INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad -500 043

MECHANICALENGINEERING

COURSE DESCRIPTOR

Course Title	**MANUFACTURING TECHNOLOGY**				
Course Code	AMEB16				
Programme	B.Tech				
Semester	FIFTH				
Course Type	Foundation				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	3	2
Chief Coordinator	Dr. K. China Apparao, Associate Professor				

I. COURSE OVERVIEW:

Manufacturing 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 about the various machining processes like turning, shaping, planning, drilling, milling and grinding and to develop measurement procedures, conduct metrological experiments.

II. COURSEPRE-REQUISITES:

Level	Course Code	Semester	Prerequisites	Credits
B. Tech	AMEB05	III	Manufacturing Processes	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Manufacturing Technology	70 Marks	30 Marks	100

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES:

✔	PPT	✔	Chalk & Talk	✔	Assignments	✗	MOOCs
✔	Open Ended Experiments	✔	Seminars	✗	Mini Project	✔	Videos
✗	Others:						

V. EVALUATION METHODOLOGY:

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.

Semester End Examination (SEE): The SEE is conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into five modules and each module 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 module. Each question carries 14 marks. **There could be a maximum of two subdivisions in a question.**

The expected percentage of cognitive level of the questions is broadly based on the criteria given in Table: 1.

Table 1: The expected percentage of cognitive level of questions in SEE.

Percentage of Cognitive Level	Blooms Taxonomy Level
25%	Remember
34%	Understand
33%	Apply
8%	Analyse
0%	Evaluate
0%	Create

Continuous Internal Assessment (CIA):

CIA is conducted for a total of 30 marks (Table 2), with 20 marks for Continuous Internal Examination (CIE), 05 marks for Quiz and 05 marks for Alternative Assessment Tool (Table 3).

Table 2: Assessment pattern for CIA

Component	Theory			Total Marks
Type of Assessment	CIE Exam	Quiz	AAT	
CIA Marks	20	05	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 every course.

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, MOOCs etc. The AAT chosen for this course is given in table 3**.**

Table 3: Assessment pattern for AAT

5 Minutes Video	Assignment	Tech-talk	Seminar	Open Ended Experiment
20%	30%	30%	10%	10%

VI. COURSE OBJECTIVES:

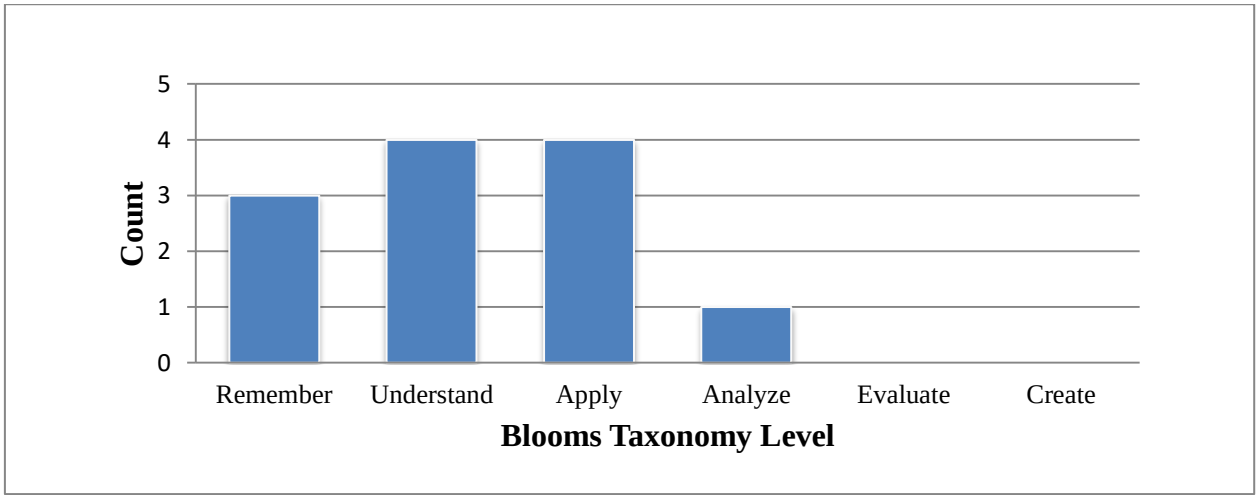
The student will try to learn:	
I	The fundamental concepts of the metal cutting principles to study the behavior of various machining processes
II	The importance of tool materials, cutting parameters, cutting fluids and tool wear mechanisms for optimized machining
III	The principles of linear and angular measuring instruments for accurate measurement of a given component
IV	The mechanics of machining process and optimization of various significant parameters in order to yield the optimum machining.

VII. COURSE OUTCOMES:

After successful completion of the course, students will be able to:		
Course Outcomes		**Knowledge Level (Bloom's Taxonomy)**
CO 1	**Recognize** the importance of geometry of cutting tools, coolants and tool materials for the analysis of material behavior during manufacturing processes	Remember

CO 2	**Illustrate** mechanism of orthogonal and oblique cutting along with developed cutting forces	Understand
CO 3	**Explain** the chip formation mechanism by measuring the cutting forces during the chip formation process	Understand
CO 4	**Explain** the operational principles of different lathe machines and various reciprocating machines for quality machining	Understand
CO 5	**Select** a machining operation, corresponding machine tool for a specific application in real time	Remember
CO 6	**Identify** most significant process parameters in machine tool for optimal machining	Remember
CO 7	**Explain** the working principles of Milling, drilling and surface grinding machines for manufacturing the components of their requirement	Understand
CO 8	**Estimate** machining times for machining operations at specified levels of cutting parameters of machine tools	Apply
CO 9	**Apply** the principles of limits, fits and tolerance while designing and manufacturing the components of their requirement	Apply
CO10	**Choose** an appropriate measuring instrument for accurate inspection of the dimensional and geometric features of a given component	Apply
CO11	**Apply** various methods for the measurements of screw threads, surface roughness parameters and the working of optical measuring instruments	Apply
CO12	**Analyze** the results of various measuring systems and instruments for motion and dimensional measurements	Analyze

COURSE KNOWLEDGE COMPETENCY LEVELS



VIII. HOW PROGRAM OUTCOMES AREASSESSED:

Program Outcomes		Strength	Proficiency assessed by
PO 1	**Engineering Knowledge**: Capability to apply the knowledge of mathematics, science and engineering in the field of mechanical engineering.	3	CIE/Quiz/AAT

PO 2	**Problem Analysis:** An ability to analyze complex engineering problems to arrive at a relevant conclusion using knowledge of mathematics, science and engineering.	1	CIE/Quiz/AAT
PO 3	**Design/ development of solutions:** Competence to design a system, component or process to meet societal needs within realistic constraints.	1	Discussion/AAT

3 = High; 2 = Medium; 1 = Low

IX. HOW PROGRAM SPECIFIC OUTCOMES AREASSESSED:

Program Specific Outcomes		Strength	Proficiency assessed by
PSO 1	Formulate and evaluate engineering concepts of design, thermal and production to provide solutions for technology aspects in digital manufacturing.	1	Discussion /AAT

3 = High; 2 = Medium; 1 = Low

X. MAPPING OF EACH CO WITH PO(s), PSO(s):

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	√	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	√	-	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 6	-	√	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 7	√	√	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 8	√	√	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 9	√	√	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 10	√	-	√	-	-	-	-	-	-	-	-	-	√	-	-
CO 11	√	-	-	-	-	-	-	-	-	-	-	-	√	-	-
CO 12	-	√	√	-	-	-	-	-	-	-	-	-	√	-	-

XI. JUSTIFICATIONS FOR CO – PO/PSO MAPPING – DIRECT

Course Outcomes	PO's/ PSO's	Justification for mapping, (students will be able to):	No. of Key competencies
CO 1	**PO 1**	Recognize (knowledge) the importance of geometry of cutting tool, Tool life, coolants and tool materials to analyze *material behaviour during manufacturing processes* by applying the principles of **mathematics, science** and **Manufacturing fundamentals**	**3**
CO 2	**PO 1**	Illustrate the mechanisms of orthogonal and oblique cutting processes to know about the *material deformation* that takes place while machining and about to analyse *cutting forces developed* in various metal cutting operations by applying the principles of **manufacturing engineering fundamentals, mathematics and scientific methodologies**	**3**
	PO 2	Understand the given **problem statement** and **formulate** *various equations regarding metal cutting operation*. **Translate the information** into the illustration of force triangles from the provided information **to develop solutions** based on the orthogonal and oblique cutting, **and validate** the illustrated force triangles in reaching substantiated conclusions by the **interpretation of results**.	**6**
CO 3	**PO 1**	**Explain** (Understand) the chip formation mechanism by measuring the *cutting forces during the chip formation process* in solving (complex) manufacturing problems by applying the principles of **mathematics and engineering fundamentals.**	**2**
	PO 2	Problem analysis based on **principles of mathematics, Manufacturing engineering fundamentals** and **sciences** is essential to evaluate the *chip formation mechanism* by *measuring the cutting forces during* the chip formation process	**3**
CO 4	**PO 1**	**Apply** the operational principles of different *lathe machines and* various *reciprocating machines for* quality machining by applying the **knowledge of mathematics**, **science** and **engineering fundamentals**	**3**
CO 5	**PO 1**	Selection of operations which have to be carried out *using machine tools for a specific applications*, need the knowledge of **science** and **engineering fundamentals**	**2**
	PSO 1	**Analysing** the metal *cutting process in various machine tools* to anable them to design, analyse and fabricate **complex designs**.	**2**
CO 6	**PO 1**	Student will able to identify most significant *process parameters* in machine tool for *optimal machining* by applying the **knowledge of mathematics, science** and **production engineering fundamentals**	**3**
	PO 2	Problem analysis based on **principles of mathematics, Manufacturing engineering fundamentals** and **sciences** is essential to analyse and identify most *significant process parameters in machine tool* for optimal machining	**3**
	PSO 1	**Analysing** the metal cutting process in *various machine tools* to anable them to design, analyse and fabricate **complex designs**.	**2**
CO 7	**PO 1**	**Explain (**Understand**)** the *working principles of Milling, drilling and surface grinding machines* for solving (complex) manufacturing problems by applying the principles of **mathematics, science and engineering fundamentals**	**3**
	PO 2	Understand the given **problem statement** and **formulate** the design (complex) engineering problems for *working processes*	**4**

Course Outcomes	PO's/ PSO's	Justification for mapping, (students will be able to):	No. of Key competencies
		of machine tools from the provided **information and data** in reaching substantiated conclusions by the **interpretation of results**.	
	PSO 1	**Analysing** the metal *cutting process in various machine tools* for the development of modern tools to to design, and fabricate **complex designs**.	**2**
CO 8	**PO 2**	Problem analysis based on **principles of mathematics, Manufacturing engineering fundamentals and science** in various metal cutting operations to *estimate machining times for machining operations* at specified levels of cutting parameters of machine tools	**3**
CO 9	**PO 1**	Identify (knowledge) the principles of limits, fits and tolerance while designing to get *accurate and precision measurement of the manufactured components* by using acquired knowledge in **mathematics and science (**physics and engineering**)**.	**2**
	PO 2	Application of the *principles of limits, fits and tolerance* while designing can be used for **identifying, formulating, and analysing complex problems.**	**3**
	PSO 1	Ability to **apply** the *principle of limits, fits and tolerance* while designing and manufacturing help them to design, analyse and fabricate **complex designs**.	**2**
CO 10	**PO 1**	Ability to select, *calibrate and use appropriate measuring equipment* requires identification of measurend, selection of equipment by referring standard available equipment, and analysing the results using reference values are carried out by applying the **knowledge of mathematics, science** and **metrology engineering fundamentals**	**3**
	PO 3	A good **knowledge** in **measuring equipment** and an ability to calibrate, equip them to **design solutions to complex engineering Problems** by measuring *various parameters* which are affecting them.	**3**
	PSO 1	Ability to select, use and **analyse** the results obtained from measuring instruments help them to design, analyse and fabricate **complex designs**.	**2**
CO 11	**PO 1**	Ability to select and use various methods for the measurements of *screw threads, surface roughness parameters* and the working of optical measuring instruments for proper analysis of results to reach actual conclusion requires some research based **knowledge of mathematics, science** and **metrology engineering fundamentals**	**3**
	PSO 1	Ability to select, use and **analyse** the results obtained from measuring instruments help them to design, analyse and fabricate **complex designs**.	**2**
CO 12	**PO 2**	*Accurate and precision measurement* requires usage of acquired **knowledge in mathematics, physics and engineering**.	**3**
	PO 3	A good **knowledge** in **measuring equipment** and an ability to calibrate, equip them to **design solutions to complex engg. Problems** by measuring *various parameters* affecting them.	**3**
	PSO 1	**Analyze** the results of various *measuring systems and instruments* for motion and dimensional measurements and can infer the results to give better conclusions. help them to design, analyse and fabricate **complex designs**.	**2**

XII. TOTAL COUNT OF KEY COMPETENCIES FOR CO – (PO, PSO) MAPPING

Course Outcomes	Program Outcomes / No. of Key Competencies Matched												PSOs/ No. of key competencies		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	12	4	2	1
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	6	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 6	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 7	3	4	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 8	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 9	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 10	3	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO 11	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO 12	-	3	3	-	-	-	-	-	-	-	-	-	2	-	-

XIII. PERCENTAGE OF KEY COMPETENCIES FOR CO – (PO/PSO):

Course Outcomes	Program Outcomes / No. of key competencies												PSOs/ No. of key competencies		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
	3	10	10	11	1	5	3	3	12	5	12	12	6	2	2
CO 1	100	00.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 2	100	60.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 3	66.7	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 4	100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CO 5	66.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
CO 6	100	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
CO 7	100	40.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
CO 8	00.0	20.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	00.0	0.0	0.0

CO 9	66.7	30.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
CO 10	100	00.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
CO 11	100	00.0	0.00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0
CO 12	00.0	30.0	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	0.0	0.0

XIV. COURSE ARTICULATION MATRIX (CO-PO/PSO MAPPING)

COs and POs and COs and PSOs on the scale of 0 to 3, **0** being **no correlation**, **1** being the **low correlation**, **2** being **medium correlation** and **3** being **high correlation**.

0 – **0**≤ ***C***≤ 5% –No correlation;
1 – 5 <***C***≤ 40% – Low/ Slight;
2 – 40 % <***C***< 60% –Moderate.
3 – 60% ≤ ***C***< 100% – Substantial /High

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 4	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 6	3	1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 7	3	1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 8	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO 9	3	1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 10	3	-	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 11	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO 12	-	1	1	-	-	-	-	-	-	-	-	-	1	-	-
TOTAL	30	8	2	-	-	-	-	-	-	-	-	-	7	-	-
AVERAGE	**3.0**	**1.0**	**1.0**	-	-	-	-	-	-	-	-	-	1.0	-	-

XV. ASSESSMENT METHODOLOGY – DIRECT

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

Term Paper	PO 1,PO2						

XVI. ASSESSMENT METHODOLOGY - INDIRECT

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

XVII. SYLLABUS

MODULE - I	BASIC MECHANISM OF METAL CUTTING
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, chip breakers: Mechanics of orthogonal cutting, Merchant'sforcediagram, cutting forces, cutting speeds, feed, depth of cut,tool life, coolants, machinability, tool materials.	
MODULE - II	**MACHINE TOOL - I**
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 and planning machines, Principles of working, specification, operations performed, Kinematic scheme.	
MODULE - III	**MACHINE TOOL - II**
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.	
MODULE - IV	**GEOMETRICAL DIMENSIONING AND TOLERANCES**
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.	
MODULE - V	**MEASURING INSTRUMENTS**
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

XVIII.COURSE PLAN:

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

Lecture No	Topics to be covered	Course Outcomes	Text (T) book / Reference (R) book
1-4	Elementary treatment of the metal cutting theory, element of cutting process	CO 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	CO 3	T1:1.8 R1:3.12
8-10	Mechanics of orthogonal cutting, Merchant's force diagram.	CO 2	T1:3.1 R1:3.13
11-14	Cutting speeds, feed, depth of cut, tool life, coolants, Machinability, tool materials.	CO 3	T1:3.3 R1:3.14
15-16	Engine lathe, Principle, specification, types, work and tool holding devices	CO 4	T1:2.1 R1:4.2
17-20	Automatic lathes, classification Single spindle and multi-spindle automatic lathes and its tool layouts	CO 5	T1:4.1 R1:4.4
21-23	Shaping, slotting and planning machines, Principles of working, specification, operations performed, Kinematic scheme.	CO 4	T1:5.1 R1:5.2
24-26	Milling machine, classifications, specifications, working principles of milling machines	CO 7	T1:6.1 R1:7.2
27-28	Geometry of milling cutters	CO 6	T1:6.6 R:7.4
29-30	Methods of indexing, kinematic scheme of milling machines, Drilling and boring machines, principles of working, specifications	CO 7	T1:6.11 R1:8.5
31-32	Types, operations performed, twist drill; Kinematics scheme of the drilling and boring machines.	CO 8	T1:7.1 R1:6.5
33-34	Systems of Limits and Fits: Introduction, normal size, tolerance limits, deviations, allowance, fits and their types	CO 9	T1:8.1 R3:3.2
35	Unilateral and bilateral tolerance system, hole and shaft basis systems, Interchangeability and selective assembly	CO 9	T1:9.1 R3:3.4
36-37	Linear Measurement: Slip gauges, dial indicator, micrometers; Measurement of angles and tapers	CO 10	T1:9.5 R3:4.4
38	Bevel protractor, angle slip gauges, spirit levels, sine bar.	CO 9	T1:10.1 R3:5.3
39	Optical measuring instruments	CO 10	T1:10.4 R3:7.2
40-41	Tool maker's microscope and its uses	CO 9	T1:10.8 R3:7.6

42	Collimators, optical projector, interferometer	CO 10	T1:10.9 R3:7.7
43-44	Screw thread measurement: Element of measurement	CO 11	T1:10.10 R3:7.8
45-47	Errors in screw threads, measurement of effective diameter	CO 11	T1:15.1 R3:7.9
48-49	Angle of thread and thread pitch	CO 11	T1:13.5 R3:9.2
50-52	Profile thread gauges; Surface roughness measurement	CO 12	T1:13.7 R3:9.4
53-55	CLA, R.M.S Values, Rz values	CO 12	T1:13.8
56-57	Profilograph, Talysurf	CO 12	T1:13.6 R3:10.3
58-59	Methods of measurement of surface finish	CO 11	T1:13.9 R3:12.3
59-60	ISI symbol for indication of surface finish.	CO 12	T1:14.8 R3:12.6

Prepared by:
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