



**ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY**  
**Guwahati**

**Course Structure and Syllabus**

**(From Academic Session 2018-19 onwards)**

**B.TECH**  
**INDUSTRIAL AND PRODUCTION ENGINEERING**

**5<sup>th</sup> SEMESTER**



## ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY

### Course Structure

(From Academic Session 2018-19 onwards)

#### B.Tech 5<sup>th</sup> Semester: Industrial and Production Engineering Semester V/ B.TECH/IPE

Sl. No.	Sub-Code	Subject	Hours per Week			Credit	Marks	
			L	T	P	C	CE	ESE
<b>Theory</b>								
1	IPE181501	Manufacturing Process – II	3	0	2	4	30	70
2	IPE181502	Machine Tool Technology	3	0	0	3	30	70
3	IPE181503	Plant Layout and Material Handling	3	0	2	4	30	70
4	ME181503	Mechanisms and Dynamics of Machines	3	0	0	3	30	70
5	ME181505	Engineering Inspection and Metrology	3	0	0	3	30	70
6	HS181506	Engineering Economics	3	0	0	3	30	70
<b>Practical</b>								
1	IPE181512	Machine Tool Technology Lab	0	0	2	1	15	35
2	ME181515	Engineering Inspection and Metrology Lab	0	0	2	1	15	35
3	SII181521	Internship-II (SAI-Academia)	0	0	0	1	-	100
<b>TOTAL</b>			<b>18</b>	<b>0</b>	<b>8</b>	<b>23</b>	<b>210</b>	<b>590</b>
<b>Total Contact Hours per week: 26</b>								
<b>Total Credits: 23</b>								

## Detailed Syllabus:

Course Code	Course Title	Hours per week L-T-P	Credit C
IPE181501	Manufacturing Process – II	3-0-2	4

**Course Outcomes (CO):** At the completion of the course the student will be able:

1. To understand the various plastic deformation phenomenon of metals.
2. To evaluate and understand the suitability of various metal forming processes along with latest advancements in forming technology & their practical Importance
3. To evaluate and understand the suitability of various powder metallurgy processes along with latest advancements & their practical Importance.
4. To evaluate and understand the suitability of various gear & thread manufacturing processes and various coating materials along with latest advancements & their practical Importance.

### **MODULE 1: Plastic Deformation of Metals**

Theory of plasticity – Yield criteria, Tresca’s maximum shear stress criterion, von Mises’ strain energy criterion. Mechanical working of metals, Classification, Hot, Cold and Warm working – Variables affecting mechanical working process.

### **MODULE 2: Forging**

Forgeability – Forgeable materials – Metallurgy of Forging – Classification – Hand forging operations – Forging hammers – Drop forging – Press forging – Machine forging – Calculation of Forging Load for compressing a plate between two parallel flat dies (assuming homogeneous deformation) – Forging Defects – Die design considerations.

### **MODULE 3: Rolling**

Rolling–Principle, Rolling parameters and their effects, Condition for continuous rolling – Calculation of Rolling Load (assuming homogeneous and plain strain deformation – Methods for reduction of roll separating force – Types of rolling mills – Roll pass design – Rolling Defects. Roll Piercing.

### **MODULE 4: Extrusion and Wire, Rod and Tube Drawing**

The Principle – hot and cold extrusion; Types and methods and application, Calculation of Extrusion Load (assuming homogeneous deformation) – Principle of operations of Hydrostatic extrusion, Side extrusion, Impact and Hooker’s extrusion.

Drawing of wire, rod and tubes. Calculation of Wire Drawing Load (assuming homogeneous deformation)

### **MODULE 5: Press Work and Sheet Metal Operations**

Introduction – Stock layout, types of press and press safety devices, press working operation; cutting and shearing, bending, forming, drawing, squeezing, embossing, coining and stretch forming. Principles and Operations of Cutting/Shearing and Deep drawing operations – Cutting and drawing dies – Design considerations – Defects in sheet metal formed parts. Metal Spinning.

**MODULE 6: Manufacture of threads and gears** – different methods and finishing operations.

### **MODULE 7: Power Metallurgy**

Introduction – Applications of P/M – Powder Characteristics – Powder production methods. Mixing and Blending, Briquetting techniques, Sintering. Primary and Secondary processes–Typical applications, Infiltration and Impregnation. Cemented carbides. Advantages and Disadvantages of P/M.

### **MODULE 8: Coating of Metal Surfaces**

Necessity – requirements of coating materials – organic and inorganic coatings.

#### **Textbooks/ Reference Books:**

1. Elements of Elements of Workshop Technology (Volume – 1 & 2) – **Author:** S. K. Hajra Choudhury , Nirjhar Roy , A. K. Hajra Choudhury – Media Promoters
2. Manufacturing Science Manufacturing science- Amitabha Ghosh, Asok Kumar Mallik – Prentice Hall India
3. Manufacturing Technology: Foundry, Forming and Welding, Vol – 1 – P.N. Rao, Mc Graw Hill
4. Manufacturing Engineering and Technology – Kalpakjian – Addison Wesley
5. Metal Forming Technology – R Narayanasamy – Ahuja Book Company
6. Mechanical Metallurgy – G.E. Dieter, McGraw Hill
7. Fundamentals of Manufacturing processes – G.K. Lal, S.K. Choudhury – Narosa Book Distributor
8. Fundamentals of Design and Manufacturing – G.K. Lal *et. Al.*, Alpha Science International

Course Code	Course Title	Hours per week L-T-P	Credit C
IPE181502	Machine Tool Technology	3-0-0	3

**Course Outcomes:** At the completion of the course the student will be able:

1. To develop knowledge on basic features and kinematics of machine tools.
2. To categorised different vibrations and testing methods in machine tools.
3. To interpret mechanics of metal cutting.
4. To develop knowledge on various workshop machines such as lathe, milling, grinding, shaper, planner, slotting, broaching, drilling, etc. and identify their functions.

### **MODULE 1: Introduction**

Characteristics and objectives of m/c tools – Basic features – classification, process capability and compliance, essential requirements – selection and maintenance – Efficiency, quality and Performance of a m/c tool.

### **MODULE 2: Kinematics of Machine Tools**

Classification and choice of driving systems. Basic considerations in the design of drives – Speed and structure program. Selection of optimum ray diagram. Transmission in the systems of stepped regulation. Spindle speed and design of all beared headstock – intermediate shaft diameter calculation. Stepless drives and hydraulic drive. Feed gear boxes.

### **MODULE 3: Beds, Tables and Columns**

Various types of beds, their materials, construction and design features; tables design principle – stiffness and natural frequency. Columns - material and design criteria.

M/C tool guides and Spindle. Classification and requirements of guides and spindle materials – Lubrication, kinematic Friction and stick slip vibration – Design criteria. Wearing of guides and influences of material hardness on guidewear. Temperature deformation. Effect of microstructure, chemical composition and surface preparation. Methods of calculating pressure on guides. Spindle units – material, construction and supports.

Rigidity and Vibration in m/c Tools. Introduction – Static and Dynamic rigidity, forced damped, self, excited and stick slip vibration. Vibration isolators.

Testing of m/c Tools. Necessity – Alignment tests and performances tests in Lathe, drilling and milling machines – preparation of tests charts.

### **MODULE 4: Mechanics of Metal Cutting**

Chip Formation and types of chips, Tool materials and properties, Cutting fluid, Tool life, Tool wear – Taylor's tool life equation, Machinability. Orthogonal and oblique cutting: chip thickness ratio, velocity relationships. Merchant's theory of metal cutting and Force relationship; stress and strain and power consumption. Heat zones metal cutting. Economic of metal cutting.

### **MODULE 5: Lathe**

Classification, specification and size – lathe parts, work holding devices; Lathe operations – Taper tuning, Thread cutting, Speed, feed and depth of cut. Calculation of machining time.

Introduction: tan and turrent Lathe; principles and working – comparison with engine lathe including and bar feeding mechanism. Tooling for simple products. Automatic machines: Single and multi-spindle. Swiss type automatics.

### **MODULE 6: Drilling, Boring and Reaming**

Types of drilling machines, parts and their functions; drill types, twist drill terminology, drill chucks—special drilling machines; speed, feed, torque and power consumption; machining time. Deephole drilling and Trepanning. Boring operation; boring machine – Jig boring machine. Reaming – Reamer geometry, reaming allowances on a drilled hole.

### **MODULE 7: Shaping, Planning, Slotting and Broaching Machine**

Classification, specification and size – principle of Quick return mechanism. Stroke length and Position adjustment of the ram. Simple operations – tool machining time.

**Slotting and Broaching Machine:** Purpose, tool and machine.

### **MODULE 8: Grinding and Finishing**

Types, specification and size of grinding machine. Grinding wheel – abrasive, bond, grit, grain, structure; wheel dressing, truing, balancing and mounting selection of wheels. Operation – grinding of flat, cylindrical and contoured surfaces. Centreless grinding.

Different finishing processes – Grinding, Lapping, Honing and super-finishing – Polishing, Buffing, Tumbling and Burnishing.

### **MODULE 9: Milling**

Milling machine classification, milling spindle/arbor details, milling cutter types, Geometry of plain cutter. Milling operations – up milling and down milling; End, Gang and Form milling. Indexing – milling of gear (spur and helical) and drill flute.

#### **Textbooks/ Reference Books:**

1. Principles of Machine Tools ----- Sen and Bhattacharya.
2. Design of Machine tools ----- S. K. Basu.
3. Machine Tool Engineering ----- G. R. Nagpal.
4. The Design and construction of M/C tools ----- H. C. Town.
5. Machine Tools Design hand Books ----- C.M.T.I.
6. Elements of Elements of Workshop Technology (Volume – 1 & 2) - **Author:** S. K. Hajra Choudhury, Nirjhar Roy, A. K. Hajra Choudhury – Media Promoters
7. Manufacturing Science Manufacturing science- [Amitabha Ghosh](#), [Asok Kumar Mallik](#) – Prentice Hall India
8. Manufacturing Technology: Foundry, Forming and Welding, Vol – 1 – P.N. Rao, Mc Graw Hill
9. Welding Technology and Design – V. Radhakrishnan, New Age International
10. Welding and Welding Technology – R.L. Little, Mc Graw Hill
11. Manufacturing Engineering and Technology – Kalpakjian – Addison Wesley
12. Elements of Elements of Workshop Technology (Volume – 1 & 2) - **Author:** S. K. Hajra Choudhury, Nirjhar Roy, A. K. Hajra Choudhury – Media Promoters
13. Manufacturing Science Manufacturing science- Amitabha Ghosh, Asok Kumar Mallik – Prentice Hall India
14. Manufacturing Technology: Metal Cutting and machine Tools, Vol – 2 – P.N. Rao, Mc Graw Hill
15. Manufacturing Engineering and Technology – Kalpakjian – Addison Wesley
16. Introduction to Machining Science – G.K. Lal – New Age International

Course Code	Course Title	Hours per week L-T-P	Credit C
IPE181503	Plant Layout and Material Handling	3-0-2	4

**Course Outcomes:** At the completion of the course the student will be able:

1. To develop knowledge on basic features and various factors of plant layout.
2. To design and evaluate different layouts and optimize them for better productivity.
3. To interpret various material handling equipment and their principles along with functions.
4. To design and evaluate better material handling system by calculating economics of material handling system.

**MODULE 1: Introduction**

Definition and objective of plant layout – problems and principle of plant layout: different types of layout.

**MODULE 2: Factors in Plant Layout**

Different factors influencing the Layout. man machine. Material movement, service, building, storage etc. Analysis and co-ordination – plant layout procedure – Symptom’s of bad Layout.

**MODULE 3: Planning and Layout**

Process Planning: materials, building, determination of equipment cost.

Layout fundamentals: Getting the facts, flow studies, proximity cross charts; Flexibility and Layout aids templates. Tapes, re-production methods – Evaluation of the layout.

**MODULE 4: Installing Layout**

Plant layout procedure, plant Engineering and acceptance.

**MODULE 5: Introduction to Material Handling**

Objective and elements – material handling activities and function, systems of bad material handling.

**MODULE 6: Material Handling Organizations**

Fundamental principles: relation to plant layout, safety in operation, traffic and Handling equipment. Systems of bad material handling system.

**MODULE 7: Material Handling Equipment**

Classification and types: Conveyors, its types; Noists, Mobile equipment – positioning equipment, Supper equipment, selection of material handling equipment.

**MODULE 8: Economics**

Unit load concept in material handling, systematic handling analysis: economics of material handling.

**Textbooks/ Reference Books:**

1. Plant layout and Mmaterial Handling ----- G. K. Agarwalla.
2. Practical Plant Layout ----- Mather.
3. Material Handling ----- Immer.
4. Plant Layout Design ----- Moore.
5. Industrial Engineering and production Management -----M. Telsang

Course Code	Course Title	Hours per week L-T-P	Credit C
ME181503	Mechanisms and Dynamics of Machines	3-0-0	3

**Course Outcomes (COs) are:**

**CO1:** To illustrate Kinematic analysis of plane motion graphically and analytically and to draw velocity and acceleration diagram; to understand the concept of Coriolis acceleration used in solving problems in kinematics.

**CO2:** To synthesize mechanisms to generate the desired motions by combination of different machine elements using analytical and graphical approaches.

**CO3:** To understand different types of mechanisms used in engineering applications and their working principles.

**CO4:** To estimate gyroscopic action in certain machine elements using principle of gyroscope and their practical applications.

**CO5:** To analyze balancing of rotating and reciprocating masses, single and multi-cylinder engines, importance of firing order and study of balancing instruments

**MODULE 1: Kinematic Analysis of Plane Motion**

Velocity diagram, Acceleration diagram, Coriolis component of acceleration, Analytical method of kinematic analysis.

**MODULE 2: Kinematic Synthesis of Linkages**

Introduction, number synthesis, basic features, analytical methods, graphical methods.

**MODULE 3: Mechanisms**

Mechanism, Mobility, Inversion, Test for 4 bar mechanism by Grashoff's law, Straight line mechanism, Oscillatory mechanism, Quick return mechanism, Steering mechanism, Spatial mechanism – Hook's joints.

**MODULE 4: Gyroscopic Action in Machines**

Gyroscopic action and force, method of analysis, Gyroscopic action in certain machine elements, use of gyroscopic principles in instruments.

**MODULE 5: Balancing**

Balancing of rotating masses, two plane balancing, balancing of reciprocating masses, Graphical solution, balancing of single cylinder and multi-cylinder engines, firing order, Balancing of rotors, Field balancing, Balancing instruments.

**Textbooks/ Reference Books:**

1. Theory of Machines: Kinematics and Dynamics by Sadhu Singh, Pearson
2. Theory of Machines by V P Singh, Dhanpat Rai & Co
3. Theory of Machine By Rattan, Tata McGraw Hill

Course Code	Course Title	Hours per week L-T-P	Credit C
ME181505	Engineering Inspection and Metrology	3-0-0	3

**Course Outcomes (CO):** At the completion of the course the student will be able:

**CO1:** To apply proper instruments for dimensional measurements according to level of precision.

**CO2:** To apply necessary standards for obtaining desired fit and design appropriate limit gauges.

**CO3:** To develop analytical and experimental techniques for precise measurement of thread and gear parameters.

**CO4:** To design appropriate control charts for statistical process control.

**CO5:** To estimate texture of machined surface by stylus equipment and optical interferometry.

### **MODULE 1: Introductory Concept**

(a) Meaning of engineering metrology. Precision, Accuracy, Sources of errors in measurement.

(b) Meaning of engineering inspection, types of inspection, merit/demerit of 100% inspection.

(c) Sampling inspection – Representative sample.

Standards of measurement and sub-division of standards.

### **MODULE 2: Statistical Process Control**

(a) Dimensional variations during manufacture, Chance causes and Assignable causes.

(b) Control chart and its significance in statistical process control, Meaning of process under statistical control. Examples of control charts.

(c) Computer implementation of control charts.

### **MODULE 3: Tolerance, Limits of Size and Fits**

(a) Concept of tolerance, allowance and clearance

(b) Natural tolerance limits, Process capability and Specification limits.

(c) Hole and shaft basis systems of specifying limits of size and tolerances.

(d) Indian Standard for fits and tolerances.

(e) Limit gauges – Meaning of gauge, Taylor’s principle of limit gauging, Design of hole/ring gauge and plug gauge and their use, Type I and Type II statistical errors.

(f) Interchangeability – its importance in production, techniques of achieving interchangeability during manufacture of industrial products.

Comparators – Features of comparators, classification of comparators, different comparators and their uses in mass production.

### **MODULE 4: Tool Room Measuring Instruments**

Vernier Calliper, Micrometer screw gauge, Height gauge, Depth gauge, V blocks, Straight edges, Radius gauge, Feeler gauge, Wire gauge, Thread pitch gauge, Bevel protractor, Combination set, Bore gauge, Sine bar and slip gauges, Dial indicator with magnetic base, Surface plate, Profile projector (PP), Tool maker’s microscope (TMM), Diameter measuring machine (DMM) and Coordinate measuring machine (CMM): Types of CMM, Role of CMM, and applications of CMM.

### **MODULE 5: Measurement of Screw Threads**

- (a) Parameters for measurement of screw threads.
- (b) Measurement of various parameters of screw thread such as diameter, thread angle, effective diameter and pitch.
- (c) Use of screw thread micrometer and Thread pitch gauge
- (d) One wire, Two wire and Three wire methods.
- (e) Use of TMM, PP, DMM in thread measurement.

### **MODULE 6: Measurement of Gears**

- (a) Profile of gear tooth and Involute function.
- (b) Spur gear measurements by functional and analytical tests. Parkson gear tester.
- (c) Measurement of tooth thickness – chordal thickness method, constant chord method, base tangent method.
- (d) Check for pitch circle diameter and tooth spacing.

### **MODULE 7: Surface Texture**

- (a) Meaning of surface texture, Elements of surface texture.
- (b) Meaning of roughness and Waviness.
- (c) Roughness width cut-off (Sampling length) and its significance
- (d) Representation of surface roughness.
- (e) Procedure of estimation of surface roughness.
- (f) Measurement of surface roughness by stylus equipment.

### **MODULE 8: Interferometry**

- (a) Condition for constructive and destructive interference of monochromatic light waves.
- (b) Sources of monochromatic light for lab use.
- (c) Use of optical flat.
- (d) Principle of Gauge length interferometer and Laser interferometer.

### **MODULE 9: Alignment Testing**

- (a) Optical methods for alignment testing
- (b) Laser alignment testing.
- (c) Alignment tests on machine tools

#### **Textbooks:**

1. Metrology and Measurement, Anand Bewoor, Vinay A. Kulkarni, TMH
2. Engineering metrology – M Mahajan
3. Engineering Metrology – R K Jain
4. Dimensional metrology – M K Khare and S Vajpayee, OXFORD-IBH Publishers

#### **Reference Books:**

1. Handbook of industrial metrology – ASTME publication
2. Engineering Metrology – K J Hume, Published by Macdonald & Co.(1968)
3. Practical Engineering Metrology – K W B Sharp, Sir Isaac Pitman & Sons
4. Engineering Precision measurements – A W Judge, Chapman and Hall publishing (1957)
5. Dimensional Metrology – L Miller, Edward Arnold publishing Co
6. Precision Measurements – Jack Johnson – Pitman publishing Co.

Course Code	Course Title	Hours per week L-T-P	Credit C
HS181506	Engineering Economics	3-0-0	3

### Course Outcomes (COs):

The students will be able to

1. Acquire knowledge about economics its nature, scope and importance.
2. Understand the economic laws, principles, and theories and their relevance in present day situation.
3. Develop the ability of critical thinking to meet the challenges at the national and global problems.
4. Apply knowledge in finding out socio-economic problems and appropriate measures to deal with them.
5. Equip students with vital knowledge to run government and non-government institutions and bodies.
6. Assemble knowledge which is vital for industry and research and evolve proper policy for economic development.

#### **MODULE 1: Introduction to Economics (3 Lectures)**

Meaning and Definition of Economics, Nature and Scope of Economics, Concept of Micro and Macro Economics.

#### **MODULE 2: Utility Analysis (3 Lectures)**

Meaning of Utility, Utility Function, Consumers Equilibrium, Concept of Indifference Curve, properties of Indifference Curve, Equilibrium under Indifference Curve.

#### **MODULE 3: Demand and Supply Analysis (4 Lectures)**

Law of Demand, Demand Function, Elasticity of Demand, Types of Elasticity of Demand, Measurement of Elasticity of Demand, Demand Forecasting, , Law of Supply, Supply Function.

#### **MODULE 4: Revenue, Production & Cost Analysis (4 Lectures)**

Average, Marginal and Total Revenue, Revenue Function, Average, Marginal and Total Cost, Cost Function, Short and Long Run Cost Curves. Break Even Point, Managerial Uses of Cost Function, Cobb Douglas Production Function.

#### **MODULE 5 : Market Structure (4 Lectures)**

Concept of Market, Price-Output Determination under Perfect Competition, Monopoly Market and Monopolistic Competition.

#### **MODULE 6 : Money, Banking and National Income (8 Lectures)**

Definition of Money, Function of Money, Index Numbers, Construction of Index Numbers, value of Money, Causes of Inflation, Functions of Commercial and central bank, Central bank and its monetary policy, Money Market and Capital Market, Functions of Stock exchange, Concept of National Income, Measurement of National Income, Concept of Investment.

**MODULE 7: Introduction to Environmental Economics****(5 Lectures)**

Concept of Environmental Economics, Cost -Benefit Analysis, Social Cost, Externalities, Concept of Pareto Equilibrium, Externality, Market Failure.

**MODULE 8: Public Finance****(3 Lectures)**

Introduction to Public Finance, Concept of Budget, Types of Budget, Budget Receipts, Concept of Goods and services Tax (GST).

**Textbooks/Reference Books:**

1. Managerial Economics by V. Agarwal: Pearson Pvt. Limited, New Delhi.
2. Engineering Economics by Dr. A. Ahmed & G. Begum: Chandra prakash, Guwahati
3. Principles of Engineering Economics with Application by Dr. Z. A. Khan, A. N. Siddiquee, B. Kumar, M. H. Abidi: Cambridge University Press.
4. Public Finance and Public Policy by Dr. R. K Choudhury: Kalayani publishers .
5. Quantitative Methods for Economics by R. Veerachamy: New Age International Publication Ltd.
6. Micro and Macro Economics by Dr. M. L. Seth: Educational Publishers , Agra -3
7. A Koutsoyiannis: Modern Microeconomics
8. Environmental Economics by R. N. Bhattacharya: Oxford Publication.

<b>Course Code</b>	<b>Course Title</b>	<b>Hours per week L-T-P</b>	<b>Credit C</b>
<b>IPE181512</b>	<b>Machine Tool Technology Lab</b>	<b>0-0-2</b>	<b>1</b>

**Course Outcomes: At the completion of the practical, students will be able**

1. To use proper metal cutting tools and fixtures for producing desired parts.
2. To apply various workshop machines for production of parts according to job design.
3. To apply the concept of transmission system in a machine tool fixture work (MFTW) system for obtaining desired motion for machine, tool and job.
4. To evaluate the effect of machining parameters on quality of machined components.

**List of Experiments**

1. Lathe
  - (a) Turning at various machining parameters to observe the effect on surface quality
  - (b) Thread cutting in lathe
  - (c) Production of external thread by hand tool
2. Shaper
 

To operate shaper for producing V groove in metal block
3. Drilling
  - (a) Production of hole in metal parts
  - (b) Cut internal thread in small holes
4. Milling
  - (a) Indexing for circular gear blank
  - (b) Cutting of gear tooth

Course Code	Course Title	Hours per week L-T-P	Credit C
ME181515	Engineering Inspection and Metrology Lab	0-0-2	1

**Course Outcomes (CO):** At the completion of the course the student will be able:

**CO1:** To apply proper instruments for dimensional measurement according to level of precision.

**CO2:** To utilize setting gauge for calibration of instrument during precision measurement.

**CO3:** To apply necessary tolerances on limit gauges for quality control.

**CO4:** To compare results of theoretical analysis with practical measurement in threads and gears.

**CO5:** To estimate precisely surface roughness of machined surface texture

### LIST OF EXPERIMENTS

*(to select experiments from the list and add similar experiments to address the COs)*

1. To use vernier caliper and standard setting gauge for precision measurement.
2. To use micrometer screw gauge to measure major diameter and minor diameter of thread
3. To measure the height of an object by using height gauge
4. To measure the depth of a hollow cylinder by using depth gauge
5. To measure the internal diameter of a hollow cylinder by using bore gauge
6. To use feeler gauge to set clearance between mating parts
7. To use radius gauge to check the radius of a fillet
8. To use plug gauge/ring gauge/snap gauge as GO/NOGO gauge
9. To use dial indicator as comparator
10. To use thread pitch gauge to estimate the pitch of screw thread
11. To use screw thread micrometer to estimate effective diameter of screw thread
12. To use standard wire method to estimate effective diameter of screw thread
13. To use profile projector in measuring linear and angular dimensions of engineering components
14. To use Tool Maker's Microscope for linear and angular measurements
15. To use bevel protractor for angular measurement
16. To use gear tooth vernier caliper in the measurement of spur gear parameters
17. To estimate roughness of a machined surface by surface roughness testing instrument.

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