

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM**  
**SCHEME OF TEACHING AND EXAMINATION FOR**  
**M.TECH.-PRODUCTION ENGINEERING (MPE)**

**I Semester**

**CREDIT BASED**

Subject Code	Name of the Subject	Teaching hours/week		Duration of Exam in Hours	Marks for		Total Marks	CREDITS
		Lecture	Practical / Field Work / Assignment/ Tutorials		I.A.	Exam		
16 MPE 11	Theory of Metal Cutting	4	-	3	20	80	100	4
16 MPE 12	Advanced Materials & Processing	4	-	3	20	80	100	4
16MPE 13	Theory of Metal Forming	4	-	3	20	80	100	4
16MPE 14	Computer Integrated Manufacturing & Automation	4	-	3	20	80	100	4
16MPE 15x	Elective - I	3	-	3	20	80	100	3
16MPE16	Lab Component	--	3	3	20	80	100	2
16MPE17	Seminar	--	3	--	100	--	100	1
<b>Total</b>		<b>19</b>	<b>6</b>	<b>18</b>	<b>220</b>	<b>480</b>	<b>700</b>	<b>22</b>

<b>Elective – I</b>	
<b>Sub. Code</b>	<b>Name of the Subject</b>
16MPE 151	Applied Probability & Statistics
16MPE 152	Composite Materials
16MPE 153	Quality & Reliability Engineering
16MPE 154	Advanced Foundry Technology



**SEMESTER 1**  
**THEORY OF METAL CUTTING**

Subject Code	: 16 MPE 11	IA Marks	: 20
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 50	Exam Marks	: 80

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**MODULE 1**

**Mechanics of Metal Cutting:** Mechanism of chip formation, Orthogonal & Oblique cutting, types of chips, built-up edge, Determination of shear plane angle, forces on the chips, forces in orthogonal cutting, Merchant circle diagram and analysis, Theory of Lee & Shaffer, co-efficient of friction, power & energy relationship, velocity relationship, shear-strain, factors affecting forces and power, problems. 10 HRS

**MODULE 2**

**Geometry of Cutting Tools:** Single point and multi point cutting tools, tools nomenclature, tool point reference systems, tool angle specifications –ISO and ASA systems, conversion from one system to another. Recommended tool angles, Effect of cutting parameters on tool geometry. 10 HRS

**MODULE 3**

**Tool Materials and Their Properties:** Characteristics of tool materials, types of tool materials – carbon tool steels, high speed steels, cast alloys, cemented carbides, ceramics, diamonds, SIALON, CBN, UCON, recommended cutting speeds for the above tools, discussion on steels, air, water, oil hardening of tools and their applications.

**Measurement of Cutting Forces:** Reasons for measuring cutting forces, Classification of cutting force dynamometers – mechanical, hydraulic, pneumatic, optical, inductance, piezoelectric, and strain gage type dynamometers, Dynamometers for lathe, drilling, and milling, Calibration of dynamometers. 10 HRS

**MODULE 4**

**Tool Wear, Tool Life:** Mechanisms of tool wear, Sudden & gradual wear, crater wear, flank wear, tool failure criteria, tool life equations, effect of process parameters on tool life, tool life tests, conventional & accelerated tool wear measurement, machinability index

**Thermal Aspects in Metal Cutting:** Heat sources in metal cutting, temperature in chip formation, temperature distribution, experimental determination of tool temperatures. 10 HRS

**MODULE 5**

**Cutting fluids:** Basic actions of cutting fluids, properties of cutting fluids, selection of cutting fluids, application of cutting fluids, filtration of fluids, recommended cutting fluids.

**Economics of Machining:** Introduction, elements of total production cost, optimum cutting speed and tool life for minimum cost, optimum cutting speed and tool life for maximum production, problems. 10 HRS

**REFERENCE BOOKS**

1. **Metal Cutting Principles** - M.C. Shaw - Oxford Publication – 1985.
  2. **Fundamentals of metal cutting & Machine Tools** - by B.L.Juneja & G.S – Sekhar - Wiley Eastern.
  3. **Metal Cutting** - V.C.Venkatesh & S.Chandrasekhanan - Pantice Hall – 1991.
- Metal Cutting** - Dr. B.J.Ranganath -Vikas Publications

## ADVANCED MATERIALS AND PROCESSING

Subject Code	: 16 MPE 12	IA Marks	: 20
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 50	Exam Marks	: 80

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### MODULE 1

**Classification and characteristics:** Metals, Ceramics, Polymers and composites.

**General properties and structure:** Atoms, molecules bonds in solids, Crystalline - Defects in Metallic structure, Dislocations and plastic deformation - Strengthening mechanism - grain size, dislocation - Cold work, precipitation hardening, dispersion hardening - phase reactions, fatigue and Creep behavior. 10 HRS

### MODULE 2

**Ferrous Alloys:** iron carbon equilibrium diagrams - Steels and cast irons - properties, structure, composition and applications transformation hardening in steels - TTT diagrams - Heat treatment processes - Effect of alloying elements - High alloy steels, Stainless steel types, tool Steels, Manganese steels, heat resistant steels, HSLA, Maraging steels. 10 HRS

### MODULE 3

**Non Ferrous alloys:** Alloys of copper, Aluminum, nickel, magnesium, titanium, lead, tin, Zinc - composition, heat treatment, structure, properties and application. 10 HRS

### MODULE 4

**Polymers and polymerizations:** Structure and properties of thermoplastics and thermo sets – Engineering Applications - property modifications - Mechanical and thermal behavior – processing methods.

**Ceramics :** Nature and structure of Ceramics - Refractory Abrasives glasses - glass ceramics - Advanced ceramics - processing methods. 10 HRS

### MODULE 5

**Composites :** Definition - classification and characteristics of composite materials - Volume fraction - laminated composites particulate composites, fibrous composites - Types of reinforcements, their shape and size - production and properties of fiber reinforced plastics, Metal Matrix composites and ceramic matrix composites - Applications.

**Processing of Polymers:** composites, ceramics - thermal spraying - Ion beam machining diamond coating techniques-tribological Applications. 10 HRS

### REFERENCE BOOKS:

1. **Engineering Metallurgy** - Raymond and Higgens - ELBS/EA
2. **Introduction to Material Science and Engineering** - James.F.Shackelford - Mc Millan, NY - 7<sup>th</sup> edition.
3. **Powder Metallurgy-Metals Hand Book** -ASM, USA - Vol.7, 1974.
4. **Composite Materials - Science and Engineering** - Chawla K.K. , Springer - Verlag, Newyork - 2<sup>nd</sup> edition, 1998.
5. **Cast Metal Matrix Composites** ASM Metals Hand Book - P.K. Rohagti - VI5.
6. **Elements of Material science and Engineering** - Van Vlack L.H. - Addison Wesley, NY - 1989.

## THEORY OF METAL FORMING

Subject Code	: 16 MPE13	IA Marks	: 20
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 50	Exam Marks	: 80

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### MODULE 1

**Introduction to Forming process:** Introduction to metal forming, Effect of temperature on forming process-hot working, cold working. Effect of Metallurgical structure, Effect of speed of deformation work of Plastic deformation, Friction in forming operation  
10 HRS

### MODULE 2

**Forging:** Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stresses in forging.  
10 HRS

### MODULE 3

**Rolling of Metals:** Classification, forces and geometrical relationships in rolling.

**Variables in Rolling:** Deformation in rolling, Defects in rolled products, Residual stresses in rolled products. Torque and Horsepower.  
10 HRS

### MODULE 4

**Extrusion:** Classification, Extrusion equipment, variables in extrusion, Deformation in extrusion, Extrusion defects, Work done in extrusion.

**Drawing:** Principles of Rod and wire drawing, variables in wire drawing, Residual stresses in rod, wire and tube drawing, Defects in Rod and wire drawing.  
10 HRS

### MODULE 5

**Sheet Metal Forming:** Introduction, Forming methods, shearing and Blanking, Bending, stretch forming, Deep drawing, redrawing operations, Defects in formed products.  
10 HRS

### REFERENCE BOOKS:

1. **Mechanical Metallurgy** - Dieter G.E. - Mc Graw Hill Publications.
2. **Principles of Metal Working** - R.Rowe - Arnold London – 1965.
3. **Metals Handbook** – ASM - Volume II -.ASM
4. **Fundamentals of working of Metals** - Sach G. - Pergamon Press.

## COMPUTER INTEGRATED MANUFACTURING AND AUTOMATION

Subject Code	: 16 MPE14	IA Marks	: 20
No. of Lecture Hours/Week	: 04	Exam Hours	: 03
Total No. of Lecture Hours	: 50	Exam Marks	: 80

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### MODULE 1

**Production Development Through CIM:** Computers in Industrial manufacturing, Product cycle & Production development cycle, Introduction of CAD/CAM & CIM, sequential and concurrent engineering, soft and hard prototyping.

**Computer Process Monitoring:** Process control methods, direct digital control, supervisory computer control, steady state optimal control, on line search strategies, adaptive control. 10 HRS

### MODULE 2

**Computer Aided Quality Control:** The computer in Q.C, automated inspection principles and methods, Contact inspection methods, non-contact inspection methods, machine vision system, optical inspection method, sensors, coordinate, measuring machine, Computer-Aided testing, Integration of CAQL with CAD/CAM. 10 HRS

### MODULE 3

**Computer Integrated Manufacturing:** Fundamentals of CAD/CAM, Computerized Manufacturing planning systems, shop floor control & automatic identification techniques. Computer Network for manufacturing and the future automated factor. 10 HRS

### MODULE 4

**Detroit type of Automation:** Flow lines, Transfer Mechanisms, work pattern transfer, Different methods, & Problems.

**Analysis of Automated flow lines:** Analysis of transfer lines without storage with storage buffer single stage, Double stage, Multistage with problems, Automated assembly systems, Design for automated assembly, parts feeding devices, analysis of Multi station assembly machine, Analysis of Single stage assembly machine, 10 HRS

### MODULE 5

**Automated Material Handling Storage:** Material functions, types of material handling equipment, analysis of material handling systems, design of system, conveyor system, automated guided vehicle systems, automated storage/retrieval systems, caroused storage systems work in process storage, interfacing handling & storage with manufacturing. 10 HRS

### REFERENCE BOOKS:

1. CAD/CAM - Zimmers & Grover – PHI.
2. CAD/CAM/CIM - P.Radhakrishna - New Age International - 2<sup>nd</sup> edition.
3. Automation, Production systems & Computer Aided Manufacturing - M.P. Grover - Prentice Hall - 1984.
4. CAD/CAM - Zeid – Mc-Graw Hill - 2005.
5. CAD/CAM - P.N.Rao - TMH.- 2<sup>nd</sup> edition, 2004.
6. Robotics for Engineering - Koren.Y - Mc-Graw Hill - 1985.
7. Robot vision & Sensory Controls - Rooks B. - North Holland. - (ed) vol-3

## Elective – I

### APPLIED PROBABILITY AND STATISTICS

Subject Code	: 16 MPE 151	IA Marks	: 20
No. of Lecture Hours/Week	: 03	Exam Hours	: 03
Total No. of Lecture Hours	: 40	Exam Marks	: 80

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#### MODULE 1

**Introduction to statistics:** Statistical Thinking, Collecting data, Statistical Modeling Frame work, measure of central tendency and variance, Importance of Data summary and Display, Tabular and Graphical display. 06 HRS

#### MODULE 2

**Discrete Random Variables and Probability distribution:** Discrete Random variables, Probability distributions and Probability mass functions, Cumulative distribution functions, Mean and Variance of a discrete random variable, discrete uniform distribution, Binominal distribution, Hyper Geometric distribution, Poisson distribution, Applications. 08 HRS

#### MODULE 3

**Continuous Random Variables and Probability Distributions:** Continuous random variables, Probability distributions and probability density functions, cumulative distribution functions, Mean and Variance of a continuous random variable, uniform distribution, Normal distribution, Normal approximation to Binominal and Poisson distribution, Exponential distribution. 08 HRS

#### MODULE 4

**Testing of Hypothesis:** Estimation theory, Hypothesis testing, Inference on the mean of a population (variance known and unknown), Inference on the variance of a normal population, Inference on a population proportion, Testing for Goodness of Fit, Inference for a difference in Means, Variances known, Inference for a difference in means of two normal distributions, Variances unknown, Inference on the Variances of two normal populations, Inference on two population proportions. 08 HRS

#### MODULE 5

**Simple Linear Regressions and Correlation:** Simple Linear Regression, Properties of Least square Estimators and Estimation of variances, Transformations to a straight line, Correlation.

**Multiple linear regressions :** Multiple linear regressions model, least square estimation of parameters, Matrix approach to multiple linear regression, properties of least square estimators and estimation of variance. 06 HRS

#### TEXT BOOKS:

1. Applied statistics and Probability for Engineers – Douglas C Montgomery, George C Runger, 2<sup>nd</sup> Edn, John Wiley and Sons, ISBN-0-471-17027-5, 1999.
2. Statistics for Management, Richard I Levin, David S Rubin, 6<sup>th</sup> Edn, Prentice Hall India, ISBN-81-203-0893-X.

#### REFERENCES:

1. **Probability and Statistics in Engineering** - William W Hines, Douglas C Montgomery - John Wiley and Sons - 2<sup>nd</sup> Edn,.
2. **Business Statistics for Management and Economics** - Daniel, Terrell - Houghton Mifflin Company - 6<sup>th</sup> Edn, ISBN-0-395-62835-0.
3. **Probability and Statistics** - by Walpole & Mayer - MacMillan Publishing Company - 1989.

## COMPOSITE MATERIALS

Subject Code	: 16 MPE 152	IA Marks	: 20
No. of Lecture Hours/Week	: 03	Exam Hours	: 03
Total No. of Lecture Hours	: 40	Exam Marks	: 80

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### MODULE 1

**Introduction to Composite Materials:** Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepegs, sandwich construction. 08 HRS

### MODULE 2

**Micro Mechanical Analysis of a Lamina:** Introduction, Evaluation of the four elastic moduli – Rule of mixture, Macro mechanics of a lamina: Hooke's law for different types of materials, number of elastic constants, Laminate code, Failure criterion. 08 HRS

### MODULE 3

**Manufacturing: Lay Up and Curing** – open and closed mould processing – Hand lay up techniques Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance Introduction, material qualification, types of defects, NDT methods. 08 HRS

### MODULE 4

**Fabrication of Composites:** Cutting, machining, drilling, mechanical fasteners & adhesive bonding joining computer aided design manufacturing tooling fabrication equipment

**Design of Fibre Reinforced Composite Structures:** Introduction, Composite structural design, Design criteria, Laminate design, Mathematical analysis of the laminate, Design of composite stiffeners. 08 HRS

### MODULE 5

**Application Developments** – Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites.

**Metal Matrix Composites:** Re-inforcement materials, types, Characteristics & Selection, base metals-selection, applications. Powder metallurgy technique, liquid metallurgy technique 08 HRS

### TEXT BOOKS:

1. **Composite Materials Handbook** - Mein Schwartz - Mc Graw Hill Book Company - 1984.
2. **Mechanics of Composite Materials** - Autar K.Kaw - CRC Press New York - 1<sup>st</sup> edi, 1997.



## QUALITY AND RELIABILITY ENGINEERING

Subject Code	: 16 MPE 153	IA Marks	: 20
No. of Lecture Hours/Week	: 03	Exam Hours	: 03
Total No. of Lecture Hours	: 40	Exam Marks	: 80

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### MODULE 1

**Basic Concepts:** Definitions of quality and Reliability, Parameters and Characteristics, Quality control, statistical Quality Control, Reliability concepts.

**Concepts in Probability and Statistics :** Events, Sample Space, Probability rules, Conditional probability, Dependent and Independent Events, Application of Probability concepts in Quality Control, Problems 08 HRS

### MODULE 2

**Introduction to Probability Distributions :** Normal, Poisson and Binomial distribution.

**Control Charts :** Variable Chart – X Bar chart, R-chart and Sigma chart. Attribute Chart : P – Chart, nP Chart, C-Chart and U – Chart. 08 HRS

### MODULE 3

**Acceptance Sampling:** Fundamentals of acceptance sampling, types of acceptance sampling, O.C Curve, AQL, LTPD, AOQL.

**Failure Data Analysis :** Introduction, Failure Data, Quantitative measures, MTTF, MTBF, Bathtub Curve, Mean Life, Life Testing, Problems, Introduction to Failure Mode and Effect Analysis. 08 HRS

### MODULE 4

**System Reliability:** Series, parallel and mixed configuration, Block diagram concept, r- out-of-n structure solving problems using mathematical models.

**Reliability Improvement and Allocation :** Difficulty in achieving reliability, Methods for improving reliability during design, Different techniques available to improve reliability, Optimization, Reliability-Cost trade off, Prediction and Analysis, Problems. 08 HRS

### MODULE 5

**Maintainability and Availability:** Introduction, Formulas, Techniques available to improve maintainability and availability trade-off among reliability, maintainability and availability, Simple problems 08 HRS

### REFERENCE BOOKS:

1. **Quality Planning and Analysis** - Tata McGraw - Juran, J.M and Gryna, F.M. - Hill publishing Coimpany Ltd., New Delhi, India – 1982.
2. **Maintainability and Reliability Handbook of Reliability Engineering and Management** - Editors – Ireson. W.G. and Cooms - C.F. McGraw - Hill Book Company Inc. – 1988.
3. **Concepts in Reliability Engineering-** Srinath L S - Affiliated East-West Press Private Limited, New Delhi, India. – 1985.
4. **An Introduction to Reliability and Maintainability Engineering** - TMH Charles Ebeling - Tata McGraw Hill – 2000.
5. **Reliability Engineering** - A K Govil - Prentice Hall – 1981.

## ADVANCED FOUNDRY TECHNOLOGY

Subject Code	: 16 MPE154	IA Marks	: 20
No. of Lecture Hours/Week	: 03	Exam Hours	: 03
Total No. of Lecture Hours	: 40	Exam Marks	: 80

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### MODULE 1

**Solidification of Casting:** Concept of solidification of metals. Homogenous and heterogeneous nucleation. Growth mechanism. Solidification of pure metals and alloys. Mechanism of columnar and dendritic growth. Coring or Segregation. Solidification time and Chvorinov's rule. Concept of progressive and directional solidifications.

08 HRS

### MODULE 2

**Principles of Casting and Riser:** Purpose of the gating system. Components of the gating System and its functions. Design of the gating System. Different types of gates. Gating ratio and its functions. Definition and functions of the riser. Types of risers and their application. Design of the riser - its shape. Size and location. Use of insulating material and exothermic compounds in risers.

**Design of Casting:** Factors to be considered in casting design. Design consideration in pattern making, moulding techniques and core making and assembly. Cooling stresses and hot spots in casting and modification in casting geometry to overcome them.

**Casting Quality Control:** Casting defects and factors responsible for them. Different inspection and testing methods to evaluate the casting. Quality control activities in a foundry. Salvaging methods of defective casting. 10 HRS

### MODULE 3

**Furnace Technology:** Study of various furnaces used in foundry, construction and operation of crucible and hearth furnaces. Resistance, Arc and Induction furnaces-their construction. Operation and application. Heat treatment furnaces and drying ovens used in foundry.

**Gray Cast - Iron Foundry Practice:** Chemical Composition and structure of gray cast iron. Moulding, gating and risering techniques. Melting of gray cast iron in Cupola and induction furnace. Inoculation of gray cast iron. Application of gray cast iron castings.

**Malleable Cast Iron:** Chemical composition and structure of White-heart and black-heart malleable cast iron. Melting malleabilisation heat treatment and application of malleable cast iron.

**Ductile Cast Iron:** Chemical composition and structure of ductile cast iron. Melting and spheroidisation treatment. Inoculation of 'ductile' iron Properties and application of ductiles iron casting. 10 HRS

### MODULE 4

**Steel Casting Practice:** Common steel casting, their composition, structure and properties. Melting and refining of steel. Gating and risering of steel castings cleaning of steel castings.

**Aluminium Foundry Practice:** Composition, properties and application of common aluminium alloy casting. Melting and casting of Al-alloys. Gating and risering of Al-alloy casting. 06 HRS

### MODULE 5

**Copper alloy Foundry Practice:** General characteristics of common cast copper alloys. Melting and casting of copper alloys. Gating and risering of Cu-alloy castings. 06 HRS

### REFERENCE BOOKS:

1. **Principle of metal casting** - Heine, et. al - Tata-McGraw-Hill Publication - 2003.

2. **A test book of Foundry Technology** - Lal, M. Khanna, P.O - Dhanpat Rai & Sons Publication.
3. **Foundry Technology** - Beelely, P.R. – Butterworth.

## **Laboratory Exercises**

### **16 MPE 16**

#### **Perform any Eight / Ten experiments:**

1. Determination of Chip reduction co-efficient (reciprocal of chip thickness ratio) during single point turning.
2. Forces measurements during orthogonal turning.
3. Estimation of Power required during orthogonal turning.
4. Torque and Thrust measurement during drilling.
5. Determination of cutting forces during milling using Milling tool dynamometer
6. Measurement of Chip tool Interface temperature during turning using thermocouple technique.
7. Study the variation of surface roughness with different speed and feed during plain milling operation on flat surface.
8. Study of capstan lathe and its tooling and prepare a tool layout & job as per given drawing.
9. To prepare metallic samples for metallographic examination and to study the principle & construction of the Metallurgical Microscope.
10. Study of Microstructure and Hardening of steel in different medium and cooling rates.
11. Effect of Carbon percentage on the hardness of Steel.
12. CNC milling- Writing and execution of part program for contour milling.

#### **REFERENCE BOOKS**

4. **Metal Cutting Principles** - M.C. Shaw - Oxford Publication – 1985.
5. **Fundamentals of metal cutting & Machine Tools** - by B.L.Juneja & G.S – Sekhar - Wiley Eastern.
6. **Metal Cutting** - V.C.Venkatesh & S.Chandrasekhanan - Pantice Hall – 1991.
7. **Metal Cutting** - Dr. B.J.Ranganath -Vikas Publications.