Curriculum Book

and

Assessment and Evaluation Scheme

based on

Outcome Based Education (OBE)

and

Choice-Based Credit System (CBCS)

in

Master of Technology

2 Year Degree Program

Revised as on 01 August 2023
Applicable w.e.f. Academic Session 2023-24

AKS University

Satna 485001, Madhya Pradesh, India

Faculty of Engineering and Technology
Department of Mechanical Engineering

AKS University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum & Syllabus of M.Tech.(Mechanical Engineering) program

(Revised as on 01 August 2023)

CONTENTS

***

AKS University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mechanical Engineering) Program

Forwarding

I am thrilled to observe the updated curriculum of the Mechanical Engineering Department for M.Tech. Mechanical Engineering Program, which seamlessly integrates the most recent technological advancements and adheres to the guidelines set forth by AICTE. The revised curriculum also thoughtfully incorporates the directives of NEP-2020 and the Sustainable Development Goals.

The alignment of course outcomes (COs), Programme Outcome (POs) and Programme specific outcomes (PSOs) has been intricately executed, aligning perfectly with the requisites of NEP-2020 and NAAC standards. I hold the belief that this revised syllabus will significantly enhance the skills and employability of our students.

With immense satisfaction, I hereby present the revised curriculum for the M. Tech. in Mechanical Engineering program for implementation in the upcoming session.

ER. Anant Soni
Pro Chancellor & Chairman
AKS University, Satna

01 August 2023

AKS University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mechanical Engineering) Program

From the Desk of the Vice-Chancellor

AKS University is currently undergoing a process to revamp its curriculum into an outcome-based approach, with the aim of enhancing the teaching and learning process. The foundation of quality of quality education lies in the implementation of a curriculum that aligns with both societal and industrial needs, focusing on relevant outcomes. This entails dedicated and inspired faculty members, as well as impactful industry internships.

Hence, it is of utmost importance to begin this endeavor by crafting an outcome-based curriculum in collaboration with academia and industry experts. This curriculum design should be informed by the latest technological advancements, market demands, the guidelines outlined in the National Education Policy (NEP) of 2020, and sustainable goals.

I'm delighted to learn that the revised curriculum has been meticulously crafted by the Mechanical Engineering Department, in consultation with an array of experts from the cement industry, research institutes, and academia. This curriculum effectively integrates the principles outlined in the NEP-2020 guidelines, as well as sustainable goals.

Our M.Tech. Mechanical Engineering curriculum is meticulously crafted to provide students with a comprehensive understanding of the core principles, latest advancements, and practical applications in the field. We recognize the pivotal role that mechanical engineers play in shaping the future of technology, innovation, and sustainable development.
At the heart of our curriculum lies a commitment to excellence, innovation, and relevance. We continually strive to integrate emerging trends, cutting-edge technologies, and industry best practices into our courses, ensuring that our graduates are well-equipped to tackle the challenges of the modern world.
Furthermore, we place a strong emphasis on fostering critical thinking, problem-solving skills, and ethical leadership among our students. Our curriculum is designed not only to impart knowledge but also to nurture creativity, resilience, and a passion for lifelong learning.

I am confident that the updated curriculum for Mechanical Engineering will not only enhance students' technical skills but also contribute significantly to their employability. During the process of revising the curriculum, I am pleased to observe that the Mechanical Engineering department has diligently adhered to the guidelines provided by the AICTE. Additionally, they have maintained a total credit requirement of 75 for the M. Tech Mechanical Engineering program.

It's worth noting that curriculum revision is an ongoing and dynamic process, designed to address the continuous evolution of technological advancements and both local and global concerns. This ensures that the curriculum remains responsive and attuned to the changing landscape of education and industry AKS University warmly invites input and suggestions from industry experts and technocrats and Alumni students to enhance the curriculum and make it more student-centered. Your valuable insights will greatly contribute to shaping an education that best serves the needs and aspirations of our students.

Professor B. A. Chopade
Vice- Chancellor

AKS University, Satna
01 August 2023

AKS University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mechanical Engineering) Program

Preface

As part of our commitment to ongoing enhancement, the Department of Mechanical Engineering consistently reviews and updates its M.Tech. Mechanical Engineering program curriculum every three years. Through this process, we ensure that the curriculum remains aligned with the latest technological advancements, as well as local and global industrial and social demands.

During this procedure, the existing curriculum for the M.Tech. Mechanical Engineering Program undergoes evaluation by a panel of technocrats, industry specialists, and academics. Following meticulous scrutiny, the revised curriculum has been formulated and is set to be implemented starting from August 01, 2023. This implementation is contingent upon the endorsement of the curriculum by the University's Board of Studies and Governing Body.

This curriculum closely adheres to the AICTE model syllabus distributed in May 2023. It seamlessly integrates the guidelines set forth by the Ministry of Higher Education, Government of India, through NEP- 2020, as well as the principles of Sustainable Development Goals. In order to foster the holistic skill development of students, a range of practical activities, including Hands-On Training, Industrial Visits, Project planning and execution, Report Writing, Seminars, and Industrial On-Job Training, have been incorporated. Furthermore, in alignment with AICTE's directives, the total credit allocation for the M. Tech Mechanical Engineering program is capped a 75 credits.

This curriculum is enriched with course components in alignment with AICTE guidelines, encompassing various disciplines.To ensure a comprehensive learning experience, detailed evaluation schemes and rubrics have also been meticulously provided.

For each course, a thorough mapping of Course Outcomes, Program Outcomes, and Programme Specific Outcomes has been undertaken. As the course syllabus is being meticulously developed, various elements such as session outcomes, laboratory instruction, classroom instruction, self-learning activities, assignments, and mini projects are meticulously outlined.

We hold the belief that this dynamic curriculum will undoubtedly enhance independent thinking, skills, and overall employability of the students.

Mr. Shailendra Singh Parihar
Head of Department
Mechanical Engineering

AKS University
01 August 2023

AKS University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mechanical Engineering) Program

Introduction:

AKS University, a trailblazing institution, initiated a comprehensive 2-year M. Tech program in Mechanical Engineering in 2012. The Mechanical Department owes its distinction to the dedicated contributions of its teaching and non-teaching staff, who have played an integral role in enhancing the teaching and learning processes. Recognizing the importance of equipping students with practical knowledge in mechanical engineering to meet industrial demands and establish a strong reputation in the field, the department has diligently provided hands-on training experiences, bridging the gap between conventional and modernized technology systems.

The curriculum has been thoughtfully designed to include cutting-edge technologies such as CNC Machineries, Wire cut EDM, Advanced Thermal Measurement Techniques, 3D Printing, and Advanced Casting Technologies. These elements have been seamlessly integrated to groom students into adept engineers well-prepared for contemporary technological challenges. Additionally, the department is committed to nurturing entrepreneurship in its students by offering industry-oriented training programs that complement their academic pursuits.

Every step in this educational journey has been carefully planned to introduce novelty into the lives of our students within the engineering environment. Our innovative curriculum is meticulously tailored to align with the evolving needs of industries and the latest technological advancements. Presently, a thriving community of aspiring students is actively enrolled in the B. Tech program in Mechanical Engineering within our department.

Vision:

To conduct its key programs and activities in a unique manner that promotes excellence and leadership in education, research, innovation in Mechanical Engineering and fosters an environment that is safe, highly productive, cooperative and collegial, and dedicated to sustainable improvement.

Mission:

M 01: By employing advanced teaching-learning methods and fostering strong collaborations with industries, our aim is to provide comprehensive and high-quality education.

M 02: To nurture the potential of young and dynamic minds, empowering them to become proficient professionals, and ultimately, to attain a prominent national ranking.

M 03: To meet international standards, contributing to the realization of the Government's "Make In India" industrial policy through continuous innovation and research efforts.

M 04: To empower students to address the demands of both individuals and industries involved in academic pursuits, applied research, and developmental endeavors associated with Mechanical Engineering.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO 01: Prepare with strong foundation in mathematical, scientific and engineering fundamentals that will enable them to have successful career in Mechanical and Interdisciplinary Industries. **(KNOWLEDGE).**

PEO 0 2: Strengthen their knowledge and skills through self-learning abilities throughout their professional career or during higher education. **(SKILL & PROFESSIONALISM).**

PEO 03 : Impart critical thinking skills and to develop innovative ideas for Research & Development **(RESEARCH & INNOVATION).**

PEO 04 : Ability to understand the impact of professional engineering solutions in societal, economic and environmental contexts and demonstrate knowledge and need for sustainable development.

Program Outcomes (POs)

M.Tech Mechanical Engineering Post Graduate will able to perform:

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, andenvironmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms ofthe engineering practice.

PO 9: Individual and teamwork: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

On completion of M. Tech. Mechanical Engineering program, the students will achieve the following program specific outcomes: -

PSO 1: Mechanical System Design and Analysis: Students will be able to apply engineering principles to design, analyze, and optimize mechanical systems and components, considering factors such as functionality, safety, manufacturability, and cost-effectiveness.

PSO 2: Manufacturing Processes and Automation: Students will possess the skills to select, plan, and implement appropriate manufacturing processes, including automation and robotics, to efficiently produce mechanical components and products.

PSO 3: Computational Modeling and Simulation: Students will have expertise in using computational tools and simulations to model and analyze complex mechanical phenomena, aiding in design and decision-making.

PSO 4: Product Innovation and Development: Students will possess the skills to innovate and develop new mechanical products or systems, from concept to prototype, considering market needs and user requirements.

Consistency/Mapping of PEOs with Mission of the Department

PEO	M 1	M 2	M 3	M 4
PEO 1	3	2	3	2
PEO 2	2	2	2	3
PEO 3	2	3	2	1
PEO 4				

1*: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) "-": No correlation*

GENERAL COURSE STRUCTURE & THEME

1. Definition of Credit

1 Hr. Lecture (L) per week	1 Credit
1 Hr. Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

2. Range of Credits:

In the light of the fact that a typical Model Two-year Post graduate degree program in Engineering has about 75 credits, the total number of credits proposed for the Two-year M.Tech.in Mechanical Engineering is kept as 75 considering NEP-20 and NAAC guidelines.

AKS University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mechanical Engineering) Program

General Course Structure and Credit Distribution

Curriculum of M.Tech. Mechanical Engineering

Semester-I

Course Code	Course Name	L	T	P	C
MMF104I	Processing of Advanced Materials	03	1	--	04
MMF102	CNC Technology	03	1	--	04
MMF104E	Advanced Tool Design	03	1	--	04
MMF101–MMF104N	Elective-I	03	--	--	03
MMF101–MMF104N	Elective-II	03	--	-	03
MMF104A	Finite Element Method	02	--	-	02
MPE101	Manufacturing Engineering Laboratory (PGLAB)	--	--	03	02
	Total for Semester-I	**17**	**03**	**03**	**22**

List of Elective Courses

Elective (I&II) Semester I

Sr .No.	Course Code	Course Name
1.	MMF104B	Machine Tool Design
2.	MMF104C	Sheet Metal Engineering
3.	MMF104H	Quality Control and Reliability
4.	MMF104L	Manufacturing Planning and Control

AKS University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mechanical Engineering) Program

Semester-II

Course Code	Course Name	L	T	P	C
MMF201	Metal Forming Processes	03	1	-	04
MMF202	Casting and Molding Technology	03	1	-	04
MMF203A–MMF203P	Elective-III	03		-	03
MMF203A–MMF203P	Elective-IV	03	-	-	03
MMF204A–MMF204C	Elective-V-**(Open)**	03	-	-	03
PE201	Seminar-I	--	04	-	02
PE202	Mini-Project	--	04	-	02
	Total for Semester II	**15**	**10**	**-**	**21**

List of Elective Courses

Elective (III and IV) Semester II

Sr. No.	Course Code	Course Name
1.	MMF203H	Total Productive Maintenance
2.	MMF203I	Metrology and Computer Aided Inspection
3.	MMF203M	Modeling and Simulation
4.	MMF203K	Processing and Characterization Techniques

Elective-V (Open Elective) Semester-II

Sr. No.	Course Code	Course Name
1.	MMF204A	Research Methodology

AKS University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mechanical Engineering) Program

Semester-III

Course Code	Course Name	L	T	P	C
MMF301	Project Management and Intellectual Property Rights (Self Study)*	--	--	--	02
PE302	Project Stage-I	---	--	--	10
	Total for Semester III	**--**	**--**	**--**	**12**

Semester-IV

Course Code	Course Name	L	T	P	C
PE401	Project Stage-II	-	-	-	20
	Total for Semester IV	**-**	**-**	**-**	**20**

Semester-I

Course Code: **MMF104E**

Course Title: Advanced Tool Design

Pre-requisite: Understanding of engineering principles, proficiency in CAD software, knowledge of materials science, and experience in manufacturing processes are essential prerequisites.

Rationale: Advanced tool design enhances manufacturing efficiency, ensures precision in component production, reduces production costs, and facilitates complex operations, thereby supporting innovation and competitiveness in the industrial sector.

Course Outcomes:

MMF104E**.1:** Define tooling's for different types of production systems.
MMF104E**.2:** Understand jigs and fixture design and their elements.
MMF104E**.3:** Design fixture for machining, welding and inspection using forces.
MMF104E.**4:** Study cost analysis, maintenance and CAD of tools.
MMF104E**.5:** Apply software knowledge for design of tools.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**MMF104E**	Advanced Tool Design	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
PCC	MMF 104E	Advanced Tool Design	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF104E**.1:** Define tooling's for different types of production systems.

Approximate Hours

Item	AppX Hrs
Cl	7
LI	0
SW	3
SL	1
Total	11

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO1.1 Understand the impact of tooling on quality and productivity in manufacturing, especially for flexible, small lot production within tight lead times... **SO1.2** Evaluate tooling requirements for optimizing quality and productivity in scenarios of flexible manufacturing with constraints on lead time.. SO1.3 Apply knowledge of tooling's influence to enhance quality, productivity, and adaptability in small lot production, respecting lead time limitations..	.	**Unit-1.0 Introduction to tooling** 1.1 Influence of tooling on 1.2 quality 1.3 productivity 1.4 requirement of tooling 1.5 requirement of tooling for flexible 1.6 small lot production 1.7 constraints on lead time.	1. Importance of tooling

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Describe the tool procedure

MMF104E**.2:** Understand jigs and fixture design and their elements.

Approximate Hours

Item	AppX Hrs
Cl	13
LI	0
SW	3
SL	1
Total	17

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO2.1 Grasp fundamental principles of jigs and fixtures for effective part locating and development, integrating clamping and indexing elements seamlessly. **SO2.2 Construct jigs and fixtures using advanced techniques in part locating, clamping, and indexing, ensuring precise tool setting and operational efficiency.**	.	Unit-2 Jigs and fixtures 2.1 Introduction of Jigs and fixtures 2.2 basic principles 2.3 basic principles of locating 2.4 Introduction of development of fixture 2.5 development of fixture 2.6 fixture using locating 2.7 clamping 2.8 indexing tool 2.9 indexing tool setting 2.10 indexing tool setting elements 2.11 Tutorial -1 2.12 Tutorial -2 2.13 Tutorial -3	2.14 Constructional features of Jigs and fixtures .

SW-2 Suggested Sessional Work(SW):

a. Assignments:

i. Analyze theTypes of Jigs and fixtures

MMF104E**.3:** Design fixture for machining, welding and inspection using forces.

Approximate Hours

Item	AppX Hrs
Cl	16
LI	0
SW	3
SL	1
Total	20

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO3.1 Standardize force analysis for machining, welding, assembly fixtures with examples; design special tooling like form cutters, broaches for CNC applications. **SO3.2** Innovate modular fixtures for fragile parts, plastics in tooling; apply force analysis to develop flexible, efficient tooling solutions..	.	**Unit-3:** Force analysis 3.1 standardization of elements 3.2 illustrative examples of machining 3.3 welding 3.4 assembly 3.5 inspection fixtures. 3.6 Design of special tooling 3.7 tooling for CNC 3.8 development of modular fixtures 3.9 development of modular Tool 3.10 helical interpolation 3.11 High-speed machining (HSM) 3.12 flexi tools 3.13 innovative concepts 3.14 innovative concepts like tooling 3.15 fragile parts 3.16 plastics for tooling	1.Design of special tooling form cutters

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Explain the Design of special tooling form cutters, broaches

MMF104E.**4:** Study cost analysis, maintenance and CAD of tools.

Approximate Hours

Item	AppX Hrs
Cl	14
LI	0
SW	3
SL	1
Total	18

Session Outcomes (SOs)	(LI)	Classroom Instruction (Cl)	Self Learning (SL)
SO4.1 Explore tool manufacture and maintenance, tool room technology management, and cost estimation with benefit analysis, integrating CAD customization for tool design.. **SO4.2** Manage tool room technology and costs effectively; apply CAD for customized tool design, emphasizing maintenance, manufacture efficiency, and cost analysis.	.	**Unit-4 :** Manufacture and maintenance of tools 4.1 Introduction 4.2 Manufacture of tools 4.3 maintenance of tools 4.4 Tool room Settings 4.5 technology of a tool room 4.6 management of a tool room 4.7 cost estimation 4.8 cost benefit analysis 4.9 automotive parts 4.10 CAD of tools 4.11 customization of CADD 4.12 Tutorial -1 4.13 Tutorial -2 4.14 Tutorial-3	1.Importance of maintenance of tools

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Application of 4.10CAD of tools

MMF104E**.5:** Apply software knowledge for design of tools.

Approximate Hours

Item	Appx Hrs
Cl	10
LI	0
SW	3
SL	1
Total	14

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Utilize tool design software for parametric programming of tool libraries, mechanistic analysis, and integrate finite element methods for effective part modeling and manufacture.. **SO5.2** Implement parametric programming in tool design software, conduct mechanistic analysis, and utilize finite element methods to integrate part modeling with efficient tool manufacture.		**Unit5:** Tool design software 5.1 introduction 5.2 Tool design software 5.3 parametric programming of tool libraries 5.4 mechanistic analysis 5.5 use of finite element methods 5.6 techniques for integration 5.7 techniques for integration of part modeling 5.8 tool design 5.9 tool manufacture. 5.10Tutorial-1	1Application of Tool design software

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Application of mechanistic analysis

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
MMF104E.1: Define tooling's for different types of production systems.	7	3	1	**11**
MMF104E.2: Understand jigs and fixture design and their elements.	13	3	1	**17**
MMF104E.3: Design fixture for machining, welding and inspection using forces.	16	3	1	**20**
MMF104E.4: Study cost analysis, maintenance and CAD of tools.	14	3	1	18
MMF104E.5: Apply software knowledge for design of tools.	10	3	1	**14**
Total Hours	**60**	15	5	**80**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Introduction to tooling	01	02	03	06
CO-2	Jigs and fixtures	01	03	07	11
CO-3	Force analysis	01	07	04	12
CO-4	Manufacture and maintenance of tools	01	06	04	11
CO-5	Tool design software	01	06	03	10
Total		5	24	21	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Advanced Tool Design** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher
1	Tool Design	Donaldson, Lecain&Gold	*TataMcGraw*-Hill, NewDelhi, 1978
2	Tool Engineers Handbook,	F.W.Wilson,	Tata McGraw-Hill, New Delhi, 1980.
3	Jigs and Fixtures	P.H.Joshi	Tata McGraw-Hill, New Delhi, 1988.
4	Fundamentals of Tool Design.	E.G.Hoffman	S.M.E. Michigan, 1984
5	Fundamentals of Fixtures Design,	V.Korskov	Mir Publishers, Moscow, 1989.

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M. Tech. Mechanical
Engineering Course Code: PCC- MMF104E
Course Title: Advanced Tool Design

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1: Define tooling's for different types of production systems.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 Understand jigs and fixture design and their elements	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Design fixture for machining, welding and inspection using forces.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Study cost analysis, maintenance and CAD of tools.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Apply software knowledge for design of tools.	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO1: Define tooling's for different types of production systems.	SO1.1 SO1.2 SO1.3		Unit -1 Introduction to tooling 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 2:Understand jigs and fixture design and their elements	SO2.1 SO2.2		Unit-2 Jigs and fixtures 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3: Design fixture for machining, welding and inspection using forces.	SO3.1 SO3.2		Unit-3 Force analysis 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Study cost analysis, maintenance and CAD of tools.	SO4.1 SO4.2		Unit-4: Manufacture and maintenance of tools 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO5: Apply software knowledge for design of tools.	SO5.1 SO5.2		Unit-5: Tool design software 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10	

Semester-I

Course Code: MMF102

Course Title: CNC Technology

Pre-requisite: For CNC Technology include basic understanding of engineering principles, proficiency in technical drawing interpretation and geometric dimensions, familiarity with computer systems and programming concepts, and hands-on experience with machine tools and workshop practices. These fundamentals prepare individuals to effectively operate, program, and optimize CNC machines in modern manufacturing environments.

Rationale: CNC technology revolutionizes manufacturing by providing precise control, enhancing efficiency, and enabling versatile production capabilities. It integrates automation with advanced CAD/CAM systems, ensuring high-quality outputs, reducing operational costs, and fostering innovation in product design and manufacturing processes, thereby driving competitiveness and meeting diverse industry demands effectively.

Course Outcomes:

MMF102**.1:** Understand how the Cartesian coordinate system relates to CNC Routing, Turning and Milling operations

MMF102**.2:** Write simple part programs for the two axis CNC lathe and router and milling machines

MMF102**.3:** Be introduced to master cam's machining of tw are program

MMF102.**4:** Calculate speeds and feeds for CNC machining operations and Debug a CNC part programming.

MMF102**.5:** Simulate part program son CNC machining simulation software

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	MMF102	CNC Technology	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ ESA)
PCC	MMF 102	CNC Technology	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF102**.1:** Understand how the Cartesian coordinate system relates to CNC Routing, Turning and Milling operations

Approximate Hours

Item	AppX Hrs
Cl	7
LI	0
SW	3
SL	1
Total	11

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 Understand NC, CAM: their role in modern manufacturing practices.. **SO1.2** Trace historical development and evolution of CNC technology. SO1.3 Identify CNC system components, types of machines, and operational advantages.	.	**Unit-1.0 Introduction to CNC Technology** 1.1 Introduction to Numerical Control (NC) 1.2 Computer-Aided Manufacturing (CAM) 1.3 Historical development and evolution of CNC technology 1.4 Components of CNC systems 1.5 Types of CNC machines 1.6 Comparison of CNC with conventional machining processes 1.7 controllers, drives, motors	1. feedback devices

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Describe the evolution of CNC machines

MMF102.2: Write simple part programs for the two axis CNC lathe and router and milling machines

Approximate Hours

Item	AppX Hrs
Cl	13
LI	0
SW	3
SL	1
Total	17

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO2.1 Understand constructional features and kinematics of CNC machines. **SO2.2** Explore tooling systems, ATC, cooling, and safety features in CNC.	.	Unit-2 CNC Machine Construction and Features 2.1 Constructional features of CNC machines 2.2 bed, column, saddle 2.3 spindle, tool turret/changer 2.4 Types of tool holders 2.5 Automatic tool changers 2.6 tool management systems 2.7 CNC machine kinematics 2.8 linear axes 2.9 rotary axes 2.10 multi-axis configurations 2.11 Role of cooling systems 2.12 chip management 2.13 safety features in CNC machines	2.14 Constructional features of CNC machines .

SW-2 Suggested Sessional Work(SW):

a. Assignments:

i. Analyze theTypes of tool holders

MMF102**.3:** Be introduced to master cam's machining of tw are program

Approximate Hours

Item	AppX Hrs
Cl	16
LI	0
SW	3
SL	1
Total	20

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO3.1 Master basics of CNC programming, G-codes, and M-codes application. **SO3.2** Utilize CAD/CAM integration for toolpath generation and program verification.	.	**Unit-3:** CNC Programming and Interpolation 3.1 Basics of CNC programming 3.2 G-codes 3.3 M-codes 3.4 CAD/CAM integration 3.5 generating tool paths 3.6 post-processing 3.7 Interpolators 3.8 linear interpolation 3.9 circular interpolation 3.10 helical interpolation 3.11 High-speed machining (HSM) 3.12 techniques 3.13 strategies 3.14 Simulation 3.15 verification of CNC programs 3.16 Tutorial-1	i. Explain the application of G-codes

SW-3 Suggested Sessional Work (SW):

a. Assignments:

Explain the application of M-codes

MMF102.**4:** Calculate speeds and feeds for CNC machining operations and Debug a CNC part programming.

Approximate Hours

Item	AppX Hrs
Cl	14
LI	0
SW	3
SL	1
Total	18

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO4.1 Explore advanced machining operations and complex geometry machining techniques. **SO4.2** Examine adaptive control systems and CNC applications in diverse industries.	.	**Unit-4 :** Advanced CNC Operations and Applications 4.1 Advanced machining operations 4.2 contour milling 4.3 thread milling 4.4 pocket milling 4.5 Machining complex geometries 4.6 Machining complex surfaces 4.7 Adaptive control system in CNC 4.8 CNC in manufacturing of aerospace components 4.9 automotive parts 4.10 medical devices 4.11 Trends in CNC technology 4.12 additive manufacturing (AM) 4.13 hybrid machining 4.14 Tutorial-1	1.Importance and Types . additive manufacturing (AM)

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Application of Adaptive control system in CNC

MMF102**.5:** Simulate part program son CNC machining simulation software

Scheme of Studies:

Approximate Hours

Item	Appx Hrs
Cl	10
LI	0
SW	3
SL	1
Total	14

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Implement maintenance, troubleshooting, and optimization practices for CNC systems. **SO5.2** Explore CNC's role in lean manufacturing and economic/environmental considerations.		**Unit5:** Maintenance, Optimization, and Management of CNC Systems 5.1 Maintenance practices for CNC systems machining 5.2 preventive maintenance, calibration, alignment 5.3 Troubleshooting 5.4 diagnostics of CNC machines 5.5 Optimization of CNC operations 5.6 Utilization of CNC in lean manufacturing 5.7 agile production systems 5.8 economic consideration of CNC 5.9 tool life management, cutting parameters 5.10 Tutorial-1	1. Application of high speed machining

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Application of Plasma Machining

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
MMF102.1: Understand how the Cartesian coordinate system relates to CNC Routing, Turning and Milling operations	7	3	1	**11**
MMF102.2: Write simple part programs for the two axis CNC lathe and router and milling machines	13	3	1	**17**
MMF102.3: Be introduced to master cam's machining of tw are program	16	3	1	**20**
MMF102.4: Calculate speeds and feeds for CNC machining operations and Debug a CNC part programming.	14	3	1	18
MMF102.5: Simulate part program son CNC machining simulation software	10	3	1	**14**
Total Hours	**60**	15	5	**80**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Introduction to CNC Technology	01	02	03	06
CO-2	CNC Machine Construction and Features	01	03	07	11
CO-3	CNC Programming and Interpolation	01	07	04	12
CO-4	Advanced CNC Operations and Applications	01	06	04	11
CO-5	Maintenance, Optimization, and Management of CNC Systems	01	06	03	10
Total		5	24	21	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for **CNC Technology** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher
1	CNC Technology and Programming	S.Krar, A.Gill	McGraw-Hill Publishing Co.,1990.
2	Computer Numerical Control Programming	P.J.Amic	Prentice Hall, 1996
3	Adaptive Control (2nd Ed.),	K.J.Astrom, B.Wittenmark	Addison-Wesley,1994.
4	CNC: An Introduction to Machining and Part	D.Gibbs, T.Crandell	Industrial Press, 1991
5	Computer Numerical Control for Machining	M.Lynch	McGraw-Hill, 1992.

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M. Tech. Mechanical
Engineering Course Code: PCC- MMF102
Course Title: CNC Technology

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1: Understand how the Cartesian coordinate system relates to CNC Routing, Turning and Milling operations	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 Write simple part programs for the two axis CNC lathe and router and milling machines	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Be introduced to master cam's machining of tw are program.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Calculate speeds and feeds for CNC machining operations and Debug a CNC part programming.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Simulate part program son CNC machining simulation software.	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO1: Understand how the Cartesian coordinate system relates to CNC Routing, Turning and Milling operations	SO1.1 SO1.2 SO1.3		Unit -1 Introduction to CNC Technology 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 2 Write simple part programs for the two axis CNC lathe and router and milling machines	SO2.1 SO2.2		Unit-2 CNC Machine Construction and Features 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3: Be introduced to master cam's machining of tw are program.	SO3.1 SO3.2		Unit-3 : CNC Programming and Interpolation 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Calculate speeds and feeds for CNC machining operations and Debug a CNC part programming.	SO4.1 SO4.2		Unit-4: Advanced CNC Operations and Applications 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO5: Simulate part program son CNC machining simulation software.	SO5.1 SO5.2		Unit-5: Maintenance, Optimization, and Management of CNC Systems 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10	

AKS University
Faculty of Engineering & Technology
Department of Mechanical Engineering
Curriculum & Syllabus of M.Tech. Mechanical Engineering program

Semester-I

Course Code:	**MMF104A**
Course Title :	**Finite Element Method**
Pre-requisite:	Student should have basic knowledge of Mathematics such as matrix algebra, differential equation etc. and knowledge of core engineering subjects such as SOM, Mechanical vibrations and HMT etc.
Rationale:	Familiarize with the fundamental concepts of finite element method. Inculcate the formulation of finite element models by selecting a suitable element, developing element matrices & vectors, and incorporating boundary conditions. Familiarize with finite element procedures to solve structural, thermal, and fluid flow problems using commercial finite element packages

Course Outcomes:

PEC- MMF104A.1: Understand the fundamental concepts of finite element method to solve engineering problems.

PEC- MMF104A.2: Formulate finite element models using appropriate element selection, development of stiffness & force matrices, and application of boundary conditions

PEC- MMF104A.3: Solve structural, thermal, and fluid flow problems in one dimension using the developed finite element formulations

PEC- MMF104A.4: Formulate Two-Dimensional Finite Element models and shape function derivation for triangular and rectangular elements.

PEC- MMF104A.5: Solve two dimensional problems for plane stresses-strains and for dynamic systems using the developed finite element formulations.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours(Cl+LI+SW+SL)	
Professional Elective courses(PCC)	**PEC-MMF104A**	**Finite Element Method**	3	0	1	1	5	3

Legend: Cl: Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial

(T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:
Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ESA)
PEC	**PEC-MMF104A**	Finite Element Method	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PEC- MMF104A.1: Explain Introductory Concepts, general FEM procedure and approximate methods to solve differential equations.

Approximate Hours

Item	AppX Hrs
Cl	5
LI	0
SW	2
SL	1
Total	8

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO1.1 Ability to understand theFEM procedure. **SO1.2**Ability to Understand various weighted integral methods used to get approximate solutions. **SO1.3**The students will be able to Analyze and solve field problems in engineering practices.	.	**Unit-1: Introductory Concepts:** 1.1 General FEM procedure, Applications of FEM invarious fields Advantages and disadvantages of FEM 1.2 Mathematical Modelling of field problems in engineering practices. 1.3 Governing equations, Differential equations in different fields. 1.4 Approximate solution of differential equations using Least square method. 1.5 Approximate solution of differential equations using Galerikin method. 1.6 Tutorial one. 1.7 Tutorial two.	Numerical problems based on Galerikin method.

SW-1 Suggested Sessional Work (SW):

a. Assignments: Numerical problem solving on least square method.

b. Mini Project: Prepare a chart listing down various approximate methods used in FEM.

PEC- MMF104A.2: Analyzing and solving problems using Weighted Residual Methods - Ritz Technique.

Approximate Hours

Item	Approx. Hrs
Cl	9
LI	0
SW	2
SL	1
Total	12

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning (SL)
SO2.1 The students will be able to understand the FEA Procedure. **SO2.2** The students will be able to understand Global & local boundary conditions. **SO2.3**The students will be able to apply the Rayleigh-Ritz method in design offins.	.	**Unit-2**:**FEA Procedure:** 2.1 Weighted Residual Methods - Ritz Technique. 2.2 Definitions of various terms used in FEM like element, order of the element, internal and external node/s, degree of freedom, primary and secondary variables 2.3 Global & local boundary conditions. 2.4 Minimization of a functional. 2.5 Principle of minimum total potential. 2.6 Piecewise Rayleigh-Ritz method 2.7 Design of fins for maximum heat transfer. 2.8 Formulation of 'stiffness matrix'. 2.9 Transformation and assembly concepts	Numerical problem on heat conduction using Piecewise Rayleigh-Ritz method.

SW-2 Suggested Sessional Work (SW):

a. Assignments: Numerical problem on a cantilever beam using Piecewise Rayleigh-Ritz method.
MiniProject: Prepare a mind map explaining the Formulation of 'stiffness matrix'.

PEC-ME 04.3: Analyzing and solving one Dimensional Problems using FEA.
Approximate Hours

Item	AppX Hrs
Cl	8
LI	0
SW	2
SL	1
Total	11

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (Cl)**	**Self-Learning (SL)**
SO3.1 The students will be able to understand discretizationelement types - linear and higher, order elements. **SO3.2** The students will be able to solve problems in one dimensional for structural beams. **SO3.3** The students will be able to solve problems in one dimensional for spring cart.	.	**Unit-3 :One Dimensional Problems:** 3.1 One dimensional second order equations-discretizationelement types - linear and higher, order elements 3.2 stiffness matrices and force vectors, Assembly of Matrices 3.3 solution of problems in one dimensional for structural beams. 3.4 solution of problems in one dimensional for taper bars. 3.5 solution of problems in one dimensional for Fluid flow network. 3.6 solution of problems in one dimensional for planer truss. 3.7 solution of problems in one dimensional for heat conduction. 3.8 solution of problems in one dimensional for spring cart system. 3.9 Tutorial one. 3.10 Tutorial Two.	Revise the discretization and assembly procedure.

SW-3 Suggested Sessional Work(SW):

a. Assignments:

Problem on one dimensional for Fluid flow network.

b. MiniProject:

Problems of designing a taper bar subjected to axial loading.

PEC- MMF104A.4: Two-Dimensional Finite Element Formulations.

.

Approximate Hours

Item	Appx. Hrs
Cl	10
LI	0
SW	2
SL	2
Total	14

SessionOutcomes (SOs)	LaboratoryInstruction (LI)	ClassroomInstruction (Cl)	SelfLearning (SL)
SO4.1 To understand serendipity and Lagrange's methods for deriving shape functions **SO4.2**To derive the shape function of three noded triangular element. **SO4.3**. To analyse and solve the problems on shape function of three and fournoded elements.	.	**Unit-4:Two-Dimensional Finite Element Formulations:** 4.1 serendipity and Lagrange's methods for deriving shape functions. 4.2Derivation of shape function for three noded triangular element. 4.3Derivation of shape function for four nodedrectangular element. 4.4Derivation of shape function for four node quadrilateral elements. 4.5Derivationof shape function for the eight-node quadrilateral element 4.6Natural coordinates and coordinates transformations 4.7Numerical problems on boiling. 4.8Sub parametric, Isoparametric, super parametric elements. 4.9Compatibility and Patch test. 4.10Convergence criterion, sources of errors.	1. Numerical Problem on three noded triangular element. 2.NumericalProblem on three noded triangular element.

SW-4 **Suggested SessionalWork(SW):**

a. Assignments:

i. Explain Natural coordinates and coordinates transformations?

ii. Write a short note on sources of errors?

b. MiniProject:

Prepare a mind map for Two-Dimensional Finite Element Formulation method.

PEC- MMF104A.5: Two Dimensional Vector Variable Problems andFinite ElementFormulation of Dynamic systems.

Approximate Hours

Item	AppX Hrs
Cl	9
LI	0
SW	2
SL	2
Total	13

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self-Learning (SL)**
SO5.1 To Undress and stress analysis in a plane using FEA. **SO5.2**To Analyses stress of CST element. **SO5.3**To determines transverse deflections of a beam.		**Unit 5: 2-D Vector Variable Problems** and **Finite Element Formulation of Dynamic systems.** 5.1Equations of elasticity - Plane stress, plane strain and ax symmetric problems 5.2 stress analysis of CST element. 5.3 stress analysis of four node Quadratic element. 5.4 free vibration problems of a beam. 5.5 Lumped and consistent mass matrices Solutions techniques to Dynamic problems. 5.6 longitudinal vibration frequencies and mode shapes. 5.7 Fourth order beam equation. 5.8 Numerical problems on radiation shields. 5.9 transverse deflections and natural frequencies of beams.	1. Free vibration problem of a beam. 2. Longitudinal vibration problem of a beam.

SW-5 SuggestedSessionalWork(SW):

a. Assignments:

i. Numerical problems on radiation shields.

ii. Numerical problem on transverse deflections and natural frequencies of beams

MiniProject:

Explain how the frequencies and mode shapes of longitudinal vibration can be determined using FEA?

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PEC- MMF104A.1: Explain Introductory Concepts, general FEM procedure and approximate methods to solve differential equations.	7	2	1	10
PEC- MMF104A.2: Analysing and solving problems using Weighted Residual Methods - Ritz Technique	9	2	1	12
PEC- MMF104A.3: Analyzing and solving one Dimensional Problems using FEA.	10	2	2	14
PEC- MMF104A.4: Explain Two-Dimensional Finite Element Formulation method and shape functions.	10	2	2	14
PEC- MMF104A.5: Analyze and solve Two-Dimensional Vector Variable Problems and Finite Element Formulation of Dynamic systems	9	2	2	13
Total Hours	45	10	8	63

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Introductory Concepts, general FEM procedure and approximate methods.	02	05	05	12
CO-2	Analysing and solving problems using Weighted Residual Methods - Ritz Technique.	02	03	03	8
CO-3	Analyzing and solving one Dimensional Problems using FEA.	02	05	05	12
CO-4	Two-Dimensional Finite Element Formulation method and shape functions.	02	04	04	10
CO-5	Two-Dimensional Vector Variable Problems and Finite Element Formulation of Dynamic systems	01	04	03	08
Total		9	21	20	50

Legend: R:Remember, U:Understand, A:Apply

TheendofsemesterassessmentforProcess calculation willbeheldwith written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wiseteachers for above tasks. Teachers can also design different tasks as per requirement, for endsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visit to cement plant
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

SuggestedLearningResources:

(a) Books:

S. No.	Title	Author	Publisher	Edition&Year
1	Finite Element Method	JNReddy,	McGraw Hill	9th Edition, 2004
2	'Introduction to Finite Elements in Engineering	Chandrupatla and Belegundu	Pearson Education	1998
3	A first course in Finite Element Method	Logan D L, Thomson.	Asia PvtLtd	5th Edition, 2002
4	The Finite Element Method in Engineering	SS, Rao, Butter WorthHeinemann	Wiley Sons	4th Edition, 2018
5	Lecture notes provided by Dept. of Mechanical engineering, AKS University, Satna.			

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

Cos, Pos and PSOs Mapping

Course Title: M. Tech. Mechanical Engineering

Course Code: MMF104A

Course Title: Finite Element Method

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineeringknowledge	Problemanalysis	Design/development ofsolutions	Conductinvestigations ofcomplex problems	Moderntool usage	Theengineerandsociety	Environmentandsustainability:	Ethics	Individualandteamwork:	Communication:	Projectmanagementandfinance:	Life-longlearning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation.	Product Innovation and Development
CO-1: Introductory Concepts, general FEM procedure and approximate methods.	2	1	2	2	3	2	2	2	2	1	3	2	2	2	1	2
CO-2: Analyzing and solving problems using Weighted Residual Methods - Ritz Technique.	1	1	1	1	3	2	2	2	2	1	2	2	1	2	1	2
CO-3: Analyzing and solving one Dimensional Problems using FEA.	2	2	1	1	3	1	2	2	2	1	1	2	1	2	1	1
CO-4:2-D Finite Element Formulation method and shape functions.	2	2	2	1	3	2	2	2	2	1	2	2	1	2	1	2
CO-5: Two-Dimensional Vector Variable Problems and Finite Element Formulation of Dynamic systems	2	1	1	1	1	3	2	2	2	1	2	2	1	2	1	1

Pos & PSOs No.	Cos No.& Titles	SOs No.	Class room Instruction(CI)	Self Learning(SL)
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4	CO-1:Introductory Concepts, general FEM procedure and approximate methods.	SO1.1 SO1.2 SO1.3	Unit-1: Introductory Concepts: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7.	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4	CO-2:Analyzing and solving problems using Weighted Residual Methods - Ritz Technique.	SO2.1 SO2.2 SO2.3	Unit-2:FEA 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9.	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4	CO-3:Analyzing and solving one Dimensional Problems using FEA.	SO3.1 SO3.2 SO3.3	Unit-3 : One Dimensional Problems. 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8 3.9, 3.10,.	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4	**CO-4:**2-D Finite Element Formulation method and shape functions.	SO4.1 SO4.2 SO4.3	Unit-4:Two-Dimensional Finite Element. 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10.	
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4	CO-5:Two-Dimensional Vector Variable Problems and Finite Element Formulation of Dynamic systems	SO5.1 SO5.2 SO5.3	Unit 5: 2-D Vector Variable Problems and Finite Element Formulation of Dynamic systems.. 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9.	

Semester-I

Course Code: PE105

Course Title: **Manufacturing Engineering Laboratory**

Pre-requisite: Manufacturing engineering laboratory typically include coursework in engineering fundamentals, materials science, and machining processes, ensuring foundational knowledge in mechanical principles, manufacturing techniques, and safety protocols..

Rationale: A manufacturing engineering laboratory serves to provide hands-on experience in applying theoretical knowledge to practical scenarios. It fosters skills in process optimization, quality control, and problem-solving, preparing students for careers in industrial manufacturing and engineering innovation.

.

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

PE105.1: Measure cutting forces in turning, milling and drilling operations.

PE105.2: Modeling of machine components using software like ANSYS, LSDYNA.

PE105.3: Experiment on EDM, PCM, Wire EDM.

PE105.4: Design a Pneumatic circuit for a given application.

PE105.5: Optimize the machining processes. Experiment on CMM, Robotics and PROCAST.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
PCC	**PE105**	**Manufacturing Engineering Laboratory**	0	4	1	1	6	2

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ ESA)
Elective	**PE105**	Manufacturing Engineering Laboratory	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PE105.1 Measure cutting forces in turning, milling and drilling operations**.**

Approximate Hours

Item	AppX Hrs
Cl	0
LI	6
SW	1
SL	1
Total	8

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 Determine cutting forces in CNC milling using force dynamometers. **SO1.2** Measure cutting forces in CNC turning operations using force dynamometers. **SO1.3** Perform practical experiments on cutting force determination in CNC operations.	1.1 Study of Cutting force determination using force dynamometer in CNC Milling operation 1.2 Experiment of Study of Cutting force determination using force dynamometer in CNC Milling operation 1.3 Study of Cutting force determination using force dynamometer in CNC Turning operation 1.4 Experiment of Cutting force determination using force dynamometer in CNC Turning operation 1.5 Tutorial 1 1.6 Tutorial 2		1. How does the cutting speed affect the magnitude of cutting forces measured by a force dynamometer during CNC milling operations?

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. What are the factors influencing the accuracy of cutting force measurements using a force dynamometer in CNC milling, and how can these influences be minimized or controlled?

PE105.2: Modeling of machine components using software like ANSYS, LSDYNA.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	6
SW	1
SL	1
Total	8

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2.1 Create solid models of structural components using modeling software. **SO3.2** Develop solid models of machine components using modeling software. **SO3.3** Conduct practical experiments in solid modeling of structural and machine components.	2.1 Study of Solid modeling of structural components using modeling software 2.2 Experiment of Solid modeling of structural components using modeling software. 2.3 Study of Solid modeling of machine components using modeling software 2.4 Experiment of Solid modeling of machine components using modeling software 2.5 Tutorial 1 2.6 Tutorial 2		i. Compare and contrast the advantages of using parametric modeling versus direct modeling software for creating structural components. Justify your preferred choice based on specific design criteria and industry applications.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Given a specific engineering problem requiring the design of a structural component, demonstrate how you would utilize solid modeling software to create a detailed 3D model. Discuss the steps you would take to ensure the model meets design specifications and functional requirements.

PE105.3: Experiment on EDM, PCM, Wire EDM.

Approximate Hours

Item	AppX Hrs
Cl	0
LI	6
SW	1
SL	1
Total	8

Session Outcomes (SOs)	(LI)	Classroom Instruction (Cl)	Self Learning (SL)
SO3.1 Analyze machine components using ANSYS and LSDyna software. **SO3.2** Optimize processes using statistical quality control software. Conduct experiments with analysis and quality control software tools	3.1 Study of Analysis of machine components using ANSYS, LSDyna etc. software. 3.2 Experiment on Analysis of machine components using ANSYS, LSDyna etc. software. 3.3 Study of Use of statistical quality control software for process optimization 3.4 Experiment on Use of statistical quality control software for process optimization. 3.5 Tutorial 1 3.6 Tutorial 2		i. Analyze the factors that influence the selection of EDM or Wire EDM as a machining process for specific metal components. How does the choice of parameters such as discharge current, pulse duration, and electrode material impact machining efficiency and accuracy?

SW-3 Suggested Sessional Work (SW):

a. Assignments:

- Using PROCAST simulation software, design a simulation model for a complex metal casting process. Describe the steps involved in setting up the simulation, including defining material properties, mold geometry, and cooling conditions. Discuss how simulation results can guide optimization of casting parameters.

PE105.4: Design a Pneumatic circuit for a given application

Approximate Hours

Item	AppXHrs
Cl	0
LI	6
SW	1
SL	1
Total	8

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO4.1 Understand EDM/Wire EDM processes for precision metal machining. **SO4.2** Simulate metal casting processes using PROCAST software. **SO4.3** Apply practical skills in EDM and metal casting simulations through experiments.	4.1 Study of EDM /Wire EDM for metal machining. 4.2 Experiment on EDM/ Wire EDM for metal machining. 4.3 Study of Metal casting simulation using PROCAST. 4.4 Experiment on Metal casting simulation using PROCAST. 4.5 Tutorial 1 4.6 Tutorial 2		1. Using a pneumatic trainer kit, design and sequence a control system to operate multiple cylinders in a specified sequence.

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Compare and contrast the sequencing techniques used in pneumatic systems with those in hydraulic systems. Discuss the advantages and disadvantages of each approach, considering factors such as speed control, response time, and system complexity.

PE105.5: Optimize the machining processes. Experiment on CMM, Robotics and PROCAST..

Approximate Hours

Item	Appx Hrs
Cl	0
LI	6
SW	1
SL	1
Total	8

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO5.1 Understand and sequence cylinders using pneumatic trainer kits. **SO5.2** Model components and determine their mass properties accurately. **SO5.3** Inspect engineering components using Coordinate Measuring Machines (CMM).	5.1 Study on Sequencing of cylinders using pneumatic trainer kit. 5.2 Experiment on Sequencing of cylinders using pneumatic trainer kit. 5.3 Study on Modeling of component and determination of mass properties. 5.4 Experiment on Modeling of component and determination of mass properties. 5.5 Study on Inspection of an engineering component using CMM. 5.6 Experiment on Inspection of an engineering component using CMM.		1. Compare the methods of modeling a component (e.g., solid modeling, surface modeling) and their implications on determining mass properties such as center of gravity and moment of inertia. Evaluate how different modeling techniques affect accuracy and computational efficiency.

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Perform an inspection task using a CMM on a precision-engineered component. Outline the procedure

for setting up the CMM, programming the measurement path, and interpreting measurement data. Propose strategies to ensure measurement reliability and address any encountered challenges during the inspection process.

ii. Using modeling software of your choice, create a 3D model of a complex engineering component and determine its mass properties. Describe the steps involved in setting up the model, specifying material properties, and analyzing the results. Discuss how these mass properties could influence the component's performance in real-world applications.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Laboratory Instruction (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PE105.1: Measure cutting forces in turning, milling and drilling operations.	0	6	1	1	**8**
PE105.2: Modelling of machine components using software like ANSYS, LSDYNA.	0	6	1	1	**8**
PE105.3: Experiment on EDM, PCM, Wire EDM.	0	6	1	1	**8**
PE105.4: Design a Pneumatic circuit for a given application.	0	6	1	1	8
PE105.5: Optimize the machining processes.Experiment on CMM, Robotics and PROCAST..	0	6	1	1	**8**
Total Hours	**0**	30	5	5	**40**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Measure cutting forces in turning, milling and drilling operations	01	04	05	10
CO-2	Modelling of machine components using software like ANSYS, LSDYNA	02	04	04	10
CO-3	Experiment on EDM, PCM, Wire EDM	02	04	04	10
CO-4	Design a Pneumatic circuit for a given application	02	03	05	10
CO-5	Optimize the machining processes.Experiment on CMM, Robotics and PROCAST.	02	02	06	10
Total		09	17	24	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Manufacturing Engineering Laboratory** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Manufacturing Science	Amitabha Ghosh and A.K. Mallick	Affiliated East-West Press Pvt Ltd.	Revised edition 2010
2	Manufacturing Processes for Engineering Materials	Kalpakjian and Schmid	Pearson India	2014
3	Manufacturing process	H.N. Gupta R.C.Gupta Arun Mittal	New Age International Publisher	Second edition 2009
4	Manufacturing Technology	R.K. Rajput	Laxmi Publisher Ltd.	2007
5	Lecture notes provided by Dept. of Mechanical Engineering, AKS University, Satna			

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M. Tech. Mechanical

Engineering Course Code: PE105

Course Title: Manufacturing Engineering Laboratory

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1: Measure cutting forces in turning, milling and drilling operations.	3	2	2	2	1	2	3	2	2	1	2	2	1	1	2	1
CO 2 : Modelling of machine components using software like ANSYS, LSDYNA.	3	2	2	2	1	2	3	2	2	1	2	2	1	1	2	2
CO3: Experiment on EDM, PCM, Wire EDM.	2	2	3	1	1	1	2	2	1	2	1	2	1	1	1	2
CO 4: Design a Pneumatic circuit for a given application.	2	3	3	2	2	2	3	2	2	1	2	3	1	2	3	2
CO5: Optimize the machining processes.Experiment on CMM, Robotics and PROCAST..	2	3	2	1	2	1	3	3	1	1	2	2	2	2	2	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO-1: Measure cutting forces in turning, milling and drilling operations.	SO1.1 SO1.2 SO1.3	Unit-1 1.1, 1.2, 1.3, 1.4, 1.5, 1.6		As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 2: Modeling of machine components using software like ANSYS, LSDYNA.	SO2.1 SO2.2 SO2.3	Unit-2 2.1,2.2,2.3,2.4,2.5,2.6		
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3 : Experiment on EDM, PCM, Wire EDM.	SO3.1 SO3.2	Unit-3 : 3.1, 3.2, 3.3, 3.4, 3.5, 3.6		
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Design a Pneumatic circuit for a given application.	SO4.1 SO4.2 SO4.3	Unit-4: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6		
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 5: Optimize the machining processes. Experiment on CMM, Robotics and PROCAST.	SO5.1 SO5.2 SO5.3	Unit-5: 5.1, 5.2, 5.3, 5.4, 5.5,5.6		

Semester-I

Course Code: MMF104H

Course Title: **Quality Control and Reliability**

Pre-requisite: Understanding of quality concepts, statistical methods, engineering processes, problem-solving skills, standards compliance, and effective communication.

Rationale: The rationale of quality control and reliability lies in ensuring products consistently meet customer expectations. It minimizes defects, enhances customer satisfaction, and reduces costs associated with rework and recalls. Reliability ensures products perform as intended over their lifecycle, fostering trust and loyalty while meeting regulatory requirements and maintaining competitive advantage in the market.

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

MMF104H.1: Study various approaches of quality.

MMF104H.2: Understand kaizen, Deming and Juran's quality control policies.

MMF104H.3: Study design of experiments using factorial approach and analyze the experiments.

MMF104H.4: Discuss various quality improvement processes using charts, block diagram, distribution and QFD.

MMF104H.5: Understand statistical processes controlling quality and reliability assessment of product. Apply Taguchi's experimental design for quality control

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Elective	MMF104H	Quality Control and Reliability	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
Elective	**MMF104H**	Quality Control and Reliability	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF104H.1 Study various approaches of quality**.**

Approximate Hours

Item	AppX Hrs
Cl	09
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 Explore TQM culture, its axioms, and impacts on management. Understand costs, tools, and Japan's influence on quality practices. **SO1.2** Trace Deming's impact with his 14 management points, combatting organizational sins, and practical implementation insights into effective management **SO1.3** Embrace quality as a habitual pursuit through Juran's trilogy. Compare his breakthrough sequence and managerial perspectives with Deming's philosophies.	.	**Unit-1.0 Introduction** 1.1 New culture of TQM, TQM axioms. 1.2 consequences of total quality managing. 1.3 cost of total quality, valuable tools for quality, the Japanese factor. 1.4 The Deming Approach to management : Historical background shearing processes 1.5 Deming's fourteen points for management, deadly sins &diseases. 1.6 implementing the Deming's philosophy, Deming on management. 1.7 Juran on Quality: Developing a habit of quality. 1.8 Juran`s quality trilogy, the universal breakthrough	1. Compare and contrast Deming's 14 Points for Management with Juran's Quality Trilogy. How do these frameworks address organizational effectiveness and quality improvement differently?.

		sequence. 1.9 Juran Vs Deming	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. How did the introduction of TQM revolutionize traditional management practices? Discuss its core principles and the impact of the Japanese influence on its development.

MMF104H.2: Understand kaizen, Deming and Juran's quality control policies.

Approximate Hours

Item	AppX Hrs
Cl	09
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2.1 Analyze Crosby's diagnosis of organizational issues, implement his quality principles, and apply his structured approach for continuous improvement.. **SO2.2** Explore Kaizen's philosophy of continuous improvement and its impact on innovation, management practices, and its alignment with Deming's principles. **SO2.3** Understand practical applications of Kaizen in enhancing efficiency, quality, and employee involvement, comparing its methodology with other quality management approaches.	.	**Unit-2 Crosby & the Quality Treatment** 2.1 Crosby diagnosis of a troubled company . 2.2 Crosby's quality vaccine . 2.3 Crosby's absolutes for quality management . 2.4 Crosby's fourteen steps for quality improvement . 2.5 The concept ,Kaizen . 2.6 Kaizen & innovation . 2.7 the Kaizen management practices . 2.8 Kaizen & Deming. 2.9 Application of Kaizen	i. Discuss Crosby's "Quality Vaccine" and its application in real-world scenarios.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Explain the concept of Kaizen as proposed by Imai. How does Kaizen foster innovation within organizations, and what are the key management practices associated with its successful implementation?

ii. Compare and contrast Crosby's Fourteen Steps for Quality Improvement with Imai's Kaizen philosophy. How do these approaches differ in their focus and methodologies, and what are their respective impacts on organizational culture and performance?

MMF104H.3: Study design of experiments using factorial approach and analyze the experiments.

Approximate Hours

Item	AppX Hrs
Cl	09
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO3.1 Cover central tendency, dispersion measures, hypothesis testing, probability distributions, and linear associations, essential for foundational statistical proficiency. **SO3.2** Explore factorial designs, aliasing effects, constructing fractional designs, and conducting analysis of variance for efficient experimental design and interpretation.	.	**Unit-3:** Basic Techniques for Statistical Analysis 3.1 Basic Techniques for Statistical Analysis: Introduction 3.2 measures of central tendency & dispersion 3.3 confidence intervals, hypothesis testing 3.4 frequency distributions & histograms 3.5 probability distributions, measuring linear associations 3.6 Design & Analysis of Experiments: Introductions 3.7 factorial experiments 3.8 aliasing, constructing fractional designs 3.9 analysis of variance	i. What are the key measures of central tendency and dispersion used in statistical analysis? Explain their significance in understanding data variability and decision-making.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

- How do factorial experiments contribute to efficient experimental design? Discuss the concept of aliasing and its implications in constructing fractional designs for optimizing resources and analyzing experimental outcomes.

MMF104H.4: Discuss various quality improvement processes using charts, block diagram, distribution and QFD

Approximate Hours

Item	AppXHrs
Cl	09
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO4.1 Utilize tools like Pareto analysis, control charts, and cause-effect diagrams for structured problem-solving and continuous improvement initiatives. **SO4.2** Implement QFD to align customer requirements with product/service features, ensuring enhanced quality and customer satisfaction. **SO4.3** Apply tools like decision analysis, risk analysis, and Weibull analysis to mitigate uncertainties and make informed quality improvement decisions.	.	**Unit-4 :** Supporting of Quality Improvement Processes 4.1 Supporting of Quality Improvement Processes: Affinity diagram 4.2 bar chart, block diagram brain storming . 4.3 cause and effect analysis, control charts 4.4 cost benefit analysis, customer-supplier relationship check list 4.5 decision analysis, flow charts 4.6 force field analysis, line graph/run charts . 4.7 pareto analysis, quality costing . 4.8 quality function development (QFD),quality project approach & problem solving process 4.9 risk analysis scatter diagrams,Weibull analysis, 6 Sigma.	i. Discuss the role of risk analysis, decision analysis, and Weibull analysis in the context of quality improvement initiatives. ii. How can organizations effectively utilize Pareto analysis, control charts, and cause-and-effect diagrams to prioritize and address quality issues in their operations?

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Explain the concept of Quality Function Deployment (QFD) and its significance in enhancing product or service quality. How does QFD facilitate the alignment of customer requirements with design and production processes?

MMF104H.5: Understand statistical processes controlling quality and reliability assessment of product. Apply Taguchi's experimental design for quality control**.**

Approximate Hours

Item	Appx Hrs
Cl	09
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Master data collection planning, interpret variables and attributes charts to maintain process stability and enhance quality control effectiveness. **SO5.2** Explore Taguchi's design techniques for robust products, linking his methods with Deming's principles for comprehensive quality improvement. **SO5.3** Study life cycle curves, probability distributions, and reliability testing plans to ensure product/system reliability and optimize performance through effective data-driven decisions.		**Unit5: Statistical Process Control** 5.1 Statistical Process Control: Introduction. 5.2 data collection plan, variables charts, attributes, interpreting the control charts 5.3 Taguchi's Approach to Experimental Design & Offline Quality Control: Introduction 5.4 background to the method, Taguchi's recommended design techniques 5.5 from Deming to Taguchi & vice-versa. 5.6 Reliability: Introduction 5.7 life cycle curves & probability distribution in modeling reliability 5.8 system reliability, operating characteristic curves 5.9 reliability and life testing plans.	1. Explain the concept of reliability in engineering and quality management. How do life cycle curves, probability distributions, and reliability testing plans contribute to assessing and improving system reliability?

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. How does Statistical Process Control (SPC) enhance quality management? Discuss the importance of data collection plans and the interpretation of control charts in maintaining process stability.

ii. What are the key principles of Taguchi's Approach to Experimental Design? Compare Taguchi's recommended design techniques with traditional methods and their impact on product quality and cost efficiency.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
MMF104H.1: Study various approaches of quality.	9	1	1	**11**
MMF104H.2: Understand kaizen, Deming and Juran's quality control policies.	9	1	1	**11**
MMF104H.3: Study design of experiments using factorial approach and analyze the experiments.	9	1	1	**11**
MMF104H.4: Discuss various quality improvement processes using charts, block diagram, distribution and QFD.	9	1	1	11
MMF104H.5: Understand statistical processes controlling quality and reliability assessment of product. Apply Taguchi's experimental design for quality control.	9	1	1	**11**
Total Hours	**45**	5	5	**55**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Study various approaches of quality	04	04	02	10
CO-2	Understand kaizen, Deming and Juran's quality control policies	03	04	03	10
CO-3	Study design of experiments using factorial approach and analyze the experiments	02	04	04	10
CO-4	Discuss various quality improvement processes using charts, block diagram, distribution and QFD	02	04	04	10
CO-5	Understand statistical processes controlling quality and reliability assessment of product. Apply Taguchi's experimental design for quality control	04	02	04	10
Total		15	18	17	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Quality Control and Reliability** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Managing forTotal Quality From Demingto Taguchi and SPC	N.Logothetis	Prentice Hall of India, New Delhi	2005
2	Designing for Quality	R.F.Lochner & J.E.Matar	Chapman & Hall	2001
3	Fundamental of Quality Control & Improvement	A.Mitra	Prentice Hall of India, New Delhi, 2nd edition	2003
4	SPC:Concepts, Methodologies and Tools	A.Zaidi	Prentice Hall of India, New Delhi	1995
5	Lecture notes provided by Dept. of Mechanical Engineering, AKS University, Satna			

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni, Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M. Tech. Mechanical

Engineering Course Code: MMF104H

Course Title: Quality Control and Reliability

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1: Study various approaches of quality.	3	1	1	1	1	2	3	2	2	1	2	2	1	1	2	1
CO 2 : Understand kaizen, Deming and Juran's quality control policies.	3	2	1	2	1	2	3	2	2	1	2	2	1	1	2	2
CO3: Study design of experiments using factorial approach and analyze the experiments.	2	2	3	1	1	2	2	2	1	2	1	2	1	1	1	2
CO 4: Discuss various quality improvement processes using charts, block diagram, distribution and QFD.	2	2	3	2	2	2	3	2	2	1	2	3	1	2	3	2
CO5: Understand statistical processes controlling quality and reliability assessment of product. Apply Taguchi's experimental design for quality control.	2	2	2	1	2	2	3	3	1	1	2	2	2	2	2	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO-1: Study various approaches of quality.	SO1.1 SO1.2 SO1.3		Unit-1 Study various approaches of quality 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7,1.8,1.9	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 2: Understand kaizen, Deming and Juran's quality control policies.	SO2.1 SO2.2 SO2.3		Unit-2 Understand kaizen, Deming and Juran's quality control policies 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3 : Study design of experiments using factorial approach and analyze the experiments.	SO3.1 SO3.2		Unit-3 : Study design of experiments using factorial approach and analyze the experiments 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8 3.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Discuss various quality improvement processes using charts, block diagram, distribution and QFD.	SO4.1 SO4.2 SO4.3		Unit-4: Discuss various quality improvement processes using charts, block diagram, distribution and QFD 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 5: Understand statistical processes controlling quality and reliability assessment of product. Apply Taguchi's experimental design for quality control.	SO5.1 SO5.2 SO5.3		Unit-5: Understand statistical processes controlling quality and reliability assessment of product. Apply Taguchi's experimental design for quality control 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	

Semester-I

Course Code: MMF104C

Course Title: **Sheet Metal Engineering**

Pre-requisite: Basic understanding of materials science, manufacturing processes, CAD software proficiency and mechanical engineering principles.

Rationale: The rationale of sheet metal engineering lies in its efficiency and versatility in manufacturing lightweight, durable components for various industries. It enables cost-effective production through processes like forming, cutting, and joining, meeting demands for complex geometries while ensuring structural integrity and adherence to stringent performance and aesthetic requirements.

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

MMF104C.1: Understand the applications of sheet metal processes.

MMF104C.2: Predict the spring back in metal forming products.

MMF104C.3: Understand the presses used in metal forming.

MMF104C.4: Describe the computer aided metal forming.

MMF104C.5: Draw the forming limiting diagrams

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Elective	MMF104C	Sheet Metal Engineering	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
Elective	**MMF104C**	Sheet Metal Engineering	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF104C.1 Understand the applications of sheet metal processes**.**

Approximate Hours

Item	AppX Hrs
Cl	09
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 Understand processes ensuring high-quality sheet metal. **SO1.2** Evaluate techniques for controlling sheet metal properties during processing for optimal performance **SO1.3** Identify and differentiate shearing processes (blanking, piercing, punching).	.	**Unit-1.0** 1.1 Introduction of sheet metal 1.2 Production of high quality sheet metal. 1.3 Properties of sheet metal processes. 1.4 control of its properties during processing. 1.5 Application of sheet metal processes 1.6 shearing processes 1.7 blanking. 1.8 piercing. 1.9 punching.	1. Discuss their applications and parameters influencing quality in sheet metal manufacturing.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Describe the factors influencing the production of high-quality sheet metal. Discuss how these factors can be controlled during processing to ensure consistent material properties and performance.

ii. Compare and contrast the shearing processes of blanking, piercing, and punching in sheet metal manufacturing. Explain the specific applications of each process and the key parameters that affect the quality of the final product.

MMF104C.2: Predict the spring back in metal forming products.

Approximate Hours

Item	AppX Hrs
Cl	09
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO2.1 Explain shallow and deep drawing techniques for cylindrical and rectangular bodies. **SO2.2** Analyze methods for estimating and controlling springback to achieve accurate part dimensions.	.	**Unit-2** 2.1 Drawing processes. 2.2 Shallow drawing processes. 2.3 Shallow drawing of rectangular bodies. 2.4 Shallow drawing of cylindrical bodies. 2.5 Deep drawing of rectangular bodies. 2.6 Deep drawing of cylindrical bodies. 2.7 forming and bending 2.8 estimation of spring back. 2.9 control of spring back.	i. Compare and contrast the techniques used in forming and bending operations in sheet metal manufacturing. Provide examples of applications where each technique is preferred, and discuss the challenges associated with achieving precise dimensional control.

SW-2 Suggested Sessional Work(SW):

a. Assignments:

i. Explain the concept of spring back in sheet metal forming. How does springback occur during drawing processes, and what are the factors that contribute to it? Discuss strategies to minimize or control springback effects..

MMF104C.3: Understand the presses used in metal forming.

.

Approximate Hours

Item	AppX Hrs
Cl	09
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO3.1 Identify mechanical and hydraulic press types and their design features. **SO3.2** Analyze force diagrams to understand the mechanical principles governing sheet metal forming processes.	.	**Unit-3:** 3.1 Equipment for sheet metal working 3.2 mechanical and hydraulic presses 3.3 mechanical press design 3.4 mechanical press features 3.5 mechanical press force diagram 3.6 hydraulic press design 3.7 hydraulic press features 3.8 hydraulic press force diagram 3.9 compare mechanical and hydraulic presses	i. Compare and contrast mechanical and hydraulic presses used in sheet metal working. Discuss their design features, operational advantages.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

- Explain the importance of force diagrams in understanding sheet metal forming processes using presses. Illustrate how force distribution affects material deformation and part quality, providing examples from practical applications.

MMF104C.4: Describe the computer aided metal forming

Approximate Hours

Item	AppXHrs
Cl	09
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO4.1 Utilize software for nesting to optimize material usage and reduce waste in sheet metal manufacturing. **SO4.2** Apply computer-aided tools for efficient tool selection and process planning in sheet metal operations. **SO4.3** Design compound and progressive dies using CAD software for enhanced efficiency and precision.	.	**Unit-4 :** 4.1 Computer applications in sheet metal. 4.2 Computer applications in sheet metal with particular reference. 4.3 tool selection 4.4 process planning 4.5 die design 4.6 die design with special reference to compound dies. 4.7 die design with special reference to progressive dies. 4.8 Types of press 4.9 Die and punch assembly	i. How does computer-aided nesting software optimize material utilization in sheet metal manufacturing ?

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Explain the role of computer-aided tools in tool selection and process planning for sheet metal operations. How do these tools contribute to improving productivity, quality, and cost-effectiveness in manufacturing processes?

MMF104C.5: Draw the forming limiting diagrams**.**

Approximate Hours

Item	Appx Hrs
Cl	09
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO5.1 Explain the creation and utilization of forming limit diagrams (FLDs) to assess material behavior and predict failure in sheet metal forming. **SO5.2** Discuss case studies and examples demonstrating the application of hydro-forming for complex shapes and lightweight components.		**Unit5:** 5.1 Introduction to Formability. 5.2 forming limit diagrams 5.3 forming limit diagrams creation 5.4 forming limit diagram use 5.5 soft tool processes 5.6 hydro-forming 5.7 hydro-forming analysis 5.8 hydro-forming application 5.9 advantages of hydro forming.	1. How are forming limit diagrams (FLDs) created and utilized in sheet metal forming? Discuss their significance in predicting material behavior and optimizing process parameters.

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Explain the principles and advantages of hydro-forming as a soft tool process in sheet metal manufacturing. Provide examples of applications where hydro-forming is preferred over conventional forming techniques, and discuss the key factors influencing its success.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
MMF104C.1: Understand the applications of sheet metal processes.	9	1	1	**11**
MMF104C.2: Predict the spring back in metal forming products.	9	1	1	**11**
MMF104C.3: Understand the presses used in metal forming.	9	1	1	**11**
MMF104C.4: Describe the computer aided metal forming.	9	1	1	11
MMF104C.5: Draw the forming limiting diagrams.	9	1	1	**11**
Total Hours	**45**	5	5	**55**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Understand the applications of sheet metal processes	03	05	04	12
CO-2	Predict the spring back in metal forming products	03	03	04	10
CO-3	Understand the presses used in metal forming	02	04	04	10
CO-4	Describe the computer aided metal forming	02	04	04	10
CO-5	Draw the forming limiting diagrams	02	02	04	08
Total		12	18	20	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for **Sheet Metal Engineering** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Techniques of Press Working,	D.Eary and E.Reed	Prentice Hall	1989
2	Die Design Hand book		ASTME	1989
3	Sheet Metal Engineering	A. S. Desh pande		1999
4	Lecture notes provided by Dept. of Mechanical Engineering, AKS University, Satna			

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M. Tech. Mechanical Engineering Course Code: MMF104C

Course Title: Sheet Metal Engineering

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1: Understand the applications of sheet metal processes.	3	2	1	1	2	2	3	2	2	1	3	2	2	3	3	1
CO 2 : Predict the spring back in metal forming products.	3	2	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Understand the presses used in metal forming.	2	2	1	1	3	2	2	2	1	2	1	2	1	1	2	2
CO 4: Describe the computer aided metal forming.	2	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Draw the forming limiting diagrams.	2	2	2	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO-1: Understand the applications of sheet metal processes.	SO1.1 SO1.2 SO1.3		Unit-1 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7,1.8,1.9	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 2: Predict the spring back in metal forming products.	SO2.1 SO2.2		Unit-2 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3 : Understand the presses used in metal forming.	SO3.1 SO3.2		Unit-3 : 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8 3.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Describe the computer aided metal forming.	SO4.1 SO4.2 SO4.3		Unit-4: 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 5: Draw the forming limiting diagrams.	SO5.1 SO5.2		Unit-5: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	

Semester-I

Course Code: **MMF104B**

Course Title: Machine tool design

Pre- requisite: Student should have basic knowledge engineering mechanics, material science and engineering and manufacturing process.

Rationale: The rationale for machine tool design is to create equipment that not only meets technical specifications but also addresses economic, safety, environmental, and societal considerations while supporting efficient manufacturing processes.

Course Outcomes:

MMF104B.1 Study kinematics o f various machine tools.
MMF104B.2: Understand principles of various machine tool feed and speed drives..
MMF104B.3 Design power screws, slide ways and machine tool spindle with bearings
MMF104B.4: Design structure and other auxiliary mechanism of machine tool.
MMF104B 5: Apply modular design aesthetics and ergonomics for machine tool.
MMF104B 6: Study acceptance test of machine tools and methods of machine tool condition

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	MMF104B	Machine tool design	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ ESA)
ESC	MMF104B	Machine tool design	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF104B.1: Study kinematics o f various machine tools.

Approximate Hours

Item	AppX Hrs
Cl	8
LI	0
SW	1
SL	1
Total	10

Session Outcomes (SOs)	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Recall the basic principles of kinematics in machine tools, such as types of motion (rotational, linear) and the components involved (spindle, tool slide, worktable) SO1.2 Apply kinematic principles to analyze and predict the movement and positioning capabilities of specific machine tools in different machining scenarios. SO1.3 Critique the design of machine tools based on their kinematic capabilities and propose improvements or modifications to enhance performance.		1.1 Introduction to metal cutting machine tools 1.2 criteria for the selection of operating capacity 1.3 design parameters 1.4 Types of motion 1.5 Degree of freedom 1.6 numericals 1.7 Kinematics of machine tools. 1.8 numericals	**1.** Design or modify a machine tool conceptually based on a given set of machining requirements, incorporating appropriate kinematic principles.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

1. Develop a simulation or virtual model that demonstrates the kinematic behavior of a custom-designed machine tool for specific machining tasks.

MMF104B-2 Understand principles of various machine tool feed and speed drives.

Item	AppX Hrs
Cl	07
LI	00
SW	01
SL	01
Total	09

Session Outcomes (SOs)	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO2.1 Explain the relationship between feed rate and spindle speed in determining the material removal rate (MRR) and surface finish in machining operations. SO2.2 Describe how different types of feed mechanisms (e.g., lead screws, racks and pinions) and speed drives (e.g., variable speed drives, gearboxes) influence the performance of machine tools. SO2.3 Develop a plan to integrate advanced feed and speed control systems (e.g., CNC adaptive control) into existing machine tools to enhance productivity and precision.		. .2.1 Basic principles of machine tool design 2.2 estimation of drive power 2.3 machine tool drives 2.4 electrical drive 2.5 Mechanical drive 2.6 fluid drives 2.7 stepped and step less speed arrangements and systems.	1. Evaluate the effectiveness of chosen feed and speed settings in achieving machining goals, such as dimensional accuracy, surface finish, and production rate.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

1. Design a set of optimal feed and speed parameters for a specific machining scenario, considering factors such as tool material, workpiece material, and machining strategy.

MMF104B-3 Design power screws, slide ways and machine tool spindle with bearings.

Approximate Hours

Item	AppX Hrs
Cl	08
LI	00
SW	01
SL	01
Total	10

Session Outcomes (SOs)	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO3.1 Explain the principles of spindle design, including considerations for rotational speed, stiffness, and thermal management. SO3.2 Describe the role of bearings in supporting radial and axial loads, ensuring precision, and minimizing vibration in machine tool spindles. SO3.3 Apply knowledge of spindle design principles to select appropriate bearing types, sizes, and arrangements for specific machine tool applications.		3.1 Design of machine tool spindles and bearings 3.2 design of power screws 3.3 Numericals 3.3 design of slideways 3.5 numericals 3.6selective mechanisms. 3.7pre-selective mechanisms. 3.8 numericals	1.Evaluate the impact of spindle design parameters (e.g., bearing clearance, shaft material) on spindle performance and reliability.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

I. . Develop innovative solutions for enhancing spindle performance, such as designing modular spindle units for quick changeovers or implementing predictive maintenance technologies

MMF104B-4. Design structure and other auxiliary mechanism of machine tool.

Approximate Hours

Item	AppX Hrs
Cl	08
LI	00
SW	01
SL	01
Total	10

Session Outcomes (SOs)	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
So4.1 Analyze the structural integrity of machine tool components under various operating conditions (e.g., static loads, dynamic forces, thermal gradients**).** So4.2 • Critique existing machine tool structures based on their ability to withstand machining forces, minimize deflections, and maintain geometric tolerances over time. So4.3 Design a comprehensive auxiliary system configuration for a specific machine tool setup, considering factors such as production volume, material type, and machining complexity.		4.1 Machine tool structures-beds 4.2 columns 4.3 tables and supports 4.4 stock feed mechanism, 4.5 Measurement and control of machine tools, 4.6 protective and safety devices, 4.7design of precision machine tools. 4.8 Numericals	1. Develop innovative solutions for integrating smart technologies (e.g., IoT-enabled sensors, predictive maintenance systems) into auxiliary mechanisms to enhance automation and efficiency.

SW-4 Suggested Sessional Work (SW):

a. Assignments:

1. Design or modify auxiliary mechanisms to optimize their performance in terms of fluid management, material handling, or tool management.

MMF104B-5. Apply modular design aesthetics and ergonomics for machine tool.

Approximate Hours

Item	AppX Hrs
Cl	07
LI	00
SW	1
SL	1
Total	9

Session Outcomes (SOs)	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO5.1Explain how modular design principles contribute to simplifying manufacturing processes and reducing lead times in machine tool production. SO5.2Describe the concept of standardization and its role in modular design for ensuring compatibility and flexibility in machine tool configurations. SO5.3Apply knowledge of ergonomic principles to evaluate and redesign machine tool interfaces (e.g., control panels, tool access points) for improved operator comfort and efficiency.		**5.1** Micro-feeding mechanisms 5.2 concept of modular design 5.3 integration of SPM`s 5.4 numericalas 5.5 Concepts of aesthetic 5.6 ergonomics applied to machine tools. 5.7 numericals	1.Describe the role of anthropometric data and task analysis in optimizing machine tool ergonomics.,

SW-5 Suggested Sessional Work (SW):

a. Assignments:

1. Explain how ergonomic design principles improve operator productivity, reduce fatigue, and minimize the risk of injury in machine tool environments.

MMF104B-6 Study acceptance test of machine tools and methods of machine tool condition

Approximate Hours

Item	AppX Hrs
Cl	07
LI	00
SW	1
SL	1
Total	9

Session Outcomes (SOs)	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO6.1 The learner recalls facts and basic concepts related to acceptance testing of machine tools and methods of machine tool condition. SO6.2 The learner designs new approaches or procedures for machine tool acceptance testing or condition assessment based on their understanding and analysis.		**6.1** Acceptance tests 6.2standardization Of machine tools 6.3 machine tool conditioning , 6.4 numericals 6.5 latest trends in machine tool design 6.6introduction to CAD techniques. 6.7 numericals	1. evaluates the effectiveness of different methods of machine tool condition assessment and acceptance testing in various contexts.

SW-6 Suggested Sessional Work (SW):

Assignments:

1. designs new approaches or procedures for machine tool acceptance testing or condition assessment based on their understanding and analysis.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Lecture (LI)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+LI+SW+SI)
MMF104B.1 Study kinematics o f various machine tools.	8	0	1	**1**	10
MMF104B.2 Understand principles of various machine tool feed and speed drives..	7	0	1	**1**	9
MMF104B.3 Design power screws, slide ways and machine tool spindle with bearings.	8	0	1	1	10
MMF104B.4 Design structure and other auxiliary mechanism of machine tool.	8	0	1	1	10
MMF104B.5 Apply modular design aesthetics and ergonomics for machine tool.	**7**	**0**	**1**	**1**	9
MMF104B.6 Study acceptance test of machine tools and methods of machine tool condition.	7	0	1	**1**	9
Total Hours	45	00	6	6	57

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Study kinematics o f various machine tools.	03	01	01	05
CO-2	Understand principles of various machine tool feed and speed drives.	02	06	02	10
CO-3	. Design power screws, slide ways and machine tool spindle with bearings.	03	07	05	15
CO-4	Design structure and other auxiliary mechanism of machine tool.	-	10	05	15
CO-5	Apply modular design aesthetics and ergonomics for machine tool.				
CO-6	Study acceptance test of machine tools and methods of machine tool condition	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for Machine tool design will be held with writtenexamination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

2. Improved Lecture
3. Tutorial
4. Case Method
5. Group Discussion
6. Role Play
7. Visit to cement plant
8. Demonstration
9. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
10. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	*Machine tool design*	N.K.Mehta	TataMcgraw-hill,NewDelhi	1989
2	*Machine tool design*,Vol.3and4	N.Acherkan	Mirpublisher,Moscow	1968
3	*Design principles of metal cutting machine tools*	A.Koenigsburger	Pergamonpress,	1964
.				
6	Training Manual			
7	Lecture note provided by Dept. of Mechanical Engineering, AKS University, Satna .			

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanichal Engg.
3. Mr Deepak Pandey , Assistant Professor , Dept. of Mechanichal Engg
4. Mr.,Keshav Pratap Singh, Assistant Professor , Dept. of Mechanichal Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanichal Engg
6. Mr K.P Tiwari , Assistant Professor , Dept. of Mechanichal Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanichal Engg
8. Mr. K.C. Kori, Faculty, Assistant Professor , Dept. of Mechanichal Engg
9. Mr,Lokesh Agrawal, Assistant Professor , Dept. of Mechanichal Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanichal Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanichal Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

Cos,POs and PSOs Mapping

Course Title: M. Tech Mechanical Engineering

Course Code : PEC MMF104B

Course Title: Machine tool design

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	They should have a comprehensive understanding of different power generation systems, including fossil fuel-based, renewable energy, nuclear, and combined cycle power plants.	Ability to design, analyze, and optimize power plant systems considering factors like efficiency, environmental impact, and cost-effectiveness.	Proficiency in thermodynamic principles and heat transfer mechanisms, which are fundamental to power generation processes.	Capability to identify, troubleshoot, and resolve operational issues in power plants, along with knowledge of maintenance strategies.
CO1 : Study kinematics of various machine tools..	1	1	2	2	2	2	3	1	2	2	1	2	2	2	1	-
CO 2 Understand principles of various machine tool feed and speed drives.	1	2	2	2	1	2	2	1	1	1	2	3	2	2	2	1
CO3 Design power screws, slide ways and machine tool spindle with bearings.	2	2	1	1	2	2	2	1	1	2	1	2	2	1	2	2
CO 4: : Design structure and other auxiliary mechanism of machine tool.	3	2	2	-	3	1	3	1	2	1	-	2	3	3	3	2
CO5 Apply modular design aesthetics and ergonomics for machine tool.																
CO 6: . Study acceptance test of machine tools and methods of machine tool condition	1	2	2	-	1	1	3	1	1	1	2	2	3	3	1	3

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO1 : . Study kinematics o f various machine tools	SO1.1 SO1.2 SO1.3 SO1.4		Unit-1. Study kinematics o f various machine tools. 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,	As mentionedin page number 2 to 6
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 2 Understand principles of various machine tool feed and speed drives..	SO2.1 SO2.2 SO2.3 SO2.4		Unit-2 Understand principles of various machine tool feed and speed drives. 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7,	
PO 1,2,3,4,5,6 7,8,9,10,11,12	CO3 : . Design power screws, slide ways and machine tool spindle with bearings	SO3.1 SO3.2		Unit-3 Design power screws, slide ways and machine tool spindle with bearings. 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8	
PSO 1,2, 3, 4, 5 PSO 1,2, 3, 4, 5	CO4 : . Design structure and other auxiliary mechanism of machine tool.	SO3.3 SO3.4 SO3.5 SO3.5		Unit-.4 Design structure and other auxiliary mechanism of machine tool. 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 5: . Apply modular design aesthetics and ergonomics for machine tool.	SO4.1 SO4.2 SO4.3		Unit5 Apply modular design aesthetics and ergonomics for machine tool. 5.1,5.2,5.3,5.4,5.5,5.6,5.7	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO6: Study acceptance test of machine tools and methods of machine tool condition selection of plant	SO5.1 SO5.2 SO5.3 SO5.4		Unit 6. Study acceptance test of machine tools and methods of machine tool condition 6.1,6.2,6.3,6.4,6.5,6.6,6.7	

Semester-I

Course Code: **MMF104L**

Course Title: **Manufacturing Planning and Control**

Pre- requisite: Student should have basic knowledge of basic mechanical engineering and engineering graphics..

Rationale: The rationale of Manufacturing Planning and Control lies in its ability to optimize resources, meet customer demands efficiently, ensure product quality, control costs, and enhance operational agility. By achieving these objectives, MPC contributes significantly to the overall success and profitability of an organization's manufacturing operations.

Course Outcomes:

MMF104L.1: Apply the systems concept for the design of production and service systems.

MMF104L.2 Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.

MMF104L.3: Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources.

MMF104L 4: Explain Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand Circumstances.

MMF104L.5 Understand the lot sizing and production scheduling and Study about quality planning, cost planning and control.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**MMF104L**	**Manufacturing Planning and Control**	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C:Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Couse Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test 2 (2 best out of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
ESC	**MMF104L**	**Manufacturing Planning and Control**	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF104L.1: Apply the systems concept for the design of production and service systems.

Approximate Hours

Item	AppX Hrs
Cl	6
LI	0
SW	1
SL	1
Total	8

Session Outcomes (SOs)	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO1.1 Apply knowledge of manufacturing systems to analyze a given production scenario. SO1.2 Design a simple assembly line layout for a specific manufacturing process. SO1.3 Compare and contrast different manufacturing systems in terms of efficiency and cost-effectiveness.		Unit1 **introduction of manufacturing systems** 1.1 introduction to manufacturing systems 1.2 overview on manufacturing systems 1.3 assembly line 1.4 various issues of interest assembly line 1.5 batch manufacturing 1.6 Repetitive batch manufacturing.	**1.** Develop a comprehensive manufacturing plan incorporating lean principles.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

1. Design an innovative assembly line layout to optimize production efficiency.

MMF104L.2 **Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques**

Approximate Hours

Item	AppX Hrs
Cl	13
LI	00
SW	1
SL	01
Total	15

Session Outcomes (SOs)	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO2.1 Recall key quantitative techniques used for forecasting in manufacturing and service sectors (e.g., time series analysis, regression analysis, exponential smoothing). SO2.2 Implement forecasting models using software tools or spreadsheet applications. SO2.3 Propose improvements to existing forecasting processes based on analysis and evaluation.		**Unit-2 forecasting and inventory planning** 2.1 Cellular manufacturing 2.2FMS 2.3 JIT 2.4 CIM 2.5 pre planning 2.6 ERP 2.7 fore casting 2.8delpi method 2.9 other statistical techniques 2.10 economic analysis 2.11 aggregate planning 2.12 capacity planning, 2.13 inventory planning.	1.. Describe how different forecasting techniques work and their respective strengths and limitations.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

1. Explain the importance of accurate forecasting in manufacturing and service sectors..

MMF104L.3: Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources

Approximate Hours

Item	AppX Hrs
Cl	09
LI	00
SW	01
SL	01
Total	11

Session Outcomes (SOs)	LaboratoryInstruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO3.1 Recall the key principles and techniques of production planning and control relevant to resource optimization. SO3.2 Explain how production planning and control practices contribute to efficient resource utilization in manufacturing and service sectors. SO3.3 Analyze production data to identify inefficiencies in resource allocation and propose solutions for improvement.		**Unit-3.0 group technology and line balancing** 3.1 Decision making 3.2 Decision making in design of manufacturing systems 3.3 problem 3.4 Decision making in group technology 3.5 part family formation techniques 3.6 classification and coding techniques 3.7 problem 3.8 line balancing 3.9 problem	1. Propose improvements to existing production and service systems to enhance resource efficiency and operational effectiveness.

SW-3 Suggested Sessional Work (SW):

a. Assignments:

I. Design a customized production scheduling system tailored to specific manufacturing or service sector requirements.

MMF104L 4: Explain Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand Circumstances.

Approximate Hours

Item	AppX Hrs
Cl	09
LI	00
SW	01
SL	01
Total	11

Session Outcomes (SOs)	LaboratoryInstruction (LI)	Class room Instruction (CI)	Self Learning (SL)
SO4.1 Students can recall and list key concepts, principles, and components of operational planning, MRP, and JIT. **SO4.2** Students can explain the purpose and objectives of operational planning, MRP, and JIT and they can interpret how these methods contribute to efficient production and inventory management. SO4.3 They can judge the effectiveness of JIT approaches in minimizing waste and optimizing supply chain management.		Unit-4.0 **operation planning** 4.1 Operations planning 4.2 MRP 4.3 MRPII 4.4 Distributions requirements planning 4.5 hierarchical planning systems 4.6 JITsystems 4.7 capacity planning and utilization 4.8 production activity control 4.9 advanced concept in scheduling.	1. Students can design an improved operational planning framework tailored to a specific manufacturing or service industry.

SW-4 Suggested Sessional Work (SW):

Assignments:1. Explain strengths and weaknesses of MRP systems in managing inventory and production schedules.

MMF104L.5 Understand the lot sizing and production scheduling and Study about quality planning, cost planning and control

Approximate Hours

Item	AppX Hrs
Cl	08
LI	00
SW	1
SL	1
Total	10

Session Outcomes (SOs)	**LaboratoryInstruction (LI)**	**Class room Instruction (CI)**	**Self Learning (SL)**
SO5.1 They remember definitions and basic principles of quality planning and control, cost planning and control, and simulation analysis in manufacturing systems. SO5.2 They can utilize simulation software to model and simulate various manufacturing scenarios and analyze the results. SO5.3 Students can analyze the impact of different lot sizing decisions on inventory levels, production efficiency, and costs in FMS.		**Unit-5. FMS operation and control** 5.1 FMS Operation and control 5.2 lot sizing decisions 5.3 production scheduling 5.4 line of balance 5.5 Quality planning and control 5.6 cost planning and control 5.7 Simulation analysis of manufacturing systems 5.8 case studies	1. Evaluate the effectiveness of lot sizing strategies in terms of cost savings and production efficiency.

SW-5 Suggested Sessional Work (SW):

a. **Assignments:** Design a comprehensive lot sizing strategy tailored to a specific FMS environment, considering various factors like demand variability and machine capacities.

.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (Cl)	Lab Lecture (LI)	Sessional Work (SW)	Self Learning (SI)	Total hour (Cl+LI+SW+SI)
MMF104L.1: Apply the systems concept for the design of production and service systems	6	0	1	**1**	8
MMF104L.2 Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.	13	0	1	**1**	15
MMF104L.3: Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources	9	0	1	1	11
MMF104L 4: Explain Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand Circumstances	9	0	1	1	11
MMF104L.5 Understand the lot sizing and production scheduling and Study about quality planning ,cost planning and control .	8	0	1	**1**	10
Total Hours	45	00	05	5	55

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	**introduction of manufacturing systems**	03	01	01	05
CO-2	**forecasting and inventory planning**	02	06	02	10
CO-3	. **group technology and line balancing**	03	07	05	15
CO-4	**operation planning**	-	10	05	15
CO-5	**FMS operation and control**	03	02	-	05
Total		11	26	13	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment .for power plant engineering will be held with writtenexamination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to cement plant
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/Tutorials CBT, Blog, Facebook,Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a) Books :

S. No.	Title	Author	Publisher	Edition & Year
1	,*IntegratedProduction Control,System-management, Analysis and Design*,,	D.D.Bedworthand J.EBailey	John Wiley,	1983
2	*AnalysisandControlofProductionSystems*	E.A.ElsayedandT.O. Boucher	Prentice Hall,	1985
3	,*ProductionPlanningandControl*,PergamonPress	J.R.King	,Oxford,	1975
4	*Quantitative Production Management*,	P.F.Bestwick and K.Lockyer	Pitman Publications	1982
5	Training Manual			
6	Training Manual			
7	Lecture note provided by Dept. of Mechanical Engineering, AKS University, Satna .			

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanichal Engg.
3. Mr Deepak Pandey , Assistant Professor , Dept. of Mechanichal Engg
4. Mr.,Keshav Pratap Singh, Assistant Professor , Dept. of Mechanichal Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanichal Engg
6. Mr K.P Tiwari , Assistant Professor , Dept. of Mechanichal Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanichal Engg
8. Mr. K.C. Kori, Faculty, Assistant Professor , Dept. of Mechanichal Engg
9. Mr,Lokesh Agrawal, Assistant Professor , Dept. of Mechanichal Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanichal Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanichal Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

Cos,POs and PSOs Mapping

Course Title: M. Tech Mechanical Engineering

Course Code : MMF104L

Course Title: manufacturing planning and control

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
	Engineering knowledge	Problem analysis	Design/ development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability:	Ethics	Individual and team work:	Communication:	Project management and finance:	Life-long learning	They should have a comprehensive understanding of different power generation systems, including fossil fuel-based, renewable energy, nuclear, and combined cycle power plants.	Ability to design, analyze, and optimize power plant systems considering factors like efficiency, environmental impact, and cost-effectiveness .	Proficiency in thermodynamic principles and heat transfer mechanisms, which are fundamental to power generation processes.	Capability to identify, troubleshoot, and resolve operational issues in power plants, along with knowledge of maintenance strategies.
CO1 Apply the systems concept for the design of production and service systems.	1	1	2	2	2	2	3	1	2	2	1	2	2	2	1	-
CO 2 Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.	1	2	2	2	1	2	2	1	1	1	2	3	2	2	2	1
CO3 Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources.	2	2	1	1	2	2	2	1	1	2	1	2	2	1	2	2

CO 4: Explain Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand Circumstances	3	2	2	-	3	1	3	1	2	1	-	2	3	3	3	2
co 5: . 5 Understand the lot sizing and production scheduling and Study about quality planning,cost planning and control.	1	2	2	-	1	1	3	1	1	1	2	2	3	3	1	3

Legend: 1 – Low, 2 – Medium, 3 – High

Course Curriculum Map:

POs & PSOs No.	COs No.& Titles	SOs No.	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO1 : . : Apply the systems concept for the design of production and service systems	SO1.1 SO1.2 SO1.3		Unit-1.0 . **introduction of manufacturing systems** 1.1,1.2,1.3,1.4,1.5,1.6	As mentionedin page number 2 to 6
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 2 : Make forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques.	SO2.1 SO2.2 SO2.3		Unit-2 **forecasting and inventory planning** 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8,2.9,2.10,2.11,2.12,2.13	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO3 : . : Apply the principles and techniques for planning and control of the production and service systems to optimize/make best use of resources	SO3.1 SO3.2 SO3.3		Unit-3 : **group technology and line balancing** 3.1, 3.2,3.3,3.4,3.5,3.6,3.7,3.8,3.9	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 4: . Explain Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand Circumstances.	SO4.1 SO4.2 SO4.3		Unit-4 : . **operation planning** 4.1, 4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9	
PO 1,2,3,4,5,6 7,8,9,10,11,12 PSO 1,2, 3, 4, 5	CO 5: 5 Understand the lot sizing and production scheduling and Study about quality planning,cost planning and control.	SO5.1 SO5.2 SO5.3		Unit 5 **FMS operation and control** 5.1,5.2,5.3,5.4,5.5,5.6,5.7,5.8	

Semester-I

Course Code: MMF104I

Course Title: Processing of Advanced Materials

Pre-requisite: Processing advanced materials requires specialized knowledge of their properties and behaviors, along with access to advanced equipment and strict adherence to safety, quality, and regulatory standards.

Rationale: Enhanced Performance: Processing refines material properties to achieve superior mechanical, electrical, or chemical performance.

Innovative Applications: Enables development of cutting-edge technologies in industries like aerospace, electronics, and healthcare.

Sustainability: Facilitates the creation of lightweight, durable, and eco-friendly solutions to meet evolving societal and environmental demands.

Course Outcomes:

MMF104I.1: Understand the advanced materials and their applications
MMF104I.2: Describe the manufacturing methods for GFRP composites
MMF104I.3: Explain the manufacturing methods for MMC and CMC composites
MMF104I.4: Identify the difficulties in machining of advanced materials
MMF104I.5: UnderstandtheapplicationofHighspeedmachiningforadvancedmaterials

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	MMF104I	Processing of Advanced Materials	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
PCC	**MMF104I**	Processing of Advanced Materials	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF104I.1: Understand the advanced materials and their applications **Approximate Hours**

Item	AppX Hrs
Cl	7
LI	0
SW	3
SL	1
Total	11

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (Cl)	Self Learning (SL)
SO1.1 Comprehensive Understanding of Advanced Materials: Participants will gain in-depth knowledge of various advanced materials such as ceramics, glasses, polymers, composites, non-ferrous alloys, special alloys, and shape memory alloys, including their properties, synthesis methods, and characterization techniques. **SO1.2** Practical Application Knowledge: Participants will be able to identify and analyze the applications of advanced materials in diverse industries, such as aerospace, automotive, electronics, biomedical, and construction, and understand the factors influencing material selection for specific applications.	.	**Unit-1.0 Introduction** 1.1 • Advanced materials such as ceramics 1.2 glasses, polymers 1.3 composites 1.4 their properties and applications 1.5 non-ferrous alloys 1.6 their properties and applications 1.7 special alloys,	1. shape memory alloys.

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Analyze The properties of Composite materials

MMF104I.2: Describe the manufacturing methods for GFRP composites.

Approximate Hours

Item	AppX Hrs
Cl	13
LI	0
SW	3
SL	1
Total	17

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2.1 Participants will acquire comprehensive knowledge of polymerization processes, the structure, properties, and classifications of thermoplastics and thermosets, and the design principles underlying composites with polymer matrices. **SO2.2** Participants will explore the engineering applications of polymers and composites in various industries, such as automotive, aerospace, biomedical, and consumer products, and evaluate their mechanical, thermal, and chemical behaviors to optimize material selection & performance.	.	Unit-2 Polymers 2.1 Introduction of Polymers 2.2 polymerization 2.3 structure 2.4 study properties of thermoplastics 2.5 thermosets 2.6 engineering applications 2.7 property modifications 2.8 mechanical thermal behaviors 2.9 composites 2.10 polymer matrix 2.11 ceramics 2.12 Tutorial-1 2.13 Tutorial-2	i. Properties of Glasses .

SW-2 Suggested Sessional Work(SW):

a. Assignments:

i. Analyze the properties of Ceramics

MMF104I.3: Explain the manufacturing methods for MMC and CMC composites

Approximate Hours

Item	AppX Hrs
Cl	16
LI	0
SW	3
SL	1
Total	20

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO3.1 Participants will acquire knowledge of fabrication methods for glass ceramics and metal/ceramic matrix composites, understanding their properties and industrial applications. **SO3.2** They will develop proficiency in machining techniques for advanced materials like MMCs, GFRP, nickel alloys, refractory metals, and powder metallurgy materials, enabling effective material processing and application in engineering contexts.	.	**Unit-3:** Glass ceramics 3.1 Introduction of Glass ceramics 3.2 fabrication methods 3.3 metal matrix 3.4 ceramic matrix composites 3.5 Machining 3.6 traditional 3.7 non-traditional 3.8 composite materials such as MMC 3.9 GFRP 3.10 nickel alloys 3.11 refractory metals 3.12 Introduction of powder metallurgy materials 3.13 Properties ofpowder metallurgy materials 3.14 Application of powder metallurgy materials 3.15 Tutorial-1 3.16 Tutorial-1	i. Explain the application of metal matrix

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Analyze fabrication methods

MMF104I.4: Identify the difficulties in machining of advanced materials

Approximate Hours

Item	AppXHrs
Cl	14
LI	0
SW	3
SL	1
Total	18

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO4.1 Participants will gain proficiency in processing polymers, fabricating composites, and processing ceramics, understanding their respective techniques, properties, and industrial applications. **SO4.2** They will explore and apply non-traditional machining processes like EDM, USM, AJM, AFM, LBM, and EBM, enhancing their ability to manufacture and refine advanced materials effectively in diverse engineering contexts.	.	**Unit-4 :** Processing of polymers 4.1 Introduction to Processing of polymers 4.2 fabrication of composites 4.3 processing of ceramics 4.4 super plastic forming 4.5 Application of non-traditional machining processes 4.6 Introduction of EDM 4.7 Application of EDM 4.8 USM processes 4.9 AJM 4.10 AFM 4.11 Introduction of LBM 4.12 Application of LBM 4.13 EBM. 4.14 Tutorial-1	1.Importance and Types . super plastic forming

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Application of AFM

MMF104I.5: Understand the application of High speed machining for advanced materials

Approximate Hours

Item	Appx Hrs
Cl	10
LI	0
SW	3
SL	1
Total	14

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO5.1 Participants will gain comprehensive knowledge of plasma machining, high-speed machining, and other advanced machining techniques applied to materials like polymers, composites, ceramics, and alloys, focusing on mechanisms of material removal, unique features, and specific applications. **SO5.2** They will explore recent trends and future prospects in these machining technologies, understanding how advancements contribute to enhanced		**Unit5:** Plasma machining 5.1 Introduction to Plasma machining 5.2 high speed machining 5.3 advanced materials 5.4 special emphasis on mechanism of material removal 5.5 characteristic features 5.6 applications in each case 5.7 Recent trends 5.8 future prospects. 5.9 Tutorial-1 5.10 Tutorial-2	1. Application of high speed machining

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Application of Plasma Machining

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
MMF104I.1:Understand the advanced materials and their applications	7	3	1	**11**
MMF104I.2: Describe the manufacturing methods for GFRP composites	13	3	1	**17**
MMF104I.3: Explain the manufacturing methods for MMC and CMC composites	16	3	1	**20**
MMF104I.4: Identify the difficulties in machining of advanced materials	14	3	1	18
MMF104I.5: UnderstandtheapplicationofHighspeedmachiningforadvancedmaterials	10	3	1	**14**
Total Hours	**60**	15	5	**80**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Introduction	01	02	03	06
CO-2	Polymers	01	03	07	11
CO-3	Glass ceramics	01	07	04	12
CO-4	Processing of polymers	01	06	04	11
CO-5	Plasma machining	01	06	03	10
Total		5	24	21	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Processing of Advanced Materials** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher
1	Principles of Manufacturing Materials and Processes	J.S.Campbell	McGraw-Hill, New York.
2	Materials and processes in manufacturing	E.P. De Garmo	Collier Mac Millan, New York.
3	Principles of Polymer Processing	Zehev Tadmor	Wiley-Inter science Publications
4	Manufacturing Engineering and Technology	Serope Kalpakjian and Steven R. Schmid	Addison Wesley Longman (Singapur) Pvt. Ltd., India Branch
5	Manufacturing Science	Ghosh,A. and Mallik,A.K	East-West Press Private Ltd

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M. Tech. Mechanical

Engineering Course Code: PCC- MMF104I

Course Title: Processing of Advanced Materials

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1: Understand the advanced materials and their applications	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 Describe the manufacturing methods for GFRP composites	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Explain the manufacturing methods for MMC and CMC composites	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Identify the difficulties in machining of advanced materials	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: UnderstandtheapplicationofHighspeedmachiningforadvancedmaterials	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO1: Understand the advanced materials and their applications	SO1.1 SO1.2		Introduction 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 2 Describe the manufacturing methods for GFRP composites	SO2.1 SO2.2		Unit-2 Polymers 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3: Explain the manufacturing methods for MMC and CMC composites	SO3.1 SO3.2		Unit-3 : Glass ceramics 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, 3.15, 3.16	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Identify the difficulties in machining of advanced materials	SO4.1 SO4.2		Unit-4: Processing of polymers 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO5:Understandtheapplicationo fHighspeedmachiningforadvance dmaterials	SO5.1 SO5.2		Unit-5: Plasma machining 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10	

Semester-II

Course Code: PCC-MMF202

Course Title: **Casting and Moulding Technology**

Pre-requisite: Knowledge of materials properties such as strength, hardness, elasticity, and thermal conductivity is essential. Understanding how different materials behave under various conditions (e.g., temperature, pressure) is crucial for selecting the right materials for casting and molding processes.

Rationale: Casting and moulding technology is fundamental to manufacturing, offering versatility in materials, cost efficiency, design flexibility, and sustainability. It supports innovation, integrates with modern technologies, and provides diverse career opportunities across industries worldwide. Understanding these techniques is essential for efficient production and product development in today's manufacturing landscape.

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

PCC-MMF202.1: Identify suitable casting processes and their working principles to manufacture products

PCC-MMF202.2: Design and analyze the melt flow in mould gating and rising system

PCC-MMF202.3: Understanding casting solidification phenomenon and identify various casting defects and their remedies.

PCC-MMF202.4: Classify different mould types for plastics product and understood polymerization and synthesis techniques

PCC-MMF202.5: Understand different plastics processing methods and their working principles

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**PCC-MMF202**	**Casting and Moulding Technology**	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
PCC	**PCC-MMF202**	Casting and Moulding Technology	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PCC-MMF202.1 Understand the theory of plasticity and yield criteria**.**

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	2
Total	16

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
SO1.1 Understand the fundamental principles and techniques of metal casting processes.. **SO1.2** Identify suitable materials for casting parts and tools based on their properties and applications. **SO1.3** Design efficient foundry layouts and select appropriate equipment for various casting operations. **SO1.4** Apply principles of pattern and core design to optimize casting production and quality.	.	**Unit-1.0** Introduction to Metal Casting 1.1 Historical development and modern applications of metal casting... 1.2 Basic terminology and principles in metal casting. 1.3 Selection criteria for casting materials: metals, alloys, and molds.. 1.4 Examples of commonly used materials and their applications in different casting processes. 1.5 Principles of foundry layout	1 Comparative analysis of different molding methods and their advantages in various applications. Ii Importance of quality control in metal casting processes.

		design and optimization. 1.6 Essential equipment in metal casting: furnaces, molds, ladles, crucibles, and gating systems 1.7 Types of patterns: solid, split, matchplate, and shell patterns. 1.8 Design considerations for pattern making and material selection 1.9 Introduction to cores: types, materials, and core-making processes. 1.10 Applications of cores in creating internal features and complex geometries. homogeneous materials 1.11 Techniques for core assembly and integration into casting molds 1.12 Molding Techniques	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Analysis of case studies highlighting successful metal casting projects

ii. Other Activities(Role play):

Design and present a comprehensive metal casting process optimization plan..

PCC-MMF202.2: Design and analyze the melt flow in mould gating and rising system

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	1
SL	1
Total	14

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO2.1 To understand the concept of melt flow in casting and moulding processes. **SO2.** To analyze gating systems and their role in controlling flow patterns. **SO2.3** To evaluate fluidity and its influence on casting quality. **SO2.4** To perform flow analysis to optimize process parameters.. **SO2.5** To apply theoretical concepts to practical scenarios in mould design and process optimization.	.	Unit-2 Melt Flow Analysis and Gating Systems 2.1 Introduction to Melt Flow 2.2 Factors influencing melt flow behavior 2.3 Types of gating systems (e.g., sprue, runner, gates) 2.4 Design considerations for effective gating 2.5 Fluidity of Molten Materials 2.6 Factors affecting fluidity (e.g., temperature, composition) 2.7 Techniques for simulating and analyzing melt flow 2.8 Strategies to minimize defects (e.g., shrinkage, porosity) 2.9 Balancing flow and pressure distribution in the mould cavity 2.10 Mold flow analysis experiments) 2.11. Tutorial-1 2.12 Tutorial-1I	i. Experimental Methods for Flow Analysis.

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. injection molding processes

PCC-MMF202.3: Understanding casting solidification phenomenon and identify various casting defects and their remedies

Approximate Hours

Item	AppX Hrs
Cl	13
LI	0
SW	2
SL	1
Total	16

Session Outcomes (SOs)	(LI)	Classroom Instruction (Cl)	Self Learning (SL)
SO3. 1 Analyze heat transfer mechanisms during solidification in different casting processes.. **SO3.2** Identify types of solidification defects (e.g., shrinkage, porosity, hot tearing) and their attributes. **SO3.3** Apply simulation techniques to predict solidification patterns and optimize casting processes.. **SO3.4** Evaluate inspection techniques used to detect casting defects and assess part quality. **SO3.5** Utilize expert systems for diagnosing casting defects and recommending process improvements.	.	**Unit-3:** Introduction to Solidification in Casting 3.1 Overview of solidification processes in casting 3.2 Heat transfer mechanisms during solidification 3.3 Shrinkage defects: causes, attributes, and prevention 3.4 Porosity and gas defects in castings 3.5 Design and optimization of feeding systems 3.6 Hot tearing and other structural defects 3.7 Formation of dendritic and equiaxed grain structures 3.8 Influence of alloy composition on microstructure 3.9 Simulation Techniques for Solidification Analysis 3.10 Principles of solidification simulation 3.11 Case studies using casting simulation software 3.12 . Tutorial-1 3.13 Tutorial-1I	i. Optimization of casting processes based on simulation results

SW-3 Suggested Sessional Work (SW):

a. Assignments:

b. Case studies of expert system applications in casting industries

c. Corrective measures for common casting defects

PCC-MMF202.4: Classify different mould types for plastics product and understood polymerization and synthesis techniques

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO4.1 Understand the chemical composition and structures of different types of plastics used in molding. **SO4.2** Learn about polymerization processes and synthesis techniques for plastics.. **SO4.3** Explore various molding methods and understand their applications, advantages, and limitations.. **SO4.** Gain practical knowledge of processing parameters, equipment, and material selection for different molding processes.. **SO4.5** Analyze case studies and real-world applications of plastics molding and processing.	.	**Unit-4 :** Introduction to Plastics 4.1 Overview of plastics materials 4.2 Chemical composition and molecular structures of polymers 4.3 Types of polymerization: addition, condensation 4.4 Synthesis methods: bulk, solution, suspension, emulsion polymerization 4.5 Principles and process steps of Injection Molding 4.6 Design considerations and tooling of Injection Molding 4.7 Basics of extrusion 4.8 Types of extrusion processes: hot and cold extrusion 4.9 Principles and variations (extrusion blow molding, injection blow molding) 4.10 Transfer molding process and applications 4.11 Casting and Reaction Injection Molding (RIM) 4.12 Advantages and limitations of casting and RIM	i. Applications and case studies of injection moulding

SW-4 Suggested Sessional Work (SW):

a. Assignments:

I Environmental considerations in plastics molding

ii Common defects and troubleshooting techniques.

PCC-MMF202.5: Understand different plastics processing methods and their working principles.

Approximate Hours

Item	Appx Hrs
Cl	11
LI	0
SW	1
SL	1
Total	13

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 To understand the fundamentals of plastic flow behavior in mold design. **SO5.2** To analyze pressure and shear stress distribution in injection molding processes. **SO5.3** To develop effective gating layout strategies for optimizing mold design **SO5.4** To conduct cooling analysis to enhance efficiency and quality in molding processes.. **SO5.5** To review existing CAD/CAM packages tailored for casting and molding applications.		**Unit5:** Introduction to Plastic Flow in Mold Design 5.1 Definition and importance of plastic flow in molding processes. 5.2 Types of molds and their applications. 5.3 Principles of pressure distribution during injection molding. 5.4 Shear stress effects on material flow and mold design considerations. 5.5 Types of gates: sprue, runner, and gate design principles. 5.6 Factors influencing gate location and size. 5.7 Importance of cooling in mold	I mold design simulations and analysis.

		design. 5.8 Techniques for analyzing and optimizing cooling channels. 5.9 CAM software capabilities for machining and manufacturing molds. 5.10 . Tutorial-1 5.11 Tutorial-1I	

SW-5 Suggested Sessional Work (SW):

a. Assignments:

Advantages, challenges, and industrial applications of plastics moulding

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PCC-MMF202.1: Identify suitable casting processes and their working principles to manufacture products.	12	2	2	**16**
PCC-MMF202.1: Design and analyze the melt flow in mould gating and rising system	12	1	1	**14**
PCC-MMF202.3: Understanding casting solidification phenomenon and identify various casting defects and their remedies	13	2	1	**16**
PCC-MMF202.4: Classify different mould types for plastics product and understood polymerization and synthesis techniques	12	2	1	15
. **PCC-MMF202.5** Understand different plastics processing methods and their working principles.	11	1	1	**13**
Total Hours	**60**	8	6	**74**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Introduction to metal casting process	01	02	03	06
CO-2	Metal flow process	01	03	07	11
CO-3	Solidifications and heat transfer	01	07	04	12
CO-4	Plastic mouldings	01	06	04	11
CO-5	Plastic flow and gating system	01	06	03	10
Total		5	24	21	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Casting and Moulding Technology** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher	Edition &Year
1	*PrinciplesofMetalCasting*	R.W.Heine,C.R.LoperandP.C.Rosenthal	McGraw Hill	1976
2	*Fundamentals of Metal Casting Technology*	P. C.Mukherjee	Oxford and IBH Publ. Co.	1979
3	*Plastics Mold Engineering*	J.H.Dubois And W.bble	NostrandReihnhold, New York	1987
4	*TheDieCastingBook*,	A.C.Street	PortcullisPressLtd	1986

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M. Tech. Mechanical

Engineering Course Code: PCC-MMF202

Course Title: Casting and Moulding Technology

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1: Understand the theory of plasticity and yield criteria.	2	2	2	2	3	2	3	2	2	1	3	1	2	3	3	1
CO 2 : Understanding Casting and Moulding Technology and Applications	2	2	1	2	2	2	3	2	1	1	2	1	2	2	2	1
CO3: Analyze Casting and Moulding Technology.	2	2	2	1	2	2	2	2	1	2	1	1	1	1	2	2
CO 4 Design rolls for rolling, forging and extrusion.	2	3	3	2	3	2	3	2	2	1	2	1	1	3	3	2
CO5: Describe the latest trends in metal forming	2	1	1	1	2	3	3	2	1	1	2	2	1	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO-1: Understand the theory of plasticity and yield criteria.	SO1.1 SO1.2 SO1.3 SO1.4		Introduction to metal casting process 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7,1.8, 1.9, 1.10, 1.11, 1.12	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 2: Understanding Casting and Moulding Technology and Applications.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 Metal flow process 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9, 2.10, 2.11, 2.12,	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3 : Analyze Casting and Moulding Technology.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Solidifications and heat transfer 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8 3.9, 3.10, 3.11, 3.12, 3.13	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Design rolls for rolling, forging and extrusion	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4: Plastic mouldings 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 5: Describe the latest trends in metal forming	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit-5: Plastic flow and gating system 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10 , 5.11,	

Semester-II

Course Code: PCC-MMF201

Course Title: **Metal Forming Processes**

Pre-requisite: Understanding the properties of metals, such as mechanical properties (strength, hardness, ductility), thermal properties, and microstructure.Basic knowledge of various manufacturing processes like casting, machining, and welding

Rationale: Metal forming processes constitute a significant portion of manufacturing techniques employed across various industries. Studying these processes provides insights into how raw materials (metals) are shaped into finished products through controlled deformation. Metal forming techniques find applications across diverse industries such as automotive, aerospace, electronics, and construction. Understanding these processes prepares engineers for various career opportunities and allows them to contribute effectively to industry-specific challenge

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

PCC-MMF201.1: Understand the theory of plasticity and yield criteria.

PCC-MMF201.2: Understanding Metal Forming Processes and Applications.

PCC-MMF201.3: Analyze metal forming processes.

PCC-MMF201.4: Design rolls for rolling, forging and extrusion.

PCC-MMF201.5: Describe the latest trends in metal forming

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**PCC-MMF201**	**Metal Forming Processes**	4	0	1	1	6	4

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
PCC	**PCC-MMF201**	Metal Forming Processes	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

PCC-MMF201.1 Understand the theory of plasticity and yield criteria**.**

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 Understand Fundamental Concepts **SO1.2** Explain the theory of plasticity and its significance in material behavior during deformation.. **SO1.3** Explore different yield criteria theories, focusing on isotropic materials. **SO1.4** Application examples and practical implications in engineering design and analysis. **SO1.**5 Focus on isotropic yield criteria and their application to homogeneous materials	.	**Unit-1.0 Introduction** 1.1 Introduction of the subject 1.2 Define plasticity and distinguish between elastic and plastic deformation.. 1.3 Introduce key terms such as yield stress, flow stress, and strain hardening. 1.4 Theory of plasticity and its significance in material behavior during deformation. 1.5 different yield criteria theories, focusing on isotropic material 1.6 stress and strain curves for plastic materials	1. fundamental concepts in plasticity theory and yield criteria.

		1.7 Explanation of yield point, ultimate tensile strength, and plastic deformation mechanisms. 1.8 Overview of key theories (e.g., Von Mises, Tresca) and their assumptions. 1.9 Derivation of stress criteria for plastic deformation. 1.10 Introduction to yield criteria and their role in predicting material failure 1.11 isotropic yield criteria and their application to homogeneous materials 1.12 Application examples and practical implications in engineering design and analysis	

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Problem-solving exercises to assess understanding of stress-strain relationships and yield criteria.

ii. Other Activities(Role play):

engagement in discussions on the application of plasticity theory in engineering practice..

PCC-MMF201.2: Understanding Metal Forming Processes and Applications.

Approximate Hours

Item	AppX Hrs
Cl	14
LI	0
SW	2
SL	2
Total	18

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2.1 To introduce the basics of metal forming processes and their significance in manufacturing **SO2.2** Understanding the Principles of Hot Working in Metal Forming **SO2.3** Acquire practical knowledge and skills in cold working techniques and understand their role in manufacturing. **SO2.4** To introduce the warm working processes, benefits, and practical applications. **SO2.5** To explore the principles and applications of bulk forming techniques, with a focus on rolling processes..	.	Unit-2 Hot, cold and warm working 2.1 Introduction to metal forming processes 2.2 Importance of metal forming in industry 2.3 Classification of metal forming processes (bulk forming, sheet forming, etc.) 2.4 Definition and characteristics of hot working processes. Recrystallization temperature and its importance 2.5 Types of hot working processes (e.g., forging, extrusion, rolling) 2.6 Definition and characteristics of cold working, 2.7 Types of cold working processes (e.g., cold rolling, cold forging) 2.8 Material properties and effects of cold working 2.9 Quality control in cold working processes	i. Equipment used in rolling processe. ii. Analysis of case studies illustrating successful implementation of rolling processes

		2.10 Definition and characteristics of warm working . Types of warm working processes (e.g., warm rolling, warm forging) 2.11 Industry examples and case studies of warm working applications 2.12 Principles of rolling and its variants (hot rolling, cold rolling) 2.13 Material considerations and selection for rolling	

SW-2 Suggested Sessional Work(SW):

a. Assignments:

i. challenges and strategies for optimizing cold working processes.

ii. Case studies and examples of industries using hot working processes.

PCC-MMF201.3: Analyze metal forming processes.

.

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	2
SL	2
Total	15

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO3.1 understand the fundamental principles of forging processes. **SO3.2** Exploring Extrusion Techniques **SO3.3** understand the concepts and applications of wire drawing. **SO3.4** Applying Upper Bound Equilibrium Techniques in Manufacturing. **SO3.5** Analyze Techniques for Process Optimization	.	**Unit-3:** Introduction to Advanced Manufacturing Processes 3.1 Overview of advanced manufacturing processes: forging, extrusion, and wire drawing. 3.2 Importance of advanced manufacturing techniques in various industries. 3.3 Historical evolution and current trends in advanced manufacturing. 3.4 Fundamentals of forging: deformation, metal flow, and heat treatment 3.5 Basics of wire drawing Wire drawing process and equipment 3.6 Factors influencing wire drawing operations	i. Simulation exercises for upper-bound equilibrium analysis ii. Applications and case studies of forging process

		3.7 Introduction to upper-bound methods in materials processing 3.8 Application of upper-bound equilibrium to slab processes 3.9 Case studies and practical examples of upper bounded equillibrium 3.10 . Tutorial-1 3.11 Tutorial-1I	

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Applications and case studies of wire drawing processes

b. Case studies and practical examples of Upper-Bound Equilibrium

c. Project:

PCC-MMF201.4: Design rolls for rolling, forging and extrusion

Approximate Hours

Item	AppXHrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	(LI)	Classroom Instruction (Cl)	Self Learning (SL)
SO4.1 Understand the assumptions and principles underlying slip-line field theory.. **SO4.2** Identify different types of forming tools used in metal forging processes. **SO4.3** Analyze the factors influencing die wear and maintenance in forging operations. **SO4.4** Apply advanced principles of die design to optimize forging processes. **SO4.5** Evaluate real-world examples of forging tool and die design challenges and solutions..	.	**Unit-4 :** Introduction to Metal Forming and Slip-Line Field Analysis 4.1 Introduction to slip-line field theory and its applications in metal forming 4.2 Derivation and application of slip-line field equations for various forming processes 4.3 Types and functions of forming tools in metal forging processes 4.4 Design considerations: materials selection, geometry, and heat treatment of forming tools 4.5 Design principles for forging dies: cavity design, draft angles, and parting lines 4.6 Advanced Techniques in Die Design for Forging 4.7 Optimization techniques for die design in forging operations 4.8 Simulation tools for predicting metal flow and optimizing die geometry	i. Principles and assumptions of slip-line field theory

		4.9 Innovations in die materials and coatings to enhance die life and performance 4.10 Advanced roles in metal forming industries Overall equipment effectiveness 4.11 Tutorial-1 4.12 Tutorial-2	

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Real-world examples of successful tool and die designs in forging industries.

ii Case studies on overcoming challenges in forging operations through innovative tool and die solutions

PCC-MMF201.5: Describe the latest trends in metal forming**.**

Approximate Hours

Item	Appx Hrs
Cl	12
LI	0
SW	2
SL	1
Total	15

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO5.1 Identify key parameters and materials for forging rolls.. **SO5.2** Evaluate design principles for rolling mill rolls.. **SO5.3** Apply algorithms to solve LP problems and optimize solutions. **SO5.4** Discuss emerging techniques like forming from the mashy stage, isothermal forging, and near-net-shape manufacturing. **SO5.5** Apply theoretical knowledge to practical design and manufacturing scenarios..		**Unit5:** 5.1 Principles of roll design for various forging techniques (open die, closed die, etc.) Constraints 5.2 Material selection, heat treatment, and surface coating considerations for forging rolls Simplex method 5.3 Case studies and examples of effective roll designs in forging operations Transportation 5.4 Functions and types of rolls used in rolling mills (flat, profile, universal) 5.5 Design parameters and	I Simulation techniques for predicting roll performance and optimizing design

		considerations for rolling mill rolls 5.6 Types of extrusion processes (hot, warm, cold) and their die requirements 5.7 Die design principles: cavity geometry, land length, and exit angle optimization 5.8 Die design principles: cavity geometry, land length, and exit angle optimization 5.9 Optimization methods for die and roll design in metal forming processes 5.10 Simulation software tools for analyzing metal flow and optimizing tooling design 5.11 Innovations in die materials and coatings to enhance performance and durability 5.12 Emerging techniques: forming from the mushy stage, isothermal forging, and near-net-shape manufacturing	

SW-5 Suggested Sessional Work (SW):

a. Assignments:

Advantages, challenges, and industrial applications of advanced forming methods

b. Project: Design projects focusing on the optimization of roll and die designs using simulation tools.

AKS University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M. Tech. (Mechanical Engineering) Program

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PCC-MMF201.1: Understand the theory of plasticity and yield criteria .	12	2	1	**15**
PCC-MMF201.1: Understanding Metal Forming Processes and Applications.	13	2	2	**17**
PCC-MMF201.3: Analyze metal forming processes	11	2	2	**15**
PCC-MMF201.4: Design rolls for rolling, forging and extrusion	12	2	1	15
. **PCC-MMF201.5** Describe the latest trends in metal forming	12	2	1	**15**
Total Hours	**60**	10	7	**77**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Introduction	01	02	03	06
CO-2	Hot cold and warm processes	01	03	07	11
CO-3	Forging extrusion and wire drawing	01	07	04	12
CO-4	Forming tools	01	06	04	11
CO-5	Design of forming rolls	01	06	03	10
Total		5	24	21	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Metal Forming Processes** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher	Edition &Year
1	Metal forming	K.Lange	McGraw Hill	1985
2	Foreign materials and practices	A.M.Sabaroff	ReinholdPublishers,	1982
3	Extrusion metals	Wiley	Pearson	1980
4	Manufacturing Technology Vol.I&Vol.II	G.W.Rowe.	EllisHorwood	1987

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni, Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M. Tech. Mechanical

Engineering Course Code: PCC-MMF201

Course Title: Metal Forming Processes

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
co1: Understand the theory of plasticity and yield criteria.	3	3	3	2	3	2	3	2	2	1	3	1	2	3	3	1
co 2 : Understanding Metal Forming Processes and Applications	3	2	1	2	1	2	3	2	1	1	2	1	2	2	2	1
co3: Analyze metal forming processes.	3	2	2	1	1	2	2	2	1	2	1	1	1	1	2	2
co 4 Design rolls for rolling, forging and extrusion.	1	3	3	2	3	2	3	2	2	1	2	1	1	3	3	2
co5: Describe the latest trends in metal forming	3	1	1	1	1	3	3	3	1	1	2	2	1	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO-1: Understand the theory of plasticity and yield criteria.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Introduction 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7,1.8, 1.9, 1.10, 1.11, 1.12	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 2: Understanding Metal Forming Processes and Applications.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2 Hot cold and warm processes 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3 : Analyze metal forming processes.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 : Forging extrusion and wire drawing 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8 3.9, 3.10, 3.11	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Design rolls for rolling, forging and extrusion	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4: Forming tools 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 5: Describe the latest trends in metal forming	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit-5: Design of forming rolls 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10 , 5.11, 5.12	

Semester-II

Course Code: MMF203I

Course Title: Metrology and computer aided inspection

Pre-requisite: Students should have knowledge about Calculus, Physics, Programming, CAD, Statistics, Material Science, NDT Methods, Quality Control, Analytical Skills, Technical Skills, Problem-Solving Skills.

Rationale: Ensures precise measurements, enhances inspection accuracy, and supports quality control by integrating advanced technologies like CAD and NDT methods. Critical for improving manufacturing processes and maintaining high standards in engineering applications.

Course Outcomes:

MMF203I.1: Understanding metrology standards, GD&T procedures, surface metrology, and tolerance analysis for precision measurement and quality assurance.

MMF203I.2: Application of laser-based metrology for dimensional, roundness, and surface roughness measurements in manufacturing and inspection processes.

MMF203I.3: Use of optoelectronic devices, machine vision, and advanced techniques for on-line monitoring, tool wear measurement, and surface characterization.

MMF203I.4: Types and applications of Coordinate Measuring Machines (CMMs), integration with computer systems for dimensional and surface finish metrology.

MMF203I.5: Utilization of various sensors including optical, inductive, capacitive, and advanced technologies like laser and ultrasonic for inspection in manufacturing environments.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**MMF203 I**	Metrology and Computer aided inspection.	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ESA)
PCC	**MMF203I**	Metrology and Computer aided Inspection	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF203I.1: Understanding metrology standards, GD&T procedures, surface metrology, and tolerance analysis for precision measurement and quality assurance.

Approximate Hours

Item	AppX Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 Define metrology standards and traceability principles. SO1.2 Review standard instruments for dimension and form tolerance. SO1.3 Apply tolerance analysis in surface metrology methods.	.	**Unit-1.0 Metrology and Techniques:** 1.1 Standands in metrology-definition, 1.2 Traceability, 1.3 Characteristics Length & Angular measurements- 1.4 Review of standard instruments, 1.5 GD and tolerance procedure- 1.6 Review of dimension & form tolerance and methods of measurement, 1.7 Tolerance analysis, 1.8 Surface metrology and instruments, 1.9 Methods and new approaches	1. Precision engineering techniques 2. Advancements in metrology technology

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Discuss the evolution of measurement accuracy in engineering, focusing on the role of standards, tolerance analysis, and modern surface metrology techniques.

MMF203I.2: Application of laser-based metrology for dimensional, roundness, and surface roughness measurements in manufacturing and inspection processes.

Approximate Hours

Item	AppX Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2.1 Describe LASER light sources and interferometers in metrology. SO2.2 Perform in-process measurements using LASER micrometers. SO2.3 Apply LASER techniques for roundness and surface roughness measurement.	.	**Unit-2 Laser Applications in Metrology:** 2.1 LASER light source, 2.2 LASER interferometer, 2.3 LASER alignment telescope, 2.4 LASER micrometer. 2.5 On-line and in-process measurements of diameter, 2.6 Roundness and surface roughness using LASER, 2.7 Micro holes and topography measurements 2.8 Straightness measurement 2.9 Flatness measurement	1. Applications of photonics in metrology 2. Advanced techniques in laser metrology

SW-2 Suggested Sessional Work(SW):

a. Assignments:

i. Examine the role of laser technology in advancing metrology, focusing on its applications in dimensional measurement, surface characterization, and precision alignment..

MMF203I.3: Use of optoelectronic devices, machine vision, and advanced techniques for on-line monitoring, tool wear measurement, and surface characterization.

Approximate Hours

Item	AppX Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO3.1 Compare optoelectronic devices for contact and non-contact measurements. SO3.2 Apply machine vision for shape identification and edge detection. SO3.3Integrate robot interfacing with image processing for surface roughness measurement.	.	**Unit -3.0 Special Measuring Instruments and Techniques:** 3.1 Optoelectronic devices 3.2 Contact and non-contact types 3.3 Applications in on-line and In-process monitoring systems 3.4 Tool wear measurement, 3.5 Surface measurement, Machine vision, shape Identification, 3.6 Edge detection techniques, Normalisation, 3.7gray scale correlation, Template Techniques, 3.8 Surface roughness using vision system, 3.9 Interfacing robot and image processing system.	1. Emerging trends in automated inspection systems 2. Integration of robotics in metrology applications

SW-3 Suggested Sessional Work (SW):

a. Assignments:

i. Explore the integration of advanced optoelectronic devices and machine vision systems in industrial metrology, emphasizing their roles in real-time monitoring, tool wear analysis, and automated quality control.

MMF203I.4: Types and applications of Coordinate Measuring Machines (CMMs), integration with computer systems for dimensional and surface finish metrology.

Approximate Hours

Item	AppXHrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO4.1 Identify types of CMM and their respective probes for dimensional metrology. SO4.2 Utilize non-contact electro-optical sensors for surface finish measurements. SO4.3 Integrate CMM data with computer systems for statistical evaluation and logging.	.	**Unit -4 Co-ordinate Measuring Machine:** 4.1 Types of CMM. 4.2 Probes used 4.3 Applications, 4.4 Non-contact CMM using electro optical sensors for dimensional metrology, 4.5 Non-contact sensors for surface finish measurements, 4.6 Statistical evaluation of data using computer, 4.7 Data integration of CMM and data logging in computers. 4.8 Tutorial 1 4.9 Tutorial 2	1. Innovations in coordinate measuring technology 2. Advantages of non-contact metrology techniques

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Discuss the evolution of Coordinate Measuring Machines (CMMs), detailing various types, probe technologies, and their applications in dimensional metrology and surface finish analysis. Explain the role of statistical data evaluation and computerized data integration in enhancing measurement accuracy.

MMF203I.5: Utilization of various sensors including optical, inductive, capacitive, and advanced technologies like laser and ultrasonic for inspection in manufacturing environments.

Approximate Hours

Item	Appx Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Apply photo detectors and deflection methods in manufacturing. SO5.2 Evaluate applications of inductive, capacitive, and microwave sensors. SO5.3 Analyze advanced sensor technologies like bar code systems and tactile sensors.		**Unit 5.0: Sensors in Inspection:** 5.1 Manufacturing applications of photo detectors, 5.2 Deflection methods-beam detection, 5.3 Reflex detection, & Proximity detection. 5.4 Applications of Indutive and Capacitive proximity sensors 5.5 Understanding microwave sensing applications laser sensors and limit switches. 5.6 Advanced sensor technology - Bar code systems 5.7 Principles and application of color sensors 5.8 electro-magnetic identifier, Tactile sensors 5.9 Ultrasonic sensors, Odour sensors	1. Innovative applications of sensor technology in manufacturing. 2. Emerging trends in sensor integration for industrial automation

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Explore the diverse applications of sensor technologies in modern manufacturing, focusing on their roles in automated detection systems and quality control processes. Discuss advancements in sensor types, including proximity, optical, and tactile sensors, and their contributions to enhancing industrial productivity and product quality.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
MMF203I.1: Understanding metrology standards, GD&T procedures, surface metrology, and tolerance analysis for precision measurement and quality assurance.	9	1	1	11
MMF203I.2: Application of laser-based metrology for dimensional, roundness, and surface roughness measurements in manufacturing and inspection processes.	9	1	1	11
MMF203I.3: Use of optoelectronic devices, machine vision, and advanced techniques for on-line monitoring, tool wear measurement, and surface characterization.	9	1	1	11
MMF203I.4: Types and applications of Coordinate Measuring Machines (CMMs), integration with computer systems for dimensional and surface finish metrology.	9	1	1	11
MMF203I.5: Utilization of various sensors including optical, inductive, capacitive, and advanced technologies like laser and ultrasonic for inspection in manufacturing environments.	9	1	1	11
Total Hours	45	5	5	55

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Metrology and Techniques	01	02	03	06
CO-2	Laser Applications in Metrology	01	03	07	11
CO-3	Special Measuring Instruments and Techniques	01	07	04	12
CO-4	Co-ordinate Measuring Machine	01	06	04	11
CO-5	Sensors in Inspection	01	06	03	10
Total		5	24	21	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Metrology and computer aided inspection** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher
1	Fundamentals of dimensional Metrology	T.Busch and R. Harlow	Delmar,3e
2	Enginneering metrology	G.Thomas and G.Butter worth	PUB
3	Sensors and control systems in manufacturing	Sabne Soloman	McGraw Hill Book
4	Measurment systems : Application and design	Doebelin	International Student edition
5	Optoelectronics for technology and engineering	Robert G. Seippel	Prentice Hall India
6	Lecture notes provided by Dept. of Mechanical Engineering, AKS University, Satna		

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M.Tech Mechanical

Engineering Course Code: MMF203I

Course Title: Metrology and Computer aided inspection

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO 5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO:1 : Understanding metrology standards, GD&T procedures, surface metrology, and tolerance analysis for precision measurement and quality assurance.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO: 2: Application of laser-based metrology for dimensional, roundness, and surface roughness measurements in manufacturing and inspection processes.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO: 3: Use of optoelectronic devices, machine vision, and advanced techniques for on-line monitoring, tool wear measurement, and surface characterization.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO: 4: Types and applications of Coordinate Measuring Machines (CMMs), integration with computer systems for dimensional and surface finish metrology.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO: 5: Utilization of various sensors including optical, inductive, capacitive, and advanced technologies like laser and ultrasonic for inspection in manufacturing environments.	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	**MMF203I.1:** Understanding metrology standards, GD&T procedures, surface metrology, and tolerance analysis for precision measurement and quality assurance.	SO1.1 SO1.2 SO1.3		Unit :1 Metrology and Techniques 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7,1.8,1.9	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	**MMF203I.2**: Application of laser-based metrology for dimensional, roundness, and surface roughness measurements in manufacturing and inspection processes.	SO2.1 SO2.2 SO2.3		Unit :2 Laser Applications in Metrology 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	**MMF203I.3:** Use of optoelectronic devices, machine vision, and advanced techniques for on-line monitoring, tool wear measurement, and surface characterization.	SO3.1 SO3.2 SO3.3		Unit :3 Special Measuring Instruments and Techniques 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8,3.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	**MMF203I.4:** Types and applications of Coordinate Measuring Machines (CMMs), integration with computer systems for dimensional and surface finish metrology.	SO4.1 SO4.2 SO4.3		Unit :4 Co-ordinate Measuring Machine 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	**MMF203I.5:** Utilization of various sensors including optical, inductive, capacitive, and advanced technologies like laser and ultrasonic for inspection in manufacturing environments.	SO5.1 SO5.2 SO5.3		Unit :5 Sensors in Inspection 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	

Semester-II

Course Code: MMF203M

Course Title: Modeling and simulation

Pre-requisite: Basic knowledge of statistics, probability, and computer programming, along with an understanding of system analysis and mathematical modeling.

Rationale: Modeling and simulation are essential for analyzing complex systems, making informed decisions, and optimizing performance in various engineering and management applications.

Course Outcomes:

MMF203M.1: Analyze different system models and simulations, understanding their steps, advantages, and hypothesis testing.

MMF203M.2: Develop and validate credible simulation models using statistical procedures and stochastic input elements.

MMF203M.3: Generate random variates and variables using various methods and understand simulation languages and their features..

MMF203M.4: Perform output data analysis, applying methods for steady-state analysis and comparing simulation techniques.

MMF203M.5: Apply simulation techniques to flow shop, job shop systems, and inventory management problems

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	MMF203M	Modeling and Simulation	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ESA)
PCC	**MMF203M**	Modeling and Simulation	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF203M.1: Analyze different system models and simulations, understanding their steps, advantages, and hypothesis testing.

Approximate Hours

Item	AppX Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1.1 Understand different methods for analyzing systems and applying appropriate models. **SO1.2** Define simulation and categorize types of simulation models, evaluating their pros and cons. **SO1.3** Explore parameter estimation techniques, including point estimates, confidence intervals, and hypothesis testing principles.	.	**Unit-1.0 System Analysis, Modeling, Simulation Basics** 1.1 System – ways to analyze the system 1.2 Model - types of models 1.3 Simulation – Definition – Types of simulation models 1.4 Steps involved in simulation – Advantages & Disadvantages. 1. 5Parameter estimation – estimator – properties – estimate 1.6 Point estimate – confidence interval estimates 1.7 Independent – dependent – hypothesis 1.8 Types of hypothesis – steps 1.9 Types 1 & 2 errors – Framing , Strong law of large numbers	1. Comparative Analysis Techniques in System Modeling 2. Critical Evaluation of Statistical Estimation

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. How do different types of models aid in understanding complex systems? Discuss their application in simulation and parameter estimation

MMF203M.2: Develop and validate credible simulation models using statistical procedures and stochastic input elements.

Approximate Hours

Item	AppX Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2.1 Develop simulation models with validation, verification, and timing credibility. **SO2.2** Apply principles for valid simulation modeling and statistical verification techniques. **SO2.3** Assess stochastic input modeling using suitable theoretical distributions effectively.	.	**Unit-2.0 Building, Validating Simulation Models** 2.1 Building of Simulation model – 2.2 validation – verification 2.3 credibility – their timing 2.4 Principles of valid simulation Modeling 2.5 Techniques for verification 2.6 Statistical procedures for developing credible model. 2.7 Modeling of stochastic input elements – importance 2.8 various procedures 2.9 theoretical distribution – continuous – discrete – their suitability in modeling.	1.Effective Strategies for Simulation Model Validation 2. Optimizing Input Modeling Techniques in Simulation

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. How can the principles of valid simulation modeling be applied to ensure credibility and accuracy in simulation models? Discuss techniques for validation and verification..

MMF203M.3: Generate random variates and variables using various methods and understand simulation languages and their features..

Approximate Hours

Item	AppX Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO3.1 Master techniques for generating and validating random variates and variables. **SO3.2** Compare simulation languages and simulators, analyzing their software and statistical capabilities. **SO3.3** Simulate and evaluate M/M/1 queue models using different simulation languages.	.	**Unit -3.0 Random Variate Generation, Simulation** 3.1 Generation of random variates – factors for selection 3.2 methods – inverse transform – composition 3.3 convolution – acceptance – rejection 3.4 generation of random variables – exponential – uniform – weibull – normal 3.5 Bernoullie – Binomial – uniform – poison. 3.6 Simulation languages – comparison of simulation languages with general purpose languages – 3.7 Simulation languages vs Simulators – software features 3.8 statistical capabilities – G P S S – SIMAN-SIMSCRIPT 3.9 Simulation of M/M/1 queue – comparison of simulation languages.	1.Advanced Techniques in Random Variate Generation 2.Evaluation of Simulation Language Capabilities

SW-3 Suggested Sessional Work (SW):

a. Assignments:

How does the selection of random variate generation methods impact simulation accuracy? Compare simulation languages and their capabilities in modeling stochastic processes like M/M/1 queues.

MMF203M.4: Perform output data analysis, applying methods for steady-state analysis and comparing simulation techniques.

Approximate Hours

Item	AppXHrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO4.1 Analyze output data and apply techniques for effective interpretation. **SO4.2** Differentiate types of simulations based on output data analysis methods. **SO4.3** Implement warm-up periods and Welch algorithm for accurate simulation results.	.	**Unit -4 Output Data Analysis, Simulation Types** 4.1 Output data analysis – 4.2 Types of Simulation with respect to output data analysis 4.3 warm up period 4.4 Welch algorithm 4.5 Approaches for Steady 4.6 State Analysis 4.7 replication 4.8 Batch means methods 4.9 comparisons	1.Modern Approaches to Output Data Analysis 2. Comparative Methods in Simulation Performance Evaluation

SW-4 Suggested Sessional Work (SW):

a. Assignments:
iHow do different types of simulation approaches, such as batch means methods and the Welch algorithm, contribute to output data analysis and steady-state assessment?

MMF203M.5: Apply simulation techniques to flow shop, job shop systems, and inventory management problems

Approximate Hours

Item	Appx Hrs
Cl	9
LI	0
SW	1
SL	1
Total	11

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO5.1 Apply simulation techniques to analyze and optimize flow shop and job shop systems. **SO5.2** Evaluate M/M/1 queues with infinite and finite capacities using simulation. **SO5.3** Implement simulation for fixed period inventory systems and operational scenarios like the Newsvendor problem.		**Unit 5.0: Simulation Applications in Operations** 5.1 Applications of Simulation 5.2 flow shop system 5.3 job shop system 5.4 M/M/1 queues with infinite 5.5 M/M/1 queues with finite capacities 5.6 Simple fixed period inventory system 5.7 New boy paper problem. 5.8 Numerical 1 5.9 Numerical 2	1. Optimizing Flow Shop and Job Shop Systems 2. Analyzing Inventory Systems with Simulation

SW-5 Suggested Sessional Work (SW):

a. Assignments:
i. How can simulation techniques be applied to optimize operations in flow shop and job shop systems? Discuss specific applications in inventory management and queueing theory.

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
MMF203M.1: Analyze different system models and simulations, understanding their steps, advantages, and hypothesis testing.	9	1	1	11
MMF203M.2: Develop and validate credible simulation models using statistical procedures and stochastic input elements.	9	1	1	11
MMF203M.3: Generate random variates and variables using various methods and understand simulation languages and their features..	9	1	1	11
MMF203M.4: Perform output data analysis, applying methods for steady-state analysis and comparing simulation techniques	9	1	1	11
MMF203M.5: Apply simulation techniques to flow shop, job shop systems, and inventory management problems	9	1	1	11
Total Hours	45	5	5	55

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	System Analysis, Modeling, Simulation Basics	01	02	03	06
CO-2	Building, Validating Simulation Models	01	03	07	11
CO-3	Random Variate Generation, Simulation	01	07	04	12
CO-4	Output Data Analysis, Simulation Types	01	06	04	11
CO-5	Simulation Applications in Operations	01	06	03	10
Total		5	24	21	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for **Modeling and Simulation** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher
1	Simulation Modelling and Analysis	Law, A.M. & Kelton	McGraw Hill
2	Discrete Event System Simulation	Banks J. & Carson J.S	PH, Englewood Cliffs
3	Simulation of Manufacturing Systems	Carrie A.	Wiley
4	A Course in Simulation	Ross, S.M.	McMillan
5	Simulation Modelling and SIMNET	Taha H.A.	PH, Englewood Cliffs
6	Lecture notes provided by Dept. of Mechanical Engineering, AKS University, Satna		

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M.Tech in Mechanical Engineering

Engineering Course Code: MMF203M

Course Title: Modeling and Simulation

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO 5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO-1 Analyze different system models and simulations, understanding their steps, advantages, and hypothesis testing.	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO-2 Develop and validate credible simulation models using statistical procedures and stochastic input elements.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO-3 Generate random variates and variables using various methods and understand simulation languages and their features	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO-4 Perform output data analysis, applying methods for steady-state analysis and comparing simulation techniques	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO-5 Apply simulation techniques to flow shop, job shop systems, and inventory management problems	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	**MMF203M.1:** Analyze different system models and simulations, understanding their steps, advantages, and hypothesis testing.	SO1.1 SO1.2 SO1.3		**Unit:1 System Analysis, Modeling, Simulation Basics** 1.1,1.2,1.3,1.4,1.5,1.6,1.7,1.8,1.9	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	**MMF203M.2:** Develop and validate credible simulation models using statistical procedures and stochastic input elements.	SO2.1 SO2.2 SO2.3		**Unit :2 Building, Validating Simulation Models** 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	**MMF203M.3:** Generate random variates and variables using various methods and understand simulation languages and their features..	SO3.1 SO3.2 SO3.3		**Unit :3 Random Variate Generation, Simulation** 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8,3.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	**MMF203M.4:** Perform output data analysis, applying methods for steady-state analysis and comparing simulation techniques	SO4.1 SO4.2 SO4.3		**Unit :4 Output Data Analysis, Simulation Types** 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8, 4.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	**MMF203M.5:** Apply simulation techniques to flow shop, job shop systems, and inventory management problems	SO5.1 SO5.2 SO5.3		**Unit :5 Simulation Applications in Operations** 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9,	

Semester-II

Course Code: **MMF203K**

Course Title: Processing and Characterization Techniques

Pre-requisite: Prerequisites include understanding fundamental principles of materials science, familiarity with basic laboratory techniques, and knowledge of data analysis methods essential for processing and characterizing materials effectively in various applications.

Rationale: Processing and characterization techniques are crucial for understanding material properties, optimizing manufacturing processes, ensuring quality control, and advancing research in fields like materials science, engineering, and technology development.

Course Outcomes:

MMF203K**.1:** Enhance knowledge on processing for different material..
MMF203K**.2:** To know the characteristic and properties after processing of material.
MMF203K**.3:** To know about latest characterization technique
MMF203K.**4:** Enhance knowledge of thermal analysis technique
MMF203K**.5:** To examine fine detail using microscope.
Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**MMF203K**	Processing and Characterization Techniques	3	0	1	1	5	3

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),
LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
PCC	MMF 203K	Processing and Characterization Techniques	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF203K.1: Enhance knowledge on processing for different material..

Approximate Hours

Item	AppX Hrs
Cl	7
LI	0
SW	3
SL	1
Total	11

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (Cl)	Self Learning (SL)
SO1.1 Understand fundamental principles of melting, casting, heat treatment, thermo-mechanical processing, sheet metal forming, and welding in industrial applications... **SO1.2** Apply theoretical knowledge to analyze and optimize processes like melting, casting, heat treatment, thermo-mechanical processing, sheet metal forming, and welding.. SO1.3 Demonstrate proficiency in selecting appropriate processing techniques for specific materials and applications, ensuring quality and efficiency in production..	.	**Unit-1.0 Processing** 1.1 Introduction of Processing 1.2 melting 1.3 casting 1.4 heat treatment 1.5 thermo-mechanical processing 1.6 sheet metal forming 1.7 welding	1. Importance of Sheet metal forming

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Describe the welding processes

MMF203K.2: To know the characteristic and properties after processing of material..

Approximate Hours

Item	AppX Hrs
Cl	9
LI	0
SW	3
SL	1
Total	13

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO2.1 Utilize advanced techniques such as electron microscopy and crystallography to analyze phase transformations and structural characteristics in materials. **SO2.2** Evaluate mechanical properties including fatigue, fracture toughness, and integrity assessment in relation to material structure and processing methods.	.	Unit-2 Structural characterization 2.1 Introduction of Structural characterization 2.2 basic principles of phase transformation 2.3 basic principles of electron microscopy 2.4 crystallography by using modern techniques 2.5 Properties: mechanical 2.6 properties like fatigue, fracture toughness, integrity assessment 2.7 relating to structure 2.8 processing 2.9 corrosion evaluation	1 Constructional features of electron microscopy .

SW-2 Suggested Sessional Work (SW):

a. Assignments:

i. Analyze the Types of corrosion

MMF203K**.3:** To know about latest characterization technique

Approximate Hours

Item	AppX Hrs
Cl	11
LI	0
SW	3
SL	1
Total	15

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO3.1 Master X-ray diffraction for crystal structure analysis and phase identification, and apply residual stress measurement techniques in practical applications. **SO3.2** Develop skills in IR- and Raman spectroscopy for materials analysis, enabling identification and characterization of molecular structures and chemical compositions.	.	**Unit-3:** Characterization Techniques 3.1 X-ray diffraction 3.2 crystal structure 3.3 phase identification 3.4 residual stress measurement 3.5 other applications 3.6 Transmission Electron Microscopy 3.7 Construction of a TEM 3.8 operation of a TEM 3.9 development of modular Tool 3.10 helical interpolation 3.11 Electron diffraction	1.Design of crystal structure

SW-3 Suggested Sessional Work (SW):

a. Assignments:
Explain the Design of TEM

MMF203K.**4:** Enhance knowledge of thermal analysis technique

Approximate Hours

Item	AppX Hrs
Cl	6
LI	0
SW	3
SL	1
Total	10

Session Outcomes (SOs)	(LI)	Classroom Instruction (Cl)	Self Learning (SL)
SO4.1 Gain a comprehensive understanding of Differential Thermal Analysis (DTA), Differential Scanning Calorimetry (DSC), and Thermogravimetric Analysis (TGA) techniques, including their instrumentation and operational principles. **SO4.2** Explore diverse applications of DTA, DSC, and TGA in materials science and engineering through case studies, demonstrating their utility in studying phase transitions, thermal stability, and decomposition kinetics.	.	**Unit-4 :** thermal analysis 4.1 Outline of thermal analysis 4.2 thermal analysis technique 4.3 description of DTA/DSC/TGA 4.4 techniques and instrumentation 4.5 applications 4.6 case studies.	1.Importance of maintenance of DTA/DSC/TGA

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Application of thermal analysis technique

MMF203K.5: To examine fine detail using microscope.

Approximate Hours

Item	Appx Hrs
Cl	12
LI	0
SW	3
SL	1
Total	16

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Understand the principles of optical microscopy, including light optics, microscope components, and the capabilities and limitations of optical imaging techniques. **SO5.2** Gain proficiency in operating a Scanning Electron Microscope (SEM), interpreting SEM images, and extracting crystallographic information through techniques such as electron diffraction and analytical microscopy.		**Unit5:** Optical microscopy 5.1 introduction 5.2 light optics 5.3 microscope components 5.4 possibilities 5.5 limitations 5.6 Scanning Electron Microscopy 5.7 Optics 5.8 performance of a SEM 5.9 image interpretation 5.10 Crystallographic 5.11 crystallographic information in a SEM 5.12 analytical microscopy	1Application of light optics

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Application of Scanning Electron Microscopy

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
MMF203K.1:Enhance knowledge on processing for different material..	7	3	1	**11**
MMF203K.2: To know the characteristic and properties after processing of material.	9	3	1	**13**
MMF203K.3: To know about latest characterization technique	11	3	1	**15**
MMF203K.4: Enhance knowledge of thermal analysis technique	6	3	1	10
MMF203K.5: To examine fine detail using microscope.	12	3	1	**16**
Total Hours	**45**	15	5	**65**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Processing	01	02	03	06
CO-2	Structural characterization	01	03	07	11
CO-3	Characterization Techniques	01	07	04	12
CO-4	thermal analysis	01	06	04	11
CO-5	Optical microscopy	01	06	03	10
Total		5	24	21	50

Legend: R: Remember, U: Understand, A: Apply

The end of semester assessment for **Processing and Characterization Techniques** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher
1	Metallurgical Treatises,Metall.	K.Tienand J.F.Elliott (eds)	Soc.*AIME,1981*
2	Mechanical Metallurgy,	G.E. Dieter	McGraw-Hill Book Co.(Third edition),1988.
3	Physical Metallurgy Techniques and Applications, Vol. 1 and2	K.W.Andrews	George Allen & Unwin, London, 1973
4	Characterizationof Materials,Vol1.and 2	E.N. Kaufmann (Ed.inchief)	John Wiley and Sons Publication, New Jersey, 2003
5	Characterization of Materials,10^{th} Ed.	Metals handbook Vol.9	American Society of Metals, Metals Park, OH, USA, 1986.

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M. Tech. Mechanical

Engineering Course Code: PCC- MMF203K

Course Title: Processing and Characterization Techniques

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1: Enhance knowledge on processing for different material..	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 To know the characteristic and properties after processing of material.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: To know about latest characterization technique	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Enhance knowledge of thermal analysis technique	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: To examine fine detail using microscope.	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO1: Enhance knowledge on processing for different material	SO1.1 SO1.2 SO1.3		Unit -1 Processing 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 2 To know the characteristic and properties after processing of material.	SO2.1 SO2.2		Unit-2 Structural characterization 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3: To know about latest characterization technique	SO3.1 SO3.2		Unit-3 Characterization Techniques 3.1, 3.2, 3.3, 3.4, 3.5, 3.6, 3.7, 3.8 3.9, 3.10, 3.11	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Enhance knowledge of thermal analysis technique.	SO4.1 SO4.2		Unit-4: thermal analysis 4.1, 4.2, 4.3, 4.4, 4.5, 4.6	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO5: To examine fine detail using microscope.	SO5.1 SO5.2		Unit-5: Optical microscopy 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9, 5.10,5.11,5.12	

Semester-II

Course Code: **MMF204A**

Course Title: **Research Methodology**

Pre-requisite: Understanding of basics engineering principles, production planning and control and fundamentals of mechanical vibrations.

Rationale: Total Preventative Maintenance (TPM) is essential in the M. Tech. Mechanical Engineering curriculum to equip students with the knowledge and skills required for effective planning and implementing the suitable maintenance techniques. TPM is a critical strategy for maintaining equipment and machines. By learning the principles of TPM, the students will be able to apply it in the organizations which will certainly result in reduce machinery/facility downtime, increase efficiency, productivity and improve safety.

Course Outcomes:

PEC-MMF204A.1: Students will be able to Understand and Describe importance of research.

PEC-MMF204A.2: Students will be able to Classify and select appropriate resources for Research.

PEC-MMF204A.3: Students will be able toAnalyze the contents of literature and identify further scope.

PEC-MMF204A.4: Students will be able to Formulate a Research Problem.

PEC-MMF204A.5: Students will be able to apply effective written and oral Presentation skills.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Program Elective (PEC)	**PEC-MMF204A**	**Research Methodology**	3	0	1	1	5	3

Legend: **CI:**ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),
LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: SessionalWork(includesassignment,seminar,miniprojectetc.),
SL: SelfLearning,
C:Credits.

Note: SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

Scheme of Assessment:

Theory

Board ofStudy	Course Code	CourseTitle	Scheme of Assessment (Marks)							
			ProgressiveAssessment(PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5number 3 marks each (CA)	Class Test2 (2bestout Of3) 10 marksea ch(CT)	Seminar one (SA)	ClassActivityanyone (CAT)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
PEC	**PEC-MMF204A**	Research Methodology	15	20	5	5	5	50	50	100

Course-CurriculumDetailing:

This course syllabus illustrates the expected learning achievements, both at the course and sessionlevels, which students are anticipated to accomplish through various modes of instruction includingClassroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL).
Asthecourseprogresses,studentsshouldshowcasetheirmasteryofSessionOutcomes(SOs),culminatingint heoverallachievementof CourseOutcomes (COs) uponthecourse'sconclusion.

PEC-MMF204A.1: Students will be able to Understand and Describe importance of research.

.

ApproximateHours

Item	AppXHrs
Cl	8
LI	0
SW	2
SL	1
Total	11

Session Outcomes (SOs)	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self Learning (SL)
SO1.1 Define research and classify it's types. **SO1.2**Understand the concepts and objectives of research. **SO1.3**Differentiate between descriptive, theoretical, applied and experimental researches.		**Unit-1.0 Introduction** 1.1 Introduction of the subject 1.2 Research Concepts. 1.3 Research objectives 1.4 Research motivation 1.5 Types of research – descriptive research 1.6 Theoretical research. 1.7 Applied research. 1.8 Experimental research.	1. Historical development and evolution of Research methodology.

SW-1Suggested Sessional Work(SW):

a. Assignments:

i. Prepare a chart comparing various types of researches.

PEC-MMF204A.2: Students will be able to Classify and select appropriate resources for Research.

Approximate Hours

Item	AppXHrs
Cl	10
LI	0
SW	1
SL	2
Total	13

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2.1 Understand the criteria for good research. **SO2.2** Formulate the Research Task. **SO2.3** Understand how to review the Literature. **SO2.4** Understandhow to prepare the hypotheticalproposalsforfuturedevelopment.		Unit-2 Researchprocess 2.1 Criteria for good research. 2.2 Problems encountered by Indian researchers. 2.3 Formulation of Research Task. 2.4 Literature Review. 2.5 Importance & Methods of research. 2.6 Quantification of Cause Effect Relations 2.7 Discussions on Field Study 2.8 Critical Analysis of Facts Generated. 2.9 Tutorial-1	i. Study various hypothesis testing methods.

SW-2 SuggestedSessional Work(SW):

a. Assignments:

i. Prepare a literature review for a particular research topic.

PEC-MMF204A.3: Students will be able toAnalyze the contents of literature and identify further scope.

ApproximateHours

Item	AppXHrs
Cl	9
LI	0
SW	2
SL	2
Total	13

SessionOutcomes (SOs)	**(LI)**	**ClassroomInstruction (CI)**	**SelfLearning (SL)**
SO3.1 Understand the Concepts of hypothetical proposals. **SO3.2** Ability to use the Methods of writing hypothetical proposals. **SO3.3 Understand the process of proposal testing.**		**Unit-3:**Hypothetical proposals 3.1 Hypothetical proposals concept, examples. 3.2 Methods of writing hypothetical proposals 3.3 Hypothetical proposals for future development. 3.4 Proposal testing- Need. 3.5 Proposal testing- Procedure. 3.6 Proposal testing- methods. 3.7 Selection of Research task. 3.8 Case studies.	Numerical problems on hypothesis testing.

SW-3SuggestedSessionalWork(SW):

a. Assignments:

i. Prepare a chart highlighting different hypothetical research proposal methods.

PEC-MMF204A.4: Students will be able to Formulate a Research Problem.

ApproximateHours

Item	AppXHrs
Cl	9
LI	0
SW	1
SL	1
Total	11

SessionOutcomes(SOs)	(LI)	ClassroomInstruction (CI)	Self Learning (SL)
SO4.1 Understand the Concepts of modelling. **SO4.2** Ability model a real-life problem using suitable method. **SO4.3 Understand the process of simulation.** .		**Unit-4:** Mathematical modelling and simulation. 4.1 Concepts of modelling. 4.2 Classification of mathematical models. 4.3 Modelling with – Ordinary differential equations 4.4 Modelling with Difference equations 4.5 Modelling with Partial differential equations. 4.6 Modelling using Graphs. 4.7 Process of formulation of model based on simulation. 4.8 Tutorial-1 4.9 Tutorial-2	i. Numerical problems on modelling. ii. Numerical problems on simulation.

SW-4SuggestedSessionalWork(SW):

a. Assignments:
Prepare a chart highlighting different modeling methods.

b. Project:
Consider a rea life problem, model it using suitable modelling method.

PEC-MMF204A.5: Students will be able to apply effective written and oral Presentation skills.

Approximate Hours

Item	Appx Hrs
Cl	9
LI	0
SW	01
SL	01
Total	11

SessionOutcomes (SOs)	**(LI)**	**ClassroomInstruction (CI)**	**SelfLearning (SL)**
SO5.1 Understand the technique of interpretation. **SO5.2Understand the** mechanics of writing research report.		**Unit5:Interpretationandreportwriting** 5.1 Classification of Techniquesofinterpretation. 5.2 Precautionsininterpretation. 5.3 Significanceofreportwriting. 5.4 Differentstepsinreportwriting. 5.5 Layout of research report. 5.6 Mechanics of writing research report. 5.7 Layout and format: Style of writing, Typing, References, Tables, Figures, Conclusion and Appendices. 5.8 Tutorial-1 5.9 Tutorial-2	1.Different steps in report writing.

SW-5SuggestedSessionalWork(SW):

a. Assignments:

i. Prepare a chart classifying various techniques of interpretation..

BriefofHourssuggestedfortheCourseOutcome

CourseOutcomes	ClassLecture (CL)	Sessional Work (SW)	SelfLearning (Sl)	Total hour(Cl+SW+Sl)
PEC-MMF204A.1: Students will be able to Understand and Describe importance of research.	8	2	1	11
PEC-MMF204A.2: Students will be able to Classify and select appropriate resources for Research.	10	1	2	**13**
PEC-MMF204A.3: Students will be able to Analyze the contents of literature and identify further scope.	9	2	2	**13**
PEC-MMF204A.4: Students will be able to Formulate a Research Problem.	9	1	1	11
PEC-MMF204A.5: Students will be able to apply effective written and oral Presentation skills.	9	1	1	**11**
TotalHours	**45**	7	7	**59**

SuggestionforEndSemesterAssessment

SuggestedSpecificationTable(ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Introduction	01	02	03	06
CO-2	Researchprocess	01	03	07	11
CO-3	Hypothetical proposals	01	07	04	12
CO-4	Mathematical modelling and simulation.	01	06	04	11
CO-5	Interpretation and report writing	01	06	03	10
Total		5	24	21	50

Legend: R:Remember, U:Understand, A:Apply

Theendofsemesterassessmentfor**Total Productive Maintenance**willbeheldwithwrittenexaminationof50 marks.

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks.
Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visitto industry
7. Demonstration
8. ICTBased TeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook, Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

SuggestedLearningResources:

(a)Books:

S. No.	Title	Author	Publisher	Edition &Year
1	StatisticalAnalysisforEngineersandScientists	J.WBames	McGrawHill,N.York p	1990.
2	TheoriesofEngineering Experiments	SchankFr.	McGrawHill,N.York	1986
3	Lecturenotes providedby Dept.of Mechanical Engineering,AKSUniversity,Satna			

CurriculumDevelopmentTeam

1. Mr. S.S. Parihar,Head of Deptt. Mech. Engg.,AKSUniversity
2. Mr. Alok Ranjan Tiwari,AssistantProfessor,Dept.ofMechanical Engg.
3. Mr. Deepak Pandey ,AssistantProfessor,Dept.ofMechanical Engg
4. Mr.Keshav Pratap Singh, AssistantProfessor,Dept. ofMechanical Engg
5. Mr.Amar Soni,AssistantProfessor,DeptofMechanical Engg
6. Mr Krishn Pratap Tiwari , AssistantProfessor,Dept.ofMechanical Engg
7. Mr. Ketan Agrawal,AssistantProfessor,Dept.ofMechanical Engg
8. Mr. K.C. Kori,AssistantProfessor,Dept.ofMechanical Engg
9. Mr. Lokesh Agrawal,AssistantProfessor,Dept.ofMechanical Engg
10. Mr. Ram Narayan Shukla,AssistantProfessor,Dept.ofMechanical Engg
11. Mr. Rishi Kumar Sharma,AssistantProfessor,Dept.ofMechanical Engg
12. Mr. Naveen Kumar Soni,AssistantProfessor,Dept.ofMechanical Engg

****

Cos,PosandPSOsMapping

CourseTitle:B.Tech. Mechanical Engineering

CourseCode:PCC-ME307

CourseTitle: Production and Operation Management

CourseOutcomes	ProgramOutcomes												ProgramSpecificOutcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1:Students will be able to Understand and Describe importance of research.	2		3				1		3			2	**2**	**1**	**2**	**1**
CO 2: Students will be able to Classify and select appropriate resources for Research.	2		2	1			1		1			2	**2**	**2**	**2**	**2**
CO3: Students will be able to Analyze the contents of literature and identify further scope.	2		3	3			1		1	2		2	**1**	**1**	**2**	**2**
CO 4: Students will be able to Formulate a Research Problem.	2	3	3	2					2	2		2	**3**	**3**	**3**	**2**
CO5: Students will be able to apply effective written and oral Presentation skills.	2		1	3			3					3	**3**	**3**	**1**	**3**

Legend:1–Low,2–Medium,3–High

CourseCurriculumMap:

POs&PSOsNo.	CosNo.&Titles	SOsNo.	LaboratoryInstruction (LI)	Classroom Instruction(CI)	SelfLearning(SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4,	CO-1: Students will be able to Understand and Describe importance of research.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1 Introduction 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.9	Asmentionedin Pagenumber 2to6
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4,5	CO 2: Students will be able to Classify and select appropriate resources for Research.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2Research process 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9, 2.10	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3: Students will be able to Analyze the contents of literature and identify further scope.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 Hypothetical proposals 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8 3.9.	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Students will be able to Formulate a Research Problem.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4Mathematical modelling and simulation 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 5: Students will be able to apply effective written and oral Presentation skills.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit-5:Interpretation and report writing. 5.1,5.2,5.3,5.4,5.5, 5.6, 5.7, 5.8, 5.9	

Semester-II

CourseCode: **MMF203H**

CourseTitle: **Total Productive Maintenance**

Pre-requisite: Understanding of basics engineering principles, production planning and control and fundamentals of mechanical vibrations.

Rationale: Total Preventative Maintenance (TPM) is essential in the M. Tech. Mechanical Engineering curriculum to equip students with the knowledge and skills required for effective planning and implementing the suitable maintenance techniques. TPM is a critical strategy for maintaining equipment and machines. By learning the principles of TPM, the students will be able to apply it in the organizations whichwill certainly result in reduce machinery/facility downtime, increase efficiency, productivity and improve safety.

CourseOutcomes:

PEC-MMF203H.1: Students will be able to understandand apply the different types of maintenance principles/practices toincrease the productivity of plant and equipment with a modest investment in maintenance.

PEC-MMF203H.2: Students will be able to understand as to how the equipment effectiveness can be maximized, they will also learn about fivepillars of TPM.

PEC-MMF203H.3: Students will be able toprepare the maintenance master plan and implement the TPM.

PEC-MMF203H.4: Students will be able to understand about human factors in maintenance, maintenance logistics and Spare parts management..

PEC-MMF203H.5: Students will be able to apply various condition monitoring techniques to identify the instantaneous condition of the machine and take the corrective action for any potential defect.

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits(C)
			Cl	LI	SW	SL	Total Study Hours(CI+LI+SW+SL)	
Program Elective (PEC)	**PEC-MMF203H**	**Total Productive Maintenance**	3	0	1	1	5	3

Legend: **CI:**ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),
LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop,fieldorotherlocationsusingdifferentinstructionalstrategies)
SW: SessionalWork(includesassignment,seminar,miniprojectetc.),
SL: SelfLearning,
C:Credits.

Note: SW&SLhastobeplannedandperformedunderthecontinuousguidanceandfeedbackofteacherto ensure outcome ofLearning.

SchemeofAssessment:

Theory

Board ofStudy	Course Code	CourseTitle	SchemeofAssessment(Marks)							
			ProgressiveAssessment(PRA)						EndSemesterAssessment	Total Marks
			Class/Home Assignment 5number 3 marks each (CA)	Class Test2 (2bestout Of3) 10 marksea ch(CT)	Seminar one (SA)	ClassActivityanyone (CAT)	ClassAttendance (AT)	TotalMarks (CA+CT+SA+CAT+AT)	**(ESA)**	(PRA+ ESA)
PEC	**PEC-MMF203H**	Total Productive Maintenance	15	20	5	5	5	50	50	100

Course-CurriculumDetailing:

This course syllabus illustrates the expected learning achievements, both at the course and sessionlevels, which students are anticipated to accomplish through various modes of instruction includingClassroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL).
Asthecourseprogresses,studentsshouldshowcasetheirmasteryofSessionOutcomes(SOs),culminatingint heoverallachievementof CourseOutcomes (COs) uponthecourse'sconclusion.

PEC-MMF203H.1: Students will be able to understand and apply the different types of maintenance principles/practices to increase the productivity of plant and equipment with a modest investment in maintenance.

.

ApproximateHours

Item	AppXHrs
Cl	7
LI	0
SW	2
SL	2
Total	11

SessionOutcomes (SOs)	**Laboratory Instruction (LI)**	**ClassroomInstruction (CI)**	**SelfLearning (SL)**
SO1.1 Define and classify maintenance types. **SO1.2**Understand the Objectives and functionsof maintenance. **SO1.3**Differentiate between preventive, predictive and reliability centered maintenance (RCM). **SO1.4**Describing the terotechnology in the context of maintenance. **SO1.**5 Analyzing the RCM method. **SO1.**6 Analyzing the Maintainability, availability and effectiveness of the system.	.	**Unit-1.0 Introduction** 1.1 Introduction of the subject 1.2 Classification of Maintenancepractic es. 1.3 Concepts, Objectives and functionsof maintenance. 1.4 Understanding of Terotechnology. 1.5 Reliability Centered Maintenance(RCM) 1.6 Maintainability prediction, availability and system, effectiveness.	1. Historical development and evolution of TPM.

SW-1Suggested Sessional Work(SW):

a. Assignments:

i. Analyze real-world examples of successful maintenance strategies.

PEC-MMF203H.2: Students will be able to understand as to how the equipment effectiveness can be maximized they will also learn about five pillars of TPM.

Approximate Hours

Item	AppX Hrs
Cl	12
LI	0
SW	2
SL	2
Total	16

Session Outcomes (SOs)	(LI)	Classroom Instruction (CI)	Self Learning (SL)
SO2.1 Analyze and prepare preventive maintenance schedules. **SO2.2** Demonstrate to prepare a Detailed Project Report (DPR). **SO2.3** Understand the process of zero breakdown and zero defects. **SO2.4** Understandthe process of maximizing equipment effectiveness. **SO2.5** Understand and implement the fivepillars of TPM.	.	Unit-2 TPM pillars and maintenance models. 2.1 TPM- Maximizing equipment effectiveness. 2.2 Preventive maintenance, and breakdownmaintenance. 2.3 Preventive maintenance schedules: Deviations on target values. 2.4 Preventive maintenance schedules: functional characteristics, replacement models. 2.5 OrganizingforTPMimplementation. 2.6 PMConcepts,ImportanceofTPM. 2.7 Zero breakdown concepts, Zero Defects and TPM. 2.8 Maximizing equipment effectiveness. 2.9 Autonomous maintenance program. 2.10 Fivepillars of TPM, TPM Small group activities. 2.11 Tutorial-1 2.12 Tutorial-2	i. Study various maintenance models. ii. Analyze case studies related to TPM.

SW-2 SuggestedSessional Work(SW):

a. Assignments:

i. Analyze real-world case studies highlighting the implementation of different maintenance models.
ii. TPM Small group activities.

PEC-MMF203H.3: Students will be able toprepare the maintenance master plan and implement the TPM.

ApproximateHours

Item	AppXHrs
Cl	9
LI	0
SW	2
SL	2
Total	13

SessionOutcomes (SOs)	**(LI)**	**ClassroomInstruction (Cl)**	**SelfLearning (SL)**
SO3.1 Understand the procedure of TPM Planning and Implementation. **SO3.2**Ability to prepare the master plan. **SO3.3**Understand the ongoing global trends in TPM process planning.	.	**Unit-3:**TPM Planning and Implementation. 3.1 TPM implementation and stabilization. 3.2 TPM Planning and Implementation. 3.3 Organizationfor TPM, management decision. 3.4 Awareness and training for TPM. 3.5 Formation of master plan. 3.6 TPM implementation. 3.7 Ongoing global trendsin TPM Process planning. 3.8 Tutorial-1 3.9 Tutorial-1	i. Establishment of basic policies and goals.

SW-3SuggestedSessionalWork(SW):

a. Assignments:

i. Analyze real-world cases of successful implementation of TPM.
ii. Evaluate challenges faced and solutions implemented.

b. Project:

I. Develop a comprehensive maintenance plan for a hypothetical manufacturing unit.

PEC-MMF203H.4: Students will be able to understand about human factors in maintenance, maintenance logistics and Spare parts management.

ApproximateHours

Item	AppXHrs
Cl	10
LI	0
SW	1
SL	1
Total	12

SessionOutcomes(SOs)	(LI)	ClassroomInstruction (CI)	Self Learning (SL)
SO4.1 Understand the key principles of maintenance logistics. **SO4.2** Understand the principles of human factors in maintenance. **SO4.3** Analyze the maintenance staffing methods. **SO4.4** Analyze different queuing methods in maintenance. **SO4.5** Analyze maintenance planning and scheduling.	.	**Unit-4: Maintenance spare parts management and logistics.** 4.1 Maintenance Logistics. 4.2 Human factors in maintenance. 4.3 Maintenance manuals. 4.4 Maintenance staffing methods. 4.5 Queuing applications 4.6 Spare parts management, simulation. 4.7 Maintenance planning and scheduling. 4.8 TPM small group activities. 4.9 Tutorial-1 4.10 Tutorial-2	i. Study the Maintenance manuals. ii. Analyze the Humanfactorsi nmaintenance

SW-4SuggestedSessionalWork(SW):

a. Assignments:

i. Analyze the maintenance spare part management of a local manufacturing facility and suggest improvements.

ii. Study the maintenance staffing methods of a local manufacturing facility.

PEC-MMF203H.5: Students will be able to apply various condition monitoring techniques to identify the instantaneous condition of the machine and take the corrective action for any potential defect.

Approximate Hours

Item	Appx Hrs
Cl	9
LI	0
SW	01
SL	01
Total	11

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Understand the online condition monitoring technique. **SO5.2**Identify suitable condition monitoring technique for a particular application. **SO5.3Understand and** Apply the method of Corrosion Monitoring and Control.		**Unit5: Condition monitoring techniques.** 5.1 The PM prize for outstanding TPM plants. 5.2 Online Condition Monitoring Techniques. 5.3 Vibration Monitoring. 5.4 Signature Analysis. 5.5 Wear Debris Monitoring technique. 5.6 Maintenance Management Information system. 5.7 Corrosion Monitoring and Control.	1.Application of different monitoring techniques.

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Make a chart comparing various condition monitoring methods.

Brief of Hours suggested for the Course Outcome

Course Out comes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
PEC-MMF203H.1: Students will be able to understand and apply the different types of maintenance principles/practices to increase the productivity of plant and equipment with a modest investment in maintenance.	7	2	2	11
PEC-MMF203H.2: Students will be able to understand as to how the equipment effectiveness can be maximized they will also learn about five pillars of TPM.	12	2	2	**16**
PEC-MMF203H.3: Students will be able to prepare the maintenance master plan and implement the TPM.	9	2	2	**13**
PEC-MMF203H.4: Students will be able to understand about human factors in maintenance, maintenance logistics and Spare parts management.	10	1	1	12
PEC-MMF203H.5:Students will be able to apply various condition monitoring techniques to identify the instantaneous condition of the machine and take the corrective action for any potential defect.	7	1	1	**9**
TotalHours	**45**	8	8	**61**

SuggestionforEndSemesterAssessment

SuggestedSpecificationTable(ForESA)

CO	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO-1	Introduction	01	02	03	06
CO-2	TPM pillars and maintenance models.	01	03	07	11
CO-3	TPM Planning and Implementation.	01	07	04	12
CO-4	Maintenance spare parts management and logistics.	01	06	04	11
CO-5	Condition monitoring techniques.	01	06	03	10
Total		5	24	21	50

Legend: R:Remember, U:Understand, A:Apply

Theendofsemesterassessmentfor**Total Productive Maintenance**willbeheldwithwrittenexaminationof50 marks.

Note.DetailedAssessmentrubricneedtobepreparedbythecoursewiseteachersforabovetasks.
Teacherscanalsodesigndifferenttasksasperrequirement,forendsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visitto industry
7. Demonstration
8. ICTBased TeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook, Twitter,Whatsapp,Mobile,Onlinesources)
9. Brainstorming

SuggestedLearningResources:

(a)Books:

S. No.	Title	Author	Publisher	Edition &Year
1	TrainingForTPM	Nahchi-Fujikoshi	Japan Institute of Plant Maintenance	1990.
2	IntroductionToTPM,ThePurtorFactory	S.Nakajjima	JapanInstituteofPlantMaintenance	1986
3	TPMNyumon	S. Nakajjima	Japan Institute of Plant Maintenance	1989
4	Lecturenotes providedby Dept.of Mechanical Engineering,AKSUniversity,Satna			

CurriculumDevelopmentTeam

1. Mr. S.S. Parihar,Head of Deptt. Mech. Engg.,AKSUniversity
2. Mr. Alok Ranjan Tiwari,AssistantProfessor,Dept.ofMechanical Engg.
3. Mr. Deepak Pandey ,AssistantProfessor,Dept.ofMechanical Engg
4. Mr.Keshav Pratap Singh, AssistantProfessor,Dept. ofMechanical Engg
5. Mr.Amar Soni,AssistantProfessor,DeptofMechanical Engg
6. Mr Krishn Pratap Tiwari , AssistantProfessor,Dept.ofMechanical Engg
7. Mr. Ketan Agrawal,AssistantProfessor,Dept.ofMechanical Engg
8. Mr. K.C. Kori,AssistantProfessor,Dept.ofMechanical Engg
9. Mr. Lokesh Agrawal,AssistantProfessor,Dept.ofMechanical Engg
10. Mr. Ram Narayan Shukla,AssistantProfessor,Dept.ofMechanical Engg
11. Mr. Rishi Kumar Sharma,AssistantProfessor,Dept.ofMechanical Engg
12. Mr. Naveen Kumar Soni,AssistantProfessor,Dept.ofMechanical Engg

****

Cos, Pos and PSOs Mapping

Course Title: M.Tech. Mechanical Course

Code: PCC- MMF203H

Course Title: Total Productive Maintenance

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1:Students will be able to understand and apply the different types of maintenance principles/practices to increase the productivity of plant and equipment with a modest investment in maintenance.	1	1	2	2	3	2	3	2	2	1	3	2	2	1	2	1
CO 2: Students will be able to understand as to how the equipment effectiveness can be maximized, they will also learn about five pillars of TPM.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	2
CO3: Students will be able to prepare the maintenance master plan and implement the TPM.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Students will be able to understand about human factors in maintenance, maintenance logistics and Spare parts management.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Students will be able to apply various condition monitoring techniques to identify the instantaneous condition of the machine and take the corrective action for any potential defect.	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend:1–Low,2–Medium,3–High

Course Curriculum Map:

Pos &PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction(LI)	Classroom Instruction(CI)	Self Learning(SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4,	CO-1: Understanding of the intricacies of production systems and resources, the classification of production types and the pivotal roles played by line supervisors and production managers.	SO1.1 SO1.2 SO1.3 SO1.4 SO1.5		Unit-1 Introduction 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7	As mentioned in Page number 2to6
PO1,2,3,4,5,6 7,8,9,10,11,12 PSO1,2,3,4,5	CO 2: students will be able to effectively manage the entire project life cycle, from concept phase to execution and completion, while ensuring quality, handling risks, and achieving project objectives.	SO2.1 SO2.2 SO2.3 SO2.4 SO2.5		Unit-2TPM pillars and maintenance models 2.1,2.2,2.3,2.4,2.5,2.6,2.7, 2.8, 2.9, 2.10,2.11,2.12	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3 : Students will be able to effectively plan, control, and manage production and supply chain operations to achieve optimal efficiency and cost-effectiveness.	SO3.1 SO3.2 SO3.3 SO3.4 SO3.5		Unit-3 TPM Planning and Implementation 3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8 3.9.	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Understand the principles of factory management and their application in modern manufacturing systems. Apply the concepts of factory management to improve productivity, quality, and sustainability.	SO4.1 SO4.2 SO4.3 SO4.4 SO4.5		Unit-4Maintenance spare parts management and logistics. 4.1,4.2,4.3,4.4,4.5,4.6,4.7,4.8,4.9,4.10	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 5: students will be able to apply mathematical and problem-solving techniques to optimize resource allocation and decision-making in various operational and logistical systems.	SO5.1 SO5.2 SO5.3 SO5.4 SO5.5		Unit-5:Condition monitoring techniques. 5.1,5.2,5.3,5.4,5.5, 5.6, 5.7, 5.8, 5.9	

A K S University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mech. Engg.) Program

(Revised as on 01 August 2023)

Semester-II

Course Code: **PE202**

Course Title : **Mini-Project**

Pre-requisite: Students should have basic knowledge for design, development and analysis of project.

Rationale: Students should be well-versed in the Mechanical manufacturing process and concrete production. Keeping abreast of the latest technological trends is crucial for identifying contemporary R&D topics. A fundamental understanding of the physical and chemical properties of Material is essential. Additionally, students must be proficient in statistical methods for effective data analysis and interpretation. Competence in Microsoft Word and Excel is necessary for report writing and documentation. By combining technical knowledge with analytical and software skills, students will be well-prepared to tackle challenges in the field and contribute meaningfully to research and development efforts.

Course Outcomes:

PE202.1:Methodology for projectdesign and project scheduling
PE202.2: Methods of Data collection and data compiliation
PE202.3:Product development
PE202.4: Data analysis and data interpretation
PE202.5: Concluding remark and future work

SchemeofStudies:

Course Category	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Hours (CI+LI+SW+SL)	
PROJ	PE202	Mini-Project	2	6	1	1	10	5

Legend:

CI: ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),
LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop, field or other locations using different instructional strategies)
SW: Sessional Work(includesassignment, seminar, miniprojectetc.),
SL: SelfLearning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacherto ensureoutcomeofLearning.

Scheme of Assessment:

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)									
			Progressive Assessment (PRA)						End Semester Assessment			Total Marks (PRA+ESA)
			Project Scheduling	Data collection and sampling	Product design	Product analysis and data interporetaion	Report writing and concluding remark	Total Mark	Seminar	Project Viva	Total Marks	
PROJ	PROJ-CT-301	Engineering Project-II (Design& Analysis)	05	05	05	25	10	50	15	35	50	100

Course-CurriculumDetailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Lab Work Assignment (LA) Best of 5 of the total, Viva-Voice on Lab Work (VV), and Lab Attendance (LA). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Course Outcome	Activities	Time Schedule (in hours)	
		Class Activity Per week (5 Credit)	Self Learning /Home activity Per week
PE202: CO.1: Methodology for design and project scheduling	**1. Literature review and identification of Cement and concrete related projects and project scheduling** Examining recent literature on Materials projects	5	10

	unveils advancements, methodologies, and applications. This review identifies emerging trends, innovative materials, and sustainable practices, significantly impacting construction, durability, and environmental outcomes. Noteworthy projects illustrate novel approaches, enriching insights and guiding future developments in Material technology. **Project scheduling** : Project scheduling involves planning and organizing tasks to ensure timely completion. It includes defining activities, setting deadlines, and allocating resources efficiently. Effective scheduling helps manage time, costs, and personnel, enhancing productivity and project success. It's crucial for meeting goals, coordinating efforts, and maintaining project momentum		
PE202: CO.2: Methods of Data collection and data compiliation	2**. Design and formulation projects** i. Methods of data collection and data compiletion ii. Design and formulation projects concentrate on innovating products through meticulous recipe development and methodological refinement. These initiatives prioritize material optimization, functional enhancement, and quality assurance. By blending creativity with technical prowess, they propel advancements across industries, fostering the creation of distinctive, efficient, and commercially viable solutions.	8	15
PE202: CO.3: Product development	**3. Sample analysis and product development** Testing samples determines their suitability by assessing quality, performance, and compliance with standards. It involves rigorous analysis and evaluation to ensure materials meet project requirements. This process identifies strengths and weaknesses, guiding decision-making and ensuring the reliability and effectiveness of the chosen samples for intended applications. Product design and analysis in R&D involve creating and refining products to meet market needs. This	10	25

	process includes conceptualizing, prototyping, and testing to optimize functionality and performance. Analyzing results helps improve designs, ensuring products are innovative, efficient, and ready for successful market introduction.		
PE202. CO.4: Data analysis and data interpretation	**i. Product Dataanalysis &compilation** Project data compilation involves collecting and organizing all relevant information for analysis and reporting. This process ensures data accuracy and completeness, facilitating informed decision-making and efficient project management. It helps track progress, identify trends, and generate insights, supporting successful project outcomes and future planning. ii. **Statistical data analysis and data interpretation** Statistical data analysis involves examining and processing data to uncover patterns and trends. Data interpretation translates these findings into meaningful insights, aiding decision-making and strategy development. This process enhances understanding, supports evidence-based conclusions,	40	15
PE202. CO.5: Concluding remark and future work	**5. Report Writing, Conclusion, Recommendations and Future work in Research work** **Report Writing** : Comprehensive project report writing **Conclusion:** The study successfully demonstrated key findings. It underscores implications, validating hypothesis/objectives. This contributes field significance, laying groundwork for applications. **Recommendation**: Future research should explore expansion areas, emphasizing methodological improvements. Collaboration partners/stakeholders would enrich knowledge transfer. **Future Work:** Innovations in technology/techniques could advance potential benefits. Addressing challenges would refine outcomes, fostering industry/government support.	12	25

Total		75	90

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

Course Outcome	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
PE202: CO.1: Methodology for design and project scheduling	1. Literature review and identification of Material related projects and project scheduling	02	03	-	5
PE202: CO.2: Methods of Data collection and data compiliation	2. Design and formulation projects	-	05	03	8
PE202: CO.3: Product development	3. Sample analysis and product development	-	08	04	12
PE202. CO.4: Data analysis and data interpretation	4. Product Data analysis, data interpretation and findings	-	08	12	20
PE202. CO.5: Concluding remark and future work	5. Report writing, concluding remark and future work		03	02	5
Total		02	27	21	50

Legend: R:Remember, U:Understand, A:Apply

TheendofsemesterassessmentforEngineering Project-1 (Literature Review) willbeheld with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wiseteachers for above tasks. Teachers can also design different tasks as per requirement, for endsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial

3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visit to cement plant
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp, Mobile,Onlinesources)
9. Brainstorming

SuggestedLearningResources:

(a) Books:

S.No.	Title	Author	Publisher	Edition &Year
1	The literature review : six steps to success	Lawrence A. Machi, Brenda T. McEvoy.	Corwin Press, Inc	2022
2	Lee			
3	Tylor			
4	Manufacturing Processes			
5				

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanichal Engg.
3. Mr Deepak Pandey , Assistant Professor , Dept. of Mechanichal Engg
4. Mr.,Keshav Pratap Singh, Assistant Professor , Dept. of Mechanichal Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanichal Engg
6. Mr K.P Tiwari , Assistant Professor , Dept. of Mechanichal Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanichal Engg
8. Mr. K.C. Kori, Faculty, Assistant Professor , Dept. of Mechanichal Engg
9. Mr,Lokesh Agrawal, Assistant Professor , Dept. of Mechanichal Engg

10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanichal Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanichal Engg
12. Mr. Naveen Kumar Soni, Assistant Professor , Dept. of Mechanichal Engg

COs, POsandPSOs Mapping

ProgramTitle:M.Tech Mechanical Engineering

Course Code:PE202; **CourseTitle:** Mini-Project

CourseOutcomes	Program Outcomes												ProgramSpecificOutcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation.	Product Innovation and Development
PE202: CO.1: Methodology for design and project scheduling	2	1	1	1	1	3	3	1	1	1	1	2	3	3	3	3
PE202: CO.2: Methods of Data collection and data compiliation	3	1	2	2	2	3	3	1	1	1	1	2	3	3	3	3
PE202: CO.3: Product development	2	1	1	1	1	3	3	1	1	1	1	2	3	3	3	3
PE202. CO.4: Data analysis and data interpretation	3	1	2	2	2	3	3	1	1	1	1	2	3	3	3	3
PE202. CO.5: Concluding remark and future work	2	1	1	1	1	3	3	1	1	1	1	2	3	3	3	3

Legend:1–Low,2–Medium,3–High

CourseCurriculumMap:Engineering Project-1 (Literature Review)

POs&PSOsNo.	COsNo.&Titles	SOsNo.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning(SL)
	PE202: CO.1: Methodology for design and project scheduling				
	PE202: CO.2: Methods of Data collection and data compiliation				
	PE202: CO.3: Product development				
	PE202. CO.4: Data analysis and data interpretation				
	PE202. CO.5: Concluding remark and future work				

A K S University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mech. Engg.) Program

(Revised as on 01 August 2023)

Semester-II

Course Code: **PE201**

Course Title : **Seminar-I**

Pre-requisite: Students should have basic knowledge on design and presentation of technical seminar.

Rationale: The student possesses knowledge of the processes involved in the manufacture of Machines. Additionally, the student should be familiar with the latest trends in Mechaniacal manufacturing and the challenges faced by the Mechaniacal industry. Presenting the latest technological advanMechanicals in Mechanical manufacturing is essential for the seminar.

Course Outcomes:

CO.1: Identification and objective of the seminar topic, along with a literature review that includes recent technological trends.

CO.2: In-depth analysis and interpretation of technical data related to the seminar topic, including case studies and practical implementation examples.

CO.3: Preparation and delivery of the seminar presentation, including a question and answer session.

SchemeofStudies:

Course Category	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Hours (CI+LI+SW+SL)	
PROJ	PE201	Seminar-I		2		3	3	1

Legend:

CI: ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)andTutorial (T)andothers),

LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop, field or other locations using different instructional strategies)

SW: Sessional Work(includesassignment, seminar, miniprojectetc.),

SL: SelfLearning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacherto ensureoutcomeofLearning.

Scheme of Assessment:

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)								
			Progressive Assessment (PRA)					End Semester Assessment			Total Marks (PRA+ESA)
			Identification of seminar topic	Data collection	Prepartionpresenation	Seminar presentation	Total Mark	Seminarcontent	Presentation and Questionanswer	Total Marks	
PROJ	PE201	Seminar-I	05	05	25	15	50	10	40	50	100

Course-CurriculumDetailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Lab Work Assignment (LA) Best of 5 of the total, Viva-Voice on Lab Work (VV), and Lab Attendance (LA). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Course Outcome	Activities	Time Schedule (in hours)	
		Class Activity Per week (1 Credit)	Self Learning /Home activity Per week
CO.1: Identification and objective of the seminar topic, along with a literature review that includes recent technological trends.	1. **Introduction and fundamentals Seminar** - Objectives of the Seminar - Identification and Overview of Topics to be Covered - Importance and Relevance of the Seminar	3	5

	in Current Industry Trends - Introduction to the Technical Field - Basic Concepts and Terminology - Historical Development and Milestones - Current State of the Technology		
CO.2: In-depth analysis and interpretation of technical data related to the seminar topic, including case studies and practical implementation examples	2.0 **In-depth Technical Sessions and preparation of presentation** **Module 1: Advanced Theoretical Concepts** - Key Theories and Principles - Mathematical Foundations - Models and Algorithms **Module 2: Practical Applications** - Industry Applications - Case Studies - Real-world Scenarios **Module 3 : Practical Implementation** - Step-by-step Guide to Solving a Problem - Coding and Development - Debugging and Optimization	7	15
CO.3: Preparation and delivery of the seminar presentation, including a question and answer session.	**Prepartion of seminar content in proper presentation format and seminar presentation** Prsentaion andQuartion answer session Seminar feed back and over view	5	10
Total		15	30

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

Course Outcome	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
CO.1: Identification and objective of the seminar topic, along with a literature review that includes recent technological trends.	Introduction and fundamentals Seminar	05	05		10
CO.2: In-depth analysis and interpretation of technical	In-depth Technical Sessions and preparation of		10	05	15

data related to the seminar topic, including case studies and practical implementation examples	presentation				
CO.3: Preparation and delivery of the seminar presentation, including a question and answer session	Prepartion of seminar content in proper presentation format and seminar presentation		10	15	20
Total		05	25	20	50

Legend: R:Remember, U:Understand, A:Apply

Note. Detailed Assessment rubric need to be prepared by the course wiseteachers for above tasks. Teachers can also design different tasks as per requirement, for endsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visit to Mechanical plant
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp, Mobile,Onlinesources)
9. Brainstorming

SuggestedLearningResources:

(a) Books:

S.No.	Title	Author	Publisher	Edition &Year
1				
2				

3				
4	Manufacturing process			
5				

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanichal Engg.
3. Mr Deepak Pandey , Assistant Professor , Dept. of Mechanichal Engg
4. Mr.,Keshav Pratap Singh, Assistant Professor , Dept. of Mechanichal Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanichal Engg
6. Mr K.P Tiwari , Assistant Professor , Dept. of Mechanichal Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanichal Engg
8. Mr. K.C. Kori, Faculty, Assistant Professor , Dept. of Mechanichal Engg
9. Mr,Lokesh Agrawal, Assistant Professor , Dept. of Mechanichal Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanichal Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanichal Engg
12. Mr. Naveen Kumar Soni, Assistant Professor , Dept. of Mechanichal Engg
13. Mr. Umesh Bagri ,Assistant Professor , Dept. of Mechanichal Engg

COs, POsandPSOs Mapping

ProgramTitle:M.Tech Mechanical Engineering

Course Code:PE201; **CourseTitle:** **Seminar-I**

CourseOutcomes	Program Outcomes												ProgramSpecificOutcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation.	Product Innovation and Development
CO.1: Identification and objective of the seminar topic, along with a literature review that includes recent technological trends.	2	1	1	1	1	3	3	1	1	1	1	2	3	3	3	3
CO.2: In-depth analysis and interpretation of technical data related to the seminar topic, including case studies and practical implementation examples	3	1	2	2	2	3	3	1	1	1	1	2	3	3	3	3
CO.3: Preparation and delivery of the seminar presentation, including a question and answer session.	3	3	3	3	3	3	3	2	3	1	3	3	3	2	3	1

Legend:1–Low,2–Medium,3–High

CourseCurriculumMap: Seminar-I

POs&PSOsNo.	COsNo.&Titles	SOsNo.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning(SL)
	CO.1: Identification and objective of the seminar topic, along with a literature review that includes recent technological trends.				
	CO.2: In-depth analysis and interpretation of technical data related to the seminar topic, including case studies and practical implementation examples				
	CO.3: Preparation and delivery of the seminar presentation, including a question and answer session.				

Semester-III

Course Code: **MMF301**

Course Title: Project Management and Intellectual Property Rights

Pre-requisite: Project Management: Business understanding, organization, communication, risk management, leadership.

Intellectual Property Rights: Understanding laws, types, protection strategies, enforcement, innovation impact.

Rationale: Project Management ensures efficient project execution and stakeholder satisfaction. Intellectual Property Rights safeguard innovations, promote creativity, and secure competitive advantage through legal protection and strategic management of intellectual assets.

Course Outcomes:

MMF301**.1:** Enumerate and demonstrate fundamental terms such as copy-rights, Patents, Trademarks etc.,

MMF301**.2:** Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.

MMF301**.3:** Exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.

MMF301.**4:** • Develop awareness at all levels (research and innovation) of society to develop patentable technologies.

MMF301**5:** • Apply trade mark law, copy right law, patent law and also carry out intellectual property audits

Scheme of Studies:

Board of Study	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			Cl	LI	SW	SL	Total Study Hours (CI+LI+SW+SL)	
Program Core (PCC)	**MMF301**	Project Management and Intellectual Property Rights	2	0	1	1	4	2

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)

SW: Sessional Work (includes assignment, seminar, mini project etc.),

SL: Self Learning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Theory

Board of Study	Course Code	Course Title	Scheme of Assessment (Marks)							
			Progressive Assessment (PRA)						End Semester Assessment	Total Marks
			Class/Home Assignment 5 number 3 marks each (CA)	Class Test2 (2 best out Of 3) 10 marks each (CT)	Seminar one (SA)	Class Activity any one (CAT)	Class Attendance (AT)	Total Marks (CA+CT+SA+CAT+AT)	(ESA)	(PRA+ ESA)
PCC	MMF 301	Processing Project Management and Intellectual Property Rights	15	20	5	5	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

MMF301.1: Enumerate and demonstrate fundamental terms such as copy-rights, Patents, Trademarks etc.,

Approximate Hours

Item	AppX Hrs
Cl	6
LI	0
SW	3
SL	1
Total	10

Session Outcomes (SOs)	**Laboratory Instruction (LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO1. Understand project characteristics, management objectives, and project management stages. **SO1.2** Learn project planning, work definition, and cost estimation methods. SO1.3 Master scheduling tools: Work Breakdown Structure, Gantt charts, CPM/PERT.	.	**Unit1.Introduction to Project management** 1.1 Definition and objectives of Project Management 1.2 Stages of Project Management 1.3 Project Planning Process, Establishing Project 1.4 Work definition: Defining work content, Time Estimation Method 1.5 Project Cost Estimation and budgeting, Project Risk Management 1.6 Project scheduling and Planning Tools: Work Breakdown structure	1. Importance of LRC, Gantt charts

SW-1 Suggested Sessional Work (SW):

a. Assignments:

i. Describe the CPM/PERT Networks

MMF301.2: Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research

Approximate Hours

Item	AppX Hrs
Cl	6
LI	0
SW	3
SL	1
Total	10

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO2.1 Create project plans, analyze cash flow, schedule with constraints. **SO2.2** Implement resource leveling, allocation, and time-cost trade-offs.	.	Unit-2 Developing Project Plan 2.1 Project cash flow analysis 2.2 Project scheduling with resource constraints 2.3 Resource Leveling 2.4 Resource Allocation. 2.5 Time Cost Trade off 2.6 Crashing Heuristic	1 Describe Project cash flow analysis .

SW-2 Suggested Sessional Work(SW):

a. Assignments:

i. Analyze Crashing Heuristic

MMF301**.3:** Exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.

Approximate Hours

Item	AppX Hrs
Cl	6
LI	0
SW	3
SL	1
Total	10

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (Cl)**	**Self Learning (SL)**
SO3.1 Implement and monitor projects using PERT/Cost and computer applications. **SO3.2** Conduct comprehensive post-project analysis to evaluate outcomes.	.	**Unit-3:** Project Implementation 3.1 Project Monitoring and Control with PERT/Cost 3.2 Computers applications in Project Management 3.3 Contract Management 3.4 Project Procurement Management. 3.5 Post-Project Analysis 3.6 Tutorial 1	1.Design of Project Monitoring

SW-3 Suggested Sessional Work (SW):

a. Assignments:
Explain the Post-Project Analysis

MMF301.4: • Develop awareness at all levels (research and innovation) of society to develop patentable technologies

Approximate Hours

Item	AppX Hrs
Cl	6
LI	0
SW	3
SL	1
Total	10

Session Outcomes (SOs)	(LI)	Classroom Instruction (Cl)	Self Learning (SL)
SO4.1 Understand the basics and importance of Intellectual Property Rights (IPR). **SO4.2** Explore IPR practices in India and abroad; patents definition.	.	**Unit-4 :** Introduction to IPR 4.1 Overview & Importance 4.2 IPR in India 4.3 IPR abroad 4.4 Patents 4.5 Their definition; granting 4.6 infringement	1.Importance of searching & filing

SW-4 Suggested Sessional Work (SW):

a. Assignments:

i. Application of Utility Models

MMF3015**:** Apply trade mark law, copy right law, patent law and also carry out intellectual property audits

Approximate Hours

Item	Appx Hrs
Cl	6
LI	0
SW	3
SL	1
Total	10

Session Outcomes (SOs)	**(LI)**	**Classroom Instruction (CI)**	**Self Learning (SL)**
SO5.1 Define copyrights, their granting, infringement, searching, and filing. **SO5.2** Learn trademark protection, registration, and the significance of domain names.		**Unit5:** Copyrights 5.1 introduction 5.2 their definition 5.3 granting; infringement 5.4 searching & filing 5.5 distinction between related and copy rights 5.6 Trademarks ,role in commerce ,importance	1Application protection, registration

SW-5 Suggested Sessional Work (SW):

a. Assignments:

i. Application of Scanning domain names

AKS University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M. Tech. (Mechanical Engineering) Program

Brief of Hours suggested for the Course Outcome

Course Outcomes	Class Lecture (CL)	Sessional Work (SW)	Self Learning (Sl)	Total hour (Cl+SW+Sl)
MMF301.1: Enumerate and demonstrate fundamental terms such as copy-rights, Patents, Trademarks etc.,	6	3	1	**10**
MMF301.2: Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.	6	3	1	**10**
MMF301.3: Exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.	6	3	1	**10**
MMF301.4: Develop awareness at all levels (research and innovation) of society to develop patentable technologies.	6	3	1	10
MMF3015: Apply trade mark law, copy right law, patent law and also carry out intellectual property audits	6	3	1	**10**
Total Hours	**30**	15	5	**50**

Suggestion for End Semester Assessment

Suggested Specification Table (For ESA)

CO	Unit Titles	Marks Distribution			Total Marks
		R	U	A	
CO-1	Introduction to Project management	01	02	03	06
CO-2	Developing Project Plan	01	03	07	11
CO-3	Project Implementation	01	07	04	12
CO-4	Introduction to IPR	01	06	04	11
CO-5	Copyrights	01	06	03	10
Total		5	24	21	50

Legend: **R: Remember,** **U: Understand,** **A: Apply**

The end of semester assessment for **Project Management and Intellectual Property Rights** will be held with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wise teachers for above tasks. Teachers can also design different tasks as per requirement, for end semester assessment.

Suggested Instructional/ Implementation Strategies:

1. Improved Lecture
2. Tutorial
3. Case Method
4. Group Discussion
5. Role Play
6. Visit to industry
7. Demonstration
8. ICT Based Teaching Learning (Video Demonstration/ Tutorials CBT, Blog, Facebook, Twitter, Whatsapp, Mobile, Online sources)
9. Brainstorming

Suggested Learning Resources:

(a)Books:

S. No.	Title	Author	Publisher
1	Project Management: Engineering, Technology, and Implementation	Shtub,BardandGloberson	Prentice Hall, India
2	Project Management Handbook,	Lock,Gower,	McGraw-Hill Book Co.(Third edition),1988.

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanical Engg.
3. Mr. Deepak Pandey , Assistant Professor , Dept. of Mechanical Engg
4. Mr. Keshav Pratap Singh, Assistant Professor , Dept. of Mechanical Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanical Engg
6. Mr Krishn Pratap Tiwari , Assistant Professor , Dept. of Mechanical Engg
7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanical Engg
8. Mr. K.C. Kori, Assistant Professor , Dept. of Mechanical Engg
9. Mr. Lokesh Agrawal, Assistant Professor , Dept. of Mechanical Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanical Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanical Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanical Engg

****

Cos,Pos and PSOs Mapping

Course Title: M. Tech. Mechanical

Engineering Course Code: MMF301

Course Title: Project Management and Intellectual Property Rights

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design /development of solutions	Conduct investigations of complex problems	Modern Tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work:	Communication	Project management And finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation	Product Innovation and Development
CO1: Enumerate and demonstrate fundamental terms such as copy-rights, Patents, Trademarks etc.,	1	1	2	2	3	2	3	2	2	1	3	2	2	3	3	1
CO 2 Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.	1	1	2	2	1	2	3	2	1	1	2	2	2	2	2	1
CO3: Exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.	2	2	1	1	1	2	2	2	1	2	1	2	1	1	2	2
CO 4: Develop awareness at all levels (research and innovation) of society to develop patentable technologies.	3	2	2	2	3	2	3	2	2	1	2	3	3	3	3	2
CO5: Apply trade mark law, copy right law, patent law and also carry out intellectual property audits	-	-	-	1	1	3	3	3	1	1	2	2	3	3	1	3

Legend: 1–Low, 2–Medium, 3–High

Course Curriculum Map:

POs & PSOs No.	Cos No.& Titles	SOs No.	Laboratory Instruction (LI)	Classroom Instruction(CI)	Self Learning (SL)
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO1: Enumerate and demonstrate fundamental terms such as copy-rights, Patents, Trademarks etc.,	SO1.1 SO1.2 SO1.3		Unit -1 Introduction to Project management 1.1, 1.2, 1.3, 1.4, 1.5, 1.6	As mentioned in Page number 2 to 6
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 2 Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.	SO2.1 SO2.2		Unit-2 Developing Project Plan 2.1,2.2,2.3,2.4,2.5,2.6	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO3: Exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.	SO3.1 SO3.2		Unit-3 Project Implementation 3.1, 3.2, 3.3, 3.4, 3.5, 3.6	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO 4: Develop awareness at all levels (research and innovation) of society to develop patentable technologies.	SO4.1 SO4.2		Unit-4: Introduction to IPR 4.1, 4.2, 4.3, 4.4, 4.5, 4.6	
PO 1, 2, 3, 4, 5, 6 7, 8, 9, 10, 11, 12 PSO 1, 2, 3, 4, 5	CO5: Apply trade mark law, copy right law, patent law and also carry out intellectual property audits	SO5.1 SO5.2		Unit-5: Copyrights 5.1, 5.2, 5.3, 5.4, 5.5, 5.6	

Semester-III

Course Code: **PE302**

Course Title : **Project Stage-I**

Pre-requisite: Students should have basic knowledge for design, development and analysis of project.

Rationale: Students should be well-versed in the Mechanical manufacturing process and concrete production. Keeping abreast of the latest technological trends is crucial for identifying contemporary R&D topics. A fundamental understanding of the physical and chemical properties of Material is essential. Additionally, students must be proficient in statistical methods for effective data analysis and interpretation. Competence in Microsoft Word and Excel is necessary for report writing and documentation. By combining technical knowledge with analytical and software skills, students will be well-prepared to tackle challenges in the field and contribute meaningfully to research and development efforts.

Course Outcomes:

PE302.1:Methodology for projectdesign and project scheduling
PE302.2: Methods of Data collection and data compiliation
PE302.3:Product development
PE302.4: Data analysis and data interpretation
PE302.5: Concluding remark and future work

SchemeofStudies:

Course Category	Course Code	Course Title	Scheme of studies(Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Hours (CI+LI+SW+SL)	
PROJ	PE302	Project Stage-I	2	6	1	1	10	5

Legend:

CI: ClassroomInstruction(Includesdifferentinstructionalstrategiesi.e.Lecture(L)anTutorial (T)andothers),

LI: LaboratoryInstruction(IncludesPracticalperformancesinlaboratoryworkshop, field or other locations using different instructional strategies)

SW: Sessional Work(includesassignment, seminar, miniprojectetc.),

SL: SelfLearning,

C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback ofteacherto ensureoutcomeofLearning.

Scheme of Assessment:

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)									
			Progressive Assessment (PRA)						End Semester Assessment			Total Marks (PRA+ESA)
			Project Scheduling	Data collection and sampling	Product design	Product analysis and data interporetaion	Report writing and concluding remark	Total Mark	Seminar	Project Viva	Total Marks	
PROJ	PE302	Project Stage-I	05	05	05	25	10	50	15	35	50	100

Course-CurriculumDetailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Lab Work Assignment (LA) Best of 5 of the total, Viva-Voice on Lab Work (VV), and Lab Attendance (LA). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

Course Outcome	Activities	Time Schedule (in hours)	
		Class Activity Per week (5 Credit)	Self Learning /Home activity Per week
PE302: CO.1: Methodology for design and project scheduling	**1. Literature review and identification of Mechanical and Material related projects and project scheduling** Examining recent literature on Materials projects	5	10

	unveils advanMechanicals, methodologies, and applications. This review identifies emerging trends, innovative materials, and sustainable practices, significantly impacting construction, durability, and environmental outcomes. Noteworthy projects illustrate novel approaches, enriching insights and guiding future developments in Material technology. **Project scheduling** : Project scheduling involves planning and organizing tasks to ensure timely completion. It includes defining activities, setting deadlines, and allocating resources efficiently. Effective scheduling helps manage time, costs, and personnel, enhancing productivity and project success. It's crucial for meeting goals, coordinating efforts, and maintaining project momentum		
PE302: CO.2: Methods of Data collection and data compiliation	2**. Design and formulation projects** i. Methods of data collection and data compiletion ii. Design and formulation projects concentrate on innovating products through meticulous recipe development and methodological refinement. These initiatives prioritize material optimization, functional enhanMechanical, and quality assurance. By blending creativity with technical prowess, they propel advanMechanicals across industries, fostering the creation of distinctive, efficient, and commercially viable solutions.	8	15
PE302: CO.3: Product development	**3. Sample analysis and product development** Testing samples determines their suitability by assessing quality, performance, and compliance with standards. It involves rigorous analysis and evaluation to ensure materials meet project requirements. This process identifies strengths and weaknesses, guiding decision-making and ensuring the reliability and effectiveness of the chosen samples for intended applications. Product design and analysis in R&D involve creating	10	25

	and refining products to meet market needs. This process includes conceptualizing, prototyping, and testing to optimize functionality and performance. Analyzing results helps improve designs, ensuring products are innovative, efficient, and ready for successful market introduction.		
PE302. CO.4: Data analysis and data interpretation	**i. Product Dataanalysis &compilation** Project data compilation involves collecting and organizing all relevant information for analysis and reporting. This process ensures data accuracy and completeness, facilitating informed decision-making and efficient project management. It helps track progress, identify trends, and generate insights, supporting successful project outcomes and future planning. ii. **Statistical data analysis and data interpretation** Statistical data analysis involves examining and processing data to uncover patterns and trends. Data interpretation translates these findings into meaningful insights, aiding decision-making and strategy development. This process enhances understanding, supports evidence-based conclusions,	40	15
PE302. CO.5: Concluding remark and future work	**5. Report Writing, Conclusion, Recommendations and Future work in Research work** **Report Writing** : Comprehensive project report writing **Conclusion:** The study successfully demonstrated key findings. It underscores implications, validating hypothesis/objectives. This contributes field significance, laying groundwork for applications. **Recommendation**: Future research should explore expansion areas, emphasizing methodological improvements. Collaboration partners/stakeholders would enrich knowledge transfer. **Future Work:** Innovations in technology/techniques could advance potential benefits. Addressing	12	25

	challenges would refine outcomes, fostering industry/government support.		
Total		75	90

Suggestion for End Semester Assessment

SuggestedSpecificationTable(ForESA)

Course Outcome	UnitTitles	MarksDistribution			Total Marks
		R	U	A	
PE302: CO.1: Methodology for design and project scheduling	1. Literature review and identification of Material related projects and project scheduling	02	03	-	5
PE302: CO.2: Methods of Data collection and data compiliation	2. Design and formulation projects	-	05	03	8
PE302: CO.3: Product development	3. Sample analysis and product development	-	08	04	12
PE302. CO.4: Data analysis and data interpretation	4. Product Data analysis, data interpretation and findings	-	08	12	20
PE302. CO.5: Concluding remark and future work	5. Report writing, concluding remark and future work		03	02	5
Total		02	27	21	50

Legend: R:Remember, U:Understand, A:Apply

TheendofsemesterassessmentforEngineering Project-1 (Literature Review) willbeheld with written examination of 50 marks

Note. Detailed Assessment rubric need to be prepared by the course wiseteachers for above tasks. Teachers can also design different tasks as per requirement, for endsemesterassessment.

SuggestedInstructional/ImplementationStrategies:

1. ImprovedLecture
2. Tutorial
3. CaseMethod
4. GroupDiscussion
5. RolePlay
6. Visit to Mechanical plant
7. Demonstration
8. ICTBasedTeachingLearning(VideoDemonstration/TutorialsCBT,Blog,Facebook,Twitter,Whatsapp, Mobile,Onlinesources)
9. Brainstorming

SuggestedLearningResources:

(a) Books:

S.No.	Title	Author	Publisher	Edition &Year
1	The literature review : six steps to success	Lawrence A. Machi, Brenda T. McEvoy.	Corwin Press, Inc	2022
2	Lee			
3	Tylor			
4	Manufacturing Processes			
5				

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanichal Engg.
3. Mr Deepak Pandey , Assistant Professor , Dept. of Mechanichal Engg
4. Mr.,Keshav Pratap Singh, Assistant Professor , Dept. of Mechanichal Engg
5. Mr.Amar Soni , Assistant Professor , Dept of Mechanichal Engg
6. Mr K.P Tiwari , Assistant Professor , Dept. of Mechanichal Engg

7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanichal Engg
8. Mr. K.C. Kori, Faculty, Assistant Professor , Dept. of Mechanichal Engg
9. Mr,Lokesh Agrawal, Assistant Professor , Dept. of Mechanichal Engg
10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanichal Engg
11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanichal Engg
12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanichal Engg

COs, POsandPSOs Mapping

ProgramTitle:M.Tech Mechanical Engineering

Course Code:PE302; **CourseTitle:** Project Stage-I

CourseOutcomes	Program Outcomes												ProgramSpecificOutcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation.	Product Innovation and Development
PE302: CO.1: Methodology for design and project scheduling	2	1	1	1	1	3	3	1	1	1	1	2	3	3	3	3
PE302: CO.2: Methods of Data collection and data compiliation	3	1	2	2	2	3	3	1	1	1	1	2	3	3	3	3
PE302: CO.3: Product development	2	1	1	1	1	3	3	1	1	1	1	2	3	3	3	3
PE302. CO.4: Data analysis and data interpretation	3	1	2	2	2	3	3	1	1	1	1	2	3	3	3	3
PE302. CO.5: Concluding remark and future work	2	1	1	1	1	3	3	1	1	1	1	2	3	3	3	3

Legend:1–Low,2–Medium,3–High

CourseCurriculumMap: Mini-Project

POs&PSOsNo.	COsNo.&Titles	SOsNo.	Laboratory Instruction (LI)	Classroom Instruction (CI)	Self-Learning(SL)
	PE302: CO.1: Methodology for design and project scheduling				
	PE302: CO.2: Methods of Data collection and data compiliation				
	PE302: CO.3: Product development				
	PE302. CO.4: Data analysis and data interpretation				
	PE302. CO.5: Concluding remark and future work				

A K S University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mech. Engg.) Program

(Revised as on 01 August 2023)

Semester IV

Course Code: PE401

Course Title: Project Stage-II

Pre- requisite: Basic Knowledge of Mechanical Industries

Rationale: The objectives of the Industrial Training include: To give students the opportunity to apply the knowledge and skills they have acquired on campus in a real-life work situation. To provide students with opportunities for practical, hands-on learning from practitioners in the student's areas of specialization. To expose students to a work environment, common practices, employment opportunities and work ethics in their relevant field. To enhance the employability skills of the students. To provide opportunities for students to be offered jobs in the organizations in which they undergo their Industrial Training.

Course Outcomes:

PE401.1: Understand the organizational environment and recognize the requirement of the organization and cope with the organizational scenario.
PE401.2: Identify career paths taking into account their individual strengths and aptitude and prepare a report about the work experience in the organization.
PE401.3: Develop the employability skills and Start-Up skills to increase his/her ability to engage in life-long learning
PE401.4: Develop individual confidence to handle various engineering assignments and acquire life skills to meet societal challenges.

Scheme of Studies:

Course Category	Course Code	Course Title	Scheme of studies (Hours/Week)					Total Credits (C)
			CI	LI	SW	SL	Total Hours (CI+LI+SW+SL)	
PROJ	PE401	Engineering Project 3 (Prototype & testing)/ On job Plant Training	3	0	1	1	3	12

Legend: **CI:** Classroom Instruction (Includes different instructional strategies i.e. Lecture (L) and Tutorial (T) and others),

LI: Laboratory Instruction (Includes Practical performances in laboratory workshop, field or other locations using different instructional strategies)
SW: Sessional Work (includes assignment, seminar, mini project etc.),
SL: Self Learning,
C: Credits.

Note: SW & SL has to be planned and performed under the continuous guidance and feedback of teacher to ensure outcome of Learning.

Scheme of Assessment:

Engineering Project

Course Category	Course Code	Course Title	Scheme of Assessment (Marks)					
			Progressive Assessment (PRA)				End Semester Assessment Final Project Report + Seminar + Viva (ESA)	Total Marks (PRA+ESA)
			5 Internal Progress Report Monthly 7 marks each (IPR)	Seminar one (TSN)	Class Attendance (TA)	Total Marks (IPR+TSN+TA)		
PROJ	PROJ 404	Engineering Project-3 (Prototype & Testing)/ On job Plant Training	35	10	5	50	50	100

Course-Curriculum Detailing:

This course syllabus illustrates the expected learning achievements, both at the course and session levels, which students are anticipated to accomplish through various modes of instruction including Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW), and Self Learning (SL). As the course progresses, students should showcase their mastery of Session Outcomes (SOs), culminating in the overall achievement of Course Outcomes (COs) upon the course's conclusion.

On Job Industrial Training & Time Schedule		
Activity	**Broad Area of Training**	**Time Schedule**
Plant Data	Product information, Capacity of the plant, is the company quoted on the stock exchange, locally, international, if so how has their share price varied during your time with the company? (Type of industry - Public Limited, Private Limited, Co-operative sector etc.) Site Plan, /Plant Layout, Flow Diagram / Process Diagram	48 Hours (1Week)
Process Technology	Manufacturing processes, Drawings (if available), specification of the machinery in use, The type of fuel, process control parameters, CCR operation	48 Hours (1Week)
Raw Materials	Quality and source of the various raw materials used by the Mechanical plant.	96 Hours (2Weeks)
Limestone Mining	Limestone Mining practices, quarry scale of operation, Pit head Quality control	96 Hours (2Week)
Homogenization and Raw meal preparation	Crushing of limestone pre homogenization stock pile, grinding and homogenisation of raw meal	96 Hours (2Weeks)
Fuel	Quality, source and preparation of fuel for firing including Alternate Fuel (if used by the plant)	96 Hours (2Weeks)
Pyro-processing and Clinker manufacture	Rotary kiln operation, pre heater , pre calciner technique , process control	96 Hours (2Weeks)
Clinker cooling	Clinker cooling practices	96 Hours (2Weeks)
Energy Management	The energy requirements of the company (machinery, lighting, heating and or air conditioning): Source, connected load, Sur-plus electricity, Correlate items that can reveal major outcomes, e.g. how power factor in electricity bill reveals production rate. Waste heat recovery system and cogeneration of power.	48 Hours (1Week)
Material Handling Systems	Material handling system of Mechanical plant	48 Hours (1Week)

Maintenance Practices of the plant	Maintenance schedule / Programmers: Preventive Maintenance, Stoppages, Breakdown Maintenance, Calibration Systems	48 Hours (1Week)
Instrumentation and control	Process automation, Type of Instrumentation and Control, Fully / Partially automated, Office Automation, Value and system analysis	48 Hours (1Week)
Plant Utilities:	Own source of water or else , Water reservoir, Boiler, DM Plant, Electricity, Power, Compressor, Air Conditioning, Effluent Treatment Plant Production of Mechanical and Despatch Systems	48 Hours (1Week)
Quality Control & Quality Assurance	Quality control system of the Mechanical plant and quality assurance practices in Mechanical manufacturing process of Mechanical	48 Hours (1Week)
Human Resource Planning and Management	Technical, Non-Technical, Administrative, Direct employment, Indirect employment, Turnover-capital employed	48 Hours (1Week)
Materials Management	Purchasing, Write-off policy, Inventory Control, Competitors, Export achievements, Building and Construction, Budgetary provisions, control and cost analysis, Budgets/Project planning/scheduling	48 Hours (1Week)
Safety and Hygiene	Environmental norms, Fire Safety norms, Industrial Safety norms.	48 Hours (1Week)
Marketing Strategy and Consumer Satisfaction measure	Marketing practices and consumer satisfaction measure taken by the Mechanical plant	48 Hours (1Week)
Total Hours		1152 Hours (24 Weeks)

OR (In campus Training)

Prototype & Testing & Time Schedule		
Activity	**Broad Area of Training**	**Time Schedule**
Project Planning/ Problem Designing /Gap Identification	This involves clearly defining the problem or research question that needs to be addressed in the laboratory. It includes understanding the context, scope, and significance of the problem.	144 Hours (3 Weeks)
Literature Review	This helps in identifying gaps in knowledge and determining the best approach to address the problem.	144 Hours (3 Weeks)
Experimental Methodology Development & Interpretation	Analysis and interpretation in lab research involve processing data for patterns, using statistical methods for insights, and contextualizing findings to draw conclusions that advance scientific understanding and guide further research.	384 Hours (8 Weeks)
Result & Discussion	Results and discussion in laboratory research entail presenting findings, interpreting their significance, and contextualizing them within existing knowledge to address research objectives and implications effectively.	192 Hours (4 Weeks)
Report Writing	Research writing involves synthesizing literature, presenting methods and findings, interpreting results, and discussing implications succinctly to contribute knowledge, validate findings, and propose further exploration in the field.	288 Hours (6 Weeks)
Total Hours		1152 Hours (24 Weeks)

Curriculum Development Team

1. Mr. S.S. Parihar, Head of Deptt. Mech. Engg., AKS University
2. Mr. Alok Ranjan Tiwari , Assistant Professor, Dept. of Mechanichal Engg.
3. Mr Deepak Pandey , Assistant Professor , Dept. of Mechanichal Engg
4. Mr.,Keshav Pratap Singh, Assistant Professor , Dept. of Mechanichal Engg

5. Mr.Amar Soni , Assistant Professor , Dept of Mechanichal Engg

6. Mr K.P Tiwari , Assistant Professor , Dept. of Mechanichal Engg

7. Mr. Ketan Agrawal, Assistant Professor , Dept. of Mechanichal Engg

8. Mr. K.C. Kori, Faculty, Assistant Professor , Dept. of Mechanichal Engg

9. Mr,Lokesh Agrawal, Assistant Professor , Dept. of Mechanichal Engg

10. Mr. Ram Narayan Shukla, Assistant Professor , Dept. of Mechanichal Engg

11. Mr. Rishi Kumar Sharma, Assistant Professor , Dept. of Mechanichal Engg

12. Mr. Naveen Kumar Soni**,** Assistant Professor , Dept. of Mechanichal Engg

13. Mr. Umesh Bagri **,**Assistant Professor , Dept. of Mechanichal Engg

****

A K S University

Faculty of Engineering and Technology

Department of Mechanical Engineering

Curriculum of M.Tech. (Mech. Engg.) Program

(Revised as on 01 August 2023)

COs, POs and PSOs Mapping

Course Title: M. Tech Mechanical Engineering

Course Code: PE401

Course Title: Project Stage-II

Course Outcomes	Program Outcomes												Program Specific Outcome			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
	Engineering knowledge	Problem analysis	Design/development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning	Mechanical System Design and Analysis	Manufacturing Processes and Automation	Computational Modeling and Simulation.	Product Innovation and Development
PE401.1: Understand the organizational environment and recognize the requirement of the organization and cope with the organizational scenario.	2	1	1	1	1	3	3	1	1	1	1	2	3	3	3	3
PE401.2: Identify career paths taking into account their individual strengths and aptitude and prepare a	3	1	2	2	2	3	3	1	1	1	1	2	3	3	3	3

report about the work experience in the organization.																
PE401.3: Develop the employability skills and Start-Up skills to increase his/her ability to engage in life-long learning	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**2**	**3**	**1**
PE401.4: Develop individual confidence to handle various engineering assignments and acquire life skills to meet societal challenges.	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**1**

Legend: 1 – Low, 2 – Medium, 3 – High