies	Software Engineering	Big Data Technologies	Software Testing and Quality Assurance
2	Information Technology	Principles of Operating Systems	Web Technology (UI/ UX)	Software Engineering Principles	DevOps	Cyber Security
3	Civil Engineering	Smart Buildings	Geoinformatics	Environmental Impact Assessment	Infrastructural Systems	Disaster Preparedness and planning
4	Electronics and Telecommunication Engineering	Fundamentals of Electronic Circuits	Electronics Design and Prototyping	Introduction to Embedded Systems	Fundamentals of Communication Techniques	Enclosure and Communication Design for IoT
5	Electronics and Computer Engineering	Analog Electronics	Digital Electronics	Microcontrollers and Peripherals	Advanced Controllers and Interfacing	Electronic System Design

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	WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR **(An Autonomous Institute)** **Third Year B.Tech. (Mechanical and Automation), Semester-V**

23MAU5CC1T: Industrial Hydraulics & Pneumatics

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

Introduction:

This course introduces hydraulic system & pneumatic system. Initially it covers the construction & working of various components of fluid power systems. Preparation of hydraulic & pneumatic circuit diagrams for various applications using the symbols of hydraulic & pneumatic components is covered. Inclusion of use of catalogues of hydraulic & pneumatic component manufacturers for selection of components is also done in this course. Students will be made familiar with use of software for hydraulic & pneumatic circuit design.

Course Prerequisite:

A basic understanding of fluid mechanics, engineering mathematics, and mechanical systems is needed for this course

Course Objectives:

1. Understand advantages & disadvantages of fluid power systems.
2. Become familiar with the construction and function of the different hydraulic & pneumatic
3. components / devices.
4. Know suitability of any hydraulic & pneumatic components for specific application.
5. Understand the operation of basic circuits

Course Outcomes:

After completing the course, students will be able to

1. Draw diagrams & symbols of various hydraulic and pneumatic components & devices.
2. Describe the construction & working of various hydraulic and pneumatic components & devices.
3. Select proper type & numbers of hydraulic and pneumatic components & devices for different applications.
4. Prepare hydraulic and pneumatic circuits for various applications.

Unit – I	**Introduction to Hydraulic system & Hydraulic actuators**	**3 Hours**

Fluid power system: introduction, types, hydraulic system: advantages, limitations & applications, basic components, hydraulic actuators - linear & rotary, types, construction & working of linear & rotary actuators, calculation of force & velocity of piston, cushioning effects, seals & packing- types, materials, applications

Unit – II	**Pumps, Accumulators, Intensifiers & Valves**	**6 Hours**

Pumps- types, working, characteristics, applications, system components- accumulators, intensifiers, their types, working, applications, symbols used in hydraulic circuits, hydraulic pressure control valves- direct acting type, pilot operated, sequence, counterbalancing, unloading, pressure reducing, construction & working, direction control valves-types, construction & working, spool actuation methods, spool centre positions, flow control valves- compensated & non-compensated, construction & working, one-way valve		
Unit – III	**Hydraulic circuits**	**5 Hours**
Simple circuit, speed control circuits: meter in, meter out & bleed off circuits, regenerative circuit, sequencing circuit, traverse & feed circuit, counterbalancing & synchronizing circuits, circuits with accumulator & intensifier, hydraulic clamping circuit, hydraulic braking system		
Unit – IV	**Introduction to Pneumatic system & Actuators**	**3 Hours**
Pneumatic system: advantages, limitations & applications of pneumatic system, hydraulic system vs pneumatic system, symbols used in pneumatic circuits, pneumatic cylinders and air motors, construction and working, types		
Unit – V	**Pneumatic System Elements**	**6 Hours**
Piping, materials and pressure ratings, piping layout, air compressors, types, working, selection criteria, FRL unit, construction and working of direction control valves, flow control valves and pressure control valves – types and working, quick exhaust valve, time delay valve		
Unit – VI	**Pneumatic circuits**	**5 Hours**
Simple pneumatic circuits, pneumatic clamping systems, pneumatic braking systems, pneumatic power tools, time delay circuit		

ICA consists of minimum 8 practical/assignments from the below list

1. Demonstration of various components of hydraulic system
2. Assignment on various symbols of hydraulic & pneumatic components
3. Demonstration of speed control circuits- Meter in, Meter out & bleed off circuits
4. Demonstration of traverse & feed circuit
5. Demonstration of sequencing circuit
6. Demonstration of regenerative circuit
7. Testing of Gear pump for determining performance characteristics
8. Demonstration of various components of pneumatic system
9. Demonstration of simple pneumatic circuits
10. Demonstration of usage software/modern tools for preparation & design of hydraulic & pneumatic circuits
11. Selection of various components from manufacturers' catalogue for design of a simple hydraulic system
12. Case studies of hydraulic & pneumatic systems from industries

Text Books

1. S. R. Majumdar, Oil Hydraulics- Principle & Maintenance, Tata McGraw Hill Publications
2. S. R. Majumdar, Pneumatics- Principle & Maintenance' Tata McGraw Hill Publications
3. H. L. Stewart, Hydraulics and Pneumatics, Industrial Press

Reference Books

1. Eaton-Vickers Industrial Hydraulics Manual 2. Festo's Manual on Pneumatic Principle, Applications 3. Jagadeesha T, Hydraulics and Pneumatics, Dreamtech Press
e-Resources
1. https://archive.nptel.ac.in/courses/112/106/112106300/ 2. https://www.youtube.com/watch?v=VfqCMqwJJK0 3. https://www.youtube.com/watch?v=oCp-PNupoEU 4. https://www.youtube.com/watch?v=4GC6OV5gwyo&vl=en

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR **(An Autonomous Institute)** **Third Year B.Tech. (Mechanical and Automation Engineering), Semester-V**			
23MAU5CC2T: Design of Machine Elements			
Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/week	**ESE**	60 Marks
Tutorial	1 Hour/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks

Introduction:

This course introduces the fundamentals of machine design, covering design procedures, load types, failure theories, and the design of joints, shafts, springs, and couplings, with emphasis on safety, material selection, and manufacturing considerations.

Course Prerequisite:

Applied Mechanics, Mechanics of Material, Kinematics and Dynamics of Machinery

Course Objectives:

1. To understand the fundamental concepts and procedures involved in the design of machine elements under various loading conditions.
2. To develop the ability to design mechanical components such as joints, shafts, springs, and couplings using relevant standards and codes.
3. To introduce students to design considerations related to manufacturing processes, including casting, forging, and machining.
4. To enable students to select appropriate mechanical elements and materials from manufacturer catalogues and design data books for specific applications.

Course Outcomes:

After completing the course, students will be able to
1. Analyse components under static and fluctuating loads to evaluate their application suitability.
2. Select belt types and specifications using fundamental machine design principles and standard catalogues.
3. Design shafts, keys, and couplings using design codes and manufacturing constraints.
4. Evaluate functional integrity and safety through design of mechanical joints and springs

Unit – I	**Fundamentals of machine design**	**3 Hours**

Procedure of machine design, procedure of design of machine element, types of loads, factor of safety, theories of elastic failure

Unit – II	**Design against static load**	**6 Hours**

Design of socket and spigot cotter joint, design of knuckle joint, design of levers (lever loaded safety valve)

Unit – III	**Design against fluctuating loads**	**6 Hours**
Stress concentration causes and remedies, fatigue failure, endurance limit, notch sensitivity, Goodman and Soderberg diagram, modified Goodman diagram, design for finite and infinite life under reversed and fluctuating stresses		
Unit – IV	**Selection of Belt**	**5 Hours**
Selection of flat and V belt from standard manufacturers' catalogue/ design data book		
Unit – V	**Manufacturing considerations in Design**	**3 Hours**
Design considerations for casting, design considerations for forging, design considerations for machined parts, design for manufacture and assembly		
Unit – VI	**Design of shafts, keys and couplings.**	**6 Hours**
Materials for shaft, design of solid and hollow shaft on strength basis (maximum principal stress theory and maximum shear stress theory) and on basis of torsional rigidity, ASME code for shaft design. design of square and flat keys, design of rigid and flexible couplings		
Unit – VII	**Design of springs.**	**5 Hours**
Types of springs and their applications, terminology of helical spring, styles of end, spring materials, stress and deflection in helical spring, series and parallel springs, introduction to leaf springs		
Unit – VIII	**Design of Joints**	**6 Hours**
Bolted joint - simple analysis, eccentrically loaded bolted joint in shear, eccentric load perpendicular to axis of bolt **Welded joints** - strength of butt welds, transverse fillet welds, axially loaded unsymmetrical lap joint, eccentrically loaded welded joint in shear **Riveted joints-** types of failure and strength equations		
ICA consists of minimum 8 practical/assignments from the below list 1. Selection of materials for various engineering applications showing their IS codes, composition and properties. 2. Static Structural Analysis of a Cotter Joint using suitable software. 3. Design of knuckle Joint. 4. Selection of Belts as per the manufacturer's catalogue. 5. Design of Shaft. 6. Design of helical compression spring subjected to static load. 7. Design consideration of Components for Casting. 8. Design of Bolted Joints under Eccentric Loading Conditions. 9. Design of Welded Joints under Static Loading Conditions. 10. Demonstration on Design of a Lever Component using Generative Design		
Text Books		
1. V. B. Bhandari, Design of Machine Elements, 4th edition, McGraw Hill Publications 2. V. B. Bhandari, Machine Design Data Book, 2nd edition. McGraw Hill Publications 3. R. S. Kurmi, Machine Design, S. Chand Publications		

Reference Books
1. J. F. Shigley, Design of Machine Element, McGraw Hill Publications. 2. M. F. Spotts, Design of Machine Element, Pearson Education Publications. 3. PSG College, Design Data: Data Book of Engineers, Kalaikathir Achchagam Coimbatore.
e-Resources
https://archive.nptel.ac.in/courses/112/105/112105125/

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR **(An Autonomous Institute)** **Third Year B.Tech. (Mechanical and Automation), Semester-V**			
23MAU5CC3T: Material Science & Metallurgy			
Teaching Scheme		**Examination Scheme**	
Lectures	2 Hours/week	**ESE**	60 Marks
Practical	2 Hours/week	**ISE**	40 Marks
Credits	3	**ICA**	25 Marks
		OE	25

Introduction:

This course provides a comprehensive overview of ferrous and non-ferrous alloys, their properties, and applications. Students will explore advanced materials, heat treatment processes, surface hardening treatments, and both destructive and non-destructive testing methods. The course also covers the fundamentals and applications of powder metallurgy.

Course Prerequisite:

Chemistry and Physics

Course Objectives:

1. To impart a thorough understanding of ferrous metals and alloys, enabling students to analyze and apply these materials in engineering.
2. To equip students with knowledge of non-ferrous alloys and advanced materials, focusing on their classifications, properties, and engineering applications.
3. To familiarize students with the principles and techniques of Heat Treatment and surface hardening processes for steels, including their purposes, methods, and applications.
4. To introduce students to both Destructive and Non-Destructive testing methods and fundamentals of Powder Metallurgy.

Course Outcomes:

After completing the course, students will be able to

1. Identify different ferrous metals and alloys, their microstructures, and their behaviour with performance in practical applications of powder metallurgy
2. Analyze various non-ferrous alloys and advanced materials, their properties
3. Apply various heat treatment and surface hardening techniques, their effects on the properties and performance of steel in engineering applications
4. Perform various testing methods to find material properties

Unit – I	**Introduction to ferrous alloys**	**6 Hours**

Brief classification of metals, crystal structure, Bravais crystal systems, concept of alloying, classification of cooling curves, types of equilibrium diagram, lever rule, phase rule, solid solution & its types, intermetallic compounds, allotropy

Unit – II	**Ferrous metals and alloys**	**8 Hours**
$Fe-Fe_3c$ equilibrium diagram, critical temperatures, plain carbon steels: composition, applications & properties, effect of alloying elements on steels, eutectic, eutectoid and peritectic transformations, types of cast irons, composition, properties, applications. alloy steels, alloying elements added to steels and their purpose, stainless steel and its types, High Speed Steels (HSS), silicon steels, and other types		
Unit – III	**Non-ferrous alloys**	**3 Hours**
Copper alloys: brass and bronze, aluminum alloys: Al-Si alloy and Al-Cu alloy, steps in precipitation hardening, Pb-Sn alloys, babbitt's, Ni alloys		
Unit – IV	**Advanced Materials**	**3 Hours**
Composite materials: classification, properties and applications nano materials, bio compatible materials – concept, effect of particle size on mechanical properties		
Unit – V	**Heat treatment of steel**	**6 Hours**
Objectives of heat treatment, TTT and CCT diagram for eutectoid steel, annealing - purposes, types, applications, limitations. normalizing- purposes, types, applications, limitations, hardening & tempering: purposes, types, applications, types of tempering, structural changes during tempering, subzero treatment, methods of hardening such as austempering, martempering, limitations of these processes		
Unit – VI	**Surface hardening treatments**	**3 Hours**
Carburising – types, nitriding, cyaniding and carbonitriding – purposes, chemistry of process, applications, limitations. induction hardening, flame hardening – concept process, advantages, limitations and applications		
Unit – VII	**Destructive and Non-Destructive testing**	**6 Hours**
Destructive testing methods: test procedure in brief, significance of tensile testing, hardness testing, impact testing, creep testing, fatigue testing Non-destructive testing methods (NDT): dye penetrant test, magnetic particle test, ultrasonic test, radiography test, eddy current test and introduction to advanced NDT methods		
Unit – VIII	**Introduction to powder metallurgy**	**5 Hours**
Significance, steps in powder metallurgy process, applications, methods of powder manufacture, mixing / blending, compaction methods, sintering processes & types, advantages & limitations, typical powder metallurgy applications and their flow chart, self-lubricated bearings, cemented carbide cutting tools, friction materials and such other types		
ICA consists of minimum 8 practical/assignments from the below list 1. Study of Metallurgical Microscope using suitable software 2. Metallography & Macroscopy 3. Microstructure of steels 4. Microstructure of Cast Iron 5. Microstructure of Non-ferrous alloys		

6. Heat treatment of EN8 steel 7. Non-destructive Testing Methods 8. Destructive testing: Tensile and Compressive Test 9. Microstructure of heat-treated steel 10. Microstructure of surface hardened steel
Text Books
1. Dr. V.D Kodgire and S.V Kodgire, Material Science and Metallurgy, Everest, Pune 2. B. K. Agarwal, Introduction to Engg. Materials, McGraw Hill Education Publications
Reference Books
1. Rajan Sharma & Sharma, Heat treatment principles and technique, PHI Learning Private Limited 2. Sidney Avner, Introduction to Physical metallurgy, McGraw Hill Education Publications 3. R. A. Higgins, Engineering Metallurgy Vol. I & VI, ELBS Publications 4. E. C. Rollason, Engineering Metallurgy, ELBS Publications 5. Lakthin, Engineering Metallurgy, MIR Publishers
e-Resources
1. https://youtu.be/9Sf278j1GTU?si=enk1J7xUMuhG_dMp 2. https://youtu.be/5nBBUahtz-c?si=PLokvQHsaQhQVavn 3. https://youtu.be/D8GMTlYCknA?si=Evrt4UoyBLXn5h7a

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR (An Autonomous Institute) Third Year B.Tech. (Mechanical and Automation), Semester-V

23MAU5E14T: Programme Elective I - Additive Manufacturing

Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/week	**ESE**	60 Marks
Practical	2 Hours/week	**ISE**	40 Marks
Credits	4	**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 Technology, Machine Drawing and CAD

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**	**8 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**	**7 Hours**
Introduction to cad, geometric modeling and its types, schemes of solid modeling, feature based modeling, introduction of CAD modeling software, features, and basic operations, overview, key features, and advanced modeling capabilities		
Unit – IV	**Materials Used in Additive Manufacturing**	**10 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/assignments from the below list

1. Feature-Based Parametric Modeling
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
2. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, Third Edition, World Scientific Publishers
3. Liou L.W. and Liou F.W., Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press

Reference Books
1. Kamrani A.K. and Nasr E.A., Rapid Prototyping: Theory and practice, Springer 2. Hilton P.D. and Jacobs P.F., Rapid Tooling: Technologies and Industrial Applications, CRC Press 3. Dougles Bryden, CAD and Prototyping for Product Design, Laurence King Publishing
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/

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR
(An Autonomous Institute)
Third Year B.Tech. (Mechanical and Automation Engineering), Semester-V

23MAU5E24T: Programme Elective Course I - Internal Combustion Engines

Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/week	**ESE**	60 Marks
Practical	2 Hours/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks

Introduction:

Internal Combustion engines (ICE) are essential power sources used in a wide range of applications, including passenger vehicles, commercial transportation, agricultural machinery, and construction equipment. I.C. engines come in various types, such as two-stroke and four-stroke, and can be designed for spark ignition (SI) or compression ignition (CI). For mechanical engineers, understanding I.C. engine is crucial, as it involves key engineering principles like thermodynamics, fluid mechanics, and heat transfer. This knowledge is vital for improving engine performance, fuel efficiency, and emission control. Engineers must also stay informed about evolving environmental regulations and the push for cleaner technologies. Despite the rise of electric and hybrid vehicles, a solid foundation in I.C. engine technology remains relevant. It helps engineers innovate in areas like turbocharging, direct fuel injection, and variable valve timing. Overall, the study of I.C. engines is fundamental to designing and maintaining the machines that power modern life.

Course Prerequisite:

Applied Thermodynamics, Fluid Mechanics

Course Objectives:

1. To provide a foundational understanding of internal combustion engine types, their operating cycles, and timing diagrams for both SI and CI engines.
2. To familiarize students with the construction, operation, and analysis of fuel supply systems in spark ignition and compression ignition engines, including modern fuel injection technologies.
3. To explain the combustion processes in SI and CI engines, factors affecting combustion, and design aspects of combustion chambers, along with the effects of abnormal combustion phenomena.
4. To develop the ability to evaluate engine performance parameters, understand supercharging/turbocharging methods, assess the use of alternative fuels.

Course Outcomes:

After completing the course, students will be able to

1. Recognize the reasons for differences in the construction of different types of internal combustion engines.
2. Evaluate differences among operating characteristics of different engine types and designs.

3. Select the most suitable engine for a given application 4. Conduct performance tests on engines		
Unit – I	**Introduction to I. C. Engines**	**7 Hours**
Introduction, classification of IC engines, engine cycles-Otto and Diesel cycle, valve timing diagram for high and low speed engines, port timing diagram for two strokes SI engines		
Unit – II	**Fuel System for S. I. Engines**	**7 Hours**
Engine fuel requirements, mixture requirements, simple carburettor, and additional systems in modern carburettor, compensating devices, calculation of air fuel ratio (exact and approximate methods), calculation of main dimensions of air and fuel supply (numerical calculations of main dimensions of carburettor), electronic petrol injection system (MPFI)		
Unit – III	**Fuel System for C. I. Engines**	**7 Hours**
Requirements of fuel injection system for ci engines, types of injection systems-individual pump, common rail and distributor systems, unit injector, types of fuel nozzles- single hole, multi-hole, pintle and Pintaux, CRDi		
Unit – IV	**Supercharging**	**7 Hours**
Purpose of supercharging, turbo charging, thermodynamic cycle of supercharged and turbocharged engines, advantages and disadvantages, limits of supercharging for SI and CI engines		
Unit – V	**Combustion in SI Engines**	**5 Hours**
Combustion in SI engines Stages of combustion in SI engines, ignition lag, flame propagation, factors affecting flame speed, abnormal combustion, octane number, HUCR, requirements of combustion chambers of SI engines and its types **Combustion in ci engines** Stages of combustion in CI engines, delay period, abnormal combustion-diesel knock, requirements of combustion chambers for CI engines and its types, comparison of abnormal combustion in SI and CI engines, cetane number		
Unit – VI	**Engine Testing and performance evaluation**	**7 Hours**
Performance parameters, measurement of performance parameters like torque, power, and volumetric efficiency, mechanical efficiency, BSFC, brake and indicated thermal efficiencies. heat balance sheet, various alternative fuels and their suitability for IC engines, SI engine emissions (HC, co, NOX), CI engines emissions (CO, NOX, smog, particulate), Bharat norms		
ICA consists of minimum 8 practical/assignments from the below list 1. Demonstration of constructional details of I.C. engines. 2. Demonstration of Engine Cooling system 3. Demonstration of Lubrication system 4. Demonstration of Ignition systems and Starting systems 5. Trial on Constant Speed Test (Influence of load on performance) 6. Trial on Morse Test 7. Trial on Heat balance sheet 8. Test on computer controlled I.C. Engine/ Variable Compression Ratio Engine		

9. Measurement of exhaust emissions of SI / CI engines 10. Demonstration of MPFI/CRDI systems
Text Books
1. Mathur and Sharma, Internal Combustion Engines, Dhanpat Rai Publications 2. Willard Pulkrabeck, Engineering Fundamentals of the Internal Combustion Engines, Prentice Hall Publications 3. V. Ganesan, Internal Combustion Engines, McGraw Hill Publications
Reference Books
1. John Heywood, Internal Combustion Engines Fundamentals, McGraw Hill Publications 2. Eran Sher, Internal Combustion Engines Emission and Control, SAE 3. S.S Thipse, Alternative Fuels, Jaico Publications 4. Maleev, Internal Combustion Engines Fundamentals, McGraw Hill Publications 5. C.F Taylor, Internal Combustion Engines Vol. 1 and Vol. 2, MIT Press 6. Fergusson & Kirkpatrick, Internal Combustion Engines: Applied Thermo sciences, Wiley Publications 7. SAE Handbook, SAE
e-Resources
https://youtube.com/playlist?list=PLM-jfaoaU5ixaFwXULZDZlJnPJePthUsY&si=Y9ptet529SOvYnI4

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR (An Autonomous Institute) Third Year B.Tech. (Mechanical and Automation Engineering), Semester-V

23MAU5E34T: Programme Elective Course I - Material Handling Systems

Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/week	**ESE**	60 Marks
Practical	2 Hours/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks

Introduction:

Material Handling Systems is a crucial subject in the field of industrial engineering and manufacturing. It covers the principles, equipment, and technologies used to efficiently move, store, control, and protect materials throughout the processes of manufacturing, distribution, consumption, and disposal. This course emphasizes improving productivity, safety, and cost-effectiveness in various industrial environments through optimal material handling design and systems integration.

Course Prerequisite:

Engineering Mechanics, Manufacturing Processes

Course Objectives:

1. Understand the principles, objectives, and benefits of effective material handling.
2. Study various types of material handling equipment and systems.
3. Understand the integration of material handling in plant layouts and automated systems like CIMS.
4. Study the environmental, human, and safety aspects related to material handling.

Course Outcomes:

After completing the course, students will be able to

1. Describe the principles, objectives, and benefits of material handling systems and their impact on plant layout and productivity.
2. Classify material handling equipments based on type, functionality, and suitability for various operational conditions.
3. Design efficient material flow systems and layouts incorporating equipment selection and flow strategies for industrial operations.
4. Apply safety standards, ergonomic principles, and automation technologies in the development of modern material handling systems for specific industries.

Unit – I	**Introduction**	**6 Hours**

Principles of material handling, objective & benefits of better material handling, material handling and plant layout, concepts of unit load, containerization and palletisation

Unit – II	**Material handling Equipments and Systems for Various Materials**	**12 Hours**

a. Storing equipments like pallets, bins, racks, decking, order picking, positioning equipments b. Hoisting equipments like jacks, pulleys, hand trolleys, hoists, power hoist, various types of cranes & elevators c. Conveying equipments like belt, chain, roller, wheel, trolley, tray conveyors, gravity & vibratory type conveyors, screw conveyors d. Mobile equipments like hand trucks, fork lift trucks, powered industrial trucks and tractors, powered stackers, reach trucks, order pickers		
Unit – III	**Material Handling in CIMS**	**4 Hours**
Need, comparison with conventional systems, equipment like industrial robots and automatically guided vehicles etc		
Unit – IV	**Material Flow**	**4 Hours**
Operation sequence, material flow pattern, stages of material flow at receiving, in process and at shipping, flow planning criteria & design of flow pattern		
Unit – V	**Selection of Material Handling Equipment**	**10 Hours**
Factors affecting selection of material handling equipment, material handling equation, choices of material handling equipment, general procedure for selection, basic analytical techniques, selection of suitable types of material handling systems, functions and parameters, affecting service, packing and storage material, selection of material handling equipment in green sand moulding foundry, sugar manufacturing industry		
Unit – VI	**Safety & Training**	**4 Hours**
Need, environmental and human factors in material handling, safety regulations		
ICA consists of minimum 8 practical/assignments from the below list 1. Case Study on Effective Material Handling 2. Identification and Classification of Material Handling Equipment 3. Design a Material Handling System for a Warehouse 4. Comparison of Conveying Systems 5. Role of AGVs and Robots in Modern Manufacturing 6. Flow Pattern Design for a Manufacturing Process 7. Equipment Selection in a Foundry 8. Material handling Equipment Selection for Sugar Industry 9. Application of Material Handling Equation 10. Safety Audit Report of a Material Handling System		
Text Books		
1. Immer J. R., Material Handling, McGraw Hill Publications 2. James Apple, Plant Layout & Material Handling, John Wiley Publications 3. Theodore H. Allegre Sr., Material Handling Principles & Practice, CBS Publishers & Distributors 4. John R. Immer, Material Handling, McGraw Hill Co. Ltd., New York 5. O. P. Khanna, Work Study, Dhanpatrai & Sons Publications		
Reference Books		

1. Raymond A. Kulweic, Handbook of Materials Handling, Industrial Press 2. Charles D. Reese, Material Handling Systems: Designing for Safety and Health, CRC Press 3. Matthew P. Stephens and Fred E. Meyers, Manufacturing Facilities Design and Material Handling, Purdue University Press 4. Harold A. Bolz and George E. Hines, Material Handling Handbook, Wiley-Interscience
e-Resources
http://kcl.digimat.in/nptel/courses/video/113105104/L49.html

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR
(An Autonomous Institute)
Third Year B.Tech. (Mechanical and Automation), Semester-V

23MAU5IK5T: Indian Knowledge System II - Measurement in Ancient India

Teaching Scheme		**Examination Scheme**	
Lectures	2 Hours/week	**ISE**	50 Marks
Credits	2	**ICA**	----

Introduction:

This course explores the scientifically grounded measurement systems used in ancient India. It emphasizes historical units for length, mass, time, and volume, and links them with modern metrology. The course is rooted in the Indian Knowledge System (IKS) and demonstrates the relevance of traditional knowledge in mechanical and automation engineering contexts.

Course Prerequisite:

Familiarity with Ancient Indian history

Course Objectives:

1. To introduce students to the traditional systems of measurement in ancient India.
2. To study ancient Indian units with contemporary SI units.
3. To understand the mathematical, philosophical, and practical basis of traditional measurement systems.
4. To understand the relevance and application of ancient measurement concepts in modern engineering contexts.

Course Outcomes:

After completing the course, students will be able to
1. Understand the principles and practices of measurement systems in ancient India.
2. Analyse ancient texts and archaeological data to extract measurement systems and their purposes.
3. Apply ancient Indian units to evaluate and interpret engineering structures and designs.
4. Correlate traditional measurement systems with modern engineering and metrology practices.

Unit – I	**Introduction to Measurement in Indian Knowledge System**	**4 Hours**

Definition of IKS, need for IKS in engineering, importance of measurement in ancient engineering (architecture, town planning, rituals) measurement practices in the Indus valley (e.g., calibrated ivory rulers, standardized bricks), Mauryan and Mughal standardized weights, land revenue systems

Unit – II	**Length and Distance Measurement**	**5 Hours**

Rraditional units: aṅgula, hasta dhanu, gaz, tola, ser, mana;, dhanusha; practical applications in temple architecture, town planning (e.g., harappan civilization); instruments and measurement techniques, standardization and accuracy, comparison with modern systems, comparison with

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modern metrology and relevance today, conversion to modern units, conversions to si, role in architecture, metallurgy, ayurveda measures		
Unit – III	**Weight and Mass Measurement**	**5 Hours**
Weights in harappan civilization: binary and decimal weight systems, ancient weighing devices and units: ratti, masha, tola, ser, dron, tulā, standardization during the mauryan (arthashastra) and mughal periods, balance scales, steelyards, rock-cut measuring systems, coin-based systems, metallurgy and trade considerations, principles of uniformity and reproducibility, connection to modern units: conversion of ancient units to grams/kilograms		
Unit – IV	**Volume and Capacity**	**4 Hours**
Measurement in grain trade, construction: units like kudava, droṇa, and khari: standardization methods, units of volume: mana, drona, adhaka, kumbha, patra, tools: graduated pots, conical and cylindrical containers for grain/oil, temple and trade practices: standard volumetric stones, estimation techniques: visual, tactile, comparative, inscriptions and scriptures documenting standards (e.g., copper plate grants)		
Unit – V	**Time Measurement and Calendrical Systems**	**5 Hours**
Philosophical and practical concepts of time (kāla) in vedas and jyotisha, time divisions: nimesha, kshana, muhurta, yama, tithi, nakshatra, ghatika, kāla, pañchāṅga system, instruments used: gnomon (shanku), water clocks (ghati yantra) sundials, the panchāṅga system and its use in daily life and rituals, development of lunar, solar, and lunisolar calendars, astronomical treatises: surya siddhanta, aryabhatiya and panchasiddhantika, astronomical relevance in rituals and agriculture		
Unit – VI	**Engineering Applications and Relevance Today**	**5 Hours**
Principles of measurement: precision, accuracy, error minimization, comparison between ancient Indian and modern measurement standards, SI system and evolution of metrication in India, indigenous knowledge and sustainable technologies, integration of IKS in smart manufacturing and digital calibration systems, ethics, standardization, and global relevance of ancient Indian systems, case studies: iron pillar of Delhi, Lothal dockyard, step-wells, integration with modern metrology and automation principles		

Text Books

1. Subhash Kak, The Astronomical Code of the Rgveda, Munshiram Manoharlal Publishers
2. K. V. Sarma, Measurement Systems in Indian Astronomy, Indian National Science Academy
3. S. Balachandra Rao, Indian Astronomy: A Source-Book, Universities Press
4. Saradha Srinivasan, Mensuration in ancient India, Archaeological Department of India

Reference Books

1. Debiprasad Chattopadhyaya, History of Science and Technology in Ancient India
2. D. P. Agrawal, The Archaeology of India
3. V. S. Agrawala, India as Known to Panini
4. R. G. Bhandarkar, Lectures on the Ancient History of India
5. Michel Danino, The Lost River: On the Trail of the Sarasvati
6. Indian Knowledge Systems Division (AICTE), Reading Materials on IKS (https://iksindia.org).

e-Resources
1. https://iksindia.org 2. https://onlinecourses.swayam2.ac.in/ini25_hs46/preview 3. https://onlinecourses.swayam2.ac.in/imb23_mg53/preview 4. https://www.youtube.com/watch?v=TvMsKRP6FlQ

	WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR **(An Autonomous Institute)** **Third Year B.Tech. (Mechanical and Automation Engineering), Semester-V**

23MAU5CC8P: Programming in Python

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

Introduction:

This course introduces Python programming concepts and applications tailored for mechanical engineering. Topics include fundamental programming principles, advanced Python techniques, numerical methods, data analysis, automation, hardware interfacing, and project work.

Course Prerequisite:

This course requires that the students are familiar with programming language such as C/C++.

Course Objectives:

1. To impart foundational and advanced programming skills in Python to confidently design and implement solutions to engineering problems.
2. To apply Python libraries such as NumPy and SciPy to perform numerical computations, solve mathematical equations, and analyze engineering data.
3. To visualize engineering data effectively using Python-based tools like Matplotlib and Seaborn to generate clear, informative plots and charts.
4. To automate engineering workflows and interact with hardware devices by writing Python scripts that interface with sensors, actuators, and other control systems.

Course Outcomes:

After completing the course, students will be able to

1. Develop proficiency in writing Python programs to solve basic engineering problems.
2. Apply Python libraries to perform numerical computations related to mechanical problems.
3. Utilize Python for data visualization and interpretation of engineering data.
4. Automate engineering tasks using Python scripts and tools.

Unit – I	**Introduction to Python Programming**	**3 Hours**
Python installation and setup, basic syntax and data types (numbers, strings, lists, tuples, dictionaries), control structures (if statements, loops), functions and modules		
Unit – II	**Advanced Python Concepts**	**2 Hours**
File handling (reading from and writing to files), exception handling, introduction to object-oriented programming (classes and objects), modules and packages		
Unit – III	**Numerical Methods and Computation**	**2 Hours**
Introduction to Numpy library, arrays and matrices operations, solving linear equations, numerical integration and differentiation		
Unit – IV	**Data Analysis and Visualization**	**1 Hours**

Introduction to Pandas library, data manipulation and analysis, plotting and visualization with matplotlib, advanced visualization with seaborn		
Unit – V	**Applied Mechanics and Simulations**	**2 Hours**
Introduction to Scipy library, mechanics-related functions (forces, moments, equilibrium), simulations of mechanical systems, solving differential equations		
Unit – VI	**Automation and Scripting**	**2 Hours**
Introduction to scripting for task automation, batch processing and file manipulation, automating report generation, real-world engineering task automation		
Unit – VII	**Interfacing with Hardware**	**1 Hours**
Introduction to interfacing with sensors and actuators, Basics of serial communication, controlling hardware using python (e.g., Raspberry Pi), real-time data acquisition and control		
Unit – VIII	**Project Work and Case Studies**	**1 Hours**
Real-world case studies in mechanical engineering, developing comprehensive projects, integration of python tools for problem-solving, presentation and documentation of projects		

ICA consists of minimum 8 practicals/assignments from the below list:

1. Basic Programming using Python.
2. Python Programs on File Handling, OOP, Modules & Packages.
3. Python Programs on Numerical Methods and Computation
4. Python Programs on Data Analysis and Visualization
5. Simulation of Projectile Motion using Python
6. Python Programs on Applied Mechanics and Simulations
7. Finite Element Analysis (FEA) Basics using Python
8. Python Programs on Automation and Scripting
9. Python Script (Interfacing with Hardware)
10. Project Work and Case Studies

Text Books

Programming in Python 3, Second Edition, Mark Summer field

Reference Books

1. Python Cookbook, Third Edition, David Beazley and Brian K. Jones, Shroff Publishers & Distributors Pvt. Ltd.
2. Mark Lutz, Learning Python Fifth Edition, O'Reilly Media Publications
3. Testing Python, David Sale, Wiley India (P) Ltd.

e-Resources

1. https://docs.python.org/2/
2. https://docs.python.org/2/

23MAU6CC1T: Heat Transfer

Teaching Scheme		Examination Scheme	
Lectures	3 Hours/week	**ESE**	60 Marks
Practical	2 Hours/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks
		OE	25 Marks

Introduction:

This course deals with study of various modes of heat transfer such as conduction, convection and radiation. The students will formulate and analyse a heat transfer problem, involving any of the three modes of heat transfer. The students will obtain exact solutions for the temperature variation using analytical methods, where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer. The students will analyse the performance of devices such as heat exchangers and also estimate the insulation needed to reduce heat losses wherever necessary.

Course Prerequisite:

Engineering Mathematics, Applied Thermodynamics, Fluid Mechanics

Course Objectives:

1. To understand the modes of heat transfer.
2. To use general heat conduction equations.
3. To examine the mechanisms of convective and radiative heat transfer in various engineering applications.
4. To understand heat exchangers, boiling and condensation.

Course Outcomes:

After completing the course, students will be able to
1. Identify different modes of heat transfer for steady and unsteady processes and extended surfaces.
2. Apply the different laws to the radiation phenomenon.
3. Analyse heat transfer in case of natural & forced convection, boiling & condensation.
4. Evaluate the heat exchanger performance.

Unit – I	Conduction	7 Hours

Introduction, relevance of heat transfer, relation of heat transfer to thermodynamics, modes of heat transfer. Basic laws of heat transfer, Thermal conductivity and its variation with temperature for various Engineering materials

Steady State Heat Conduction

Derivation of generalized heat conduction equation in Cartesian coordinate & its reduction to Fourier, Laplace and Poisson’s equations, generalized heat conduction equation in cylindrical and spherical

coordinates and its reduction to one dimension (1D) heat conduction through plane wall, cylinder, sphere; composites, critical radius of insulation for cylinder and sphere, one dimensional steady state heat conduction with uniform heat generation for wall & cylinder **Unsteady State Heat Conduction** Systems with negligible internal resistance, BIOT and Fourier number and their significance, lumped heat capacity analysis		
Unit – II	**Extended Surfaces**	**7 Hours**
Introduction, types and applications of fins, governing equation for constant cross section area fins, solution for fins with convective tip, adequately long (with insulated end) and infinitely long, fin effectiveness and efficiency		
Unit – III	**Radiation**	**7 Hours**
Nature of thermal radiation, definitions of absorptivity, reflectivity, transmissivity, monochromatic emissive power. total emissive power and emissivity, concept of black body & gray body, Kirchhoff's law, Wein's law and Planck's law, Lambert cosine rule, intensity of radiation, energy exchange by radiation between two black surfaces with non-absorbing medium in between and in absence of reradiating surfaces, concept of radiation shape factor and its properties, energy exchange by radiation between two gray surfaces without absorbing medium and absence of irradiation and radiosity, radiation network method, network for two surfaces which see each other		
Unit – IV	**Convection**	**7 Hours**
Forced Convection Mechanism of convection and its types, concept of hydrodynamic and thermal boundary layer, local and average convective coefficient, dimensional analysis, dimensionless numbers and their physical significance, empirical correlations for internal and external flow in forced convection problems **Natural Convection** Introduction, dimensional analysis, dimensionless numbers and their physical significance, empirical correlations for natural convection problems		
Unit – V	**Boiling and condensation**	**5 Hours**
Boiling heat transfer, types of boiling, pool boiling curves, force boiling phenomenon, condensation heat transfer, film wise and drop wise condensation. introduction of heat pipe		
Unit – VI	**Heat Exchangers**	**7 Hours**
Introduction, classification and types of heat exchangers, fouling factor, and overall heat transfer coefficient, analysis by LMTD and NTU method for parallel and counter flow, design consideration for heat exchangers		
ICA consists of minimum 8 practical/assignments from the below list 1. Determination of Thermal Conductivity of an Insulating Powder 2. Determination of Thermal Conductivity of a Composite Wall 3. Determination of Heat Transfer Coefficient – Natural Convection 4. Determination of Heat Transfer Coefficient – Forced Convection 5. Determination of Emissivity of a Surface 6. Determination of Stefan–Boltzmann Constant 7. Trial on Heat Exchangers 8. Demonstration of Heat Pipe		

9. CFD Analysis – Conduction Through a Wall and pipe 10. Micro Project: Heat transfer evaluation of an industrial process/system./ product.
Text Books
1. Dr. S. P. Sukhatme, A Textbook on Heat Transfer, Orient Longman Publication, Hyderabad. 2. P. K. Nag, Heat Transfer, McGraw Hill Publishing Company Ltd., New Delhi. 3. Mahesh M. Rathore, Engineering Heat and Mass Transfer, University Science Press, New Delhi.
Reference Books
1. J. P. Holman, Heat Transfer, McGraw Hill Book Company, New York. 2. Frank P. Incropera, David P., Fundamentals of Heat & Mass Transfer (Fifth Edition), John Wiley. 3. R. C. Sachdeva, Fundamentals of Heat and Mass Transfer, Wiley Eastern Ltd. 4. Yunus A. Cengel, Heat Transfer – A practical approach, McGraw Hill Publications 5. S.C. Arora and S. Dokoundwar, Heat and Mass Transfer, Dhanpat Rai and Sons, Delhi. 6. Dr. D. S. Kumar, Heat and Mass Transfer, S. K. Kataria & Sons, Delhi.
e-Resources
https://www.youtube.com/watch?v=UrWdWbc7HpY&list=PLM-jfaoaU5ixjX4DUXX-ycA0RHHpbe8Fp

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR (An Autonomous Institute) Third Year B.Tech. (Mechanical and Automation), Semester-VI			
23MAU6CC2T: Metrology and Quality Control			
Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/week	**ESE**	60 Marks
Tutorial	1 Hour/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks

Introduction:

In today's advanced manufacturing landscape, precision and consistent quality are essential. This course equips students with crucial skills in measurement science and quality assurance. The course covers linear, angular, and form measurements, advanced gear metrology, and the role of accurate measurement in design and inspection. It also explores modern quality practices, including Total Quality Management (TQM), Statistical Quality Control (SQC), and Acceptance Sampling. Students gain practical knowledge to analyse processes, ensure dimensional accuracy, and uphold product quality—preparing them for careers in quality assurance, manufacturing engineering, and product development across various industrial sectors.

Course Prerequisite:

Knowledge of Engineering Physics, Material Science, Basics of Manufacturing Processes

Course Objectives:

1. To provide students with a foundational and applied understanding of measurement systems.
2. To introduce modern quality control methodologies including Statistical Quality Control (SQC), Acceptance Sampling, and the implementation of Total Quality Management (TQM) principles
3. To make familiar with metrological tools and quality control systems such as CMMs, surface testers, control charts, and ISO quality frameworks.

Course Outcomes:

After completing the course, students will be able to

1. Demonstrate the principles of engineering metrology and the use of standard instruments for performing accurate linear and angular measurements.
2. Evaluate gear parameters, surface finish, and gauge designs using relevant metrological tools and standards.
3. Apply quality control tools and Total Quality Management (TQM) techniques to improve manufacturing processes.
4. Interpret statistical quality control charts and quality management systems for assessing process capability.

Unit – I	**Introduction to Metrology and Comparators**	**7 Hours**
Introduction to metrology: measurement standard, principles of engineering metrology, standards: line, end and wavelength standards, types and sources of error, linear and angular measurement, calibration **Comparator**: mechanical, pneumatic, optical		
Unit – II	**Gear Metrology and Advancements in metrology**	**7 Hours**
G**ear metrology:** errors in gears, gear terminology of spur gear, gear tooth vernier, profile projector **Advancements in metrology**: co-ordinate measuring machine, tool maker's microscope, universal measuring machine		
Unit – III	**Limits, Fits, Tolerances and Gauge Design**	**6 Hours**
Surface finish measurement: surface texture, measuring surface finish by stylus probe, Tomlinson and Talysurf, analysis of surface traces: methods. concepts related to limits, fits and tolerances; mechanical gauges: types and uses, Taylor's principle for design of gauges and Indian standard (is 919-1963) for gauge design		
Unit – IV	**Introduction to Quality and Quality Tools**	**6 Hours**
Quality control basics: cost of quality and value of quality, quality of design, quality of conformance, quality of performance **Seven quality control tools**: check sheet, flow chart, pareto analysis, cause and effect diagram, scatter diagram, brain storming, quality circles		
Unit – V	**Total Quality Management**	**7 Hours**
Definitions, principles and key elements of TQM, introduction to lean manufacturing, introduction to tools of TQM: Quality Function Deployment (QFD), 5s, Kaizan, Kanban, Just-in-Time (JIT), Poka Yoke		
Unit – VI	**Statistical Quality Control**	**7 Hours**
Statistical quality control: statistical concept, frequency diagram, concept of variance analysis, control chart for variable & attribute, process capability, six sigma: statistical meaning and methodology, acceptance sampling: sampling inspection, OC curve and its characteristics, sampling methods. quality management systems: introduction to ISO 9001:2015		
ICA consists of minimum 8 practical/assignments from the below list 1. Comparison of measurements using vernier calliper and micrometre. 2. Calibration of vernier calliper and micrometre using slip gauge. 3. Measure Run Out of cylindrical component using dial gauge indicator. 4. Measurement of gear parameters using gear tooth vernier. 5. Measurement of taper angle using vernier bevel protractor and sine bar in combination with slip gauge. 6. Design a gauge by using concept of limits, fits and tolerances. 7. Measurement of surface roughness using surface roughness tester. 8. Draw the frequency histogram, polygon, and normal distribution curve for the sample data. Also interpret the results from the central tendency and dispersion parameters		

9. Draw and interpret the control charts ($\bar{X}$ and R chart) for given data.
10. Draw and interpret the control charts (P- chart and C-chart) for given data.

Text Books

1. I. C. Gupta, Engineering Metrology, Dhanpat and Rai Publications, New Delhi, India.
2. M. S. Mahajan, Statistical Quality Control, Dhanpat and Rai Publications.

Reference Books

1. R. K. Jain, Engineering Metrology, Khanna Publications.
2. V. A. Kulkarni, A. K. Bewoor, Quality Control, Wiley India Publication
3. K. J. Hume, Engineering Metrology, McDonald Publications.

e-Resources

1. https://mycollegevcampus.com/sjcet/notes/Unit_II_Lesson_3_Linear_and_Angular_Measurements.pd
2. https://www.engineeringenotes.com/metrology/gear-tooth-vernier-caliper-diagram-and-its-calculations/48925
3. https://www.mechanicalbooster.com/2018/09/taylors-principle-of-limit-gauges.html
4. https://asq.org/quality-resources/seven-basic-quality-tools
5. https://www.simplilearn.com/lean-tools-article
6. https://asq.org/quality-resources/control-chart

	WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR **(An Autonomous Institute)** **Third Year B.Tech. (Mechanical and Automation Engineering), Semester-VI**

23MAU6E13T: Programme Elective Course II - Computational Fluid Dynamics

Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/week	**ESE**	60 Marks
Tutorial	1 Hour/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks

Introduction:

Computational Fluid Dynamics (CFD) is a powerful tool used to simulate and analyze fluid flow and heat transfer problems using numerical methods and computer-based models. It combines the principles of fluid mechanics, thermodynamics, and numerical analysis to solve real-world engineering problems that are often difficult or expensive to study experimentally. At the undergraduate level, this course introduces the fundamental concepts of CFD, including governing equations (continuity, momentum, and energy), discretization techniques, grid generation (meshing), and boundary conditions. Students will also be introduced to basic solver methods and learn how to interpret simulation results. Emphasis is placed on understanding the physical meaning of flow phenomena and gaining hands-on experience using commercial CFD software to analyze simple fluid flow problems. This foundational knowledge prepares students for more advanced fluid dynamics courses and real-world engineering applications.

Course Prerequisite:

Applied Thermodynamics, Engineering Mathematics, Fluid Mechanics, Heat and Mass Transfer, MATLAB, and Python or C++

Course Objectives:

1. Understand the fundamental principles of fluid flow and heat transfer based on conservation laws.
2. Study formulation of mathematical models of fluid flow using governing equations such as the Navier-Stokes equations.
3. Study basic discretization techniques like the Finite Difference and Finite Volume Methods to simple flow problems.
4. Understand computational meshes and their influence on solution accuracy and convergence.
5. Study the use commercial CFD software to simulate and analyze basic fluid flow and heat transfer problems.
6. Interpret CFD results to draw meaningful engineering conclusions and recognize the limitations of numerical simulations.

Course Outcomes:

After completing the course, students will be able to

1. Describe the fundamental governing equations of fluid flow and heat transfer used in CFD analysis.
2. Apply numerical methods to discretize and solve basic fluid dynamics problems.

3. Use commercial CFD software to set up fluid flow and heat transfer in simple systems. 4. Interpret CFD results to make informed engineering decisions and identify potential errors or limitations.		
Unit – I	**Introduction to CFD**	**7 Hours**
Steps in CFD, advantages, disadvantages and applications of CFD governing equations continuity, momentum equation, energy equation		
Unit – II	**Boundary conditions-**	**7 Hours**
Classification, initial & boundary value problems-finite difference schemes-forward, central & backward difference, four basics of finite volume schemes, Implicit & explicit approaches		
Unit – III	**Finite Difference Method**	**7 Hours**
Finite Difference Method (FDM) for steady one-dimensional and two-dimensional heat conduction equation in steady state, simple problems, Transient one-dimensional heat conduction equation		
Unit – IV	**Grid Generation and Mesh Quality**	**7 Hours**
1D heat transfer and 2D transient problems, finite volume formulation, uniform & nonuniform grids, numerical errors, (simple numerical treatment) grid independence test		
Unit – V	**Governing Equations**	**5 Hours**
Governing equations, stream function – vorticity method, determination of pressure for viscous flow, simple procedure of Patankar & Spalding, computation of boundary layer flow, finite difference approach, unstructured grids for viscous flows		
Unit – VI	**CFD Software and Practical Applications**	**7 Hours**
Introduction to commercial CFD software, setting up problems, simulation, post-processing results		
ICA consists of minimum 8 practical/assignments from the below list 1. Concept Map and Application Case Study 2. Numerical Derivative Calculation using Finite Difference Schemes 3. 1D Steady-State Heat Conduction using Finite Difference Method 4. Transient 1D Heat Conduction using Explicit and Implicit Schemes 5. Grid Generation and Mesh Quality Evaluation 6. Grid Independence Test for a 2D Heat Conduction Problem 7. Stream Function–Vorticity Method for 2D Incompressible Flow 8. Implementation of the SIMPLE Algorithm for Pressure-Velocity Coupling 9. CFD Simulation of External Flow over an Airfoil or Cylinder 10. CFD Analysis of Internal Flow through a Pipe		
Text Books		
1. Ghoshdastidar P.S, Computational Fluid Dynamics, Oxford University Press 2. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing. 3. Muralidhar, K., and Sundararajan, T. Computational Fluid Flow & Heat Transfer, Narosa		

Publishing House, New Delhi, 1995. 4. Bose, T.X. – Numerical Fluid Dynamics, Narosa Publishing House, 1997.
Reference Books
1. Anderson, John D., Computational Fluid Dynamics: The Basics with Applications, McGraw Hill, Publications 2. Taylor, C and Hughes, J.B. “Finite Element Programming of the Navier Stock Equation” Pineridge Press Ltd., U.K.
e-Resources
https://youtu.be/aShONtHloUk?si=IO8W63bQbtlx9ZJ_

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR (An Autonomous Institute) Third Year B.Tech. (Mechanical and Automation Engineering), Semester-VI			
23MAU6E23T: Programme Elective Course II - Tool Design			
Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/week	**ESE**	60 Marks
Tutorial	1 Hours/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks

Introduction:

The Tool Design course is a pivotal component of the Mechanical Engineering curriculum, focusing on the principles and practices involved in designing tools essential for manufacturing processes. This course provides students with a comprehensive understanding of the design, analysis, and application of various tools such as cutting tools, jigs, fixtures, and press tools. Emphasizing both theoretical knowledge and practical skills, the course prepares students to address real-world challenges in tool design and manufacturing.

Course Prerequisite:

Machine tools, Engineering Drawing, Strength of Materials,

Course Objectives:

1. Study the fundamental concepts and methodologies involved in designing tools for various manufacturing processes.
2. Understand the principles to design single-point and multi-point cutting tools, considering factors like material selection, geometry, and cutting parameters.
3. Study the design of jigs and fixtures for specific machining operations, ensuring accuracy, repeatability, and efficiency in manufacturing.
4. Understand the design and operation of press tools, including blanking, piercing, and forming operations, and their applications in sheet metal working.

Course Outcomes:

After completing the course, students will be able to

1. Develop designs for single-point and multi-point cutting tools, incorporating appropriate geometry and material selection.
2. Design jigs and fixtures for enhancing precision and efficiency.
3. Evaluate tool wear mechanisms and tool life based on cutting conditions and material properties
4. Comprehend the design and functioning of press tools, including the calculation of tonnage and clearance for various operations

Unit – I	**Introduction to tool design**	**3 Hours**

Tooling, requirements of a tool designer, general tool design procedure, tool engineering function and its importance to enhance productivity and quality. review of cutting tool materials. tool angles and signature, carbide inserts grades, ISO designation and applications, tool holders for turning-iso designation. solid type tool, brazed tip tool, throwaway indexable insert types, coated carbides and chip breakers

Unit – II	**Design of single point cutting tools**	**8 Hours**
Design of shank dimensions using strength and rigidity considerations for rectangular, square and round cross section and selection of tool geometry		
Unit – III	**Design of Multi Point Cutting Tools**	**7 Hours**
Types of drills, drill bit design - elements like back taper, web thickness, land width, margin, flute length and cross section and selection of tool geometry, re-sharpening of drill bit, tool holders for milling, different tapers used for mounting tool holders in milling, iso designation. Tool mounting systems Design of milling cutters: design of elements like number of teeth and height, circular pitch, body thickness, chamfer width, fillet radius and selection of tool geometry. Profile sharpened and form relieved milling cutters. re-sharpening of side and face milling cutter and end mill		
Unit – IV	**Jigs and Fixtures**	**7 Hours**
Introduction to different types of fixtures like- welding fixtures, measuring / inspection fixtures. Functions and differences between jigs and fixtures, advantages in mass production, design principles, economics of jigs and fixtures. 3-2-1 Principle of location, different types of locating elements, principles of clamping, types of clamping devices, and power clamping. drill bushes; drill jigs: different types, exercises of designing jigs for simple components, fixture design: turning fixtures, milling fixtures, grinding fixtures, fixturing for CNC machining centres, and modular fixtures, design exercises on fixtures for turning and milling for simple component		
Unit – V	**Press tools**	**8 Hours**
Classification and working of power presses, concept and calculations of press tonnage and shut height of a press, components of a simple die, press tool operation, die accessories, shearing action in punch & die, clearance, shear on punch and die, Centre of pressure, and strip layout, simple, progressive, compound, combination and inverted dies, design problems on blanking and piercing dies for simple components, bending dies introduction, bend allowance, spring back, edge bending die design		
Unit – VI	**Advanced Topics in Tool Design**	**7 Hours**
Computer-Aided Tool Design (CATD): introduction to cad tools in tool design, tooling for advanced manufacturing: design considerations for additive manufacturing and micro-machining, tool maintenance and management: tool life management, re-sharpening, and inventory control. emerging trends: smart tools, iot in tooling, and sustainable tooling practices		
ICA consists of minimum 8 practical/assignments from the below list 1. Measurement and inspection of tools using micrometres, vernier calipers, and gauges. 2. Design and drawing of press tool for particular component. 3. Design and drawing of draw tool for particular component. 4. Design and drawing of a jig for given component. 5. Design and drawing of milling fixture for particular component. 6. Design progressive cutting die for simple component 7. Design a simple blanking and piercing die. 8. Use of CAD software to model a cutting tool component. 9. Simulating sheet metal operations using software tools. 10. Industrial visit report		

Text Books
1. Cyril Donaldson, George H. Lecain, and V.C. Goold, Tool Design, 5th Edition, McGraw-Hill Education 2. John G. Nee, Fundamentals of Tool Design, 6th Edition, Society of Manufacturing Engineers
Reference Books
1. Erik Oberg, Franklin D. Jones, Holbrook L. Horton, and Henry H. Ryffel, Machinery's Handbook, 32nd Edition, Industrial Press 2. P.H. Joshi, Press Tool Design and Construction, McGraw-Hill Education 3. Bart Raeymaekers, Design of Mechanical Elements: A Concise Introduction to Mechanical Design Considerations and Calculations, Wiley-Blackwell Publication
e-Resources
1. https://archive.nptel.ac.in/courses/112/105/112105127/ 2. https://nptel.ac.in/courses/112105233

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR
(An Autonomous Institute)
Third Year B.Tech. (Mechanical & Automation Engineering), Semester-VI

23MAU6E33T: Programme Elective Course II - Design of Transmission Systems

Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/week	**ESE**	60 Marks
Tutorial	1 Hour/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks

Introduction:

The course on Design of Transmission Systems provides a comprehensive understanding of the principles and practices involved in the design of mechanical elements used in power transmission systems. It covers the selection and design of gears, bearings, shafts, and other components essential for efficient power transmission in various mechanical systems. The course also emphasizes the application of theoretical knowledge through practical examples and case studies, preparing students for real-world engineering challenges in the field of machine design.

Course Prerequisite:

Basic Mathematics, Kinematics and Dynamics of Machinery, Design of machine elements, CAD software

Course Objectives:

1. To understand the fundamental principles of gear design, including the terminology, types, and failure modes of gears, to ensure efficient power transmission in mechanical systems.
2. To study gear trains and design complex mechanical systems, considering factors such as efficiency and power flow.
3. To learn the selection and design of bearings, both rolling element and sliding contact, to optimize the performance and longevity of transmission components.

Course Outcomes:

After completing the course, students will be able to
1. Design different gears considering strength, wear for specific application requirements.
2. Select appropriate rolling contact and sliding contact bearings using load-life relationships and performance analysis techniques.
3. Analyse gear and bearing failures, propose remedies for enhanced system performance.
4. Integrate theoretical concepts with practical tools to enhance efficiency of power transmission components for engineering applications.

Unit – I	**Spur Gears**	**8 Hours**

Gear terminology and types, types of gear failures, hunting of gear tooth, tooth profiles and standards, minimum number of teeth, design considerations of gears and gear materials, design of spur gears: strength and wear considerations		
Unit – II	**Helical Gears**	**6 Hours**
Helical gear geometry and nomenclature, virtual number of teeth, force analysis, design of helical gears: strength and wear considerations, advantages and applications of helical gears		
Unit – III	**Bevel Gears**	**6 Hours**
Types and geometry of bevel gears, force analysis, strength and wear considerations of bevel gears, bevel gear mountings, applications of bevel gears in transmission systems		
Unit – IV	**Worm Gears**	**6 Hours**
Characteristics and geometry of worm gears, force analysis, friction and efficiency, design of worm gears: strength and wear rating, applications and limitations of worm gears		
Unit – V	**Rolling Contact Bearings**	**8 Hours**
Types of rolling element bearings: ball bearings, roller bearings, Stribeck's equation, static and dynamic load carrying capacity, load-life relationship and bearing selection, equivalent bearing load, bearing failures and their remedies		
Unit – VI	**Sliding Contact Bearings**	**6 Hours**
Bearing types and their constructional details, introduction to hydrostatic bearing, hydrodynamic lubrication: performance analysis hydrodynamic bearing by Raimondi method and by Boyd method		
ICA consists of minimum 8 practical/assignments from the below list 1. Identify and label gear terminology on a sample spur gear. Sketch the tooth profile and compare it to standard profiles. 2. Design a spur gear for a given application using Lewis's equation for strength and Buckingham's equation for wear. 3. Perform a force analysis for a given helical gear specification. Calculate axial and radial force components. 4. Compare the efficiency and applications of spur and helical gears using practical examples. 5. Design a bevel gear for specified input and output parameters considering strength and wear limitations. 6. Perform force analysis on a bevel gear pair and calculate the tangential, radial, and axial forces acting on the gears. 7. Evaluate the efficiency of a worm gear set for given friction conditions and suggest ways to improve it. 8. Design a worm gear drive for a specified load and speed ratio, considering strength and wear. 9. Select a suitable rolling element bearing for a given application by calculating the equivalent bearing load and load-life relationship. 10. Using CAD software, design a gearbox for given application and submit the digital model and a brief report on the design process.		

Text Books
1. V. B. Bhandari, Design of Machine Elements, Tata McGraw-Hill Education 2. J. E. Shigley, C. R. Mischke, R. G. Budynas, Mechanical Engineering Design, McGraw-Hill Publications
Reference Books
1. R. L. Norton, Machine Design: An Integrated Approach, Prentice Hall Publications 2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayaram, C. V. Vaishak, Design of Machine Elements, Pearson Publications
e-Resources
1. https://archive.nptel.ac.in/courses/112/105/112105234/ 2. https://onlinecourses.nptel.ac.in/noc24_me71/preview

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR (An Autonomous Institute) Third Year B.Tech. (Mechanical & Automation Engineering), Semester-VI			
23MAU6E14T: Programme Elective Course III - Instrumentation & Control Engineering			
Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/week	**ESE**	60 Marks
Practical	2 Hours/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks

Introduction:

Measurement activities are given prime importance in industry. The art of measurement plays an important role in all branches of engineering. This course aims at making mechanical engineering students familiar with the principle of instrumentation, transducer and measurement of non-electrical parameters like temperature, pressure, flow, speed, force, and torque for engineering applications. Also this course covers topics such as Fundamentals of automatic control, Root locus method and Bode plots.

Course Prerequisite:

Basics of Metrology, Engineering Physics & Engineering Mathematics

Course Objectives:

1. To study various types of measurement systems and their static and dynamic characteristics for accurate instrumentation.
2. To study appropriate transducers and devices for the measurement of physical quantities such as temperature, pressure, displacement, speed, flow, and force.
3. To become aware of control systems using block diagrams, root locus, and Bode plots for stability and performance analysis.
4. To understand various control strategies (P, I, D, PI, PD, PID) and assess their impact on the behaviour and stability of control systems.

Course Outcomes:

After completing the course, students will be able to

1. Analyze a generalized measurement system and various types of instrumentation errors and calibration methods.
2. Apply suitable sensors and measurement techniques to determine temperature, pressure, displacement, speed, flow, and force in real-world systems.
3. Simplify block diagrams to transfer functions for given control systems using algebraic rules.
4. Develop root locus and Bode plots to find system stability through gain and phase margin calculations.

Unit – I	**Introduction to Instrumentation**	**4 Hours**

Generalized measurement system & its functional elements, static & dynamic characteristics and terms, calibration, classification of errors

Unit – II	**Temperature & Pressure Measurement**	**4 Hours**
Measurement of temperature: concept of temperature, scales, thermometer, thermocouples, RTDS, thermistors Measurement of pressure & vacuum: terminology of pressure & vacuum, bourdon tube, deadweight pressure gauge, diaphragm gauge, vacuum gauges-McLeod's gauge		
Unit – III	**Displacement & Speed Measurement**	**4 Hours**
Measurement of linear position & displacement: potentiometer, LVDT Angular speed measurement: - inductive pickup, photoelectric pickup		
Unit – IV	**Flow & Force Measurement**	**4 Hours**
Flow measurement: -rate meters and quantity meters, turbine meter, rotameter, hot-wire anemometer Force measurement: hydraulic & pneumatic load cells, proving ring		
Unit – V	**Introduction to Control Systems**	**4 Hours**
Introduction, classification, open loop and closed loop control systems, modes of control- P, I, D, PI, PD and PID		
Unit – VI	**Block Diagram Representation**	**6 Hours**
General representation of a feedback control system, transfer function, block diagram algebra rules		
Unit- VII	**Root Locus Method**	**8 Hours**
Significance of root locus, angle & magnitude conditions, pole-zero plot, root locus terminologies, general steps to solve root locus problems		
Unit- VIII	**Bode Plots**	**8 Hours**
Introduction to bode plots, standard form of open loop transfer function, bode plots of standard factors, steps to sketch bode plots, calculation of G. M and P. M from bode plot, comment on system stability, frequency response specifications		
ICA consists of minimum 8 practical/assignments from the below list 1. Experiment on Temperature measurement using RTD/Thermometer 2. Experiment on angular speed measurement using Photoelectric pickup 3. Force Measurement using proving ring, load cells. 4. Displacement Measurement using LVDT. 5. Flow measurement using rotameter. 6. Control system simulation using suitable software 7. Assignment to demonstrate modes of control. 8. Assignment on determination of transfer function using block diagram algebra 9. Construction of Root Locus using suitable software 10. Construction of Bode Plots using suitable software		
Text Books		
1. Dr. D. S. Kumar, Mechanical Measurement & Control, Metropolitan Book Co. Pvt. Ltd. 2. F. H. Raven, Automatic control Engineering McGraw Hill International editions, New Delhi, Fifth		

edition

3. U.A. Bakshi and V.U. Bakshi, Control Systems, Technical Publications, Pune, Fifth revised Edition –

Reference Books

1. Dr Sirohi & Dr. Radhakrikshan, Mechanical Measurements, New Age International Ltd.
2. Beckwith & Buck, Mechanical Measurements, Pearson Publications
3. K. Ogata, Modern Control Engineering, Prentice Hall of India Pvt. Ltd., New Delhi., 4th Edition.

e-Resources

https://archive.nptel.ac.in/courses/107/106/107106081/

	WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR **(An Autonomous Institute)** **Third Year B.Tech. (Mechanical and Automation Engineering), Semester-VI**

23MAU6E24T: Programme Elective Course III - Finite Element Analysis

Teaching Scheme		**Examination Scheme**	
Lectures	3 Hours/week	**ESE**	60 Marks
Practical	2 Hours/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks

Introduction:

The Finite Element Method (FEM) or Finite Element Analysis (FEA) is a numerical technique to find approximate solutions of partial differential equations. FEM is an integral part of CAE and is extensively used in analysis and design of real-life complex problems. Several sophisticated commercial and free FEM software are available in the market, but to use these effectively and to understand & analyze the results, theoretical foundations of FEM are essential. This course is designed to cover both aspects (theory and software) of FEM. This course will enable the student to formulate and solve the mathematical equations for 1D, 2D and 3D finite by hand and using FEM software. This course is designed to give the students a hands-on approach on FEM.

Course Prerequisite:

Fundamentals of mechanics, elementary solid mechanics (SOM), elementary fluid mechanics, and principles of heat transfer, basic engineering mathematics

Course Objectives:

1. To introduce the fundamental principles and historical development of the Finite Element Method (FEM) and its distinction from other computational techniques.
2. To enable students to formulate and solve structural and thermal problems using 1D, 2D, and 3D finite elements.
3. To develop the mathematical foundation of FEM through variational methods, shape functions, and numerical approximation techniques.
4. To familiarize students with nonlinear, dynamic FEM problems and commercial software tools used in industry for simulation and analysis.

Course Outcomes:

After completing the course, students will be able to

1. Demonstrate the fundamentals and significance of FEM
2. Solve 1D and 2D finite element problems using interpolation and shape functions with relevant boundary conditions.
3. Develop mathematical models using variational principles and weighted residual methods for simple engineering problems.
4. Simulate structural, thermal problems using FEM software tools considering aspects like mesh quality, nonlinear behaviour, and dynamic conditions.

Unit – I	**FEA Fundamentals**	**4 Hours**
History and fundamentals of FEA, general fem procedure, direct formulation for uniaxial elements using matrix methods, applications of fem, comparison with other computational techniques such as FDM, BEM, FVM and their applications, merits and demerits of fem compared to exact solutions and experimentation, overview of free and proprietary computational software		
Unit – II	**Finite element formulation for1D elements**	**6 Hours**
Types of 1D elements, interpolation functions for 1D elements such as truss, beams and thermal elements, shape functions for the same, formulation of system equations for 2D and 3D trusses and beam elements, calculation of stresses and strains		
Unit – III	**Finite element formulation for 2D elements**	**5 Hours**
2D elements such as triangles and quadrilaterals, pascal triangle for formulating interpolation functions, shape functions for 2D elements, LST, CST, linear and parabolic quads, axisymmetric elements, 2D shell elements element		
Unit – IV	**Finite Element formulation for 3D elements**	**5 Hours**
Interpolation functions for 3D elements, Pascal Tetrahedron, shape functions, formulation of system equations, calculation of stresses and strains		
Unit – V	**Mathematical Foundations of FEA**	**6 Hours**
Variational calculus, Ritz method, methods of weighted residuals such as collocation, least squares, Galerkin-Bubnov, boundary conditions and general comments, Elimination Method, Penalty Method, Newton Raphson method, decomposition method		
Unit – VI	**Natural Coordinates and Higher order Elements**	**5 Hours**
Shape functions in natural coordinates, derivation of shape functions of 1D, 2D and 3D elements in natural coordinates, Lagrangian polynomials, iso-parametric elements, mapping and transformation in higher order elements, Jacobian, completeness and convergence of solution		
Unit – VII	**Nonlinear and Dynamic FEM**	**5 Hours**
Nonlinear elasticity problems: material, geometric and boundary condition non linearity, contact and gaps, dynamic problems: modal analysis, transient response analysis, harmonic analysis, spectrum analysis, transient thermal analysis, introduction to explicit analysis, sub modeling and sub structuring		
Unit – VIII	**Advanced commercial packages for numerical simulations**	**4 Hours**
Review of free and commercial software, comparison of capabilities, pre-processing, solvers, Post processing, commercial finite element software, model validity, mesh design & refinement, element distortion		
ICA consists of minimum 8 practical/assignments from the below list 1. Numerical exercise on method of weighted residuals formulation. 2. Numerical exercise on 1D Element 3. Assignment on Natural Coordinates and Isoperimetric formulation 4. Software assignment supported by hand calculations on a 1D problem 5. Software assignment supported by hand calculations on a 2D problem		

6. Software assignment on a 3D problem
7. Software assignment on dynamic problems
8. Assignment on FEA applications and available commercial packages
9. Determination of mode shapes and natural frequencies in vibration problems
10. Simulation of heat conduction through plane slab with convective boundary conditions

Text Books

1. David V. Hutton, Fundamental of Finite Element Analysis, Tata McGraw-Hill Education Pvt. Ltd.
2. P. Seshu, Text book of Finite Element Analysis, PHI Learning Private Ltd., New Delhi
3. U. S. Dixit, Finite Element Methods, Cengage Publications
4. S. S. Bhavikatti, Introduction to Finite Elements, New Age International Publications

Reference Books

1. R. D. Cook, et al., Concepts and Applications of Finite Element Analysis. Wiley, India
2. K. J. Bathe, Finite Element Procedures Prentice, Hall of India (P) Ltd., New Delhi
3. O. C. Zienkiewicz, R. I. Taylor, The Finite Element Method, Butterworth- Heinemann Publications
4. M. J. Fagan, Finite Element Analysis, Theory and Practice, Pearson Education Ltd.
5. Daryl Logan, A First Course in the Finite Element Method, Cengage Publications

e-Resources

1. https://archive.nptel.ac.in/courses/112/105/112105308/
2. https://archive.nptel.ac.in/courses/112/104/112104193/

23MAU6E34T: Programme Elective Course III - Mechanical Vibrations

Teaching Scheme		Examination Scheme	
Lectures	3 Hours/week	**ESE**	60 Marks
Practical	2 Hours/week	**ISE**	40 Marks
Credits	4	**ICA**	25 Marks

Introduction:

Mechanical Vibrations is a core subject in mechanical engineering that deals with the oscillatory motion of bodies and the forces associated with them. This course provides an in-depth understanding of the principles and analysis techniques of vibratory systems, covering single and multi-degree of freedom systems, vibration measurement instruments, forced and free vibrations, and numerical methods for vibration analysis. It prepares students to tackle real-world engineering problems involving vibrations in machinery, structures, and vehicles.

Course Prerequisite:

Engineering Mechanics, Engineering Mathematics, Basics of Dynamics and Kinematics of Machines

Course Objectives:

1. Understand fundamental concepts and mathematical modeling of vibratory systems.
2. Study single and multi-degree of freedom systems under various vibration conditions.
3. Study vibration measurement techniques and instrumentation.
4. Understand analytical and numerical methods to solve practical vibration problems.

Course Outcomes:

After completing the course, students will be able to

1. Define the key terms, principles, and types of mechanical vibrations.
2. Evaluate the response of single and two-degree freedom systems under free and forced vibrations.
3. Use vibration measuring instruments and interpret the obtained data.
4. Implement numerical techniques for response of vibratory behaviour in mechanical systems.

Unit – I	Introduction	3 Hours

Importance & scope, concepts & terms used, SHM, complex method of representing vibration, Fourier series & harmonic analysis

Unit – II	Single degree of freedom systems	12 Hours

Free vibrations, types of damping, logarithmic decrement, coulomb damping, and damping materials, single degree of freedom systems: forced vibrations:
types of excitations, forced excitation, support excitation, excitation due to unbalance in machines, response due to above types of excitations, force transmissibility & motion transmissibility, vibration isolators, commercial isolation materials & shock mounts

Unit – III	Vibration Measuring Instruments	5 Hours
Instruments for measurement of displacement, velocity, acceleration & frequency of vibration, spectral analysers, FFT analyser		
Unit – IV	**Two degrees of freedom systems**	**8 Hours**
Free un-damped vibrations – principal modes and natural frequencies, co-ordinate coupling and principal co-ordinates Forced undamped vibrations: harmonic excitation, vibration, dampers & absorbers, introduction to dynamic vibration absorber – tuned & untuned type		
Unit – V	**Transient Vibration**	**4 Hours**
Response of single DOF system to an impulsive step input, pulse input (rectangular & half sinusoidal), Laplace method, phase plane method		
Unit – VI	**Introduction to Numerical Methods in Vibration**	**8 Hours**
Holzer method, Raleigh's method, matrix iteration method, introduction to fem, analysis techniques used in vibration (Eigen value analysis)		
ICA consists of minimum 8 practical/assignments from the below list 1. Experiment on equivalent spring mass system. 2. Experiment on forced vibration characteristics 3. Experiment on torsional oscillation of single rotor without damping 4. Determination of logarithmic decrement for single DOF damped system 5. Experiment on torsional vibration of two rotor without damping 6. Experiment on bi-filar and tri-filar suspension system 7. Study of different types of exciters for vibration analysis 8. Measurement of vibration parameters using vibration measuring instruments 9. Exercise on numerical calculation of natural frequencies by either Holzer, Raleigh's or matrix iteration method. 10. Study of condition monitoring technique using vibration analysis		
Text Books		
1. S. S. Rao, Mechanical Vibrations, Pearson Education 2. William T. Thomson and Marie Dillon Dahleh, Theory of Vibration with Applications, Pearson Education 3. V. P. Singh Mechanical Vibrations, Dhanpat Rai Publications		
Reference Books		
1. S. Timoshenko, D. H. Young, and W. Weaver, Vibration Problems in Engineering, Wiley Publications 2. Leonard Meirovitch, Fundamentals of Vibrations, McGraw-Hill 3. Daniel J. Inman, Engineering Vibration, Pearson Education		
e-Resources		
https://archive.nptel.ac.in/courses/112/103/112103111/		

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR
(An Autonomous Institute)
Third Year B.Tech. (Mechanical and Automation Engineering), Semester-VI

23MAU6CC5P: Programming in Java

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

Introduction:

This syllabus is designed for beginner mechanical engineers with no prior programming experience. It aims to provide a foundation in Java programming with a focus on applications relevant to mechanical engineering.

Course Prerequisite:

This course requires that the students are familiar with programming language such as C/C++ and data structures, algorithms.

Course Objectives:

1. Understand the basic concepts of programming and object-oriented programming (OOP).
2. Introduce students with Java programs using fundamental syntax and data structures.
3. Familiarize control flow statements for decision making and loops for repetitive tasks.
4. Work with functions for code reusability and modularity.
5. Introduce students with arrays for data organization and manipulation relevant to mechanical engineering problems.
6. Introduce basic concepts of classes and objects for building simulations or models

Course Outcomes:

After completing the course, students will be able to

1. Write Java programs on basic syntax, control structures, and object-oriented principles.
2. Apply Java programming concepts to develop methods, arrays, and object-oriented solutions for engineering applications.
3. Analyze exception handling, file I/O operations, and implement relevant Java libraries for solving engineering problems.
4. Develop Java-based GUI applications to simulate and solve mechanical engineering problems

Unit – I	**Introduction to Java Programming**	**1 Hours**

Overview of Java and its applications in engineering, setting up the development environment, Writing and executing your first Java program, Basic program structure

Unit – II	**Basic Java Syntax**	**2 Hours**

Variables, data types, and operators, control structures: if-else, switch-case, loops: for, while, do-while

Unit – III	**Methods and Arrays**	**2 Hours**
Defining and calling methods, method overloading, arrays and their applications in engineering problems		
Unit – IV	**Object-Oriented Programming - Part 1**	**2 Hours**
Classes and objects, constructors and methods, encapsulation and access modifiers		
Unit – V	**Object-Oriented Programming - Part 2**	**2 Hours**
Inheritance and polymorphism, abstract classes and interfaces, case study: designing a mechanical component hierarchy		
Unit – VI	**Exception Handling and File I/O**	**2 Hours**
Introduction to exceptions, try-catch blocks, creating custom exceptions, reading from and writing to files, handling different file formats (text, CSV)		
Unit – VII	**Java Libraries for Engineering Applications**	**2 Hours**
Overview of useful Java libraries (e.g., Apache Commons Math), Implementing mathematical functions and simulations		
Unit – VIII	**Graphical User Interfaces (GUI) and Final Project**	**1 Hour**
Introduction to JavaFX, creating simple GUI applications, Application: Building a basic simulation interface, final project: Solving a mechanical engineering problem using Java		

ICA consists of minimum 8 practical/assignments from the below list

1. Introduction to Java Programming.
2. Programs based on Basic Java syntax.
3. Programs based on Methods and Arrays.
4. Programs based on Object Oriented programming (Classes & Objects, Using Constructors, Encapsulation, Object Interactions and Method in class.)
5. Programs based on Object Oriented programming (Inheritance, Polymorphism, Abstract class. Interface Implementation and Hierarchy Design.)
6. Mechanical Calculation Using Variables and Control Structures
7. Method-Based Calculator for Thermodynamic Properties
8. Programs based on Exception Handling and File I/O.
9. Programs based on Engineering Application using Java libraries.
10. Programs based on GUI and Final Project.

Text Books

1. E. Balaguruswamy, Programming with JAVA: A Primer (4th Edition), TMH Publications
2. Herbert Scheldt, JAVA: The Complete Reference (5th Edition), TMH Publications
3. Malan and Hahn, Essential JAVA for Scientists and Engineers, Butterworth-Heinemann Ltd.

Reference Books

1. P. Radhakrishna, Object Oriented Programming through JAVA, University Press
2. Motwani, Java Programming for Beginners, Shroff Publications
3. Yeshwant Kanetkar, Let us JAVA, BPB Publications
4. Mike McGrath, JAVA in Easy Steps, TMH Publications

e-Resources

https://www.iitk.ac.in/esc101/share/downloads/javanotes5.pdf

WALCHAND INSTITUTE OF TECHNOLOGY, SOLAPUR (An Autonomous Institute) Third Year B.Tech. (Mechanical and Automation Engineering), Semester-VI	

23MAU6VS7L: Advanced Manufacturing Technology

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

Introduction:

Advanced Manufacturing Technology (AMT) explores modern and intelligent methods of manufacturing with a focus on Computer Numerical Control (CNC) systems. The course aims to provide a deep understanding of CNC machines, programming, tooling, automation integration, and advanced manufacturing trends. Emphasis is placed on hands-on experience with CNC machines to prepare students for modern industrial practices.

Course Prerequisite:

Basic Manufacturing Processes, Engineering Drawing and CAD, Fundamentals of Machine Tools

Course Objectives:

1. To introduce students to the principles and components of CNC machines and systems.
2. To develop understand CNC programming for milling and turning operations.
3. To familiarize students with tooling, work holding, and process planning in CNC operations.
4. To explore advancements in automation, adaptive control, and smart manufacturing

Course Outcomes:

After completing the course, students will be able to

1. Demonstrate the working of CNC machine tools.
2. Develop part programs for CNC turning and milling operations.
3. Select appropriate tools, fixtures, and machining parameters for CNC machining tasks.
4. Identify the role of CNC technology in smart manufacturing and Industry 4.0

Unit – I	**CNC Technology & Coordinate Systems**	**3 Hours**

Overview of CNC machining, Cartesian and polar coordinate systems, absolute and incremental positioning, overview of CNC machine structure and control

Unit – II	**Programming for Turning**	**3 Hours**

Programming format: block structure, codes, facing, turning, grooving, threading, drilling cycles, tool offsets and setting values, subprograms and program loops

Unit – III	**Programming for Milling**	**3 Hours**

Linear and circular interpolation, slotting, contouring, drilling, pocketing, cutter compensation and tool radius offsets, program writing for face milling and profile milling

Unit – IV	Introduction to CAM	3 Hours
Importing and preparing CAD models, job setup, stock definition, and material selection, tool library, machine simulation setup		
Unit – V	**Toolpath Generation**	**3 Hours**
Toolpath types: contour, pocket, drill, surface, Setting up operations and machining strategies, Verification and back plotting, post-processing and G-code generation		
ICA consists of minimum 8 practical/assignments from the below list 1. Demonstration of CNC machine components and Mastercam software interface 2. Manual G-code programming for CNC turning: Basic part profile. 3. Manual G-code programming for CNC milling: Slot and pocket. 4. Importing a CAD model into software and setting up a job 5. Generating 2D toolpaths in software for contour and drilling operations. 6. Toolpath creation for turning operation in software (OD turning, facing). 7. Programming and simulating roughing and finishing operations in software. 8. Using tool libraries and creating a custom tool in software. 9. Post-processing and exporting G-code from software to CNC control. 10. Complete CNC machining process of a turned part using software.		
Text Books		
1. R. P. Radin and P. M. Saldanha, CNC Machines, New Age International 2. Mikell P. Groover, Computer Numerical Control (CNC) Machines and Programming, Pearson Education 3. Krishna Kant, CNC Technology and Programming, Laxmi Publications 4. T. Kundra, P. N. Rao, N. K. Tewari, Numerical Control and Computer Aided Manufacturing, Tata McGraw-Hill Publications		
Reference Books		
1. Mikell P. Groover, Automation, Production Systems and Computer-Integrated Manufacturing, Pearson Publications 2. Mike Mattson, CNC Programming: Principles and Applications, Delmar Cengage Learning 3. Godfrey C. Onwubolu, Mechatronics: Principles and Applications, Elsevier 4. Mikell P. Groover, Fundamentals of Modern Manufacturing, Wiley Publications		
e-Resources		
https://archive.nptel.ac.in/courses/112/105/112105211/		