INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**MACHINE TOOLS AND METROLOGY**				
Course Code	AME010				
Programme	B.Tech				
Semester	V	ME			
Course Type	Foundation				
Regulation	IARE - R16				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. K. China Apparao, Associate Professor, ME				
Course Faculty	Dr. K. China Apparao, Associate Professor, ME Mr. C. Labesh Kumar, assistant Professor, ME				

I. COURSEOVERVIEW:

Machine Tool Technology is an instructional program that prepares individuals to shape metal parts on machines such as lathes, grinders, drill presses, milling machines and shapers. This program includes instruction in safety, making computations related to work dimensions testing feeds and speeds of machines using precision measuring instruments. Metrology is highly valuable for the students and practitioners, specifically from mechanical and allied engineering stream. This course is designed to impart the knowledge to develop measurement procedures, conduct metrological experiments.

II. COURSEPRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
UG	AME006	IV	Production Technology	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Machine Tools and Metrology	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	Chalk & Talk	✔	Quiz	✔	Assignments	✗	MOOCs
✔	LCD / PPT	✔	Seminars	✗	Mini Project	✔	Videos
✗	Open Ended Experiments						

V. EVALUATIONMETHODOLOGY:

The course will be evaluated for a total of 100 marks, with 30 marks for Continuous Internal Assessment (CIA) and 70 marks for Semester End Examination (SEE). Out of 30 marks allotted for CIA during the semester, marks are awarded by taking average of two CIA examinations or the marks scored in the make-up examination.

SemesterEndExamination(SEE): TheSEEisconductedfor70marksof3hoursduration.The syllabus for the theory courses is divided into five units and each unit carries equal weightage in terms of marks distribution. The question paper pattern is as follows. Two full questions with "either" or "choice" will be drawn from each unit. Each question carries 14 marks. There could be a maximum of two sub divisions in aquestion.

The emphasis on the questions is broadly based on the following criteria:

50 %	To test the objectiveness of the concept.
50 %	To test the analytical skill of the concept OR to test the application skill of the concept.

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 1), with 25 marks for Continuous Internal Examination (CIE), 05 marks for Quiz/ Alternative Assessment Tool (AAT).

Table 1: Assessment pattern for CIA

Component	**Theory**		**Total Marks**
Type of Assessment	CIE Exam	Quiz/AAT	
CIA Marks	25	05	30

Continuous Internal Examination (CIE):

Two CIE exams shall be conducted at the end of the 8th and 16th week of the semester respectively. The CIE exam is conducted for 20 marks of 2 hours duration consisting of five descriptive type questions out of which four questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz - Online Examination

Two Quiz exams shall be online examination consisting of 25 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Such a question paper shall be useful in testing of knowledge, skills, application, analysis, evaluation and understanding of the students. Marks shall be awarded considering the average of two quiz examinations for everycourse.

Alternative Assessment Tool (AAT)

This AAT enables faculty to design own assessment patterns during the CIA. The AAT converts the classroom into an effective learning center. The AAT may include tutorial hours/classes, seminars, assignments, term paper, open ended experiments, METE (Modeling and Experimental Tools in Engineering), five minutes video, MOOCsetc.

VI. HOW PROGRAM OUTCOMES AREASSESSED:

Program Outcomes (POs)		Strength	Proficiencyassessed by
PO 1	**EngineeringKnowledge**:Capabilitytoapplytheknowledgeof mathematics,scienceandengineeringinthefieldofmechanical engineering.	2	Assignments
PO 2	**Problem Analysis:** An ability to analyze complex engineering problems to arrive at relevant conclusion using knowledge of mathematics, science and engineering.	2	Mini project
PO 3	**Design/ development of solutions:** Competence to design a system, component or process to meet societal needs within realistic constraints.	2	Industrial/ Seminars
PO 4	**Conduct investigations of complex problems:** To design and conductresearchorientedexperimentsaswellastoanalyzeand implement data using researchmethodologies.	2	Assignments

3 = High; 2 = Medium; 1 = Low

VII. HOW PROGRAM SPECIFIC OUTCOMES AREASSESSED:

Program Specific Outcomes (PSOs)		Strength	Proficiency assessed by
PSO 1	**Professional Skills:** To produce engineering professional capable of synthesizing and analyzing mechanical systems including allied engineering streams.	3	Assignments
PSO 2	**Problemsolvingskills**:Anabilitytoadoptandintegratecurrent technologies in the design and manufacturing domain to enhance theemployability.	2	Projects
PSO 3	**Successful career and Entrepreneurship**: To build the nation, by imparting technological inputs and managerial skills to become technocrats.	2	Projects

3 = High; 2 = Medium; 1 = Low

VIII. COURSE OBJECTIVES(COs):

The course should enable the students to:	
I	Visualize the generation of surface profiles using the relative motion between directrix and generatrix.
II	Understand the basic mechanism involved in metal cutting processes using different cuttingtools.
III	Understand the measurement of different attributes of metal cutting using various measuring instruments.
IV	Analyze surface topography, establish geometrical dimensioning and tolerancing.

IX. COURSE OUTCOMES(COs):

COs	Course Outcome	CLOs	Course Learning Outcome
CO 1	Explain metal cutting principles, various materials used for metal cutting and types of lathes and operations performed on lathe.	CLO 1	Understand the concepts various metals cutting machines like lathe describe various driving mechanisms of lathe.
		CLO 2	Demonstrate knowledge with sketches the constructional features and Describe the various operations related to the shaper and planer machines.
		CLO 3	Explore knowledge & ability to describe the indexing mechanism for a milling machine and also calculate simple indexing values
CO 2	Acquire the basic structure of various machine tool equipment commonly found in industry such as drilling machines, shaping machines, planning machines, etc.	CLO 4	Derive the constructional features and the terminologies related to grinding, broaching and honing machines
		CLO 5	Discuss the nature of steady and unsteady processes under the influence of time
		CLO 6	Develop the fundamentals of casting and foundry and discuss metal cutting tool theory.
CO 3	Identify the fine finishing operations to obtain dimensional accuracy and surface finish	CLO 7	Determine simple numerical on related concepts discuss in detail various materials used for cutting tools
		CLO 8	Understand the various principles and applications of Non-traditional machining (NTM) processes. Look into the concepts related to NTM processes.
		CLO 9	Knowledge to operate different machine tools with understanding of work holders and operating principles to produce different part features to the desired quality
		CLO 10	Knowledge to identify the uncertainties in dimensional metrology and the define the measurement standards.
CO 4	Apply the concept of system of limits and fits and design limit gauges.	CLO 11	Discuss the measure length and angles using linegraduatedinstruments,i.e.Vernier calipers, micrometers, bevel protractor, sine bar and surface plates
		CLO 12	Develop measure dimensions of shafts, bearings and linear surfaces in metric and imperialunitsusingcalibers,micrometers,and scales.
		CLO 13	Understand Principles of measuringinstruments and gauges and theiruses.
CO 5	Measure surface finish, perform alignment test of machine tools and write applications of coordinate measuring machines.	CLO 14	Introduction to Inspection of engineering parts with various precision instruments.
		CLO 15	Ability to use comparative length measuring instruments, i.e. dial indicator, to measure variationsinthedistancebetweentwoormoresurfaces.
		CLO 16	Explore the use of appropriate method for determination of accuracy based on product function and manufacturing capability.

X. COURSE LEARNING OUTCOMES(CLOs):

CLOCode	CLO's	At the end of the course, the student will have the ability to:	PO's Mapped	Strength of Mapping
AME010.01	CLO 1	Understand the concepts various metals cutting machines like lathe describe various driving mechanisms of lathe.	PO 1	1
AME010.02	CLO 2	Demonstrate knowledge with sketches the constructional features and Describe the various operations related to the shaper and planer machines.	PO 1	3
AME010.03	CLO 3	Explore knowledge & ability to describe the indexing mechanism for a milling machine and also calculate simple indexing values	PO 2	2
AME010.04	CLO 4	Derive the constructional features and the terminologies related to grinding, broaching and honing machines	PO 2	2
AME010.05	CLO 5	Discuss the nature of steady and unsteady processes under the influence of time	PO 2	3
AME010.06	CLO 6	Develop the fundamentals of casting and foundry and discuss metal cutting tool theory.	PO 4	2
AME010.07	CLO 7	Determine simple numerical on related concepts, discuss in detail various materials used for cutting tools	PO 3	2
AME010.08	CLO 8	Understand the various principles and applications of Non-traditional machining (NTM) processes. Look into the concepts related to NTM processes.	PO 4	3
AME010.09	CLO 9	Knowledge to operate different machine tools with understanding of work holders and operating principles to produce different part features to the desired quality	PO 3	1
AME010.10	CLO 10	Knowledge to identify the uncertainties in dimensional metrology and the define the measurement standards.	PO 4	3
AME010.11	CLO 11	Discuss the measure length and angles using line graduated instruments, i.e. vernier calipers, micrometers, bevel protractor, sine bar and surface plates	PO 3	2
AME010.12	CLO 12	Develop measure dimensions of shafts, bearings and linear surfaces in metric and imperial units using calipers, micrometers, and scales.	PO 2	3
AME010.13	CLO 13	Understand Principles of measuring instruments and gauges and their uses.	PO 3	3
AME010.14	CLO 14	Introduction to Inspection of engineering parts with various precision instruments.	PO 1,PO3	3
AME010.15	CLO 15	Ability to use comparative length measuring instruments, i.e. dial indicator, to measure variations in the distance between two ormoresurfaces.	PO 2	1
AME010.16	CLO 16	Explore the use of appropriate method for determination of accuracy based on product function and manufacturing capability.	PO 2	2

3 = High; 2 = Medium; 1 = Low

XI. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES

Course Outcomes (COs)	Program Outcomes (POs)				Program Specific Outcomes (PSOs)		
	PO 1	PO 2	PO 3	PO 4	PSO 1	PSO 2	PSO 3
CO 1	2		2		1	1	
CO 2	2	2		2		2	1
CO 3		2	2		2		
CO 4		2		2			2
CO 5	2		2	2	2	1	

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XII. MAPPING COURSE LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFICOUTCOMES:

CLOs	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CLO 1	3			2										3	
CLO 2			1										3		3
CLO 3	3			3										3	
CLO 4	2													3	
CLO 5	3			1									3		2
CLO 6	1	2													3
CLO 7	2		3											3	
CLO 8				3										1	
CLO 9													3		3
CLO 10	1		1												
CLO 11	2													3	3
CLO 12				1									3		
CLO 13	1														2
CLO 14	2			2										2	
CLO 15	1												3		2
CLO 16	3			3											2

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XIII. ASSESSMENTMETHODOLOGIES–DIRECT

CIE Exams	PO 1, PO2, PO 3, PO4, PSO 1, PSO 2, PSO 3	SEE Exams	PO 1, PO2, PO 3, PO4, PSO 1, PSO 2, PSO 3	Assignments	PO 1,PO4, PSO 1, PSO 2, PSO 3	Seminars	PO 3
Laboratory Practices	PO 3	Student Viva	PO 3	Mini Project	PO 2	Certification	-

XIV. ASSESSMENTMETHODOLOGIES-INDIRECT

✔	Early Semester Feedback	✔	End Semester OBE Feedback
✔	Assessment of Mini Projects by Experts		

XV. SYLLABUS

UNIT-I	BASIC MECHANISM OF METAL CUTTING	Classes:09
Elementary treatment of metal cutting theory,element of cutting process, geometry of single point tool and angles chip formation and types of chips,built up edge and its effects, chipbreakers: Mechanicsof orthogonal cutting,Merchant'sforcediagram,cutting forces,cuttingspeeds,feed,depth of cut,tool life, coolants, machinability, tool materials.		
UNIT-II	**MACHINE TOOL-I**	**Classes:09**
Engine lathe, Principle, specification, types, work and tool holding devices, Automatic lathes, classification: Single spindle and multi-spindle automatic lathes and its tool layouts; Shaping, slotting andplanningmachines, Principlesofworking, specification, operations performed, Kinematicscheme.		
UNIT-III	**MACHINE TOOL-II**	**Classes:09**
Milling machine, classifications, specifications, working principles of milling machines; Geometry of milling cutters, methods of indexing, kinematic scheme of milling machines. Drilling and boring machines, principles of working, specifications, types, operations performed, twist drill; Kinematics scheme of the drilling and boring machines.		
UNIT-IV	**GEOMETRICAL DIMENSIONING AND TOLERANCES**	**Classes:09**
Systems of Limits and Fits: Introduction, normal size, tolerance limits, deviations, allowance, fits and their types, unilateral and bilateral tolerance system, hole and shaft basis systems, Interchangeability and selective assembly; Linear Measurement: Slip gauges, dial indicator, micrometers; Measurement of angles and tapers: Bevel protractor, angle slip gauges, spirit levels, sine bar.		
UNIT-V	**MEASURING INSTRUMENTS**	**Classes:09**
Optical measuring instruments: Tool maker's microscope and its uses, collimators, optical projector, interferometer; Screw thread measurement: Element of measurement, errors in screw threads, measurement of effective diameter, angle of thread and thread pitch, profile thread gauges; Surface roughness measurement**:** Numerical assessment of surface finish: CLA, R.M.S Values, Rz values, methods of measurement of surface finish: profilograph, talysurf - ISI symbol for indication of surface finish.		
Text Books:		
1. Dr. R. Kesavan, Dr. R. Kesavan, "Machine Tools" Laxmi publications, 2nd Edition,2016. 2. N. K Mehta**,** "Metal Cutting and Design of Cutting Tools, Jigs & Fixtures"**,**McGraw-Hill Education, 1st Edition,2014. 3. T. L. Chaudhary, "Metal Cutting and Mechanical Tool Engineering", Khanna Publishers,5th Edition, 2013. 4. R. K. Jain, Engineering Metrology, Khanna Publishers, 1st Edition,2013.		

Reference Books:
1. B.L. Juneja, G.S. Sekhon, Nitin Seth "Fundamentals of Metal Cutting and Machine Tools ",New Age Publishers, 2nd Edition,2014.
2. Geofrey, "Fundamentals of metal machining and machine tools", Tata McGraw Hill Education, 1st Edition,2013.
3. R. S. Sirohi, H. C. Radha Krishna, "Mechanical Measurements", New Age Publishers, 3rd Edition, 2011.
4. M Mahajan "A Textbook of Metrology ", Dhanpatrai and Co, 2nd Edition,2013.

XVI. COURSEPLAN:

The course plan is meant as a guideline. Probably there may be changes.

Lecture No	Topics to be covered	Course Learning Outcomes (CLOs)	Reference
1-4	Elementary treatment of metal cutting theory, element of cutting process	CLO 1	T1:1.7 R1:3.7
5-7	Geometry of single point tool and angles chip formation and types of chips, built up edge and its effects, chip breakers	CLO 1	T1:1.8 R1:3.12
8-10	Mechanics of orthogonal cutting, Merchant's force diagram.	CLO 1	T1:3.1 R1:3.13
11-14	Cutting speeds, feed, depth of cut, tool life, coolants, Machinability, tool materials.	CLO 2	T1:3.3 R1:3.14
15-16	Engine lathe, Principle, specification, types, work and tool holding devices	CLO 2	T1:2.1 R1:4.2
17-20	Automatic lathes, classification Single spindle and multi-spindle automatic lathes and its tool layouts	CLO 3	T1:4.1 R1:4.4
21-23	Shaping, slotting and planning machines, Principles of working, specification, operations performed, Kinematic scheme.	CLO 3	T1:5.1 R1:5.2
24-26	Milling machine, classifications, specifications, working principles of milling machines	CLO 4	T1:6.1 R1:7.2
27-28	Geometry of milling cutters	CLO 4	T1:6.6 R:7.4
29-30	Methods of indexing, kinematic scheme of milling machines, Drilling and boring machines, principles of working, specifications	CLO 4	T1:6.11 R1:8.5
31-32	Types, operations performed, twist drill; Kinematics scheme of the drilling and boring machines.	CLO 5	T1:7.1 R1:6.5
33-34	Systems of Limits and Fits: Introduction, normal size, tolerance limits, deviations, allowance, fits and their types	CLO 5	T1:8.1 R3:3.2
35	Unilateral and bilateral tolerance system, hole and shaft basis systems, Interchangeability and selective assembly	CLO 6	T1:9.1 R3:3.4
36-37	Linear Measurement: Slip gauges, dial indicator, micrometers; Measurement of angles and tapers	CLO 6	T1:9.5 R3:4.4
38	Bevel protractor, angle slip gauges, spirit levels, sine bar.	CLO 7	T1:10.1 R3:5.3
39	Optical measuring instruments	CLO 7	T1:10.4 R3:7.2
40-41	Tool maker's microscope and its uses	CLO 8	T1:10.8 R3:7.6
42	Collimators, optical projector, interferometer	CLO 9	T1:10.9 R3:7.7

43-44	Screw thread measurement: Element of measurement	CLO 10	T1:10.10 R3:7.8
45-47	Errors in screw threads, measurement of effective diameter	CLO 11	T1:15.1 R3:7.9
48-49	Angle of thread and thread pitch	CLO 12	T1:13.5 R3:9.2
50-52	Profile thread gauges; Surface roughness measurement	CLO 12	T1:13.7 R3:9.4
53-55	CLA, R.M.S Values, Rz values	CLO 13	T1:13.8
56-57	Profilograph, Talysurf	CLO 14	T1:13.6 R3:10.3
58-59	Methods of measurement of surface finish	CLO 15	T1:13.9 R3:12.3
59-60	ISI symbol for indication of surface finish.	CLO 16	T1:14.8 R3:12.6

XVII. GAPS IN THE SYLLABUS - TO MEET INDUSTRY / PROFESSIONREQUIREMENTS:

S No	Description	Proposed actions	Relevance with POs	Relevance with PSOs
1	Automatic 5 axis machines	Industrial visits	PO1, PO2, PO4	PSO2
2	Gear cutting machine and process	Seminar/ industrial visit	PO4	PSO2, PSO3
3	Co-ordinate measuring machine	Seminar/ industrial visit	PO3	PSO1, PSO3

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