**KURUKSHETRA UNIVERSITY, KURUKSHETRA**

**Established by the State Legislature Act XII of 1956**

***(‘A+’ Grade, NAAC Accredited)***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING**

**(CREDIT BASED) (w. e. f. 2018-19)**

**SPECIALIZATION: MECHANICAL ENGINEERING**

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| **Sr.** **No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Hrs./****Week** | **Credits** | **Major Test** | **Minor Test** | **Practical** | **Total** | **Duration of Exam (Hrs.)** |
| 1 | MTME-101 | Industrial Engineering & Ergonomics | 3 | 0 | 0 | 3 | 3 | 60 | 40 | - | 100 | 3 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | MTIP-103A | Computer Aided Design and Manufacturing | 3 | 0 | 0 | 3 | 3 | 60 | 40 | - | 100 | 3 |
| 3 |  | \*Programme Elective-I | 3 | 0 | 0 | 3 | 3 | 60 | 40 | - | 100 | 3 |
| 4 |  | \*\*Programme Elective-II | 3 | 0 | 0 | 3 | 3 | 60 | 40 | - | 100 | 3 |
| 5 | MTRM-111A | Research Methodology and IPR | 2 | 0 | 0 | 2 | 2 | 60 | 40 | - | 100 | 3 |
| 6 | MTME-103 | Industrial Engineering Lab | 0 | 0 | 4 | 4 | 2 | - | 40 | 60 | 100 | 3 |
| 7 | MTIP-119A | Computer Aided Design and Manufacturing Lab | 0 | 0 | 4 | 4 | 2 | - | 40 | 60 | 100 | 3 |
| 8 |  | \*\*\*Audit Course-I | 2 | 0 | 0 | 2 | - | - | 100 |  | 100 | 3 |
| **Total** | **24** | **18** | **300** | **280** | **120** | **700** |  |

 **SEMESTER-1**

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| **\*PROGRAMME ELECTIVE- I for MTME 1st Semester** |
| 1. | MTIP-105A | Tool Engineering |
| 2. | MTIP-107A | Advanced Engineering Materials |
| 3. | MTIP-109A | Non – Conventional Machining |

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| **\*\*PROGRAMME ELECTIVE- II for MTME 1st Semester** |
| 1. | MTIP-111A | Product Design and Development |
| 2. | MTIP-113A | Simulation of Industrial Systems |
| 3. | MTIP-115A | Supply Chain Management |

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| **AUDIT COURSE – I for MTME 1st Semester**  |
| 1. | MTAD-101A | English for Research Paper Writing |
| 2. | MTAD-103A | Disaster Management |
| 3. | MTAD-105A | Sanskrit for Technical Knowledge |
| 4. | MTAD-107A | Value Education |

**Note: 1.**The course of program elective will be offered at 1/3rd or 6 numbers of students (whichever is smaller) strength of the class.

2. \*\*\*Along with the credit course, a student may normally be permitted to take audit course, however for auditing a course; prior consent of the course coordinator of the course is required. These courses shall not be mentioned for any award/calculation of SGPA/CGPA in the DMC. A certificate of successful completion of the audit course will be issued by the Director/Head of institution.

 3. The programme elective I & II and Audit course-I are common with M. Tech. (I&P). The course starts with MTIP code is common with M. Tech. (I&P)

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING**

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**SPECIALIZATION: MECHANICAL ENGINEERING**

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| **S No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Hrs./****Week** | **Credits** | **Major****Test** | **Minor****Test** | **Practical** | **Total** | **Duration of Exam (Hrs.)** |
| 1 | MTME-102 | Operation Research & Optimization Techniques | 3 | 0 | 0 | 3 | 3 | 60 | 40 | - | 100 | 3 |
| 2 | MTME-104 | Refrigeration & Cryogenics | 3 | 0 | 0 | 3 | 3 | 60 | 40 | - | 100 | 3 |
| 3 |  | \*Programme Elective-III | 3 | 0 | 0 | 3 | 3 | 60 | 40 | - | 100 | 3 |
| 4 |  | \*\*Programme Elective-IV | 3 | 0 | 0 | 3 | 3 | 60 | 40 | - | 100 | 3 |
| 5 | MTME -106 | Advance Welding Lab | 0 | 0 | 4 | 4 | 2 | - | 40 | 60 | 100 | 3 |
| 6 | MTME-108 | Refrigeration & Cryogenics Lab | 0 | 0 | 4 | 4 | 2 | - | 40 | 60 | 100 | 3 |
| 7 | MTME-110 | Mini Project | 0 | 0 | 4 | 4 | 2 | - | - | 100 | 100 | 3 |
| 8 |  | \*\*\*Audit Course-II | 2 | 0 | 0 | 2 | - | - | 100 | - | 100 | 3 |
| **Total** | **26** | **18** | **240** | **240** | **220** | **700** |  |

**SEMESTER-II**

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| **\*PROGRAMME ELECTIVE-II for MTME 2nd Semester** |
| 1. | MTIP-106A | Advanced Welding Processes |
| 2. | MTIP-108A | Advanced Metal Cutting |
| 3. | MTIP- 110A | Metrology |

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| **\*\*PROGRAMME ELECTIVE - IV for MTME 2nd Semester** |
| 1. | MTIP-112A | Sequencing and Scheduling |
| 2. | MTIP-114A | Quality Engineering and Management |
| 3. | MTIP-116A | Reliability Engineering |

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| **AUDIT COURSE–II for MTME 2nd Semester** |
| 1. | MTAD-102A | Constitution of India |
| 2. | MTAD-104A | Pedagogy Studies |
| 3. | MTAD-106A | Stress Management by Yoga |
| 4. | MTAD-108A | Personality Development through Life Enlightenment Skills |

**Note: 1.**The course of program elective will be offered at 1/3rd or 6 numbers of students (whichever is smaller) strength of the class.

2. \*\*\*Along with the credit course, a student may normally be permitted to take audit course, however for auditing a course; prior consent of the course coordinator of the course is required. These courses shall not be mentioned for any award/calculation of SGPA/CGPA in the DMC. A certificate of successful completion of the audit course will be issued by the Director/Head of institution.

3. The programme elective III & IV and Audit course-II are common with M. Tech. (I&P). The course starts with MTIP code is common with M. Tech. (I&P)

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING**

**(CREDIT BASED) (w. e. f. 2018-19)**

**SPECIALIZATION: MECHANICAL ENGINEERING**

**SEMESTER-III**

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| **Sr. No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Hrs./****Week** | **Credits** | **Major Test** | **Minor****Test** | **Practical** | **Total** | **Duration of Exam (Hrs.)** |
| 1 |  | \*Programme Elective-V | 3 | 0 | 0 | 3 | 3 | 60 | 40 | - | 100 | 3 |
| 2 |  | \*\*Open Elective | 3 | 0 | 0 | 3 | 3 | 60 | 40 | - | 100 | 3 |
| 3 | MTME-201 | Dissertation Phase-I | 0 | 0 | 20 | 20 | 10 | - | 100 | - | 100 | -- |
| **Total** | **26** | **16** | **120** | **180** |  | **300** |  |

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| **\*PROGRAMME ELECTIVE-V for MTME 3rd Semester** |
| 1. | MTIP-201A | Enterprise Resource Planning |
| 2. | MTIP-203A | Design of Experiments |
| 3. | MTME-205A | Strategic Entrepreneurship |

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| **\*\*OPEN ELECTIVE for MTME 3rd Semester** |
| 1. | MTOE-201A | Business Analytics |
| 2. | MTOE-203A | Industrial Safety |
| 3. | MTOE-205A | Operations Research |
| 4. | MTOE-207A | Cost Management of Engineering Projects |
| 5. | MTOE-209A | Composite Materials |
| 6. | MTOE-211A | Waste to Energy |

Note: 1 The programme elective-V and Open elective are common with M. Tech. (I&P). The course starts with MTIP code is common with M. Tech. (I&P)

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| **Sr. No.** | **Course Code** | **Course Name** | **L** | **T** | **P** | **Hrs./****Week** | **Credits** | **Major****Test** | **Minor Test** | **Practical** | **Total** | **Duration of Exam (Hrs.)** |
| 1 | MTME-202 | Dissertation Phase-II | 0 | 0 | 32 | 32 | 16 | - | 100 | 200 | 300 | -- |
| **Total** | **32** | **16** |  | **100** | **200** | **300** |  |

**SEMESTER-IV**

**Total credits=68**

## **INSTRUCTIONS FOR PAPER SETTER**

1. The question paper is to be attempted in **THREE Hours**.
2. Maximum Marks for the paper are **60.**
3. The syllabus for the course is divided into **FOUR units.**
4. The paper will have a total of **NINE questions.**
5. **Question No. 1,** which is compulsory, shall be OBJECTIVE Type **and have content from the entire syllabus (all Four Units).**

### **Q. No. 2 & 3 from Unit I**

# **Q. No. 4 & 5 from Unit II**

**Q. No. 6 & 7 from Unit III**

**Q. No. 8 & 9 from Unit IV**

1. All questions will have equal **weightage of 12 marks.**
2. The candidate will attempt a total of **FIVE questions**, each of 12 marks. Q. No. 1 is compulsory. The candidate shall attempt remaining **four** questions by selecting **only one question from each unit.**
3. A question may have any number of sections labeled as 1(a), 1(b), 1(c), 1(d), ---- 2(a), 2(b), --.A section may further have any number of subsections labeled as (i), (ii), (iii),.
4. **SPECIAL INSRUCTIONS FOR Q. No. 1 ONLY**

**Question No. 1,** which is compulsory, shall be OBJECTIVE/ short answer type **and have content from the entire syllabus (all Four Units).**

**Emphasis is to be given on the basic concepts, analytical reasoning and understanding of the various topics in the subject.** This question may have a number of parts and/or subparts. The short questions could be combination of following types:

* 1. Multiple Choice
	2. Yes/ No choice
	3. Fill in Blanks type
	4. Short numerical computations
	5. Short Definitions
	6. Matching of Tables

The above mentioned question types is **only a Guideline**. Examiner could set the question as per the nature of the subject.

***First Semester***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

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| **MTME–101** | **INDUSTRIAL ENGINEERING & ERGONOMICS** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | To provide knowledge necessary to either initiate a new or improve an existing ergonomics program for controlling health and performance problems.management of the cost benefits of an ergonomically sound workplace |
| **Course Outcomes** |
| **CO1** | Understand ergonomics and its three major components. Outline the components of a system.Ergonomics program.  |
| **CO2** | Describe the components of office and shop floor ergonomic evaluations. |
| **CO3** | Study the common risk factors and areas for ergonomic improvement within foundries |
| **CO4** | Describe how to evaluate, select and implement ergonomic solutions |

**UNIT-I**

**Introduction to industrial engineering and productivity**, measurement of productivity, introduction to work study, methods study principles and motion economy, filming techniques and micro-motion analysis.

 **Introduction to work measurement**, Time study, performance allowances, works sampling.

**UNIT-II**

**Introduction of Ergonomics**, system approach to ergonomic model, Area of study covered under ergonomics, man/machine systems, characteristics of man machine system, limitation of man & machine with respect to each other, Design approach: Work design consideration, General principles for carrying out the physical activities, Design of workplace, machine at workplace, seat for workplace, posture-standing at work, seated at work, work station heights and seat geometry.

**UNIT-III**

**Controls**: Criteria for control design, Hand controls and foot controls, Relationship between controls and display instruments, location of controls and displays, controls for high precision work (push buttons, switches, knob etc.), **Displays**:- Types of displays, Design recommendation for quantitative displays.

**Workload**: static and dynamic muscular work, physical workload, measurement of physical workload, mental workload, measurement of metal workload.

**UNIT-IV**

**Climates:** (a) Heat Humidity- Fundamentals of human thermal regulation, measuring the thermal environment, work in hot climate, work in cold climate, protection against climatic extremes and effect of climate on performance.

(b) Vibration-Terminology, response of body to low frequency (LF) vibration, Discomfort and effect of vibrations on health of worker, high frequency (HF) vibration, effect of H.F. vibrations, methods of reducing vibration.

(c) Noise- Terminology, physiological effects of noise, annoyance of noise, speed interference, hearing loss temporary and permanent thread hold shift, effect of noise on performance reduction of noise, personal noise protection,

**RECOMMENDED BOOKS:**

* 1. Method Engineering study – Krick, S.V.
	2. Work study and Ergonics- Shah, H.S. – Dhanpat Rai & Sons-1988
	3. Introduction of Ergonomics-Bridger-Tata McGraw Hill 1995
	4. Work Study – Khanna- Dhanpat Rai & Sons- 1995
	5. Work study and Ergonomics-Suresh Dalela, Saurabh.
	6. Industrial Ergonomics- Khan, M.I. – PHI Learning.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

 All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

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| **MTIP–103A** |  [**COMPUTER AIDED DESIGN AND MANUFACTURING**](#_top) |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The objective of the course is to understand about the technology of computers for the design, process planning and manufacturing the products. |
| **Course Outcomes** |
| **CO1** | To understand the fundamentals and applications of computers in the field of designing and manufacturing and the transformation of geometric models. |
| **CO2** | To understand the concepts of G.T. and FMS.  |
| **CO3** | To know the use of computers in process planning and shop floor control.  |
| **CO4** | To learn the basics of AGV and coding systems for CNC. |

**UNIT I**

**Fundamentals of CAD:** Introduction to CAD/CAM, Historical Development, Industrial Look at CAD/CAM, Application of computers in design, creating manufacturing database, Benefits of CAD. Computer Hardware, Graphic input devices, display devices, Graphics output devices, Central processing unit (CPU).

**Geometric transformations:** 2D and 3D; transformations of geometric models like translation, scaling, rotation, reflection, shear; homogeneous representations, concatenated representation; Orthographic projections, Numerical Problems

**UNIT II**

**Group Technology and Cellular Manufacturing**

Part families, parts classifications and coding, Production flow Analysis, cellular Manufacturing- composite part concept, machine cell design, applications of group technology, Grouping parts and machines by Rank order clustering technique, Arranging machines in a G.T. cell.

**Flexible Manufacturing**

Introduction, FMS components, Flexibility in Manufacturing – machine, Product, Routing, Operation, types of FMS, FMS layouts, FMS planning and control issues, deadlock in FMS, FMS benefits and applications.

**UNIT III**

**Process Planning**

Introduction, Manual process planning, Computer aided process planning – variant, generative, Decision logic- decision tables, decision trees, Introduction to Artificial intelligence.

**Shop Floor Control**

Introduction, Shop floor control features, Major displays, Major reports, Phases of SFC Order Release, Order Scheduling, Order Progress, Manufacturing control, Methodology, Applications, Shop floor data collections, Types of data collection system, Data input techniques, Automatic data, Collection system. **UNIT IV**

**CNC Basics and Part Programming**

Introduction, Historical Background, Basic Components of an NC, Steps in NC, Verifications of Numerical control machine tool programs, Classification of NC Machine tool, Basics of motion control and feedback for NC M/C, NC part programming, Part programming methods, Modern Machining system, Automatically programmed tools, DNC, Adaptive control

**Automated Guided Vehicle**

Introduction, History, Features, Functions of AGV, Types of AGV, Safety consideration for AGV, Design of AGV.

**RECOMMENDED BOOKS:**

1. Chris McMahon and Jimmie Browne, CAD/CAM – Principle Practice and Manufacturing Management, Addison Wesley England, Second Edition, 2000.

2. Ibrahim Zeid, CAD/CAM theory and Practice, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1992.

3. Ibrahim Zeid, Mastering CAD/CAM, Tata McGraw Hill Publishing Co. Ltd., New Delhi.

4. Rogers, D.F. and Adams, A., Mathematical Elements for Computer Graphics, McGraw Hill Inc, NY, 1989

5. P. Radhakrishnan, S. Subramanayan and V.Raju, CAD/CAM/CIM, New Age International (P) Ltd., New Delhi.

6. Groover M.P. and Zimmers E. W., CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall International, New Delhi, 1992.

7. Dr. Sadhu Singh, Computer Aided Design and Manufacturing, Khanna Publishers, New Delhi, Second Edition, 2000.

8. M.P. Groover, Automation, Productions systems and Computer-Integrated Manufacturing by Prentice – Hall

9. Chang, Wang & Wysk Computer Aided Manufacturing. Prentice Hall

10. Kundra & Rao, Numerical Control and Computer Aided Manufacturing by, Rao

and Tiwari, Tata Mc-Graw Hill.

11. Mattson, CNC programming Principles and applications, Cengage Learning India Pvt.

Ltd. Delhi

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

 All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

***Programme Elective-I***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1stSem.)**

**(Credit based)**

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| [**MTIP–105**](#_top)**A** | **[TOOL ENGINEERING](#_top)** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The objective of the course is to impart the students with the knowledge of various aspects of design of different types of Tools and fixtures used in Industries. |
| **Course Outcomes** |
| **CO1** | To impart knowledge of materials for cutting tool and design of cutting tools. |
| **CO2** | To acquaint students with various kinds of Gages and Work holding devices. |
| **CO3** | To impart knowledge to students about Drill jigs and Fixtures. |
| **CO4** | To let student understand the tool design process for NC Machine tools  |

**UNIT-I**

**Cutting Tool Materials:** Introduction and desirable properties, Carbon and Medium-Alloy Steels, High-Speed Steels, Cast-Cobalt Alloys, Carbides, Coated Tools, Alumina-Based Ceramics, Cubic Boron Nitride, Silicon-Nitride Based Ceramics, Diamond, Reinforced Tool Materials, Cutting-Tool Reconditioning.

**Design of Cutting Tools** Basic Requirements, Mechanics and Geometry of Chip Formation, General Considerations for Metal Cutting, Design of single point Cutting Tools, Design of Milling Cutters, Design of Drills and Drilling, Design of Reamers, Design of Taps, Chip Breakers.

**UNIT-II**

**Gages and Gage Design**: Limits fits and tolerances, Geometrical tolerances-specification and measurement, Types of gages, Gage design, gage tolerances, Material for Gages.

**Work Holding Devices**: Basic requirements of work holding devices, Location: Principles, methods and devices, Clamping: Principles, methods and devices.

**UNIT-III**

**Drill Jigs**: Definition and types of Drill Jigs, Chip Formation in Drilling, General Considerations in the Design of Drill Jigs, Drill Bushings, Drill Jigs, and Modern Manufacturing

**Design of Fixtures**: Fixtures and Economics , Types of Fixtures , Milling Fixtures , Boring Fixtures, Broaching Fixtures, Lathe Fixtures, Grinding

**UNIT-IV**

**Tool Design for Numerically Controlled Machine Tools:** Fixture Design for Numerically Controlled Machine Tools, Cutting Tools for Numerical Control, Tool-holding Methods for Numerical Control.

**RECOMMENDED BOOKS:**

1. ASTME, “Fundamentals of Tool Design”, Prentice Hall of India, 1983.

2. Donaldson, “Tool Design”, Tata-McGraw Hill, 3rd Edition, 2000.

3. Joshi P.H., “Jigs and Fixtures”, Tata-McGraw Hill, 2010.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1stSem.)**

**(Credit based)**

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| [**MTIP–107**](#_bookmark0)**A** | **ADVANCED ENGINEERING MATERIALS** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The objective of the course is to impart the students with the knowledge of various advanced and smart materials. |
| **Course Outcomes** |
| **CO1** | To impart knowledge of Piezoelectric and shape memory alloys. |
| **CO2** | To acquaint students with deep know how about Electro-rheological and composite materials |
| **CO3** | To impart knowledge to students about MEMS systems and High temperature applicationmaterials. |
| **CO4** | To let student understand the processing and characteristics of powder metallurgy processes and structural materials. |

**UNIT-I**

**Introduction to advanced Engineering materials:** Classes of Materials and their usage, Historical Perspective, Intelligent Materials, Structural Materials, Functional Materials, Primitive Functions of Intelligent Materials, Intelligence inherent in Materials, Materials Intelligently Harmonizing with humanity, Biomimetic.

**Smart Materials and Structural Systems:** Introduction, Actuator Materials, Sensing Technologies, Micro-sensors, Intelligent systems, Hybrid Smart Materials, Passive Sensory Smart Structures, Reactive Actuator based smart structures, Active Sensing and Reactive smart structures, smart skins, Aero-elastic tailoring of airfoils, Synthesis of future smart systems.

**UNIT-II**

**Electrocaloric Effect:** An Introduction, History of Electrocaloric Cooling, Mechanism of working of Electrocaloric Cooling, Electrocaloric Materials, Performance of Electrocaloric Materials.

**Heat Resistant Steels:** Conventional Heat-Resistant Steels, Silicon-Bearing High Chromium Heat-Resistant Steels, Nitride-Strengthened Reduced Activation Heat-Resistant Steels, China Low Activation Martensitic Steel Nitride-Strengthened Steels, Microstructural Stability

**UNIT-III**

**Smart Micro-systems:** Silicon Capacitive Accelerometer, Piezo-resistive Pressure sensor, Conductometric Gas sensor, An Electrostatic Comb-drive, Magnetic Microrelay, Portable Blood Analyser, Piezoelectric Inkjet Print Head.

**Buckyballs to robotics**: Bucky ball, Nano Structure of Fullerene, Carbon Nanotubes, Nano Diamond, Boron nitride nanotubes, Single electron transistors, Molecular machine, Nano Biometrics, Nano Robots,

**UNIT-IV**

**Nano-Alloys:** Introduction, Chemical Synthesis: General Concepts, Reduction of Metallic Salts, The Organometallic Route: Thermal Decomposition Method, Other Chemical Methods for synthesis of Nano-alloys,Physical Routes for synthesis of Nano-Alloys; Experimental Techniques and Examples.

 **Shape memory alloys (SMA):** Shape memory effect and the metallurgical phenomenon of SMA, Types of SMA, One way and Two way Shape memory effect. Temperature assisted shape memory effect, Applications.

**RECOMMENDED BOOKS:**

1. Gandhi, M.V. and Thompson, B.S., Smart materials and Structures, Chapman & Hall,1992.
2. Ananthasuresh G.K., Vinoy K.J., Micro and Smart Systems, Wiley India.
3. Wei Yan, Wei Wang, 9-12 Cr Heat Resistant Steels, Engineering Material series, Springer International.
4. Damien Alloyeau, Christine Mottet, Nanoalloys Synthesis, Structure and Properties, Springer International.
5. Tatiana Correia, Qi Zhang, Electrocaloric Materials: New Generation of Coolers
6. Otsuka, K. and Wayman, C. M., Shape memory materials, C.U.P,1998
7. Taylor, W., Pizoelectricity, George Gorden and Breach Sc. Pub.,1985
8. Mallick, P.K., Fiber Reinforced Composites Materials, Manufacturing andDesign. Marcel Dekker Inc, New York,1993.
9. Rama Rao, P. (ed.), Advances in Materials and their applications, Wiley EasternLtd.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q.

No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

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| **[MTIP–109](#_top)A** | **NON-CONVENTIONAL MACHINING** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | To acquaint the students with the advanced technologies and processes in various streams of Non-conventional machining. |
| **Course Outcomes** |
| **CO1** | To impart knowledge of Various Non-conventional Mechanical Working Processes, technology, process parameters and analysis for metal removal for these processes. |
| **CO2** | To acquaint students with deep knowhow about chemical and electrochemical machining processes,  |
| **CO3** | To impart knowledge to students about various kinds of Electric discharge machining processes, process parameters associated with these processes and various process characteristics. |
| **CO4** | To let student understand the working and technology associated with Laser Beam machining and Electron beam machining processes.  |

**UNIT-I**

Introduction, Need of Non-conventional machining processes, Characteristics of conventional and Non-conventional Machining processes. **Mechanical Working Processes**: **Abrasive Jet Machining:** Machining setup, Abrasives, Process Parameters, Machining Characteristics, Material removal models in AJM, Process capability, Advantages, limitations, Applications

**Water Jet Machining:** Basic mechanism of Water jet machining setup, Process parameters, Catcher, Process capabilities, Advantages, limitations, Applications **Abrasive Water Jet Machining process:** Working Principle, AWJM Machine, Process Variables, Mechanism of Metal Removal, Cutting Parameters, Process capabilities, Applications, Environmental issues.

**Ultrasonic Machining:** Fundamental principles, Equipment, Magnetostriction, Elements of process, Mechanics of cutting, Analysis of Process Parameters, Process capabilities, Economic considerations. Applications, Limitations

**UNIT-II**

**Chemical Machining:** Introduction, Fundamental Principles, Process Parameters; Maskants and Etchants, Advantages, Limitations, Applications.

**Electrochemical Machining Processes:** Introduction, Classification of ECM Processes, Fundamentals Principles of ECM, Elements of ECM, ECM Machine Tool Process, Determination of Metal Removal Rate, Evaluation of Metal Removal of an alloy, Electrochemistry of ECM, Cathode and Anode reaction, Dynamics of ECM, Self-Regulating feature of ECM, Process Parameters, Process capabilities, Electrochemical Deburring. **Electrochemical Grinding:** Schematics, Electrochemistry, Process Parameters, Process capabilities, Applications, Advantages, Limitations.

**UNIT-III**

**EDM:** Introduction, Basic Principles & Schematics, Process Parameters, Characteristics of EDM, Dielectric, Electrode Material, Modeling of Material Removal, Spark Erosion Generators, Analysis and Metal Removal Rate in RC circuit, Selection of Tool Material and Tool Design, Di-Electric system, Process Variables, Dielectric Pollution and its effects, Process Characteristics, Applications, Electric Discharge Grinding and Electric Discharge Diamond Grinding; **Wire EDM**: Working Principle, Wire EDM Machine, Advances in Wire-cut EDM Process Variables, Process Characteristics, Applications.

**UNIT-IV**

**Laser Beam Machining** Back Ground, Production of Laser, Working Principle of LBM, Types of LASERS, Process Characteristics, Metallurgical effects, Advantages and Limitations, Applications.

**Electron Beam Machining**:

Electron Beam Action, Generation and control of Electron beam, Theory of Electron Beam Machining, Process Parameters, Process capabilities, Applications.

High Energy Rate Forming, Electro-Hydraulic Forming, Explosive Forming, Hot Machining Analysis of the Process.

**RECOMMENDED BOOKS:**

* 1. V.K. Jain, Advanced Machining Processes, Allied Publishers Pvt Ltd
	2. P.C. Pandey and H.S. Shan,Modern Machining Processes, Tata McGraw- Hill
	3. M. K. Singh, Unconventional Manufacturing Process, New Age Publishers
	4. J. A. Mcgeough, Advanced Methods of Machining,Springer.
	5. Benedict, Non-Traditional Manufacturing Process, CRC pub.
	6. P. K. Mishra, Nonconventional manufacturing,Narosa Publishers

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

***Programme Elective-II***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP-111A** | **PRODUCT DESIGN AND DEVELOPMENT** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The objective of the course is to understand about the product design and developments with inputs from aesthetics, ergonomics, design for manufacturing ease and cost effectiveness apart from reliability and durability and other considerations. |
| **Course Outcomes** |
| **CO1** | To understand the concept of product design, design considerations, design practiced by the industry, production and marketing, and aesthetics. |
| **CO2** | To provide a detailed fundamental approach to several primary processes and design guidelines for manufacturing, assembly and environment. |
| **CO3** | To discuss the human factor engineering and the concept of value engineering. |
| **CO4** | To study the modern approaches to product design, concept of product development and its manufacturing and economic aspects.  |

**UNIT-I**

**INTRODUCTION:** Introduction to product design, Design by evolution and innovation, Essential factors of product design, Production consumption cycle, Flow and value addition in production consumption cycle, Morphology of design.

**PRODUCT DESIGN PRACTICE AND INDUSTRY:** Product strategies, Time to market, Analysis of the product, Basic design considerations, Role of aesthetics in product design.

**UNIT-II**

**DESIGN FOR MANUFACTURE AND ASSEMBLY:** Overview and motivation, Basic method: Design guidelines: Design for assembly, Design for piece part production, Advanced method: Manufacturing cost analysis, cost driver modeling, Critique for design for assembly method.

**DESIGN FOR THE ENVIRONMENT:** Environmental objectives, Basic DFE methods, Design guidelines, Life cycle assessment, Techniques to reduce environmental impact.

**UNIT-III**

**HUMAN ENGINEERING CONSIDERATIONS IN PRODUCT DESIGN:** Human being as applicator of forces, Anthropometry, the design of controls, the design of displays, Man/Machine information exchange, Workplace layout from ergonomic considerations.

**VALUE ENGINEERING:** Value, Nature and measurement of value, Maximum value, Normal degree of value, Importance of value, value analysis job plan, creativity, steps to problem solving and value analysis, value analysis tests, value engineering idea generation check list, Cost reduction through value engineering-case study, materials and process selection in value engineering.

**UNIT-IV**

**MODERN APPROACHES TO PRODUCT DESIGN:** Concurrent design, Quality function deployment (QFD), Rapid prototyping, 3D printing, Introduction to 4D printing.

**PRODUCT DEVELOPMENT:** A modern product development process, reverse engineering and redesign product development process, product life cycle, product development teams, Product development planning, Manufacturing & economic aspects of product development.

**RECOMMENDED BOOKS:**

1. Kail T Ulrich and Steven D Eppinger, “Product Design and Development, TMH.
2. AK Chitale and Gupta, “Product Design and Engineering, PHI.
3. Niebel& Draper, “Product Design and Process Engineering”, McGraw-Hill.
4. Kevin Otto & Kristin Wood, “Product Design-Techniques in reverse engineering and new product development”Pearson.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1stSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP–113A** | [**SIMULATION OF INDUSTRIAL SYSTEMS**](#ELECTIVE2) |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The main objective of the course is to impart the students with the knowledge of industrial systems and its simulation. |
| **Course Outcomes** |
| **CO1** | To explain the concept of industrial simulation systems and its models of simulation. |
| **CO2** | To understand the simulation of discrete and queueing systems. |
| **CO3** | To understand the simulation if inventory systems and design of simulation experiments. |
| **CO4** | To simulate the industrial problems like reliability problems, computer time sharing problem and understand the simulation languages.  |

**UNIT-I**

**Introduction and overview:** concept of system, system environment, elements of system, system modeling, types of models, Monte Carlo method, system simulation, simulation - a management laboratory, advantages & limitations of system simulation, continuous and discrete systems.

**Simulation of continuous systems**: characteristics of a continuous system, comparison of numerical integration with continuous simulation system. Simulation of an integration formula.

**UNIT-II**

**Simulation of discrete system:** Time flow mechanisms, Discrete and continuous probability density functions. Generation of random numbers, testing of random numbers for randomness and for auto correlation, generation of random variates for discrete distribution, generation of random variates for continuous probability distributions-binomial, normal, exponential and beta distributions; combination of discrete event and continuous models.

**Simulation of queuing systems:** Concept of queuing theory, characteristic of queues, stationary and time dependent queues, queue discipline, time series analysis, measure of system performance.

Kendall's notation, auto covariance and auto correlation function, auto correlation effects in queuing systems, simulation of single server queues, multi-server queues, queues involving complex arrivals and service times with blanking and reneging.

**UNIT-III**

**Simulation of inventory systems**: Rudiments of inventory theory, MRP, in-process inventory. Necessity of simulation in inventory problems, forecasting and regression analysis, forecasting through simulation, generation of Poisson and Erlang variates, simulation of complex inventory situations.

Design of Simulation experiments: Length of run, elimination of initial bias, Variance, Variance reduction techniques, stratified sampling, antipathetic sampling, common random numbers, time series analysis, spectral analysis, model validation, optimization procedures, search methods, single variable deterministic case search, single variable non-deterministic case search, and regenerative technique.

**UNIT-IV**

**Simulation of PERT:** Simulation of - maintenance and replacement problems, capacity planning, production systems, reliability problems, computer time sharing problem, the elevator system.

**Simulation Languages**: Continuous and discrete simulation languages, block structured continuous languages, special purpose simulation languages, SIMSCRIPT, GPSS SIMULA importance and limitations of special purpose languages.

**RECOMMENDED BOOKS:**

1. Loffick, Simulation and Modelling - Tata McGraw Hill
2. DeoNarsingh, System Simulation with Digital Computer - Prentice Hall
3. Hira, D.S., System Simulation-S. Chand & Co.
4. Meelamkavil, Computer Simulation and Modelling - John Willey
5. Gorden, System Simulation - Prentice hall
6. Jerry Banks and John, S. Carson II, ‘Discrete – Event System Simulation’, Prentice Hall Inc., NewJersey, 1984.
7. Geoffrey Gordon, ‘System simulation’, Prentice Hall, NJ, 1978.
8. Law, A.M. and W.D. Keltor, ‘Simulation modelling analysis’, McGraw Hill, 1982.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP–115A** | **[SUPPLY CHAIN MANAGEMENT](#_bookmark3)** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The main objective of the course is to impart the students with the knowledge of Supply chain and different aspects of supply chain management. |
| **Course Outcomes** |
| **CO1** | To impart knowledge about basics of Supply chain management and Supply chain dynamics. |
| **CO2** | To acquaint students with the different aspects involved in sourcing and procurement in supply chain management. |
| **CO3** | To impart knowledge to students about Evaluating performance of Supply chain and decision making about Transportation, Storage and warehousing. |
| **CO4** | To let student understand Quantitative tools for SCM, Information Technology in a Supply Chain:  |

**UNIT-I**

**Overview of supply chain management:** Introduction, Definition, The Objective of a Supply Chain, The Importance of Supply Chain Decisions, Decision Phases in a Supply Chain, Process Views of a Supply Chain, Examples of Supply Chains.

**Supply chain dynamics**: Introduction, Coping with Dynamics in Supply chain. Bullwhip effect, Analysis of Bullwhip Effect, Impact of Lead time, Inventory management and Supply chain dynamics, offshoring and outsourcing Effect on SC dynamics and cost.

**UNIT-II**

**Outsourcing and Make or Buy Decisions:** Strategic Decisions and Core competencies, Tactical Decisions, Factors influencing make or buy decisions, Control of Production or Quality, Unreliable Suppliers, Suppliers Specialized knowledge and research, Small Volume Requirements, Limited Facilities, Workforce Stability, Multiple Sourcing Policy, Managerial and Procurement considerations, the Volatile nature of Make/Buy situation, Administration: Procedures and Personal.

**Sourcing of Supply:** Importance of Source Selection, Responsibilities for Source Selection, Evaluating a potential supplier, The criticality of Qualifying Sources, Competitive Bidding and Negotiation, Prerequisite for competitive bidding, Two step Bidding/Negotiation, Benefits and Risks of International Sourcing, Identifying and Qualifying an International Source.

**UNIT-III**

**Supply Chain Performance: Achieving Strategic fit And Scope:** Competitive and Supply Chain Strategies, Achieving Strategic Fit, Expanding Strategic Scope**,** Challenges to Achieving and Maintaining, Strategic Fit, Supply chain drivers and metrics, Financial Measures of Performance, Drivers of Supply Chain Performance, Framework for Structuring Drivers, Facilities, Inventory, Transportation, Information, Sourcing, Pricing.

**Transportation, storage and warehousing:** Introduction, Transportation mode choice, Transport operator decisions, Trucking sectors in India, Rail transport, Air Transport, Water transport, Transport network, Storage and warehousing, types of warehousing, risk pooling, IT Integration: Supply chain information system, Role of IT in SCM process, Business process Re-engineering, Internet and its applications in SCM.

**UNIT-IV**

**Quantitative tools for SCM**: Introduction, Forecasting, Demand forecast, Forecasting strategy & technique, Management of Inventories in SC, Linear programming, Routing models, pricing decisions, Introduction to MCDM approach.

**Information Technology in a Supply Chain:** The Role of IT in a Supply Chain, The Supply Chain IT Framework Customer Relationship Management, Internal Supply Chain Management, Supplier Relationship Management, The Transaction Management Foundation, The Future of IT in the Supply Chain, Risk Management in IT, Supply Chain IT in practice.

**RECOMMENDED BOOKS:**

1. Chopra, S., and Meindl, P., Supply chain Management: Strategy, Planning and Operations. Second Edition, Pearson Education (Singapore) Pte. Ltd, 2004.
2. Rangaraj, Supply Chain Management for Competitive Advantage, TMH.
3. Simchi-Levi, D., Kaminsky, P., and Simchi-Levi, E., Designing & Managing the Supply Chain: Concepts, Strategies & Case studies. Second Edition, Tata McGraw-Hill Edition, 2003.
4. Doebler, D.W. and Burt, D.N., Purchasing and Supply Chain Management: Text and Cases, McGraw-Hill Publishing Company Limited, New Delhi, 1996.

**Note**: The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

 **(Credit based)**

|  |  |
| --- | --- |
| **MTRM-111A** | **RESEARCH METHODOLOGY AND IPR** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **2** | **0** | **0** | **2** | **60** | **40** | **100** | **3** |
|  |
| **Objective** | The objective of this course is to make the students capable of formulating the research problems/ proposals and get aware about the intellectual property and patent laws. |
| **Course Outcomes** |
| **CO 1** | Student will be able to understand research problem formulation.  |
| **CO 2** | Student will be able to analyze research related information and follow research ethics. |
| **CO 3** | Student will be able to understand the Patents, Designs, Trade and Copyright and able to apply the knowledge for patent.  |
| **CO 4** | Student will be able to understand the concept of Patent Rights, Licensing and transfer of technology and able to apply the knowledge in new developments in IPR.  |

**Unit-I**

Meaning of research problem, Sources of research problem, Criteria, characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

**Unit-II**

 Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

**Unit-III**

**Nature of Intellectual Property:** Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

**Unit-IV**

**Patent Rights:** Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and Institutions.

# **RECOMMENDED BOOKS:**

1. Stuart Melville and Wayne Goddard, “Research methodology: An introduction for science & engineering students” Kenwyn, South Africa : Juta&​ Co. Ltd., 1996
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction” Juta Academic; 2nd edition (April 28, 2004)
3. Ranjit Kumar, “Research Methodology: A Step by Step Guide for beginners” SAGE Publications Ltd; Fourth edition (14 January 2014)
4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
5. Mayall, “Industrial Design”, McGraw Hill, 1992.
6. Niebel, “Product Design”, McGraw Hill, 1974.
7. Asimov, “Introduction to Design”, Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in New Technological Age”, Aspen Publishers; Revised edition (July 25, 2007)
9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weightage of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTME-103** | **INDUSTRIAL ENGINEERING LAB** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Practical** | **Total** | **Time** |
| **0** | **0** | **4** | **2** | **-** | **40** | **60** | **100** | **3 hrs** |
| **Objective** | Student will be able to take the right decisions to optimize resources utilization by improving productivity |
| **Course Outcomes** |
| **CO1** | Student will be able to take the right decisions to optimize resources utilization by improving productivity of the Lands, Buildings, People, Materials, Machines, Money, Methods and Management effectively |
| **CO2** | Student will understand to eliminate unproductive activities under the control of the Management, Supervisor, worker and the Design of Products and Processes |
| **CO3** | Student will introduce with different attributes and variables chart and draw them to find number of defects and defectives in required sample size. |
| **CO4** | Student will get the knowledge to design the Man Machine System to improve Human Efficiency and reduce the effort of the workers through ergonomics. |

**List of Experiments:**

1. P-CHART FOR FRACTION DEFECTIVES
2. C- CHART FOR NUMBER OF DEFECTIVES (CONSTANT SAMPLE SIZE)
3. OPERATING CHARECTERSTIC CURVE OF SINGLE SAMPLING ATTRIBUTES PLAN
4. TEST FOR NORMALITY OF SAMPLE MEANS(NORMAL DISTRIBUTION)
5. X, R – CHARTS & PROCESS CAPBILITY
6. PIN BOARD STUDY EXPERIMENT
7. TO DRAW TWO HANDED PROCESS CHART FOR BOLT, WASHER & NUT

ASSEMBLY

1. MULTIPLE ACTIVITY CHART (OR) MAN MACHINE CHART
2. ERGOCYCLE EXERCISE

**Note: At Least eight experiments need to be performed by the students from the above mentioned list.**

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP-119A** | **COMPUTER AIDED DESIGN AND MANUFACTURING LAB** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Practical** | **Total** | **Time** |
| **0** | **0** | **4** | **2** | **-** | **40** | **60** | **100** | **3 hrs** |
| **Objective** | To acquaint the students with 2-D and 3-D modeling using design softwares. |
| **Course Outcomes** |
| **CO1** | To understand the basic solid modeling and applied features of the softwares. |
| **CO2** | To learn and practice of surface techniques and surface creations using software. |
| **CO3** | To learn and practice of assembly and detailed drafting. |
| **CO4** | To let student understand how to prepare MMCs using Stir Casting process. |

**List of Experiments:**

#### The students will be required to carry out the following exercises or their equivalent tasks using a 3-D modeling software package (e.g. Solid-works/ Creo/ Ideas/ Solid Edge/UG/CATIA/ etc.). Practical must be performed on licensed version (Preferably the latest version) of any one of above mentioned software.

**1 BASIC SOLID MODELING**

**Introduction & sketcher tools**

a) CAD Tools and Applications: CAD - CAM - CAE

b) Parametric Feature Based Modelling and Parent-Child Relation

c) Design Intent and Associativity between 3 Modes

d) Modelling Software - Getting Started & Graphical User Interface

e) Sketch Entities and Tools

f) Dimensioning and Adding Relations to define the Sketch

**Sketched Features** (Boss / Base and Cut)

a) Base Features

b) Extrude & Revolve

c) Reference Geometry, Curves & 3D Sketch

d) Sweep & Loft

**Editing & Refining Model**

a) Editing Sketch, Sketch Plane and Editing Feature

b) Suppress / Un-Suppress Feature and Reordering Feature

**2 ADVANCE FEATURES APPLIED FEATURES**

a) Patterns & Mirror

b) Fillet/Round & Chamfer

c) Hole & Hole Wizard

d) Draft, Shell, Rib and Scale

e) Dome, Flex and Wrap

**Multi Body**

a) Indent Tool

b) Combine Bodies – Boolean Operations

c) Split, Move/Copy and Delete Bodies

**Other Tools & Options**

a) Design Table and Configurations

b) Adding Equations and Link Values

c) Tools - Measure and Mass Properties

d) Appearance - Edit Material, Colour and Texture

e) Options - System and Document Properties

**3 SURFACING TECHNIQUES BASIC SURFACE CREATIONS**

a) Extrude & Revolve

b) Sweep & Loft

c) Boundary Surface

d) Planar Surface

**Other Derived Techniques**

a) Offset Surface

b) Radiate Surface

c) Ruled Surface

d) Fill Surface

e) Mid Surface

**Modify / Edit Surfaces**

a) Fillet/Round

b) Extend

c) Trim & Un-trim

d) Knit Surfaces

e) Delete and Patch

**Surfaces for Hybrid Modelling**

a) Thicken – Boss / Base and Cut

b) Replace face

c) End condition for Sketched feature - Up to Surface or Offset from Surface.

d) Solid body from closed surfaces

**4 ASSEMBLY & MECHANISMS BOTTOM UP ASSEMBLY APPROACH**

a) Inserting Components/Sub-Assemblies

b) Adding Mates - Standard & Advance

c) Editing Mates, Part and Replacing Components

**Top down Approach & Mechanisms**

a) Inserting New Part to Existing Assembly

b) Use of Layout Sketching

c) External References - In-context and Out-of-context, Locked and Broken

**Assembly Features**

a) Component Patterns & Mirrors

b) Cuts & Holes

c) Belt/Chain and Weld Bead

**Representations of Assembly Components**

a) Light Weight, Suppressed and Resolved

b) Hide, Transparency and Isolate

c) Exploded View

**Assembly Check**

a) Interference Detection,

b) Collision Detection and Physical Dynamics

**Motion Study**

c) Assembly Motion & Physical Simulation

d) Animation Wizard & Save as AVI file

e) Mechanism Analysis – Plot Displacement, Velocity and Acceleration Diagram

**5 DETAILED DRAFTING**

**Introduction to Engineering Drawings**

a) General Procedure for Drafting & Detailing

b) Inserting Drawing Views, Dimensioning and Adding Annotations

c) Drawing Templates & Sheet Format

d) Setting Options

**Drawing Views**

a) Model View & Standard 3 View

b) Projected View & Auxiliary View

c) Section & Aligned Section View

d) Detail View, Broken-out Section and Crop View.

**Dimensioning**

a) Standards, Rules and Guidelines

b) Dimension Insertion/Creation - Insert Model Items & Dimension tool

**Annotations**

a) Notes & Holes Callout

b) Datum & Geometric Tolerances

c) Surface Finish & Weld Symbols,Centre Mark & Centre line,BOM Balloon & Bill of Material

***Audit Course-I***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTAD-101A** | **ENGLISH FOR RESEARCH PAPER WRITING** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **2** | **0** | **0** | **-** | **-** | **100** | **100** | **3** |
| **Objective** | The objective of this course is to impart the knowledge of English for research paper writing. |
| **Course Outcomes** |
| **CO1** | To understand that how to improve writing skills and level of readability. |
| **CO2** | To Learn about what to write in each section. |
| **CO3** | To understand the skills needed when writing a title. |
| **CO4** | To learn the skills required in writing the results, discussion and conclusions. |

**Unit-I**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**Unit-II**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

**Unit-III**

Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check. Key skills needed when writing a Title, key skills needed when writing an abstract, key skills needed when writing an Introduction, skills needed when writing a Review of the Literature.

**Unit-IV**

Skills needed when writing the Methods, skills needed when writing the Results, skills needed when writing the Discussion, skills needed when writing the Conclusions, Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

**RECOMMENDED BOOKS:**

1. Goldbort R, “Writing for Science”, Yale University Press (available on Google Books)
2. Day R, “How to Write and Publish a Scientific Paper”, Cambridge University Press
3. Highman N, “Handbook of Writing for the Mathematical Sciences”, SIAM. Highman’s book.
4. Adrian Wallwork, “English for Writing Research Papers”, Springer New York Dordrecht Heidelberg London, 2011

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTAD-103A** | **DISASTER MANAGEMENT** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **2** | **0** | **0** | **-** | **-** | **100** | **100** | **3** |
| **Objective** | The objective of this course is to impart the knowledge of disasters management. |
| **Course Outcomes** |
| **CO1** | To demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.  |
| **CO2** | To critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.  |
| **CO3** | To develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.  |
| **CO4** | To critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in. |

**Unit-I**

Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

**Unit-II**

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

**Unit-III**

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data From Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.

**Unit-IV**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival.

Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

**RECOMMENDED BOOKS:**

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “’New Royal book Company.
2. Sahni, Pardeep (Eds.),” Disaster Mitigation Experiences and Reflections”, Prentice Hall of India, New Delhi.
3. Goel S. L., “Disaster Administration and Management Text and Case Studies”, Deep & Deep Publication Pvt. Ltd., New Delhi.

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

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| --- | --- |
| **MTAD- 105A** | **SANSKRIT FOR TECHNICAL KNOWLEDGE** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **2** | **0** | **0** | **-** | **-** | **100** | **100** | **3** |
|  |
| **Objective** | The objective of this course is to understand basic Sanskrit Language and Ancient Sanskrit literature related to science & technology. |
| **Course Outcomes** |
| **CO1** | Students will get a working knowledge in illustrious Sanskrit, the scientific language of the world. |
| **CO2** | Learning of Sanskrit to improve brain functioning. |
| **CO3** | Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power. |
| **CO4** | The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature. |

**Unit-I**

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

**Unit-II**

Order, Introduction of roots, Technical information about Sanskrit Literature

**Unit-III**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

**RECOMMENDED BOOKS:**

1. Dr.Vishwas, “Abhyaspustakam” Samskrita-Bharti Publication, New Delhi
2. VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam “Teach Yourself Sanskrit” Prathama Deeksha-, New Delhi Publication
3. Suresh Soni, “India’s Glorious Scientific Tradition” Ocean books (P) Ltd., New Delhi.

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTAD-107A** | **VALUE EDUCATION** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **2** | **0** | **0** | **-** | **-** | **100** | **100** | **3** |
|  |
| **Objective** | The objective of this course is to understand value education, self-development, Imbibe good values in students and Let them know about the importance of character building. |
| **Course Outcomes** |
| **CO1** | To get knowledge of self-development. |
| **CO2** | To learn the importance of Human values. |
| **CO3** | To develop the overall personality. |
| **CO4** | To know about the importance of character. |

**Unit-I**

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgments

**Unit-II**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

**Unit-III**

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

**Unit-IV**

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, studying effectively

**RECOMMENDED BOOKS:**

* + 1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

***Second Semester***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTME-102** | **OPERATION RESEARCH & OPTIMIZATION TECHNIQUES** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The main objective of this course is to aware students about the dynamic programming to solve problems of discrete and continuous variables and model the real world problem and simulate it. |
| **Course Outcomes** |
| **CO1** | Students should be able to apply the dynamic programming to solve problems of discreet and continuous variables. |
| **CO2** | Students should be able to apply the concept of non-linear programming |
| **CO3** | Students should be able to carry out sensitivity analysis |
| **CO4** | Student should be able to model the real world problem and simulate it. |

**UNIT:-1**

**Introduction to Operation Research:** Operation Research approach, scientific methods, introduction to models and modelling techniques, general methods for Operation Research models, methodology and advantages of Operation Research, history of   Operation Research.

**Linear Programming (LP):** Introduction to LP  and formulation of Linear Programming problems, Graphical solution method, alternative or multiple optimal solutions, Unbounded solutions, Infeasible solutions, Maximization – Simplex Algorithm, Minimization – Simplex Algorithm using Big-M method, Two phase method, Duality in linear programming, Integer linear programming.

**UNIT:-2**

**Transportation & Assignment Problems:**  Introduction to Transportation problems, various methods of Transportation problem, Variations in Transportation problem, introduction to Assignment problems, variations in Assignment problems.

**Network Analysis:** Network definition and Network diagram, probability in PERT analysis, project time cost trade off, introduction to resource smoothing and allocation.

**UNIT:-3**

**Inventory Model:** Introduction to inventory control, deterministic inventory model, EOQ model with quantity discount.

**Sequential optimization**; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality, Recursive equations –Forward and backward recursions.

**UNIT:-4**

**Queuing Models & Simulation:** Concepts relating to queuing systems, basic elements of queuing model, role of Poison & exponential distribution, concepts of birth and death process. Introduction & steps of simulation method, distribution functions and random number generation.

**Advanced Topics in Optimization**

Piecewise linear approximation of a nonlinear function Multi objective optimization – Weighted and constrained methods; Multi level optimization Direct and indirect search methods Evolutionary algorithms for optimization and search Applications in mechanical engineering

**RECOMMENDED BOOKS:**

1. Gupta P.K, Hira and D.S., operation research, sultan chand and sons, New Delhi. 1994.
2. Kanti Swarup, Gupta P.K. & Man Mohan, Operation Research, sultan chand and sons, New Delhi. 1990.
3. Mittal K.V., Optimization Methods in Operation Research and system Analysis, New Age International (P) ltd., New Delhi, 1992.
4. Rao S.S., Optimization Theory and applications, wlley Eastern ltd. New Delhi, 1991.
5. Sharma, S.D., Optimization Research, Kedar Nath and Ram Nath.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks.* The student will attempt a total of *FIVE questions,* each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining/our questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2ndSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTME-104** | **REFRIGERATION & CRYOGENICS** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3** |
| **Objective** | The main objective of this course is to aware students about the different refrigeration systems and their applications simulate these with cryogenics to address and find the solution of various environmental and industrial issues.  |
| **Course Outcomes** |
| **CO 1** | Understand the basic principles of refrigeration and cryogenic |
| **CO 2** | Student should analyze air refrigeration systems, vapor compression refrigeration systems, vapour absorption refrigeration systems, and steam jet refrigeration systems |
| **CO 3** | Student should be able to understand the properties, applications and environmental issues of different refrigerants |
| **CO 4** | Student should operate and analyze the refrigeration and air conditioning systems. |

**UNIT-I**

**Introduction**: Lubrication of reverse carnot cycle with vapour as a refrigerant, simple vapour compression cycle, Pressure- Enthaply diagram, Ewing’s construction, suction state for max. COP standard rating cycle & effect of operating conditions (evaporator pressure, condenser pressure, suction vapour superheat, liquid sub cooling, liquid vapour regenerative heat exchanger) deviation of actual compression cycle with that of theoretical.

**UNIT-II**

**AIR REFRIGERATION SYSTEM**: Reverse Carnot cycle, most efficient refrigeration, Bell cooling the aero plane, simple cooling & simple evaporative type, Bootstrap & Bootstrap evaporative type, Regenerative type, reduced ambient, limitations, merit & comparison. Multi Temperature: Method of improving the COP, Optimum interstate pressure for two stages refrigeration system, multistage or compound compression with flash intercooler, single expansion valve & multi expansion valve, multi evaporator system with single compressor, individual compressor with compound compression, single expansion valve & multi expansion valve

**UNIT-III**

**Vapour Absorption System**:

Simple Vapour absorption system, Max, Coefficient of performance, Modification of simple vapour absorption system, Actual vapour absorption cycle and its representation on Enthalpy- Composition diagram, Absorption systm calculations, Rich and Poor solution concentrations, Lithium & Bromide water system.

**UNIT-IV**

**CRYOGENICS:**

Limitation of simple vapour compression system, Multi-stage system, Cascade system, Production of solid carbon dioxide, Joule- Thomson effect, Liquefaction of gases, Hydrogen ,Helium, application of low temperature, Cryogenic insulation. Steam Jet Refrigeration: Steam jet Refrigerator, component of steam jet refrigeration plant, advantages of steam jet refrigeration system, Performance of system, determination of equilibrium concentration.

**RECOMMENDED BOOKS:**

1. Mechanical Refrigeration by Sporks and Diffio

2. ASHRE Handbook (Fundamentals) ASHRE.

3. Thermal Environment by Threlkeld.

4. Refrigeration & Air-Conditioning by C.P. Arora.

5. Refrigeration & Air-Conditioning by Stocker

6. Cascade system Ejector Comparison system, Method, Use of pre-cooling, liquefaction.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks.* The student will attempt a total of *FIVE questions,* each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining/our questions by selecting only one question from each unit.*

***Programme Elective-III***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP-106A** | **[ADVANCED WELDING PROCESSES](#_bookmark0)** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The main objective of the course is to impart the students with the knowledge of Welding metallurgy and welding processes. |
| **Course Outcomes** |
| **CO1** | To impart knowledge about various Weld metallurgy and Weld arc characteristics. |
| **CO2** | To acquaint students with the various welding power sources and their applications. |
| **CO3** | To impart knowledge to students about Electrode coatings and Metal transfer phenomenon in weld metal transfer. |
| **CO4** | To let student understand the basics of Solid state welding processes and some of the latest welding techniques. |

**UNIT-I**

**WELDING METALLURGY:** Introduction, Weld Metal Zone, Theory of solidification of metals and alloys, Homogeneous Nucleation, Heterogeneous Nucleation, Freezing of alloys, Epitaxial Solidification; Effect of Welding speed on Grain structure, Fusion boundary zone, Heat affected zone, Under bead zone, Grain Refined Zone, Partial transformed zone, Properties of HAZ

**WELDING ARC:** Definition of Arc, Structure and characteristics, Arc efficiency, arc blow, Electrical Characteristics of arc, Types of Welding Arcs, mechanism of arc initiation and maintenance, role of electrode polarity on arc behaviour and arc stability, analysis of the arc. Arc length regulation in mechanized welding processes.

**UNIT-II**

**WELDING POWER SOURCES**: Requirement of an Arc welding power sources, basic characteristics of power sources for various arc welding processes, duty cycles, Selection of a static Volt-Ampere characteristic for a welding process, AC/DC welding power source, DC rectifiers, thyristor controlled rectifiers, transistorized units, inverter systems, Mathematical Problems on Static volt ampere characteristics

**UNIT-III**

**COATED ELECTRODES:** Electrode coatings, classification of coatings of electrodes for SMAW, SAW fluxes, role of flux ingredients and shielding gases, classification of solid and flux code wires.

**METAL TRANSFER & MELTING RATE:** Mechanism and types of metal transfer, forces affecting metal transfer, modes of metal transfer, metal transfer in various welding processes, effective of polarity on metal transfer and melting rate.

**UNIT-IV**

**SOLID STATE WELDING:** Theory and mechanism of solid state welding,techniques and scope of friction welding, diffusion welding, cold pressure welding and ultrasonic welding, high energy rate welding,analysis of the Process.

**WELDING TECHNIQUES:** Technique, scope and application of the electron beam and laser welding processes,under water welding - process & problem.

**RECOMMENDED BOOKS:**

**1.** Raymond Sacks, ―Welding: Principles & Practices‖ McGraw-Hill

2. R.S.Parmar, ―Welding processes & Technology‖, Khanna Publishers

3. R.S.Parmar, ―Welding Engineering & Technology‖, Khanna Publishers

4. S.V. Nandkarni, ―Modern Arc Welding Technology, Oxford & IBH publishing Co.

5. L.M.Gourd, ―Principles of Welding Technology‖, ELBS/ Edward Arnold.

6. Richard L. Little ―Welding & Welding Technology‖, Mc-Graw Hill.

7. Cary, Howard ―Modern Welding Technology‘, prentice Hall, 1998.

8. Rossi ―Welding Technology‖, Mc-Graw Hill.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP–108A** | [**ADVANCED METAL CUTTING**](#_top) |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The main objective of the course is to impart the students with the knowledge of advanced cutting tools, tools geometry, mechanisms and analysis. |
| **Course Outcomes** |
| **CO1** | To impart knowledge about various functional related to tools geometry. |
| **CO2** | To acquaint with the analysis of fundamental factors affecting tool forces |
| **CO3** | To impart knowledge about cutting tool life and mathematical modelling for wear. |
| **CO4** | To let student understand abrasive machining and its process simulation.  |

**UNIT-I**

Introduction system of Tool nomenclature, Tool Geometry, Mechanism of Chip formation and forces in orthogonal cutting, Merchant’s force diagram.

**Oblique Cutting:** Normal chip reduction coefficient under oblique cutting, true shear angle, effective rake, influx region consideration for deformation, direction of maximum elongation, effect of cutting variables on chip reduction co-efficient, forces system in oblique cutting, effect of wear land on force system, force system in milling, effect of helix angle.

**UNIT-II**

Fundamentals of Dynamometry, Theoretical determination of forces, angle relations, heat and temperature during metal cutting; distribution, measurement, analysis, theoretical estimation of work piece temperature, hot machining

Fundamental factors, which effect tool forces: Correlation of standard mechanized test. (Abuladze –relation), nature of contact and stagnant phenomenon, rates of strains, shear strain and normal strain distributions, cutting variables on cutting forces.

**UNIT-III**

**Cutting Tools:** Tools materials analysis of plastic failure (from stability criterion), Analysis failure by brittle fracture, wear of cutting tools, criterion, flank and crater wear analysis, optimum tool life, tool life equations, (Taylor’s woxenetc) Tool life test, machining optimization, predominant types of wear; abrasive, adhesive, diffusion wear models, wear measurements and techniques, Major Test of tool wear oxidative mathematical modelling for wear, test of machinability and influence of metallurgy on machinability. Economics of metal machining

**UNIT-IV**

**Abrasive Machining:** Mechanics of grinding, cutting action of grit, maximum grit chip thickness, energy and grit force temperature during grinding, wheel wear, grinding, process simulation, testing of grinding wheels, mechanics of lapping and honing, free body abrasion.

**RECOMMENDED BOOKS:**

1. Sen & Bhattacharya,Principles of Machine tools, New Central Book Agency.
2. Brown,Machining of Metals, Prentice Hall.
3. Shaw,Principles of Metal cutting, Oxford I.B.H.
4. Arshimov&Alekree,Metal cutting theory & Cutting tool design, MIR Publications.
5. Machining Science & Application by Knowenberg Longman Press.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP-110A** | **Metrology** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs.** |
| **Objective** | The main objective of the course is to deal with the basic principles of dimensional measuring instruments and precision measurement techniques in achieving quality and reliability in the service of any product in dimensional control.  |
| **Course Outcomes** |
| **CO1** | To understand the students about the requirement of metrology and the concepts of limit, fits and gauges. |
| **CO2** | To study the linear and angular measurements and the optical measurement tools and techniques. |
| **CO3** | To understand how to use surface roughness and thread measuring instruments. |
| **CO4** | To study the comparators, measurement through comparators and the advanced metrology concepts. |

**UNIT-I**

**Introduction to metrology:** Definition, types, need of inspection, terminologies, methods of measurement, selection of instruments, measurement errors, units, Measurement standards, calibration, statistical concepts in metrology.

**Systems of Limits and Fits:** Introduction, nominal size, tolerance limits, deviations, allowance, fits and their types – unilateral and bilateral tolerance system, hole and shaft basis systems – interchangeability and selective assembly. Indian standard Institution system – British standard system, International standard system for plain and screwed work.

**Limit Gauges:** Taylor’s principle – Design of limit gauges, computer aided tolerancing.

**UNIT-II**

**Linear Measurement:** Length standard, line and end standards, slip gauges – calibration of the slip gauges, dial indicator, micrometres. Measurement of angles and tapers: Different methods – bevel protractor – angle slip gauges – spirit levels– sine bar – sine plate, rollers and spheres.

**Flat Surface Measurement:** Measurement of flat surfaces – instruments used – straight edges– surface plates – optical flat and auto collimator.

**Optical Measuring Instruments:**Tool maker’s microscope and its uses, collimators, optical projector, optical flats and their uses, interferometer.

**UNIT-III**

**Surface Roughness Measurement:** Introduction, terminology, specifying roughness on drawings, surface roughness parameters, factors affecting surface roughness, ideal surface roughness, roughness measurement methods, precautions in measurement, surface microscopy, surface finish softwares.

**Screw Thread Measurement**: Elements of measurement – errors in screw threads – measurement of effective diameter, angle of thread and thread pitch, profile thread gauges.

**Measurement through Comparators:** Comparator: Features of comparators, classification of comparators, different comparators, advanced comparators, thread comparators.

**UNIT-IV**

**Metrology of machine tools:** Alignment and practical tests.

**Gear Measurement:** Gear measuring instruments, gear tooth profile measurement, measurement of diameter, pitch, pressure angle and tooth thickness.

**Advanced Metrology:** Advanced measuring machines, CNC systems, Laser vision, In-process gauging, 3D metrology, metrology softwares, Nano technology instrumentation, stage position metrology, testing and certification services, optical system design, lens design, coating design, precision lens assembly techniques, complex opto mechanical assemblies, contact bonding and other joining technologies.

**RECOMMENDED BOOKS:**

1. K.J. Hume,Engineering Metrology, Macdonald and Co. (publisher) London.
2. Czichos, The Springer handbook of metrology and Testing, 2011.
3. Jay. L. Bucher, The Metrology Hand book, American Society for Quality, 2004.
4. Smith GT,Industrial Metrology, Spinger.
5. John W. Greve, Frank W. Wilson,Hand book of industrial metrology, PHI – New Delhi.
6. D.M. Anthony, Engineering Metrology, Pergamon Press.
7. Khare MK,Dimensional Metrology, OXFORD-IBH Publishers.
8. I C Gupta, “Engineering Metrology”, 5th Edition, Danapath Rai & Co, 2008.
9. R.K. Jain, “Engineering Metrology”. 20th Edition, Khanna Publishers, 2007.
10. M. Mahajan, “Engineering Metrology”, Dhanapati Rai publications, 2007.
11. BIS standards on Limits & Fits (IS 919), Surface Finish (IS 2073), Machine Tool Alignment, 1993.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

***Programme Elective-IV***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP–112A** | **SEQUENCING AND SCHEDULING** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The main objective of the course is to impart the students with the knowledge of different production and machine models of sequencing and scheduling. |
| **Course Outcomes** |
| **CO1** | To understand the concept of sequencing and scheduling. |
| **CO2** | To study and practice for the extension of basic models and parallel machine models. |
| **CO3** | To understand the concepts of the flow shop scheduling and practice for the flow shop scheduling models. |
| **CO4** | To understand the job shop problems and simulation models for dynamic job shop problem.  |

**UNIT-I**

**Single-Machine Sequencing:** Introduction, Preliminaries, Problems without Due Dates, Problems with Due Dates

**Optimization Methods for the Single-Machine Problem:** Introduction, Adjacent Pairwise Interchange Methods, A Dynamic Programming Approach, Dominance Properties, A Branch and Bound Approach.

**Earliness and Tardiness Costs:** Introduction, Minimizing Deviations from a Common Due Date, The Restricted Version, Asymmetric Earliness and Tardiness Costs, Quadratic Costs, Job-Dependent Costs, Distinct Due Dates, Sequencing for Stochastic Scheduling.

 **UNIT-II**

**Extensions of the Basic Model:** Introduction, Non-simultaneous Arrivals, Related Jobs, Sequence-Dependent Setup Times, Stochastic Models with Sequence-Dependent Setup Times.

**Parallel machine models**: Introduction, Minimizing the Makespan, Minimizing Total Flow time, Stochastic Models.

 **UNIT-III**

**Flow Shop Scheduling:** Introduction, Permutation Schedules, The Two-Machine Problem, Special Cases of The Three-Machine Problem, Minimizing the Makespan, Variations of the *m*-Machine Model, Stochastic flow shop scheduling.

 **UNIT-IV**

**The Job Shop Problem:** Introduction, Types of Schedules, Schedule Generation, The Shifting Bottleneck Procedure, Neighborhood Search Heuristics.

**Simulation Models for the Dynamic Job Shop:** Introduction, Model Elements, Types of Dispatching Rules, Reducing Mean Flowtime, Meeting Due Dates.

**RECOMMENDED BOOKS:**

1. Michael Pinedoo, Scheduling: theory, algorithms and systems, Prentice Hall, New Delhi, 1995.

2. King, J.R. Production planning and control, Pergamon International Library, 1975.

3. Kenneth R. Baker, Introduction to sequencing and scheduling, John Wiley and Sons, 1974.

4. Kenneth R. Baker and Dan Trietsch, Principles of sequencing and scheduling, John Wiley and Sons, 2009.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2ndSem.)**

**(Credit based)**

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| --- | --- |
| **MTIP–114A** | [**QUALITY ENGINEERING AND MANAGEMENT**](#elective3) |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The main objective of the course is to impart the students with the knowledge of quality tools and engineering for the improvement of product quality. |
| **Course Outcomes** |
| **CO1** | To understand the statistical concepts of quality and quality statistics.  |
| **CO2** | To study the quality control charts in production process and practice for its use in problem solving. |
| **CO3** | To understand the quality improvement tools. |
| **CO4** | To study the ISO systems, failure analysis and testing. |

**Unit-I**

**Introduction to Quality: An Historical Overview:** Defining Quality, The Total Quality System, Total Quality Management, Economics of Quality, Quality, Productivity, and Competitive Position, Quality Costs, Success Stories.

**Statistics for Quality:** Variability in Populations, Some Definitions, Quality vs. Variability, Section I: Empirical Methods for Describing Populations, Section II: Mathematical Models for Describing Populations, Section III: Inference of Population Quality from a Sample.

**Unit-II**

**Quality in Design:** Planning for Quality, Product Planning, Product Design, Process Design.

**Quality in Production-Process Control I:** Process Control, The Control Charts, Measurement Control Charts, Attribute Control Charts, Summary on Control Charts, Process Capability, Measurement System Analysis,

**Quality in Production-Process Control II:** Derivation of Limits,
Operating Characteristics of Control Charts, Measurement Control Charts for Special Situations.

**Unit-III**

**Quality in Procurement:** Importance of Quality in Supplies, Establishing a Good Supplier Relationship, Choosing and Certifying Suppliers, Specifying the Supplies Completely, Auditing the Supplier, Supply Chain Optimization Using Statistical Sampling for Acceptance,

**Continuous Improvement of Quality:** The Need for Continuous Improvement, The Problem-Solving Methodology, Quality Improvement Tools, Lean Manufacturing.

**Unit-IV**

**A System for Quality:** The Systems Approach, Dr. Deming’s System, Dr.Juran’s System, Dr.Feigenbaum’s System, Baldrige Award Criteria, ISO 9000 Quality Management Systems, ISO 9001:2008 Requirements, The Six Sigma System.

**RECOMMENDED BOOKS:**

1. Grant &Leaveworth, Statistical Quality Control, McGraw Hill
2. Duncan,Quality Control & Industrial Statistics, Irwin Press
3. Juran,Quality Control Handbook, McGraw Hill.
4. Hansen,Quality Control, Prentice Hall
5. Thomason,An Introduction to reliability & control, Machinery Publishing.
6. A.V. Taylor, Total Quality Control, McGraw-Hill
7. K.S.Krishnamoorthi, V. Ram Krishnamoorthi,A First Course in Quality Engineering: Integrating Statistical and Management Methods of Quality, Second Edition, CRC Press.

**Note:**The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units). All questions will have equal *weight of 12 marks*.

The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2ndSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP–116A** | [**RELIABILITY ENGINEERING**](#elective3)  |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The main objective of the course is to impart the students with the knowledge of reliability analysis in industrial system. Students can get acquainted with different reliability calculation models. |
| **Course Outcomes** |
| **CO1** | To understand the concepts of reliability in industrial systems.  |
| **CO2** | To study the reliability determination methods and advanced evaluation techniques. |
| **CO3** | To understand various reliability prediction and evolution methods. |
| **CO4** | To acquaint the fundamentals of reliability management and risk assessment. |

**UNIT-I**

**Reliability Engineering:** Reliability function, failure rate, Mean time between failures (MTBF), Mean time to failure (MTTF), mortality curve, useful life availability, maintainability, system effectiveness. Introduction to probability distributions.

**Time to failure distributions:** Exponential, normal, Gamma, Weibull; ranking of data, probability plotting techniques, Hazard plotting Concept of Bathtub Hazard Rate curve, Reliability evaluation of two-state device networks-series, parallel, k-out-of-m systems; Standby redundant systems, Reliability evaluation of three-state device networks-series and parallel.

**UNIT-II**

**Reliability Determination and Prediction:** Reliability Determination Methods: Network reduction technique, Path tracing technique, Decomposition technique, Delta-Star method.

**Advanced Reliability Evaluation Concepts:** Supplementary variables technique, Interference theory, Human reliability, Common cause failures, Fault trees, Failure mode and effect analysis

**UNIT-III**

**Reliability Prediction Models:** Series and parallel systems - RBD approach - Standby systems - m/n configuration - Application of Baye's theorem - cut and tie set method - Markov analysis - FTA - Limitations.

**UNIT-IV**

**Reliability testing:** Time acceleration factor, influence of acceleration factor in test planning, application to acceleration test, high temperature operating life acceleration model, temperature humidity bias acceleration model, temperature cycle acceleration model, vibration accelerator model, failure free accelerated test planning. Accelerated reliability growth.

**Risk Assessment:** Definition and measurement of risk - risk analysis techniques - risk reduction resources - industrial safety and risk assessment.

**RECOMMENDED BOOKS:**

1. Charles E. Ebeling, “An introduction to Reliability and Maintainability engineering”, TMH, 2000.

2. Roy Billington and Ronald N. Allan, “Reliability Evaluation of Engineering Systems”, Springer, 2007.

3. Sharma S C, Inspection Quality Control and Reliability, Khanna Publishers.

4. Connor P.D.T.O. Practical Reliability Engineering”, John Wiley.

5. Naikan V N A Reliability Engineering and Life Testing”, PHI Learning Private Limited.

6. Prabhakar Murthy D N and Marvin R, “Product Reliability”, Springer-Verlag.

7. Dana Crowe and Alec Feinberg, Design for Reliability, CRC Press.

**Note:**The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units). All questions will have equal *weight of 12 marks*.

The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTME–106** | **ADVANCE WELDING LAB** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Practical** | **Total** | **Time** |
| **0** | **0** | **4** | **2** | **-** | **40** | **60** | **100** | **3 hrs** |
| **Objective** | To familiar about the advance welding techniques. |
| **Course Outcomes** |
| **CO1** | To study various property of metals under different weldings. |
| **CO2** | To acquaint students various welding tests. |
| **CO3** | Various solid state weldings. |
| **CO4** | To get familiar with different types of electrodes used in welding. |

1. To study Heat Flow in welding by using Gas Welding Equipment
2. To study tensile property, bead geometry, hardness of bead, microstructure of welding bead in case of:
3. MIG Welding
4. TIG Welding
5. SAW Welding
6. Arc Welding
7. Use different destructive testing methods (Impact test- Charpy and Izod impact tests, Hardness test- Brinell, Vickers, Rockwell hardness tests) for quality control of welds.
8. Use different non destructive testing (Dye Penetrant Testing and Magnetic Particle Testing, Visual inspection; Radiography Testing) for quality control of welds.
9. To study mechanical behavior (tensile strength hardness of bead, micro structure of welding bead, impact strength, corrosion and wear, fatigue behavior) in case of
10. Frictions stir welding
11. Frictions stir processing
12. To study welding thermal cycles, weld metal solidification process and welding metallurgy during the welding of ferrous and non ferrous metals.
13. To study the different codes and symbols use in welding to differentiate electrodes and consumables according to ASME standard.

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2ndSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTME-108** | **REFRIGERATION AND CRYOGENICS LAB** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Practical Marks** | **Total** | **Time (Hrs.)** |
| **-** | **-** | **4** | **2** | **-** | **40** | **60** | **100** | **3** |
|  |
| **Objective** | **To make students understand the applications of refrigeration and cryogenics.** |
| ***Course Outcomes*** |
| **CO 1** | **Students will understand about the basics and working of refrigeration and cryogenics systems.** |
| **CO 2** | **Students will be able to identify the different cycle of operation in refrigeration.** |
| **CO 3** | **Students will know the working principle to achieve very low temperature and its importance in air-conditioning.** |
| **CO 4** | **Student will learn about the various working and design of different types of refrigeration systems.** |

**List of Experiments**

1. To study and perform experiment on compound vapour compression Refrigeration Cycle.
2. To study and perform experiment on Solar Air-conditioner based on vapour absorption cycle.
3. To study and perform experiments on multi-load systems.
4. To study and perform experiment on vapour absorption apparatus.
5. To find the performance parameter of cooling tower.
6. To study various components in room air conditioner.
7. To find performance of a refrigeration test rig system by using different expansion devices.
8. To study and perform experiments on cascade system.
9. To study and perform experiments on dry ice machine.
10. To study and perform experiments on gas liquefaction system.

**Note: Total eight experiments are to be performed selecting at least six from the above list**

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2ndSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTME-110** | **MINI PROJECT** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Practical** | **Total** | **Time** |
| **0** | **0** | **4** | **2** | **-** | **-** | **100** | **100** | **3 hrs** |
| **Objective** | In case of mini project, they will solve a live problem using software/analytical/computational tools or fabricate an experimental setup. |
| **Course Outcomes** |
| **CO 1** | Students will learn to write technical reports. |
| **CO 2** | Students will develop skills to present and defend their work in front of technically qualified audience. |

Students can take up small problems in the field of mechanical engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

Students will be required to submit a brief synopsis of 3-4 pages related to the topic by the first week of September.

***Audit Course-II***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2ndSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTAD- 102A** | **CONSTITUTION OF INDIA** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **2** | **0** | **0** | **-** | **-** | **100** | **100** | **3** |
|  |
| **Objective** | The main objective of the course is to impart the students with the knowledge of informing the twin themes of liberty and freedom from a civil rights perspective and to address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.  |
| **Course Outcomes** |
| **CO1** | To discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.  |
| **CO2** | To discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.  |
| **CO3** | To discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.  |
| **CO4** | To discuss the passage of the Hindu Code Bill of 1956.  |

**Unit-I**

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working)

Philosophy of the Indian Constitution: Preamble, Salient Features

**Unit-II**

Contours of Constitutional Rights & Duties: Fundamental Rights , Right to Equality, Right to Freedom , Right against Exploitation , Right to Freedom of Religion, Cultural and Educational Rights , Right to Constitutional Remedies , Directive Principles of State Policy , Fundamental Duties.

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions

**Unit-III**

Local Administration: District’s Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: ZilaPachayat, Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

**Unit-IV**

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

**RECOMMENDED BOOKS:**

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar, “framing of Indian Constitution”, 1st Edition, 2015.
3. M. P. Jain, “Indian Constitution Law”, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, “Introduction to the Constitution of India”, Lexis Nexis, 2015.

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2ndSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTAD-104A** | **PEDAGOGY STUDIES** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **2** | **0** | **0** | **-** | **-** | **100** | **100** | **3** |
| **Objective** | The main objective of the course is to review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers and Identify critical evidence gaps to guide the development. |
| **Course Outcomes** |
| **CO1** | Understand the pedagogical practices being used by teachers in formal and informal classrooms in developing countries. |
| **CO2** | Become aware of the evidence on the effectiveness of these pedagogical practices, in different conditions and with different population of learners. |
| **CO3** | Understand the significance of teacher education (curriculum and practicum) and the school curriculum and guidance materials for effective pedagogy. |

**Unit-I**

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions. Overview of methodology and Searching.

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

**Unit-II**

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers’ attitudes and beliefs and Pedagogic strategies.

**Unit-III**

Professional development: alignment with classroom practices and follow-up support, Peer support Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

**Unit-IV**

Research gaps and future directions: Research design, Contexts, Pedagogy, Teacher education Curriculum and assessment, Dissemination and research impact.

**RECOMMENDED BOOKS:**

1. Ackers J, Hardman F, “Classroom interaction in Kenyan primary schools”, Compare, 31 (2): 245-261.
2. Agrawal M, “Curricular reform in schools: The importance of evaluation”, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K, “Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J, “Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?” International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ, “Culture and pedagogy: International comparisons in primary education”. Oxford and Boston: Blackwell.
6. Chavan M, “Read India: A mass scale, rapid, ‘learning to read’ campaign”

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2ndSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTAD-106A** | **STRESS MANAGEMENT BY YOGA** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **2** | **0** | **0** | **-** | **-** | **100** | **100** | **3** |
|  |
| **Objective** | The main objective of the course is to achieve overall health of body and mind and to overcome stress |
| **Course Outcomes** |
| **CO1** | Develop healthy mind in a healthy body thus improving social health.  |
| **CO2** | Improve efficiency  |
| **CO3** | Learn the Yogasan |
| **CO4** | Learn the Pranayam |

**Unit-I**

Definitions of Eight parts of yog. ( Ashtanga )

**Unit-II**

Yam and Niyam. Do`s and Don’t’s in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

**Unit-III**

Asan and Pranayam

i) Various yog poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects-Types of pranayam

**RECOMMENDED BOOKS:**

1. Janardan Swami Yogabhyasi Mandal, “Yogic Asanas for Group Tarining-Part-I” : Nagpur
2. Swami Vivekananda, “Rajayoga or conquering the Internal Nature” AdvaitaAshrama (Publication Department), Kolkata

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2ndSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTAD-108A** | **PERSONALITY DEVELOPMENT THROUGH LIFE****ENLIGHTENMENT SKILLS** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **2** | **0** | **0** | **-** | **-** | **100** | **100** | **3** |
| **Objective** | To learn how to achieve the highest goal happily.To become a person with stable mind, pleasing personality and determination.To awaken wisdom in students. |
| **Course Outcomes** |
| **CO1** | Students become aware about leadership. |
| **CO2** | Students will learn how to improve communication skills |
| **CO3** | Understand the team building and conflict |
| **CO4** | Student will learn how to manage the time. |

Neetisatakam-Holistic development of personality

* 1. Verses- 19,20,21,22 (wisdom)
	2. Verses- 29,31,32 (pride & heroism)
	3. Verses- 26,28,63,65 (virtue)
	4. Verses- 52,53,59 (dont’s)
	5. Verses- 71,73,75,78 (do’s)

Approach to day to day work and duties.

Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47, 48,

Chapter 3-Verses 13, 21, 27, 35,

Chapter 6-Verses 5, 13, 17, 23, 35,

Chapter 18-Verses 45, 46, 48.

Statements of basic knowledge.

Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68

Chapter 12 -Verses 13, 14, 15, 16, 17, 18

Personality of Role model. Shrimad BhagwadGeeta:

Chapter 2-Verses 17,

Chapter 3-Verses 36,37,42,

Chapter 4-Verses 18, 38,39

Chapter18 – Verses 37,38,63

**RECOMMENDED BOOKS:**

1. Swami Swarupananda, “Srimad Bhagavad Gita” Advaita Ashram (PublicationDepartment), Kolkata
2. P.Gopinath, “Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by, Rashtriya Sanskrit Sansthanam, New Delhi.

***Third Semester***

***(Programme Elective-V)***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd.Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP–201A** | [**ENTERPRISE RESOURCE PLANNING**](#_bookmark4) |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | The main objective of the course is to impart the students with the knowledge of integrated applications to manage the business and automate many back office functions related to technology, services and human resources. |
| **Course Outcomes** |
| **CO1** | To study the basic principles and models of an enterprise. |
| **CO2** | To understand the concepts of technology and architecture in ERP. |
| **CO3** | To study ERP system packages. |
| **CO4** | To study the ERP procurement issues. |

**UNIT I**

**ENTERPRISE RESOURCE PLANNING:**

Introduction, Evolution of ERP, Principle of ERP, Enabling Technologies, ERP Characteristics, Features of ERP, The advantages of ERP, Reasons for the Failure of ERP Implementation, Risk and governance issues in an ERP, ERP Framework, Business Blueprint, Business Engineering Vs. Business Process Re-Engineering, ERP Tools and Software, Demand Chain, Value Chain, and Supply Chain.

**UNIT-II**

**ERP ARCHITECTURE:** Need to Study ERP Architecture**,** Layered Architecture, Types of ERP Architecture:Two-tier Implementations, Three-tier Client/Server Implementations, Web-based architecture, Service-Oriented Architectures, Logical Architecture of an ERP System, Physical Architecture of an ERP System, Evaluation Framework for ERP Acquisition.

**UNIT III**

**ERP PACKAGE INTEGRATION AND IMPLEMENTATION:** ERP market, SAP, Peoplesoft, BAAN company, ORACLE corporation, A comparative assessment and selection of ERP packages and modules, Sales Force Automation, Integration of ERP, Integration of ERP and the Internet, ERP implementation strategies, Comparison of Big Bang vs. Phased Approach, Implementation Strategy in Small and Medium Enterprise, Post Implementation Issues.

**UNIT IV**

**OVERVIEW OF ARCHITECTURE OF DIFFERENT ERP SOFTWARES:**

Oracle overview, Architecture, A.I.M. and applications, SAP Software architecture overview, ERP before and after Y2K, Impact of Y2K on ERP Development, Risk and Governance Issues in an ERP

**ERP MODULES:** *Finance module, Sales & Distribution module, Human Resources module, Plant Maintenance module, Quality Management module, Material management module, manufacturing management module.*

**RECOMMENDED BOOKS:**

1. Sadagopan. S, ERP-A Managerial Perspective, Tata Mcgraw Hill,1999.
2. Jose Antonio Fernandez, the SAP R/3 Handbook, Tata Mcgraw Hill,1998.
3. Vinod Kumar Crag and N.K. Venkitakrishnan, Enterprise Resource Planning- Concepts and Practice, Prentice Hall of India,1998.
4. Garg &Venkitakrishnan,ERPWARE, ERP Implementation Framework, Prentice Hall,1999.
5. Thomas E Vollmann and BeryWhybark, Manufacturing and Control Systems, Galgothia Publications,1998.
6. Alexis Leon,Enterprise resource planning, Tata Mcgraw-Hill

**Note:** The paper will have a total of *NINE questions.*QuestionNo.1,whichiscompulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all FourUnits).

All questions will have equal *weight of 12 marks*.The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Sem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP-203A** | **DESIGN OF EXPERIMENTS** |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| **Objective** | To understand the various design of experiments techniques for optimization of problems. |
| **Course Outcomes** |
| **CO1** | To understand the concepts of Design of Experiment and statistical Methods. |
| **CO2** | To understand the ANOVA and factorial design and fitting response curves and surfaces. |
| **CO3** | To study the application of Taguchi Method and testing of hypothesis |
| **CO4** | To study and implement the Response Surface Methodology. |

**UNIT-I**

**Introduction to Designed Experiments:** Introduction: Strategy of experimentation, Some typical applications of experimental design, Basic principles, Guidelines for designing experiments, Using statistical design in experimentation, A Checklist for Planning experiments, *Introduction to Minitab, Interface of Minitab, Customizing Minitab, Entering Data, Graphing Data, Printing Data and Graphs, Saving and Retrieving information.*

**Basic Statistical Methods:** Introduction, Basic statistical concepts, Types of Data, Graphical Presentation of Data.

Descriptive Statistics: Measure of Location, Measure of Variation, The Normal Distribution, Counting, Minitab Commands to Calculate Descriptive Statistics.

**Inferential Statistics:** The Distribution of Sample Means (R Known), Confidence Interval for the Population Mean (σ Known), Hypothesis testing for one sample mean (σ Known), Hypothesis test for two sample means, Testing for Normality, *Hypothesis test and Confidence Intervals with Minitab.*

### **UNIT-II**

**Analysis of Variance:** Introduction to Analysis of Variance, ANOVA assumptions and Validation, ANOVA Table, The sum of square approach to ANOVA calculations, Analysis of the fixed Effect model, Decomposition of the Total sum of squares. Statistical analysis, Estimation of the Model Parameters, Unbalanced Data, Model Accuracy Check, Practical interpretation of results. *ANOVA with Minitab*

**Factorial Experiments:** Basic definition and principles, Advantages of factorials, Two level factorial design, The 21 Factorial Experiment, The 22 Factorial Experiment, The 23 Factorial Design, Addition of Centre Cells to 2k Designs. General Procedure for Analysis of 2k designs. 2k Factorial Designs in Minitab.

### **UNIT-III**

### **Introduction to Taguchi Method:** Introduction, Taguchi Quality loss function, Orthogonal Array, Properties of Orthogonal Array, Minimum number of experiments to be conducted, Static Problems, Dynamic Problems, Assumptions of the Taguchi method, Steps in Taguchi Method, Assessment of Factors and Interactions, Selection and Application of Orthogonal arrays, Data Analysis from Taguchi Experiments, Variable Data with main factors only, Variable Data with Interactions, Attribute Data Analysis, Confirmation Experiment, Confidence Intervals, Robust Design Approach. *Applications of Taguchi Method using Minitab*.

### **UNIT-IV**

**Introduction to Response Surface Methodology:** Introduction, Terms in Quadratic Models, The method of steepest ascent, Analysis of Second order response surfaces, Experimental design for fitting response surfaces, 2k Designs with Centers, 3k Factorial Designs, Box-Behnken Designs, Central Composite Designs, Analysis of Data from RSM Designs, Design Considerations for Response Surface Experiments. *Response Surface Designs in Minitab.*

### **RECOMMENDED BOOKS:**

1. Douglas C Montgomery,Design and Analysis of Experiments, John Wiley
2. Paul G. Mathews,Design of Experiments with MINITAB, New Age International Publishers.
3. K. Krishnaiah, P. Shahabudeen, Applied Design of Experiments and Taguchi Methods,PHI.
4. Angela Dean and Daniel Voss,Design and Analysis of Experiments, Springer.
5. John P.W.M., Statistical Design and Analysis of Experiments, John Wiley
6. Montgomery D.C., Runger G. C., Introduction to Linear Regression Analysis, John Wiley
7. Myres R.H. and Montgomery D.C.,Response Surface Methodology Process and Product Optimization Using Designed Experiments, Wiley
8. G UNIPUB, White Plains,Introduction to Quality Engineering Taguchi, New York.
9. https://www.ee.iitb.ac.in/~apte/CV\_PRA\_TAGUCHI\_INTRO.htm
10. www.ecs.umass.edu/mie/labs/mda/fea/sankar/chap2.html

**Note:** The paper will have a total of *NINE questions.*QuestionNo.1,whichiscompulsory, shall be Objective Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rdSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTIP–205A** | [**STRATEGIC ENTREPRENEURSHIP**](#ELECTIVE1) |
| **Lecture** | **Tutorial** | **Practical** | **Credit** | **Major Test** | **Minor Test** | **Total** | **Time** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3 hrs** |
| Objective | To provide knowledge to the students about entrepreneurship concepts and various development programmes and policies. |
| **Course Outcomes** |
| **CO1** | To know about the small scale industries, scopes and the causes of their sickness. |
| **CO2** | To know about the EDP and different government policies.  |
| **CO3** | To learn about business incubations and its future perspectives. |
| **CO4** | To learn E-business marketing and developments. |

**UNIT-I**

**Small Scale Industries:** Definition and types of SSI’s; Role, scope and performance in national economy; Problems of small scale industries.

**Industrial Sickness:** Definition; Causes of sickness; Indian scenario, Government help; Management strategies; Need for trained entrepreneurs

**UNIT-II**

**Entrepreneurship Development Programmes:** Introduction, Origin of EDP’s , Organizations involved in EDP’s, Objectives of EDPs, Implementation of EDP’s, Short comings of EDP’s, Role in entrepreneurship development.

**Step:** Introduction, Origin, Status in India, Success and failure factors, Govt. polices and incentives, future prospects in India.

**UNIT-III**

**Business Incubation:** Introduction, Origin and development of business incubators in India and other countries, types of incubators, success parameters for a business incubator, Benefits to industries, institutes, government and society; future prospects. A few case studies (at least 2).

**Project Management:** Concept, Characteristics and Significance of Project Management. Components of Project Management. Project Life Cycle. Project Identification and Selection. Project Formulation and Appraisal.

**UNIT-IV**

**Special Aspects of Entrepreneurship:** Entrepreneurship, Social entrepreneurship, International entrepreneurship, Rural entrepreneurship, Community Development, Women entrepreneurship.

**Network Marketing:** Introduction, E-business, E-commerce, E-auction, A basic internet e-business architecture, A multi-tier e-business architecture.

**RECOMMENDED BOOKS:**

1. P.K. Gupta,Strategic Entrepreneurship, Everest Publishing House.
2. David Cleland,Project Management –Strategic Design and Implementation, McGraw Hill.
3. David H Holl,Entrepreneurship-New Venture Creation, Prentice Hall of India.
4. Steed & Steed,Sustainable Strategic Management, Prentice Hall of India.
5. Kotler,Marketing Management by Prentice Hall of India.
6. Tarek Khalil,Management of Technology, McGraw Hill.
7. Henry Steiner,Engineering Economic Principles, McGraw Hill.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weight of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

***Open Elective***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rdSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTOE-201A** | **BUSINESS ANALYTICS** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3** |
|  |
| **Objective** | The main objective of this course is to give the student a comprehensive understanding of business analytics methods. |
| **Course Outcomes** |
| **CO1** | Able to have knowledge of various business analysis techniques. |
| **CO2** | Learn the requirement specification and transforming the requirement into different models. |
| **CO3** | Learn the requirement representation and managing requirement assets. |
| **CO4** | Learn the Recent Trends in Embedded and collaborative business |

**Unit-I**

Business Analysis: Overview of Business Analysis, Overview of Requirements, Role of the Business Analyst.

Stakeholders: the project team, management, and the front line, Handling, Stakeholder Conflicts.

Life Cycles: Systems Development Life Cycles, Project Life Cycles, Product Life Cycles, Requirement Life Cycles.

**Unit-II**

Forming Requirements: Overview of Requirements Attributes of Good Requirements, Types of Requirements, Requirement Sources, Gathering Requirements from Stakeholders, Common Requirements Documents.

Transforming Requirements: Stakeholder Needs Analysis, Decomposition Analysis, Additive/Subtractive Analysis, Gap Analysis, Notations (UML & BPMN), Flowcharts, Swim Lane Flowcharts, Entity-Relationship Diagrams, State-Transition Diagrams, Data Flow Diagrams, Use Case Modeling, Business Process Modeling

**Unit-III**

Finalizing Requirements: Presenting Requirements, Socializing Requirements and Gaining Acceptance, Prioritizing Requirements.

Managing Requirements Assets: Change Control, Requirements Tools

**Unit-IV**

Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data Journalism.

**RECOMMENDED BOOKS:**

1. James Cadle, “Business Analysis”, BCS, The Chartered Institute for IT.
2. Erik Larson and, Clifford Gray, “Project Management: The Managerial Process”, McGraw-Hill Education.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weightage of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rdSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTOE-203A** | **INDUSTRIAL SAFETY** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3** |
| **Objective** | The main objective of this course is to aware students about the industrial safety maintenance and fault findings. |
| **Course Outcomes** |
| **CO1** | Understand the industrial safety. |
| **CO2** | Analyze fundamentals of maintenance engineering. |
| **CO3** | Understand the wear and corrosion and fault tracing. |
| **CO4** | Understanding when to do periodic inceptions and apply the preventing maintenance.  |

**Unit-I**

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, washrooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

**Unit-II**

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

**Unit-III**

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment’s like, I. Any one machine tool, ii. Pump iii. Air compressor iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

**Unit-IV**

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

**RECOMMENDED BOOKS:**

1. Higgins & Morrow, “Maintenance Engineering Handbook”, Da Information Services.
2. H. P. Garg, “Maintenance Engineering”, S. Chand and Company.
3. Audels, “Pump-hydraulic Compressors”, Mcgraw Hill Publication.
4. Winterkorn, Hans, “Foundation Engineering Handbook”, Chapman & Hall London.

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weightage of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rdSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTOE-205A** | **OPERATIONS RESEARCH** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3** |
| **Objective** | The main objective of this course is to aware students about the dynamic programming to solve problems of discrete and continuous variables and model the real world problem and simulate it. |
| **Course Outcomes** |
| **CO1** | Students should be able to apply the dynamic programming to solve problems of discreet and continuous variables. |
| **CO2** | Students should be able to apply the concept of non-linear programming |
| **CO3** | Students should be able to carry out sensitivity analysis |
| **CO4** | Student should be able to model the real world problem and simulate it. |

**Unit-I**

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

**Unit-II**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

**Unit-III**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

**Unit-IV**

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

**RECOMMENDED BOOKS:**

1. H.A. Taha, “Operations Research, An Introduction”, PHI, 2008
2. H.M. Wagner, “Principles of Operations Research”, PHI, Delhi, 1982.
3. J.C. Pant, “Introduction to Optimization: Operations Research”, Jain Brothers, Delhi, 2008
4. Hitler Libermann, “Operations Research”, McGraw Hill Pub. 2009
5. Pannerselvam, “Operations Research”, Prentice Hall of India 2010
6. Harvey M Wagner, “Principles of Operations Research”, Prentice Hall of India 2010

**Note:** The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weightage of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rdSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTOE-207A** | **COST MANAGEMENT OF ENGINEERING PROJECTS** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3** |
|  |
| **Objective** | The main objective of this course is to impart the students with the knowledge of cost management for the engineering project and apply cost models to the real world projects. |
| **Course Outcomes** |
| **CO1** | Students should be able to learn the strategic cost management process. |
| **CO2** | Students should be able to types of project and project team types |
| **CO3** | Students should be able to carry out Cost Behavior and Profit Planning analysis. |
| **CO4** | Student should be able to learn the quantitative techniques for cost management. |

**Unit-I**

Introduction and Overview of the Strategic Cost Management Process Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

**Unit-II**

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

**Unit-III**

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

**Unit-IV**

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

**RECOMMENDED BOOKS:**

1. Charles Thomas Horngren, “Cost Accounting a Managerial Emphasis”, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, “Advanced Management Accounting”
3. Robert S Kaplan Anthony A. Alkinson, “Management & Cost Accounting”
4. Ashish K. Bhattacharya, “Principles & Practices of Cost Accounting”, A. H. Wheeler publisher
5. N.D. Vohra, “Quantitative Techniques in Management”, Tata McGraw Hill Book Co. Ltd.

**Note:**The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weightage of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rdSem.)**

**(Credit based)**

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| --- | --- |
| **MTOE-209A** | **COMPOSITE MATERIALS** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3** |
|  |
| **Objective** | The main objective of this course is to impart the studentswith the knowledge of composites, its materials, analysis, fabrication, and performance analysis.  |
| **Course Outcomes** |
| **CO1** | Students should be able to learn the classification and characteristics of composite materials. |
| **CO2** | Students should be able to understand about different fabrication techniques related to metal matrix composites. |
| **CO3** | Students should be able to understand about different fabrication techniques related to polymer matrix composites. |
| **CO4** | Student should be able to do the analyses of the composite materials under different loading conditions. |

**UNIT–I**

**INTRODUCTION:** Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

**REINFORCEMENTS:** Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures, Iso-strain and Iso-stress conditions.

**UNIT – II**

**Manufacturing of Metal Matrix Composites**: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications.

**Manufacturing of Ceramic Matrix Composites:** Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

**UNIT–III**

**Manufacturing of Polymer Matrix Composites:** Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

**UNIT – IV**

**Strength:** Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

**RECOMMENDED BOOKS:**

1. R.W.Cahn, “Material Science and Technology” VCH, West Germany.
2. WD Callister, Jr, “Materials Science and Engineering, An introduction”
3. Balasubramaniam, “John Wiley & Sons”, NY, Indian edition, 2007.
4. Lubin, “Hand Book of Composite Materials”
5. K.K.Chawla, “Composite Materials”
6. Deborah D.L. Chung, “Composite Materials Science and Applications”
7. Danial Gay, Suong V. Hoa, and Stephen W. Tasi, “Composite Materials Design and Applications”

**Note:**The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weightage of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rdSem.)**

**(Credit based)**

|  |  |
| --- | --- |
| **MTOE-211A** | **WASTE TO ENERGY** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Total** | **Time (Hrs.)** |
| **3** | **0** | **0** | **3** | **60** | **40** | **100** | **3** |
|  |
| **Objective** | The main objective of this course is to impart the students with the knowledge of generation of energy from the waste. |
| **Course Outcomes** |
| **CO1** | Students should be able to learn the classification of waste as a fuel and biomass pyrolysis. |
| **CO2** | Students should be able to learn gasification process and different types of gasifiers. |
| **CO3** | Students should be able to learn different combustors for biomass. |
| **CO4** | Student should be able to learn the Biogas plant technology different biomass conversions processes for different applications. |

**Unit-I**

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

**Unit-II**

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

**Unit-III**

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

**Unit-IV**

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

**RECOMMENDED BOOKS:**

1. Desai, Ashok V, “Non-Conventional Energy”, Wiley Eastern Ltd., 1990.
2. Khandelwal, K. C. and Mahdi, S. S., “Biogas Technology - A Practical Hand Book - Vol. I & II”, Tata

McGraw Hill Publishing Co. Ltd., 1983.

1. Challal, D. S, “Food, Feed and Fuel from Biomass”, IBH Publishing Co. Pvt. Ltd., 1991.
2. C. Y. WereKo-Brobby and E. B. Hagan, “Biomass Conversion and Technology”, John Wiley & Sons,

1996.

**Note:**The paper will have a total of *NINE questions.* Question No. 1, which is compulsory, shall be OBJECTIVE Type and have contents from the entire syllabus (all Four Units).

All questions will have equal *weightage of 12 marks*. The student will attempt a total of *FIVE questions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rdSem.)**

**(Credit based)**

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| --- | --- |
| **MTME-201**  | **DISSERTATION PHASE - I** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Practical Marks** | **Total** | **Time (Hrs.)** |
| **0** | **0** | **20** | **10** | **-** | **100** | **-** | **100** | **-** |
|  |
| **Objective** | The main objective of this course is to plan a research work (which includes the problem formulation/literature review, proposed objectives, proposed methodologies and references) in the field of Industrial and Production Engineering or interrelated fields of applications.  |
| **Course Outcomes** |
| **CO 1** | Students will be exposed to various self-learning topics. |
| **CO 2** | Students will be exposed to an exhaustive survey of the literature such as books, national/international refereed journals, resource persons and industrial surveys for the selection/ identification of engineering/research problem. |
| **CO 3** | Students will be able to set the research objectives of the identified engineering/research problem. |
| **CO 4** | Students will learn modern tools/techniques related to the identified engineering/research problem for the solution and able to learn technical report writing skills. |
| **CO 5** | Students will develop oral and written communication skills to present and defend their work in front of technically qualified audience. |

The students will start their research work in third semester with a research problem having research potential involving scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.

The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his/her supervisor and the topic of dissertation must be mutually decided by the supervisor and student.

The students will be required to submit a progress report related to their dissertation work by the end of September. The progress report will cover the following:

* + - The goal set for the period.
* Research papers studied.
* Methodology used in achieving the goal.
* The extent of fulfillment of the goal.

The progress report must be at least of 3-4 pages and the cover page should include the tentative topic, name of the candidate, name of the supervisor, period of progress report, signature of candidate and supervisor.

The students will be required to appear for comprehensive Seminar & Viva-voce and submit a synopsis report based on their progress related to the dissertation as per the presentation date mentioned in the academic calendar for the session. The synopsis report will be submitted in the same format as that of the thesis and will contain the following:

1. Introduction
2. Literature Survey
3. Gaps in Literature
4. Objectives of the Proposed Work
5. Methodology
6. References

**\* Student will choose his/her guide in the end of second semester.**

***Fourth Semester***

**MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (4thSem.)**

**(Credit based)**

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| --- | --- |
| **MTME-202** | **DISSERTATION PHASE -II** |
| **Lecture** | **Tutorial** | **Practical** | **Credits** | **Major Test** | **Minor Test** | **Practical** | **Total** | **Time (Hrs.)** |
| **0** | **0** | **32** | **16** | **-** | **100** | **200** | **300** | **-** |
|  |
| **Objective** | The main objective of the course is to make the students able to do some good research in the field of their interests related to Industrial and Production Engineering or interrelated fields of applications.  |
| **Course Outcomes** |
| **CO 1** | Students will be able to design solutions for engineering problems that meet the specified needs with appropriate considerations. |
| **CO 2** | Students will be able to conduct investigations of engineering problems using research-based knowledge and experimental/research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.  |
| **CO 3** | Students will be able to apply resources and modern engineering tools and techniques with an understanding of the limitations. |
| **CO 4** | Students will be able to either work in a research environment or in an industrial environment.  |
| **CO 5** | Students will be conversant with technical report writing, professional ethics, responsibilities and norms of the engineering practice. |
| **CO 6** | Students will be able to present and convince their topic of study to the engineering community. |

The students are required to continue Analytical/Experimental/Computational/Industrial Problems or Case studies investigations in the field of Industrial and Production Engineering or other related fields which have been finalized in the third semester. They would be working under the supervision of a faculty member.

The students will be required to submit a progress report duly signed by their respective supervisors to the department, related to their dissertation work in the last week of March. The progress report will cover the following:

* + - The goal set for the period.
* Research papers studied.
* Methodology used in achieving the goal.
* The extent of fulfillment of the goal.
* References

The progress report must be of at least of 3-4 pages and the cover page should include the tentative topic, name of the candidate, name of the supervisor, period of progress report, signature of candidate and supervisor.

The candidate has to prepare a detailed dissertation report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up/numerical details/industrial case study etc. as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study.

The final dissertation will be submitted in the end of semester as per academic calendar for the session, which will be evaluated by internal as well as external examiners based upon his/her research work. At least one publication is expected before final submission of the dissertation from every student in peer reviewed referred journals or reputed conference from the work done by them in their dissertation. The dissertation should be presented in standard format as provided by the department.

The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a supervisor, co-supervisor etc. as decided by the Head and PG coordinator. The candidate has to be in regular contact with his supervisor.