## I Semester

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching hours/week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for Total</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lecture</td>
<td>Practical / Field Work / Assignment/ Tutorials</td>
<td>I.A.</td>
<td>Exam</td>
</tr>
<tr>
<td>14 MPY 11</td>
<td>Advanced Materials &amp; Processing</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>14 MPY 12</td>
<td>Advanced Foundry Technology</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>14 MPY 13</td>
<td>Theory of Meal Forming</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>14 MPY 14</td>
<td>Computer Integrated Manufacturing &amp; Automation</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>14 MPY 15x</td>
<td>Elective - I</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>14 MPY 16</td>
<td>Lab Component</td>
<td>--</td>
<td>3</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>14 MPY 17</td>
<td>Seminar</td>
<td>--</td>
<td>3</td>
<td>--</td>
<td>25</td>
</tr>
</tbody>
</table>

**Total** | **20** | **13** | **15** | **300** | **550** | **850** | **23** |

## Elective – I

<table>
<thead>
<tr>
<th>Sub. Code</th>
<th>Name of the Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 MPY 151</td>
<td>Applied Probability and Statistics</td>
</tr>
<tr>
<td>14 MPY 152</td>
<td>Composite Materials</td>
</tr>
<tr>
<td>14 MPY 153</td>
<td>Theory of Metal Cutting</td>
</tr>
<tr>
<td>14 MPY 154</td>
<td>Quality &amp; Reliability Engineering</td>
</tr>
<tr>
<td>14 MPY 155</td>
<td>Quantitative Techniques in Decision Making</td>
</tr>
</tbody>
</table>
### II Semester

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching hours/week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lecture</td>
<td>Practical / Field Work / Assignment/ Tutorials</td>
<td>I.A.</td>
<td>Exam</td>
</tr>
<tr>
<td>14 MPY 21</td>
<td>Industrial Robotics</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>14 MPY 22</td>
<td>Non-Traditional Machining Processes</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>14 MPY 23</td>
<td>Advanced Joining Processes</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>14 MPY 24</td>
<td>Agile Manufacturing</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>14 MPY 25x</td>
<td></td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>14 MPY 26</td>
<td>Lab Component</td>
<td></td>
<td>3</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td>14 MPY 27</td>
<td>Seminar</td>
<td></td>
<td>3</td>
<td>--</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>**Project Phase-I(6 week Duration)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Name of the Subject</th>
<th>Teaching hours/week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>13</td>
<td>15</td>
<td>300</td>
</tr>
</tbody>
</table>

**Between the II Semester and III Semester, after availing a vocation of 2 weeks.**
### III Semester: INTERNSHIP

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Subject</th>
<th>No. of Hrs./Week</th>
<th>Duration of the Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>14MPY31</td>
<td>Seminar / Presentation on Internship (After 8 weeks from the date of commencement)</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>1</td>
</tr>
<tr>
<td>14MPY32</td>
<td>Report on Internship</td>
<td>-</td>
<td>-</td>
<td>75</td>
<td>15</td>
</tr>
<tr>
<td>14MPY33</td>
<td>Evaluation and Viva-voce</td>
<td>-</td>
<td>-</td>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>-</td>
<td>-</td>
<td>25</td>
<td><strong>20</strong></td>
</tr>
</tbody>
</table>

**VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM**

**SCHEME OF TEACHING AND EXAMINATION FOR**

**M.TECH.-PRODUCTION TECHNOLOGY (MPY)**
### IV Semester

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject</th>
<th>No. of Hrs./Week</th>
<th>Duration of Exam in Hours</th>
<th>Marks for Total Marks</th>
<th>CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>14MPY41</td>
<td>Tool Design</td>
<td>4 Lecture, -- Field Work / Assignment / Tutorials</td>
<td>3</td>
<td>50 I.A. + 100 Exam</td>
<td>150</td>
</tr>
<tr>
<td>14MPY42</td>
<td>Elective-III X</td>
<td>4 Lecture, --</td>
<td>3</td>
<td>50 I.A. + 100 Exam</td>
<td>150</td>
</tr>
<tr>
<td>14MPY43</td>
<td>Evaluation of Project Phase-II</td>
<td>--</td>
<td>--</td>
<td>25 I.A. + -- Exam</td>
<td>25</td>
</tr>
<tr>
<td>14MPY44</td>
<td>Evaluation of Project Phase-III</td>
<td>--</td>
<td>--</td>
<td>25 I.A. + -- Exam</td>
<td>25</td>
</tr>
<tr>
<td>14MPY45</td>
<td>Evaluation of Project Work and Viva-voce</td>
<td>--</td>
<td>3</td>
<td>-- I.A. + 100+100 Exam</td>
<td>200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>12 Lecture, 07 Field Work / Assignment / Tutorials, 09 Tutorial</td>
<td></td>
<td>150 I.A. + 400 Exam</td>
<td>550</td>
</tr>
</tbody>
</table>

Grand Total (I to IV Sem.) : 2400 Marks; 94 Credits

### Elective – III

<table>
<thead>
<tr>
<th>Sub. Code</th>
<th>Name of the Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 MPY 421</td>
<td>Industrial Design &amp; Ergonomics</td>
</tr>
<tr>
<td>14 MPY 422</td>
<td>Smart Materials &amp; Structures</td>
</tr>
<tr>
<td>14 MPY 423</td>
<td>Advanced Fluid Power Systems</td>
</tr>
<tr>
<td>14 MPY 424</td>
<td>Rapid Prototyping</td>
</tr>
<tr>
<td>14 MPY 425</td>
<td>Advanced Manufacturing Practices</td>
</tr>
</tbody>
</table>
Note:

1) Project Phase – I: 6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carry out literature survey / visit to Industries to finalise the topic of dissertation.

2) Project Phase – II: 16 weeks duration. 3 days for project work in a week during III Semester. Evaluation shall be taken during the first two weeks of the IV Semester. Total Marks shall be 25.


Marks of Evaluation of Project:

- The I.A. Marks of Project Phase – II & III shall be sent to the University along with Project Work report at the end of the Semester.

4) During the final viva, students have to submit all the reports.

5) The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following:

   a) Head of the Department (Chairman)
   b) Guide
   c) Two Examiners appointed by the university. (out of two external examiners at least one should be present).
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, dislocations - Cold work, precipitation hardening, dispersion hardening - phase reactions, fatigue and Creep behavior.


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

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


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.

REFERENCE BOOKS:

1. Engineering Metallurgy - Raymond and Higgens - ELBS/EA
ADVANCED FOUNDRY TECHNOLOGY

Subject Code : 14 MPY12 IA Marks : 50
No. of Lecture Hours/Week : 04 Exam Hours : 03
Total No. of Lecture Hours : 52 Exam Marks : 100

**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.


**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.

**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 spherodisation treatment. Inoculation of ductile iron Properties and application of ductiles iron casting.

**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.

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

**Foundry Mechanization and Modernization:** Introduction to modernization. Mechanization of foundry and its advantages. Mechanization of sand plant, moulding and core making mechanization in melting, pouring and shakeout units. Material handling equipments and conveyor systems. Brief sketches and description of layouts of job. Captive and mechanized foundries.

**REFERENCE BOOKS:**

3. Foundry Technology - Beelely, P.R. – Butterworth.
THEORY OF METAL FORMING

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>14 MPY13</th>
<th>IA Marks</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Lecture Hours/Week</td>
<td>04</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
<tr>
<td>Total No. of Lecture Hours</td>
<td>52</td>
<td>Exam Marks</td>
<td>100</td>
</tr>
</tbody>
</table>

**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.

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

**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.

**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.

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

**REFERENCE BOOKS:**

COMPUTER INTEGRATED MANUFACTURING AND AUTOMATION

Subject Code : 14 MPE14  IA Marks : 50
No. of Lecture Hours/Week : 04  Exam Hours : 03
Total No. of Lecture Hours : 52  Exam Marks : 100


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

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.


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,

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.

REFERENCE BOOKS:

1. CAD/CAM - Zimmers & Grover – PHI.
Elective – I

APPLIED PROBABILITY AND STATISTICS

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>14 MPY 151</th>
<th>IA Marks</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Lecture Hours/Week</td>
<td>04</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
<tr>
<td>Total No. of Lecture Hours</td>
<td>52</td>
<td>Exam Marks</td>
<td>100</td>
</tr>
</tbody>
</table>

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


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.

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.

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.

TEXT BOOKS:

REFERENCES:
COMPOSITE MATERIALS

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>14 MPY 152</th>
<th>IA Marks</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Lecture Hours/Week</td>
<td>04</td>
<td>Exam Hours</td>
<td>03</td>
</tr>
<tr>
<td>Total No. of Lecture Hours</td>
<td>52</td>
<td>Exam Marks</td>
<td>100</td>
</tr>
</tbody>
</table>

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

**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.

**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.

**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.

**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

**TEXT BOOKS:**

THEORY OF METAL CUTTING

Subject Code : 14 MPY 153  IA Marks : 50
No. of Lecture Hours/Week : 04  Exam Hours : 03
Total No. of Lecture Hours : 52  Exam Marks : 100

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.

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.

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.

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.

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.

REFERENCE BOOKS

Metal Cutting - Dr. B.J.Ranganath - Vikas Publications
QUALITY AND RELIABILITY ENGINEERING

Subject Code : 14 MPY 154  IA Marks : 50
No. of Lecture Hours/Week : 04  Exam Hours : 03
Total No. of Lecture Hours : 52  Exam Marks : 100

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


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.

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.

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.

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

REFERENCE BOOKS:

Introduction: Applications of statistics in managerial decision making. The basic vocabulary of statistics, Types of variables, Data collection – primary and secondary data, the methods of collecting data, Measures of central tendency, Measure of dispersion, Skewness and Kurtosis, Measures of a population, Probability - basic concepts, types, rules of probability, Baye’s theorem; Random variables, Probability distributions - Binomial, Poisson, and Normal.


Transportation and Assignment Problems: Structure of transportation problem and various methods to find I.B.F.S., Optimality test of transportation problems by MODI method, Solution of unbalanced transportation problems and maximization problems, degeneracy in the solution of transportation problems; Assignment problems and solution by Hungarian method, Traveling Salesman problem.

Decision Making under Uncertainty: Alternative criteria for decision under uncertainty, Bayesian approach

Theory of Games: Terminology involved, Types of games, Solution of mixed strategy games by dominance rule, algebraic method, graphical method, and by linear programming approach.

Network Analysis: Network construction, Analysis techniques – PERT and CPM, Determination of critical path, Computation of ES, EF, LS, LF, TF and FF, Crashing of a project, Resource scheduling and leveling in a project.

Waiting Line: Basic structure of queuing systems and characteristics, Expressions for M/M/1 and M/M/c queuing models.

Simulation of Management Systems: Steps in building a simulation model, Advantages and disadvantages of simulation, the applications of simulation to managerial decision making, Monte Carlo Simulation, Waiting line and Inventory simulation models.

REFERENCE BOOKS:

Laboratory Exercises
14 MPY 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.
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.

REFRENCE BOOKS

7. Metal Cutting - Dr. B.J.Ranganath -Vikas Publications.
II SEMESTER

INDUSTRIAL ROBOTICS

Subject Code: 14 MPY21  IA Marks: 50
No. of Lecture Hours/Week: 04  Exam Hours: 03
Total No. of Lecture Hours: 52  Exam Marks: 100


COMPUTER CONSIDERATIONS FOR ROBOTIC SYSTEMS: Computer architecture for robots, hardware, Computational elements in robotic applications – Robot programming – sample programs path planning – Robot’s computer system.


APPLICATIONS OF ROBOTS: Capabilities of Robots – Robotics Applications – Obstacle avoidance – Robotics in India – The future of Robotics

TEXT BOOKS:


REFERENCE BOOKS:

NON-TRADITIONAL MACHINING PROCESSES

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>No. of Lecture Hours/Week</th>
<th>Exam Hours</th>
<th>Total No. of Lecture Hours</th>
<th>Exam Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 MPY 22</td>
<td>50</td>
<td>04</td>
<td>03</td>
<td>52</td>
<td>100</td>
</tr>
</tbody>
</table>


Mechanical Process: Ultrasonic Machining-Definition-Mechanism of metal elements of the process- Tool feed mechanism. theories of mechanics of causing effect of parameter applications.

Abrasive Jet Machining: Principles - parameters of the process applications-advantages and advantages.


Chemical Machining: Introduction-fundamental principle types of chemical machining Maskants- Etchens- Advantages and disadvantages-applications.

Plasma arc Machining: Introduction-Plasma-Generation of Plasma and equipment Mechanism of metals removal, PAN parameters-process characteristics - type of torches applications.

Electron Beam Machining (EBM): Introduction-Equipment for production of Electron beam - Theory of electron beam machining Thermal & Non thermal types characteristics - applications.

Laser Beam Machining (LBM): Introduction-principle of generation of lasers Equipment and Machining procedure-Types of Lasers-Process characteristics-advantages and limitations-applications

Ion Beam Machining: Introduction-Mechanism of metal removal and associated equipment-process characteristics applications


REFERENCE BOOKS:

1. **New technology Institution of Engineers** - Bhattacharya - India
5. **High Velocity Forming of Metals** - F.M Wilson - ASTME Pretice Hall.
ADVANCED JOINING PROCESSES

Distortion - methods to avoid distortion. Stresses in Joint Design.

Welding and Cladding of dissimilar materials, overlaying and surfacing.


Advanced soldering and Brazing processes different types.

Welding of plastics.

Inspection of Welds: Destructive techniques like Tensile, Bend, Nick break, Impact & Hardness. Non-Destructive techniques like 'X' rays, Ultrasonic, Magnetic particle, Dye Penetrant, Gamma ray inspection.

Welding Symbols - Need for, Representing the welds, Basic weld symbols, Location of Weld, Supplementary symbols, Dimensions of welds, Examples


Quality Control in Welding - Introduction, Quality assurance v/s Quality control, Weld quality, Discontinuities in welds, their causes and remedies and Quality conflicts.


REFERENCE BOOKS:

5. Welding for Engineers - Udin, Funk & Wulf
Introduction - What is agile Manufacturing? - Competitive environment of the future the business case for agile manufacturing conceptual frame work for agile manufacturing.

Four Core Concepts: Strategy driven approach - integrating organization, people technology interdisciplinary design methodology.

Agile Manufacturing and Change Management: The change implications. Post failures in advanced manufacturing, changes on the way, traditional management accounting, paradigm, investment appraisal, product costing - performance, measurement and control systems, Traditional organization, control technological and design paradigms traditional problems in workplace- organizational issues - role of technology.

Agile Manufacturing Enterprise Design: Agile manufacturing - enterprise design.. system concepts as the basic manufacturing theory - joint technical & organizational design and a model for the design of agile manufacturing enterprise, enterprise design process insights into design processes, what is interdisciplinary design. Main issues - simple design example.


REFERENCE BOOKS:
NON-DESTRUCTIVE TESTING

Subject Code : 14 MPY 251  IA Marks : 50
No. of Lecture Hours/Week : 04  Exam Hours : 03
Total No. of Lecture Hours : 52  Exam Marks : 100

Introduction to ND Testing: Selection of ND methods, visual inspection, leak testing, Liquid penetration inspection, its advantages and limitation.

Magnetic Particle Inspection: Methods of generating magnetic field, types of magnetic particles and suspension liquids steps in inspection – application and limitations

Eddy Current Inspection: principles, operation variables, procedure, inspection coils, and detectable defects by the method.

Microwave Inspection: Microwave holography, applications and limitations.

Ultrasonic inspection: Basic equipment characteristics of ultrasonic waves, variables inspection, inspection methods pulse echo A,B,C scans transmission, resonance techniques, transducer elements couplets, search units, contact types and immersion types inspection standards-standard reference blocks,

Radiography Inspection: principles, radiation source X-rays and gamma rays, X-ray-tube, radio graphic films, neutron radiography, Thermal inspection principles, equipment inspection methods applications.

Optical Holography: Basics of Holography, recording and reconstruction - Acoustical Holography: systems and techniques applications. Indian standards for NDT.

REFERENCE BOOKS:


Vacuum coating, FVD & CVD metal spraying - Methods, surface preparation, mechanical

Properties of sprayed metals, plasma coating.

Plastic coating of metal - PVC coating Spherodising process details, phosphate coating - mechanism of formation.

Testing of surface coating methods.

Heat treatment methods, Anleaeing, Normalizing, Tempering, Case hardening methods, flame hardening sub zero treatment.

Heat treatment methods for gears, spindles, cutting tools.

Advanced coating technologies: Hard facing, electro deposition technique, nanocoatings, coating characterization

REFERENCE BOOKS:

5. Metals Hand Book – ASM.
SIMULATION AND MODELING OF MANUFACTURING SYSTEMS.

Subject Code : 14 MPY253   IA Marks : 50
No. of Lecture Hours/Week : 04   Exam Hours : 03
Total No. of Lecture Hours : 52   Exam Marks : 100


System and Environment: Components of a system -discrete and continuous systems, Models of a system -a variety of modeling approaches.


Statistical Models in Simulation: Discrete distributions, continuous distributions.


Random Variable Generation: Inversion transforms technique-exponential distribution. uniform distribution, weibul distribution, continuous distribution, generating approximate normal variates-Erlang distribution.

Empirical Discrete Distribution: Discrete uniform -distribution poisson distribution -geometric distribution -acceptance -rejection technique for Poisson distribution gamma distribution.


Simulation Software: Selection of simulation software, simulation packages.

TEXT BOOKS:

REFERENCE BOOKS:
PRODUCT DATA MANAGEMENT

Subject Code : 14 MPY 254
IA Marks : 50
No. of Lecture Hours/Week : 04
Exam Hours : 03
Total No. of Lecture Hours : 52
Exam Marks : 100

Introduction: Introduction to PDM-present market constraints need for collaboration- Internet and developments in server-client computing.

Components of PDM: Components of a typical PDM set-up hardware and software- document management creation and viewing of documents -creating parts-version control of parts and documents –case studies.

Configuration Management: Base lines-product structure configuration management -case studies.


Change Management: Change issue -change request-change investigation- change proposal-change activity-case studies.

Generic Products and Variants: Products configuration comparison between sales configuration mild products generic-generic product modeling in configuration modeler-use of order generator for variant creation -registering of variants in product register-case studies.

REFERENCE BOOKS:


Classical Optimization Technique: Single variable optimization, with equality constraints solution by direct substitution, solution by the method of constrained Variation. Solution by the method of Lagrange multipliers, multivariable optimization with inequality constraints Kuhn – Tucker condition.


Descent Methods: Steepest descent, conjugate gradient, variable metric method.

Non Linear Programming: (Constrained Optimization problem) Characteristic of a constrained problem.

Direct Methods: The complex method, cutting plane method, methods of Feasible directions.

Indirect Methods: Transformation technique, change variables and elimination of variables, penalty function methods- interior and exterior penalty function.

TEXT BOOKS:


REFERENCE BOOKS:

Laboratory Exercises

14 MPY 26

01. Study of pick and place Robot- basic components, configuration, work volume.

02. Experiments with Robot. Kit for minimum four assembly activities and programming.

03. Programming of robots by manual, lead through and off line methods.

04. Programming languages for stacking of objects in increasing or decreasing size. Palletizing operations, assembly and inspection operation etc.

05. To become acquainted with the operation of a revolute-type 6 DOF robot. To program a robotic system using a teaching pendant and a high level programming language. Emphasis is made on the constraints associated when positioning and orienting an object within a 3-D space. The practical includes point-to-point tasks and continuous robot motion.
IV SEMESTER

TOOL DESIGN

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>No. of Lecture Hours/Week</th>
<th>Exam Marks</th>
<th>IA Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>14MPY41</td>
<td>04</td>
<td>03</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>52</td>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

**Tool-design Methods:** Introduction, the design procedure, drafting and design techniques in tooling drawing

**Tool-making Practices:** Introduction, tools of the tool maker, hand finishing and polishing, screws and dowels, hole location, jig-boring practice, installation of drilling bushings, punch and die bushings, punch and die manufacture, EDM, EDM for cavity applications, tracer and duplicating mills for cavity applications, low-melting tool materials.

**Tooling Materials and Heat Treatment:** Introduction, properties of materials, ferrous tooling materials, non-ferrous tooling materials, non-metallic tooling materials, heat treatment and tool design.

**Design of Cutting Tools:** Introduction, the metal cutting process, revision of metal cutting tools-single point cutting tools, milling cutters, drills and drilling, reamers, taps. Selection of carbide tools, determining the insert thickness for carbide tools.

**Design of Tools for Inspection and Gauging:** Introduction, work piece quality criteria, principles of gauging, types of gages and their applications, amplification and magnification of error, gage tolerances, selection of material for gages, indicating gages, automatic gages, gauging positionally tolerance parts, problems.

**Locating and Clamping Methods:** Introduction, basic principle of location, locating methods and devices, basic principle of clamping.

**Design of Drill Jigs:** Introduction, types of drill jigs, general considerations in the design of drill jigs, drill bushings, methods of construction, drill jigs and modern manufacturing.

**Design of Fixtures:** Introduction, types of fixtures, fixtures and economics.

**Design of Press-working Tools:** Power presses, cutting operations, types of die-cutting operations - and their design, evolution of blanking and progressive blanking.


**Tool Design for Joining Processes:** Introduction, tooling for physical joining processes, tooling for soldering and brazing, tooling for mechanical joining processes, problems.

**Tooling for Casting:** Introduction, tooling for sand casting, shell moulding, metal moulding and die-casting, problems.
Tool Design for NC Machine Tools: Revision of NC control, fixture design for NC machine tools, cutting tools and tool-holding methods, automatic tool changers and tool positioners.

Plastics as Tooling Materials: Introduction, plastics commonly used as tooling materials, application of epoxy plastic tools, construction methods, metal forming operations with Urethane dies, calculating forces for Urethane pressure pads, problems.

TEXT BOOKS:


REFERENCE BOOKS:

ELECTIVE -III
INDUSTRIAL DESIGN & ERGONOMICS

Subject Code : 14MPY421
IA Marks : 50
No. of Lecture Hours/Week : 04
Exam Hours : 03
Total No. of Lecture Hours : 52
Exam Marks : 100

Introduction: An approach to industrial design - elements of design structure for industrial design in engineering application in modern manufacturing systems.

Ergonomics and Industrial Design: Introduction - general approach to the man-machine relationship-workstation design-working position.

Control and Displays: shapes and sizes of various controls and displays-multiple displays and control situations - design of major controls in automobiles, machine tools etc., - design of furniture design of instruments.

Ergonomics and Production: Ergonomics and product design ergonomics in automated systems-expert systems for ergonomic design, Anthropomorphic data and its applications in ergonomic design limitations of anthropomorphic data - use of computerized database.

Visual Effects of Line and Form: The mechanics of seeing psychology of seeing, general influences of lined and form.

Colour: colour and light - colour and objects - colour and the eye colour consistency - colour terms - reactions to colour and colour continuation - colour on engineering equipments.

Aesthetic Concepts: Concept of unity - concept of order with variety - concept of purpose style and environment - Aesthetic expressions. Style-components of style - house style, observations style in capital goods.

Industrial Design in Practice: General design - specifying design equipments - rating the importance of industrial design – industrial design in the design process.

TEXT BOOKS:

Overview of Smart Materials, Structures and Products Technologies.


**Smart Sensor, Actuator and Transducer Technologies:**
- Smart Sensors: Accelerometers; Force Sensors; Load Cells; Torque Sensors; Pressure Sensors; Microphones; Impact Hammers; MEMS Sensors; Sensor Arrays Smart Actuators: Displacement Actuators; Force Actuators; Power Actuators; Vibration Dampers; Shakers; Fluidic Pumps; Motors
- Smart Transducers: Ultrasonic Transducers; Sonic Transducers.

**Measurement, Signal Processing, Drive and control Techniques**
- Quasi-Static and Dynamic Measurement Methods; Signal Conditioning Devices; Constant Voltage, Constant Current and Pulse Drive Methods; Calibration Methods; Structural Dynamics and Identification Techniques; Passive, Semi-Active and Active Control; Feedback and Feed forward Control Strategies.

**Design, Analysis, Manufacturing and Applications of Engineering Smart Structures and Products:** Case studies incorporating design, analysis, manufacturing and application issues involved in integrating smart materials and devices with signal processing and control capabilities to engineering smart structures and products. Emphasis on structures, automation and precision manufacturing equipment, automotives, consumer products, sporting products, computer and telecommunications products, as well as medical and dental tools and equipment.

**TEXT BOOKS:**

**REFERENCE BOOKS:**


ADVANCED FLUID POWER SYSTEMS

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
<th>No. of Lecture Hours/Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>14MPY423</td>
<td>50</td>
<td>04</td>
</tr>
<tr>
<td>Total No. of Lecture Hours</td>
<td>52</td>
<td>Exam Hours : 03</td>
</tr>
<tr>
<td>Exam Marks : 100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Hydraulic Power Unit: Introduction, Pumping Theory, Pump Classification, Gear Pumps, (Vane Pumps- simple, balanced & pressure compensated vane pump, Vane design) Piston Pumps- Radial, Axial (Bent axis & Swash plate), Pump Performance, Pump Noise, Ripple in pumps.


Power Controlling Elements – Valves:
   i) Directional Control Valves – Classification, 2/2, 3/2,4/2 & 4/3 ways Dcv’s, Different Centre configurations in 4/3 way valves, actuation of DCV’s, Indirect actuation, Valve Lap – Lap during Stationary and during switching.
   ii) Pressure Control Valves: Classification, opening & Closing Pressure difference, Cracking Pressure, Pressure Relief Valve – Simple & Compound type, Pressure reducing valve, sequence, unloading & Counter balance valve, Pressure switches.
   iv) Check valve, Pilot operated check valve.


Pneumatic Valve: Directional control valves, impulse valve, Quick exhaust valve, shuttle valve, Twin pressure valve, Time delay valve,

Pneumatic Circuit & Logic Circuits:- Control of single and double acting cylinder, impulse operation, speed control, sequencing, Pneumatic Vacuum system AND,OR, NOT, NAND, NOR, YES Function, Logic circuits design using shuttle valve & twin pressure valve, Binary Arithmetic, logic & Boolean Algebra, use of kannaugh veitch map for pneumatic circuit design.

Electrical Control in Fluid Power: Contactors, & Switches, Relays, Limit switch, Electro hydraulic & Electro Pneumatic Circuits, Simple Cylinder reciprocation, interlocking using relays, Proximity switches, application of proximity switches, Time dependent will dependent and travel dependent circuits.

REFERENCE BOOKS:

2. **Oil hydraulics -Principles & maintenance** - S.R. Majumdar - Tata M C Graw Hill
3. **Components & Application** - Bosch Rexroth didactic - Hydraulics Trainer - vol 1. Publication
5. **Pneumatics: Theory and Applications** - Bosch Rexroth didactic - Publication
**RAPID PROTOTYPING**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>IA Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>14MPY424</td>
<td>50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of Lecture Hours/Week</th>
<th>Exam Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>04</td>
<td>03</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total No. of Lecture Hours</th>
<th>Exam Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>100</td>
</tr>
</tbody>
</table>

**Introduction:** Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems.

**Stereo Lithography Systems:** Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.

**Selective Laser Sintering and Fusion Deposition Modeling:** Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter, Path generation, Applications

**Solid Ground Curing:** Principle of operation, Machine details, Applications.

**Laminated Object Manufacturing:** Principle of operation, LOM materials, Process details, application.

**Concepts Modelers:** Principle, Thermal jet printer, Sander's model market, 3-D printer, Genisys Xs printer HP system 5, object Quadra systems.

**Rapid Tooling:** Indirect Rapid tooling -Silicone rubber tooling –Aluminum filled epoxy tooling Spray metal tooling, Cast kirk site, 3Q keltool, etc >Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.

**RP Process Optimization:** factors influencing accuracy, Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

**TEXT BOOKS:**

1. **Stereo lithography and other RP & M Technologies** - Paul F. Jacobs - SME, NY 1996.

**REFERENCE BOOKS:**

ADVANCED MANUFACTURING PRACTICES

Subject Code : 14 MPY425
No. of Lecture Hours/Week : 04
Total No. of Lecture Hours : 52
IA Marks : 50
Exam Hours : 03
Exam Marks : 100

Need of CPC for a company, what CPC can do, CPC-getting the right tool.

JIT – Introduction – The spread of JIT Movement, some definitions of JIT, core Japanese practices of JIT, Creating continuous Flow Manufacture, Enabling JIT to occur, Basic elements of JIT, Benefits of JIT.

Just in Time Production – Primary purpose, profit through cost reduction, Elimination of over production, Quality control, Quality Assurance, Respect for Humanity, Flexible work Force, JIT Production Adapting to changing production Quantities, process layout for shortened lead Times, Standardization of operation, Automation.

Sequence and Scheduling Used by Suppliers: Monthly and daily Information. Sequenced withdrawal system by sequenced schedule table, problems and counter measures in applying the Kanban system to sub contractors.

Toyota Production System- The philosophy of TPS, Basic Frame work of TPS, Kanbans. Determining the Number of Kanbans in Toyota Production System.
  a) Kanban Number under Constant Quantity Withdrawal System.
  b) Constant Cycle, Non-constant Quantity Withdrawal System.

Supplier Kanban and the Sequence Schedule for Use by Suppliers.
  a) Later Replenishment System by Kanban.
  b) Sequenced Withdrawal System.
  c) Circulation of the Supplier Kanban within Toyota.

Production Smoothing in TPS
Production Planning
Production Smoothing
Adaptability to Demand Fluctuations
Sequencing Method for the Mixed Model Assembly Line to Realize Smoothed Production of Goal.

Just-in-Time Production with Total Quality Control just in time concept, cutting lot sizes, cutting set-up times, cutting purchase order costs, the JIT cause-Effect chain, Scrap/Quality Improvements, Motivational effects, Responsibility effects, small Group improvement Activities, withdrawal of Buffer Inventory, the total Quality Control Concept.

Total Quality Control-Introduction-Total Quality Control concepts, responsibility, learning from the west, TQC concepts categorized, Goals, Habit of improvement, perfection, Basics, process control, Easy to see Quality control as facilitator, small lot sizes, Housekeeping, Less than full capacity scheduling, Daily machine checking, Techniques and Aids, Exposure of problems, Fool proof Devices, Tools of Analysis, QC Circles, TQC in Japanese-owned US Electronics plant, TQC in Japanese-owned Automotive plants.

Plant Configurations: Introduction-ultimate lant configuration, job shop Fabrication, Frame Welding, Forming Frame parts from Tubing, Dedicated production lines, overlapped production, the daily schedule, Forward Linkage by means of Kanban, physical merger of processes, Adjacency, mixed Models, Automated production Lines, Pseudo Robots, Robots, CAD and Manufacturing, Conveyors and stacker Cranes, Automatic Quality Monitoring
TEXT BOOKS:


REFERENCE BOOKS:

1. An Integrated Approach To Just In Time - Yasuhiro Monden - Toyota Production system.