METROLOGY AND MACHINE TOOLS

Subject code: ME503PC
Regulations: R16-JNTUH
Class: III Year B. Tech MECH I Sem

Department of Mechanical Engineering
BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY
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METROLOGY AND MACHINE TOOLS (ME503PC)

COURSE PLANNER

COURSE OVERVIEW:

1. Machine tool is fundamental subject for mechanical, automobile and aeronautical engineering branches. The purpose of this course is to learn about the machines like lathe, shaping, slotting, planning, drilling, grinding, etc. In this subject, the students have to learn how to operate the machines and how to do machining for different applications. Students will come to know about metal cutting theory, different cutting tools and tool angles also. In metrology student have to learn basics of Metrology like Surface roughness, surface finish, limits and tolerances etc.

PRE-REQUISITES

1. Production Technology
2. Kinematics of Machinery
3. Machine drawing
4. Engineering Physics

COURSE OBJECTIVE:

1. To understand the basic parameters of metal cutting operation.
2. Understand different components of Machine Tools and their functions.
3. Understand the basic structure of Lathe machines.
4. Understand the features of Milling process, milling machines, Milling operations and different types of indexing.
5. Understand the basics of Metrology like Surface roughness, surface finish,limits and tolerances etc.

COURSE OUTCOME:

Sl.No	Description	Bloom's Taxonomy Level
1	Describe the basics of Machines	Understand, Apply(Level 2, Level 3)
2	Explain about metal cutting	Understand, Apply, Analyze (Level 2, Level 3, Level 4)
3	Use various machines and tools to make the different objects.	Knowledge, Create (Level 1, Level 6)
4	Describe the basics of Metrology	Understand, Apply(Level 2, Level 3)

HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes (PO)		Level	Proficiency assessed by
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems related to Mechanical Engineering.	1	Assignments

Program Outcomes (PO)		Level	Proficiency assessed by
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems related to Mechanical Engineering and reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	2	Assignments
PO3	**Design/development of solutions**: Design solutions for complex engineering problems related to Mechanical Engineering and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	3	Assignments
PO4	**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.	1	Practical's
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and mechanical tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	2	Practical's
PO6	**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 Mechanical Engineering professional engineering practice.	2	Assignments
PO7	**Environment and sustainability**: Understand the impact of the Mechanical Engineering professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	2	--
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	3	--
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	2	--
PO10	**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.	2	--
PO11	**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.	3	--
PO12	**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	1	Research

Program Outcomes (PO)		Level	Proficiency assessed by
	technological change.		

HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes (PSO)		Level	Proficiency assessed by
PSO1	The student will be able to apply the knowledge of Mathematics, Sciences and engineering fundamentals to formulate, analyze and provide solutions for the problems related to Mechanical engineering and communicate them effectively to the concerned.	2	Lectures, Assignments
PSO2	Design mechanical systems in various fields such as machine elements, thermal, manufacturing, industrial and inter-disciplinary fields by using various engineering/technological tools to meet the mercurial needs of the industry and society at large.	2	Lectures, Assignments
PSO3	The ability to grasp the latest development, methodologies of mechanical engineering and posses competent knowledge of design process, practical proficiencies, skills and knowledge of programme and developing ideas towards research.	3	--

JNTU SYLLABUS

UNIT – I

Metal cutting: Introduction, elements of cutting process – Geometry of single point tools. Chip formation and types of chips. Engine lathe – Principle of working, types of lathe, specifications. Taper turning,– Lathe attachments. Capstan and Turret lathe – Single spindle and multi-spindle automatic lathes – tool layouts.

UNIT – II

Drilling and Boring Machines – Principles of working, specifications, types, operations performed; twist drill. Types of Boring machines and applications. Shaping, slotting and planing machines –Principles of working – machining time calculations.

UNIT – III

Milling machines – Principles of working – Types of milling machines – Geometry of milling cutters methods of indexing. Grinding – theory of grinding – classification of grinding machines. Types of abrasives, bonds. Selection of a grinding wheel. Lapping, honing and broaching machines, comparison and Constructional features, machining time calculations

UNIT – IV

Limits, fits and tolerances- Unilateral and bilateral tolerance system, hole and shaft basis system. Interchangeability and selective assembly. Limit Gauges: Taylor's principle, Design of GO and NO GO gauges Measurement of angles, Bevel protractor, and Sine bar. Measurement of flat surfaces, straight edges, surface plates, optical flat and auto collimator.

UNIT –V

Surface Roughness Measurement: Roughness, Waviness. CLA, RMS, Rz Values. Methods of measurement of surface finish, Talysurf. Screw thread measurement, Gear measurement; Machine Tool Alignment Tests on lathe, milling and drilling machines. Coordinate Measuring Machines: Types and Applications of CMM.

SUGGESTED BOOKS:

A) TEXT BOOKS:

1. Production Technology by R.K. Jain and S.C. Gupta.
2. Production Technology /H.M.T./Tata McGraw Hill.
3. **Engineering Metrology / R. K. Jain / Khanna Publishers**
4. **Engineering Metrology / I C Gupta / Dhanpath Rai.**

B) REFERENCES:

5. Principles of machine tools/ Bhattacharyya A and Sen G.C. /New central book agency
6. Elements of Workshop Technology-Vol-II/Hazra Chowdhury/Media promoters
7. Manufacturing Technology/R.K Rajput/ Laxmi Publications.
8. Metal Cutting and Machine Tool Engineering/ Pakirappa/Durga publishing house.
9. Workshop Technology by B.S.RAGHVAMSHI.
10. Fundamentals of Dimensional Metrology / Connie Dotson / Thomson
11. Principles of Engineering Metrology / Rega Rajendra / Jaico Publications.
12. Engineering Metrology / Kenneth John Hume / Mc Donald

NPTEL WEB COURSE

http://nptel.ac.in/courses/112106179/1
http://nptel.ac.in/downloads/112105127/

NPTEL VIDEO COURSE

https://youtu.be/S60_tjveEKw
https://youtu.be/HpIEeBtJupY

GATE SYLLABUS:

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures, Limits, fits and tolerances, Design of GO and NO GO gauges, Surface Roughness Measurements.

IES SYLLABUS:

Metal Cutting: Turning, Methods of Screw Production, Drilling, Boring, Milling, Gear Manufacturing, Production of flat surfaces, Grinding & Finishing Processes. Computer Controlled Manufacturing Systems-CNC, DNC, FMS, Automation and Robotics.

Cutting Tools Materials, Tool Geometry, Mechanism of Tool Wear, Tool Life & Machinability; Measurement of cutting forces. Economics of Machining. Unconventional Machining Processes. Jigs and Fixtures. Fits and tolerances, Measurement of surface texture, Comparators Alignment tests and reconditioning of Machine Tools

COURSE PLAN (WEEK-WISE):

Lecture No.	Week No.	TOPIC	Course Learning outcomes	Reference
		UNIT – 1		
1.	1	Elementary treatment of metal cutting theory	**Know** about tool geometry	Book No. 1, 2
2.		Element of cutting process – Geometry of single point tool	**Know** about tool angles	
3.		Tool angles, chip formation and types of chips	**Know** about tool angles and **Understand** the formation of chips	
4.		Built up edge and its effects chip breakers.	**Gathering** Knowledge about chips.	
5.	2	Engine lathe – Principle of working, types of lathe, specifications	**Know** about lathe machines.	
6.		Taper turning,– Lathe attachments.	**Gathering** Knowledge about lathe operations.	
7.		Capstan and Turret lathe – Single spindle and multi-spindle automatic lathes – tool layouts.	**Know** the differences of various types of lathes.	
8.		Revision		
		UNIT-2		
9.	3	Introduction to Drilling	**Know** about Drilling machines.	Book No. 1, 2,5
10.		Introduction to Boring	**Know** about Boring machines.	
11.		Principles of working of Drilling.	**Understanding** the Principles of working of Drilling.	
12.		***Mock Test – I***		
13.	4	specifications, types, operations performed on drilling	**Gathering** Knowledge about Drilling machines and its operations.	
14.		specifications, types, operations performed on boring	**Gathering** Knowledge about Boring machines and its operations.	
15.		twist drill	**Know** about tool angles of twist drill.	
16.		Types of Boring machines and applications	**Gathering** Knowledge about Boring machines	
		Tutorial / Bridge Class # 1		
17.	5	Principles of working of shaping machine	**Know** about Shaping machines.	
18.		Principles of working of slotting and planning machines	**Understanding** the Principles of working	

			of various machines.	
19.		Revision		
20.		Slip Test		
		Tutorial / Bridge Class # 2		
		UNIT – 3		
21.	6	Milling machines Introduction	**Know** about Milling machines.	Book No. 1, 2,
22.		Principles of working of milling machines	**Understanding** the Principles of working of Milling machines.	
23.		Types of milling machines	**Gathering** Knowledge about various types of milling machines.	
24.		Operations performed on milling machines.	**Gathering** Knowledge about milling operations.	
		Tutorial / Bridge Class # 3		
25.	7	Geometry of milling cutters	**Know** about tool angles of milling cutter.	
26.		methods of indexing	**Understanding** the concept of Indexing.	
27.		Grinding Introduction	**Know** about Grinding operation.	
28.		theory of grinding	**Gathering** Knowledge on cutting parameters of grinding.	
		Tutorial / Bridge Class # 4		
29.	8	Classification of grinding machines	**Gathering** Knowledge about various types of milling machines.	
30.		Abrasives , Types of abrasives, bonds	**Know** about Abrasives , Types of abrasives.	
31.		Selection of a grinding wheel	**Know** how to select grinding wheel.	
32.		Lapping machines	**Know** about Lapping machines.	
		Tutorial / Bridge Class # 5		
		I Mid Examinations (Week 9)		
		UNIT – 3 Contd.		
33.	10	Honing machines	**Know** about Honing machines.	Book No. 1,2,
34.		Broaching machines.	**Know** about Broaching machines.	
35.		Lapping, honing and broaching machines, comparison	**Analyze** comparison between Lapping,	

			honing and broaching machines	
36.		machining time calculations	**Gathering** Knowledge on various cutting parameters	
		Tutorial / Bridge Class # 6		
		UNIT – 4		
37.	11	Limits, fits and tolerances introduction.	**Know** and **Analyze** Limits, fits and tolerances.	Book No.3,4 ,11
38.		Unilateral and bilateral tolerance system	**Gathering** Knowledge on tolerance system.	
39.		hole and shaft basis system	**Know** about hole and shaft basis system.	
40.		Interchangeability and selective assembly	**Analyze** concepts of tolerances.	
		Tutorial / Bridge Class # 7		
41.	12	Limit Gauges Introduction	**Know** about Limit Gauges.	
42.		Taylor's principle	**Analyze** Taylor's principle.	
43.		Design of GO and NO GO gauges	**Gathering** Knowledge on gauges.	
44.		Measurement of angles, Bevel protractor	**Know** about various measuring instruments.	
		Sine bar	**Know** about various measuring instruments	
45.	13	Measurement of flat surfaces	**Know** about various measuring instruments	
46.		Measurement of straight edges	**Know** about various measuring instruments	
47.		surface plates	**Know** about various measuring instruments	
48.		optical flat	**Know** about various measuring instruments	
		auto collimator	**Know** about various measuring instruments	
		UNIT – 5		
49.	14	Surface Roughness Measurement Introduction	**Gathering** Knowledge on Surface Roughness.	Book No.3,4 ,12
50.		Roughness	**Gathering** Knowledge on Surface Roughness.	
51.		Waviness	**Gathering** Knowledge on waviness.	

52.		CLA, RMS, Rz Values	**Analyze** CLA, RMS, Rz Values.	
		Methods of measurement of surface finish	**Know** about various measuring instruments	
53.	15	Talysurf	**Analyze** Talysurf concept.	
54.		Screw thread measurement	**Know** about various measuring methods.	
55.		Gear measurement	**Know** about various measuring methods.	
56.		Machine Tool Alignment Tests on lathe	**Analyze** Machine Tool Alignment Test.	
		Machine Tool Alignment Tests on drilling machines	**Analyze** Machine Tool Alignment Test.	
57.	16	Machine Tool Alignment Tests on milling machines	**Analyze** Machine Tool Alignment Test.	
58.		Coordinate Measuring Machines: Types	**Know** about Coordinate Measuring Machines.	
59.		Applications of CMM.	**Gathering** Knowledge on CMM.	
60.		Revision		
		Tutorial / Bridge Class # 11		
61.	17	Revision		
62.		Revision		
63.		Revision		
64.		Revision		
		Tutorial / Bridge Class # 12		
		II Mid Examinations (Week 18)		

MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

CO's	Program Outcomes (PO's)												PSO ATTAINMENT		
	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	**3**	**3**	**3**	**--**	**--**	**2**	**2**	**2**	**--**	**--**	**--**	**--**	**1**	**1**	**1**
CO2.	3	2	3	--	--	2	2	2	--	--	--	--	1	1	1
CO3	3	3	3	--	--	2	1	1	--	--	--	--	1	1	1
CO4	3	3	2	1	2	--	--	--	1	--	--	1	2	2	1

Avg	3	3	3	1	2	2	2	2	1	--	--	1	1	1	1

DESCRIPTIVE QUESTIONS:

UNIT-I Short Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	With neat figure explain the tool elements and tool angles for single point tool.	Knowledge	2
2	Discuss the variables affecting tool life.	Understand	2
3	When are magnetic chucks used for lathe operations	Apply	1
4	Why lathe beds are made of cast iron? Explain	Understand	3
5	What is meant by 'tool layout' of a turret lathe?	Apply	2
6	What is meant by Morse taper?	Knowledge	3
7	"Lathe is called a versatile machine tool"- Justify the statement	Understand	2
8	What do you understand by the term 'Tool life'? What factors influence the life of a cutting tool?	Understand	2
9	Define taper. How is the amount of taper expressed	Understand	1
10	What do you mean by back gear in lathe	Knowledge	2
11	10. What is meant by built-up-edge?	Understand	1

Long Answer Questions-

S. No	Question	Blooms Taxonomy Level	Course Outcome
1	Define cutting speed; feed and depth of cut with respect to turning process also state the units of measurements.	Understand	2
2	With the help of neat diagram explain Merchants force diagram for orthogonal cutting.	Understand	1
3	Explain about different types of chip breakers with neat diagram.	Knowledge	1
4	Explain about Discontinuous chip, Continuous chip, and continuous chip with built up edge? Explain the conditions favoring their formation.	Analysis	2
5	Name any three lathe accessories and explain their functions.	Knowledge	3
6	What are the various types of automatic lathe? Explain their differences and applications.	Understand	1
7	What is the significance of capstan, turret and automatic lathes in production shop	Knowledge	2

UNIT-II

Short answer questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Define the Lip clearance angle of a twist drill	Understand	3
2	Define Shaping ,what are the operations performed on shaper	Understand	2
3	List out the types of boring machine	Knowledge	1
4	Define Slotting, Write the operations performed on slotter.	Apply	2
5	What are the various parts of boring mill? Explain them briefly	Knowledge	2
6	Define planning and write the operations performed on planner.	Understand	1
7	Define the Lip clearance angle of a twist drill	Understand	2
8	Define the Lip Point angle of a twist drill.	Understand	3
9	Define the Rake angle of a twist drill.	Apply	1
10	What is spade drill? When is it used? Sketch one.	Apply	2

Long answer questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Discuss problems faced in a drilling operation with their causes and possible remedies.	Understand	3
2	What are vertical boring machines? Where are they preferred and why?	Understand	2
3	State the differences between honing and lapping.	Knowledge	2
4	Write the differences between single housing and double housing planning machine.	Knowledge	2
5	Write the principle of working of shaper with neat sketch.	Knowledge	1
6	Write the principle of working of slotter with neat sketch.	Understand	2
7	Describe a tapping attachment in drilling machine	Knowledge	2
8	What is a jig boring machine? Describe its construction and working detail.	Analysis	3
9	Describe a tapping attachment in drilling machine	Knowledge	1
10	List and explain various drilling operations with sketch.	Apply	2

UNIT-III

Short answer questions:

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Explain Face milling with neat sketch.	Understand	2
2	Explain Straddle milling with neat sketch.	Knowledge	2
3	Explain Dove tail milling with neat sketch.	Understand	2
4	Explain Form milling with neat sketch.	Understand	1
5	Describe a milling cutter.	Apply	2
6	What factors contribute to increased production rates in broaching?	Knowledge	2
7	Define the Grindability.	Apply	1
8	Define the Sensitivity.	Knowledge	2
9	Define the Finishability.	Analyze	1
10	Define the Grinding ratio.	Understand	2

11	Define honing process.	Knowledge	2
12	What is the difference between rough and precision grinding?	Analyze	1
13	Define grinding operation.	Knowledge	2
14	List the various types of special grinding machines.	Analyze	2
15	Explain clearly the various thermal effects in grinding.	Understand	3

Long answer questions:

S. No	Question	Blooms Taxonomy Level	Course Outcome
1	What are the common milling methods? Compare their relative merits and Demerits.	Apply	2
2	Sketch and describe the working of a 'Turret-type milling machine'.	Apply	2
3	What do you understand from the term 'Kinematic Scheme of milling cutter'? Explain in detail?	Understand	1
4	Explain with sketch different elements of a broach and describe them brief.	Knowledge	2
5	Briefly explain some of the problems caused in milling. Give their causes and Remedies.	Apply	1
6	What are the motions of the arbor mounted milling cutter has with respect to the work piece? Discuss	Knowledge	2
7	Explain the applications and differences with neat sketches, the following with reference to milling: (a) Straddle milling (b) Gang milling	Understand	2
8	Sketch typical set up for (a) Reciprocal milling (b) String milling.	Understand	2
9	Describe the set up that can be used for milling cams in a milling machine. Explain neatly with a sketch, the various attachments that one needs to use for such milling.	Apply	3
10	Explain the limitations of such a set up.	Understand	1
11	Describe the differences between a lathe and milling machine in terms of the types of surfaces generated, the types of tools used and applicability for general and production applications.	Knowledge	2
12	Explain the characteristics that distinguish a milling process from other machining processes.	Knowledge	2

UNIT-IV Short Answer Questions

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Name and sketch three main types of fits.	Understand	4
2	Write the differences between the unilateral and bilateral system.	Knowledge	4
3	State the principle of interference.	Knowledge	4
4	Define Gauge, explain go and no go gauges.	Apply	4
5	Define the terms i) Tolerance ii) Allowance and iii) Limits.	Understand	4
6	Differentiate between shaft based and hole based systems.	Understand	4
7	List out the applications of NPL gauge interferometer.	Understand	4

8	Differentiate between primary and secondary texture.	Understand	3
9	What are the advantages of optical instruments over conventional measuring instruments?	Knowledge	4
10	Explain the various standards of linear measurement	Understand	4
11	What are the applications of Optical Flats?	Knowledge	4
12	What are the instruments used for Flat surface Measurement?	Knowledge	4

Long answer questions:

S. No	Question	Blooms Taxonomy Level	Course Outcome
1	Define and explain about interchangeability and selective assembly.	Knowledge	4
2	Determine and sketch the limits of tolerance and allowance for a 45mm shaft and hole pair designated H7−d8. The basic size lies in the range of 30-50mm. The multipliers for grades 7 and 8 are 16 and 25 respectively. The fundamental deviation for'd' shaft is (-16 D0.44) microns.	Knowledge	4
3	Mention the materials used for the manufacture of GO and NOGO gauges. Explain the disposition of tolerance on GO and NO GO gauges by taking reference to work tolerances	Knowledge	4
4	Why is a Sine bar not used for generating angles greater than 450 , if high accuracy is needed? Explain it with a suitable graph. Explain the different sources of errors in Sine Bars.	Understand	4
5	With a sketch, explain the construction of autocollimator. What are its applications?	Knowledge	4
6	Determine limit dimensions for a clearance fit between mating parts of diameter 40 mm, providing a minimum clearance of 0.10 mm with a tolerance on the hole equal to 0.025mm and on shaft 0.05mm using both systems.	Knowledge	3
7	Distinguish between line and end standards. How are end standards derived from line standards? Give examples.	Knowledge	4
8	Explain briefly different types of fits with necessary sketches.	Knowledge	4
9	Explain the following in connection with gauge design: (i) Gauge tolerance (ii) Wear allowance.	Knowledge	4
10	Explain with the help of a diagram the principle of working of a sine bar for angular measurement. List the advantages and limitations of sine bar.	Understand	4
11	What are the essential considerations in selection of materials for gauges and what are the common materials used for gauges?	Understand	4

UNIT-V Short Answer Questions

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	What is the importance of surface roughness? Mention the geometrical characteristics of a surface.	Knowledge	4
2	Define the terms roughness, waviness, lay, flaws and roughness width.	Understand	4
3	What are the methods for measurement of surface finish?	Understand	4
4	What are differences between surface roughness and surface waviness?	Understand	4

5	Define surface finish.	Knowledge	4
6	What are the symbols for surface finish?	Understand	4
7	Derive the expression for 'Best size of wire' in screw thread measurement.	Understand	4
8	Define Position accuracy.	Understand	4
9	Write the applications and feature of CMM.	Understand	4

Long Answer Questions-

S.No	Question	Blooms Taxonomy Level	Course Outcome
1	Write the differences between surface roughness and surface waviness?	Knowledge	4
2	Explain the formation of interference fringes when light falls on an optical at resting on a lapped surface. What is the effect of using a monochromatic beam, instead of white light?	Understand	4
3	Make a comparative study of CLA, RMS and Ten point height method of Measurement of surface finish with the help of an example.	Knowledge	4
4	Explain about Profilograph?	Knowledge	4
5	With the help of neat sketch explain about Talysurf method for measuring surface finish?	Knowledge	4
6	Explain Tomlinson surface meter with neat sketch.	Understand	4
7	What is the symbol for fully defining surface roughness and explain each term.	Knowledge	4
8	What are the ISI symbols for indication of surface finish?	Knowledge	4
9	Explain about CLA and R.M.S values for numerical assessment of surface finish.	Knowledge	4
10	What are the methods of measurement of surface finish and explain any one.	Understand	4

OBJECTIVE QUESTIONS:

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UNIT-1

1. Tool signature means:
   a) The impression of the tool taken on a paper for any reference
   b) A numerical method of identification of tool
   c) The plan of tool
   d) the signature of operator using the tool.
2. A built –up-edge is formed while machining:
   (a) Ductile materials at high speed (b) Ductile materials at low speed
   (c) Brittle materials at high speeds (d) brittle materials at low speeds
3. A single point tool has the following specifications in ASA system 8°, 7°, 5°, 6°, 10°, 9°, 1.5. The number 1.5 represents _____.
   (a) Back rake angle (b) End relief angle (c) Side relief angle (d) nose radius
4. Chip breakers are used to:
   (a) Increase tool life (b) remove chips from bed
   (c) Break the chips short segments (d) to minimize heat generation.
5. Tool life is affected by ____. a) Depth of cut b) cutting speed c) feed d) all of these
6. Cutting speed is calculated by the formulae _____.
7. Factors effecting tool life are _____.

8. For turning aluminum components, the coolant used is _____.
9. Machinablity index (%) calculated by the formulae _____.
10. Taylor's tool life equation is _____.
11. HSS cutting tools are generally provided with _____ rake angle.
12. In orthogonal cutting shear angle and rake angle are related by the equation _____.
13. Capstan and turret lathes are usually used:
    a) To make small components b) To make large components c) For ordinary work d) for mass production
14. Tail stock set over method of taper Turning is preferred for:
    (a) Internal tapers (b) small tapers (c) long slender tapers (d) step tapers
15. Half nut mechanism is employed while performing _____operation in lathe.
    (a) Under cutting (b) plain turning (c) thread cutting (d) taper turning

UNIT-2

1. Normally shaping machine is used for producing:
   (a) Threads (b) Cylindrical surfaces (c) Surfaces composed of straight line elements (d) cylindrical holes.
2. Size of a shaper is given by:
   (a) Stroke length (b) motor power (c) weight of machine (d) table size
3. Which of the following operations cannot be performed by a drilling machine?
   a) Reaming b) Boring c) Drilling d) Slotting
4. In a mechanical shaper the lifting of the tool during idle stroke is ensured by:
   (a) Tool head (b) ratchet and power mechanism
   (c) Ram adjustment (d) clamper box mechanism
5. Enlarging an existing hole with a rotating single point tool is called:
   (a) Boring (b) drilling (c) reaming (d) internal turning
6. In reaming process:
   (a) Metal removal rate is high (b) position of drilled hole is corrected
   (c) High form accuracy is obtained (d) high dimensional accuracy is obtained
7. The type of quick return mechanism employed mostly in shaping machines is _____.
8. The machining operation in which tool is stationary and work piece reciprocates past the tool is _____.
9. The drill used for drilling deep holes is _____.
10. Twist drill is generally made up of _____.

UNIT-3

1. String milling is used for:
   a) Large work pieces b) small work pieces c) heavy work pieces d) all
2. Gang milling is used for:
   a) Large work pieces b) Number of milling cutters is used to cut simultaneously
   c) Small work pieces d) Only one milling cutters is used to cut heavy work pieces
3. _____ is used for machining rectangular slots on a vertical knee and column milling machine.
   a) End mill b) ball end mill c) slitting saw d) side and face cutter
4. Simple or plain indexing, number of rotation of the crank are _____.
   a) 40/N b) 24/N C) 21/N D) ALL
5. INDEXING of 77 divisions:
   (a) 9/21 +3/33= 40/77 (b) 26/39-18/47=40/141 (c) 5/20+1/15=19/60 (d) all

6. The characteristics of the work-piece produced by honing are _____.
7. The characteristics of the work piece produced by lapping are _____.
8. Lapping speed is _____.
9. Lapping pressure applied for soft material _____.
10. The abrasive process that uses a loose abrasive grit is ____.
11. Super finishing tools speeds used are _____.
12. Lapping is a _____operation. a) Machining b) finishing c) Both d) none
13. Broaching is used for _____ type of work pieces. a) Flat b) cone shape c) Cylindrical
14. Grinding is a process used for machining materials ____.
    (a) which are too hard (b) close dimensional accuracy
    (c) high degree of surface smoothness (d) all
15. An abrasive used in grinding wheel selected for grinding ferrous alloys is:
    a) Silicon carbide b) aluminum oxide c) diamond d) CBN

UNIT-4

1. Tolerance is specified _____.
2. (a) To obtain desired fit (b) because it is not possible to manufacture in size exactly
3. (c) To obtain high accuracy (d) to have proper allowance
4. In this type of fit shaft is always smaller than the hole:
    a) Clearance fit (b) interference fit (c) transition fit (d) push fit
5. Fundamental tolerance grade value in Indian standard limits are_____.
6. (a)17 (b) 18 (c) 22 (d) 12
7. Allowance in limits and fits refers to _____.
    (a) Axiom clearance between shaft and hole
    (b) Minimum clearance between shaft and hole
    (c) Difference between maximum and minimum size of hole
    (d) Difference between maximum and minimum size of shaft
8. The fit on a hole shaft system is specified as $117\text{-}s_6$. The type of fit is _____.
    (a) Clearance fit (b) Transition fit (c) Interference fit (d) Wringing fit
9. _____ System lower deviation of the hole is zero.
10. Engineering metrology is restricted to the measurements of _____.
11. _____ System, the dimension of a part is allowed to vary only on one side of the basic size.
12. Fundamental tolerance unit formula _____.
13. In tail stock which type of fit is used _____.
14. Slip gauges are made of the _____material.
15. The instrument based on the _____ principle that the linear motion of the rack is converted into angular motion of the pointer.

UNIT-5

1. The surface irregularities of small wave length are called _____.
    (a) Primary texture (b) Secondary texture (c) Waviness (d) Roughness
2. Using _____ methods, the surface roughness is measured as the average deviation from the nominal surface _____.
    (a) R M S method (b) Ten point method (c) a & b (d) C L A method
3. The surface roughness on a drawing is represented by _____.
    (a) Circles (b) Square (c) Zig-Zag lines (d) Triangles
4. The M and E system in metrology are related with measurement of

(a) Gears (b) Screw threads (c) Flatness (d) Angularity (e) Surface finish

5. C.L.A. values are expressed in _____.
6. The waviness is also called as _____ texture
7. Profilometer is measuring for _____ in _____ units
8. Surface Roughness value is 1.6 to 8μm then symbol for this_____.
9. Prototype meter is made of _____alloy.
10. Secondary texture is also known as _____.

GATE QUESTIONS:

1. Deep hole drilling of small diameter, say 0.2 mm is done with EDM by selecting the tool material as: (a) Copper wire (b) tungsten wire (c) Brass wire (d) tungsten carbide
2. Thickness ratio was obtained as 0.4. The shear angle (in degrees) evaluated from this data is: (a) 6.53 (b) 20.22 (c) 22.94 (d) 50.00
3. Tool life testing on a lathe under dry cutting conditions gave n and C of Taylor tool life equation as 012 and 130 m/min, respectively. When a coolant was used, C increased by 10%. What is the percent increase in tool life with the use of coolant at a cutting speed of 90 m/min?
4. A lead-screw with half nuts in a lathe, free to rotate in both directions has: (a) V-threads (b) Whitworth threads (c) Buttress threads (d) Acme threads
5. The time taken to drill a hole though a 25 mm thick plate with the drill rotating at 300 rpm and moving at a feed rate of 0.25 mm/revolution is: (a)10 sec (b) 20 sec (c) 60 sec (d) 100 sec
6. In an orthogonal cutting test on mild steel, the following data were obtained: Cutting speed 40 m/min, Depth of cut: 0.3 mm, Tool rake angle: + 5°, Chip thickness: 1.5 mm, Cutting force: 900 N, Thrust force: 450 N. Using Merchant's analysis, the Friction angle during the machining will be: (a) 26.6° (b) 31.5° (c) 45° (d) 63.4°
7. In an orthogonal cutting process the tool used has rake angle of zero degree. The measured cutting force and thrust force are 500 N and 250 N, respectively. The coefficient of friction between the tool and the chip is _____.
8. The tool life equation for HSS tool is the tool life (T) of 30 min is obtained using the following cutting conditions: V = 45 m/min, f = 0.35 mm, d = 2.0 mm. If speed (V), feed (f) and depth of cut (d) are increased individually by 25%, the tool life (in min) is: (a) 0.15 (b) 1.06 (c) 22. 50 (d) 30.0
9. A single point cutting tool with 0° rake angle is used in an orthogonal machining process. At a cutting speed of 180 m/min, the thrust force is 490 N. If the coefficient of friction between the tool and the chip is 0.7, then the power consumption (in kw) for the machining operation is _____.
10. A slot is to be milled centrally on a block with a dimension of 40 x 0.05 mm. A milling cutter of 20 mm width is located with reference to the side of the block within 0.02 mm. The maximum offset in mm between the centre lines of the slot and the block is: (a) 0.070 (b) 0.070 (c) 0.020 (d) 0.045
11. In an orthogonal machining operation: Uncut thickness = 0.5 mm, Cutting speed = 20 m/min, Width of cut = 5 mm, Chip thickness = 0.7 mm, Thrust force = 200 N, Cutting force = 1200 N, Rake angle = 15°, Assume Merchant's theory to calculate: (A) The values of shear angle and shear strain, respectively, are: (a) 30.3° and 1.98 (b) 30.3° and 4.23 (c) 40.2° and 2.97 (d) 40.2° and 1.65. (B) The coefficient of friction at the tool-chip interface is: 0.23 (b) 0.46 (c) 0.85 (d) 0.95. (C) The percentage of total

energy dissipated due to friction at the tool-chip interface is: 30% (b) 42% (c) 58% (d) 70%

12. In order to have interference fit, it is essential that the lower limit of the shaft should be _____.
    (a) Greater than the upper limit of the hole.
    (b) Lesser than the upper limit of the hole.
    (c) Greater than the lower limit of the hole.
    (d) Lesser than the lower limit of the hole.

IES QUESTIONS:

1. A hole of 20 mm diameter is to be drilled in a steel block of 40 mm thickness. The drilling is performed at rotational speed of 400 rpm and feed rate of 0.1 mm/rev. The required approach and over run of the drill together is equal to the radius of drill. The drilling time (in minute) is: (a) 1.00 (b) 1.25 (c) 1.50 (d) 1.75
2. If the Taylor's tool life exponent n is 0.2, and the tool changing time is 1.5 min, then the tool life (in min) for maximum production rate is _____.
3. A steel bar 200 mm in diameter is turned at a feed of 0.25 mm/rev with a depth of cut of 4 mm. The rotational speed of the work piece is 160 rpm. The material removal rate is _____.
4. Two cutting tools are being compared for a machining operation. The tool life equations are: Carbide tool: $VT^{1.6}=3000$, HSS tool: $VT^{0.6}=200$, where V is the cutting speed in m/min and T is the tool life in min. The carbide tool will provide higher tool life if the cutting speed in m/min exceeds: (a) 0 (b) 39.4 (c) 49.3 (d) 60.
5. In a single pass drilling operation, a through hole of 15 mm diameter is to be drilled in a steel plate of 50 mm thickness. Drill spindle speed is 500 rpm, feed is 0.2 mm/rev and drill point angle is 118°. Assuming 2 mm clearance at approach and exit, the total drill time (in seconds) is: (a) 35.1 (b) 32.4 (c) 31.2 (d) 30.1
6. Details pertaining to an orthogonal metal cutting process are given below: Chip thickness ratio 0.4, Unreformed thickness 0.6 mm, Rake angle +10°, Cutting speed 2.5 m/s, Mean thickness of primary shear zone 25 microns. The shear strain rate during the process is: (a) 0.1781×10^5 (b) 0.7754×10^5 (c) 1.0104×10^5 (d) 4.397×10^5
7. A single point cutting tool with 12° rake angle is used to machine a steel work piece. The depth of cut i.e., uncut thickness is 0.81mm.The chip thickness under orthogonal machining condition is 1.8mm. The shear angle is approximately: (a) 22° (b) 26° (c) 56° (d) 76°
8. The usual method of defining mach inability of a material is by an index based on: (a) Hardness of work material (b) Production rate of machined parts (c) Surface finish of machined surfaces (d) Tool life.
9. In Taylor's tool life equation VT= C, the constants n and C depend upon; 1. Work piece material 2.Tool material 3.Coolant: (a) 1, 2 and 3 (b) 1 and 2 only (c) 2 and 3 only (d) 1 and 3 only
10. Typical coolants used for machining aluminum are; (1)Kerosene oil (2) Soda water (3) Air (4) Paraffin oil: (a) 1, 2, 3 and 4 (b) 2 and 3 only (c) 1 and 2 only (d) 3 and 4 only
11. Match List – I with List – II and select the correct answer using the code given below the lists.

List – I	List– II

(P) Lathe	(1) Flute
(Q) Shaper	(2) Universal indexing
(R) Drilling machine	(3) Lead screw
(S) Milling machine	(4) Rocker arm

(a) P -2,Q-4,R-1,S-3 (b) P-3,Q-4,R-1,S-2 (c) P -2,Q-1,R-4,S-3 (d) P-3,Q-1,R-4,S-2

WEBSITES:

1. http://www.nptel.ac.in/downloads/112105127/
2. http://users.tamuk.edu/kfldp00/MEIE_Peel_website/Courses/MEEN5301.html
3. http://metalcutting.com/
4. http://www.engineeringarticles.org/lathe-lathe-operations-types-and-cutting-tools/
5. http://www.educationdiscussion.com/various-types-of-operations-performed-in-lathe-machine/

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2. Dr. Sai Kumar, Scientist-G, DRDL, Hyderabad
3. Dr. Manzoor Hussain, Professor, JNTU, Hyderabad
4. B. Sravan Kumar Reddy, Metrology Engineer at Schneider electrical India, Hyderabad.
5. Dr. Arkanti Krishnaiah, Associate Professor, Osmania University.
6. Abhay Sharma, Associate Professor, IIT Hyderabad.
7. Dr. S. Surya Kumar, Assistant Professor, IIT Hyderabad.
8. Dr. N. Venkaiah Assistant Professor, NITW.
9. Mr.Rahul Kumar Chandan, Metrology Engineer at Machine Tools India Limited, Bhopal, Madhya Pradesh.
10. Mr. Vijay Kumar Sharma, CMM programmer/Metrology Engineer, at TE Connectivity Bengaluru, Karnataka.

JOURNALS:

1. Journal of Machinery Manufacture and Reliability
2. International Journal of Machining and Machinability of Materials
3. International journal of pure and applied research in engineering and technology
4. International Journal of Research in Engineering and Technology
5. Machining Science and Technology-An International Journal
6. IEEE-Explore
7. Journal of Machining and Forming Technologies
8. International Journal of Advances in Machining and Forming Operations
9. International Journal of Machine Tools and Manufacturing
10. International Journal of Engineering and Advanced Technology

LIST OF TOPICS FOR STUDENT SEMINARS:

1. Cutting tool materials composition and uses.
2. Types of lathes and specifications.
3. Different types of milling machines and specifications.
4. Grinding machines and specifications.
5. Super finishing operation and super finish produced.
6. Optical Measuring Instruments.
7. Measurement of Angles and Tapers.
8. Surface Roughness Measurement.
9. Screw Thread Measurement.

CASE STUDIES / SMALL PROJECTS:

1. Design and fabrication of mini lathe for pipes.
2. Development of cutting tool inserts using modified tool geometry for thread cutting.

3. Effect of cutting forces and cutting parameters in turning process.
4. Spatial's 3D component software helps Metrology companies rapidly deliver robust solutions and better integrate with the manufacturing design process.
5. Advanced techniques for assessment surface topography: development of a basis for 3D surface texture standards.

Statistical case studies for industrial process improvement