w.e.f. 2018-19

KURUKSHETRA UNIVERSITY, KURUKSHETRA
Established by the State Legislature Act XII of 1956
('A+' Grade, NAAC Accredited)
MASTER OF TECHNOLOGYINMECHANICAL ENGINEERING
(CREDIT BASED)(w. e. f. 2018-19)
SPECIALIZATION: INDUSTRIAL & PRODUCTION ENGINEERING
SEMESTER-1

Sr. No.	Course Code	Course Name	L	T	P	Hrs./ Week	Credits	Major Test	Minor Test	Practical	Total	Duration of Exam (Hrs.)
1	MTIP-101A	Advanced Metal Casting	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	MTIP-117A	Advanced Metal Casting 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**	

*PROGRAMME ELECTIVE- I (I&P) for 1st Semester		
1.	MTIP-105A	Tool Engineering
2.	MTIP-107A	Advanced Engineering Materials
3.	MTIP-109A	Non-Conventional Machining

**PROGRAMME ELECTIVE- II (I&P) for 1st Semester		
1.	MTIP-111A	Product Design and Development
2.	MTIP-113A	Simulation of Industrial Systems
3.	MTIP-115A	Supply Chain Management

***AUDIT COURSE – I for 1st Semester (I&P)		
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.

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–101A	ADVANCED METAL CASTING						
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 moulding and casting.						
Course Outcomes							
CO1	To impart knowledge about various functional requirements of moulding materials and specifications and testing of moulding sand properties.						
CO2	To acquaint students with the phenomenon of solidification and analytics involved in solidification of Molten metal in various types of mould metal combintions.						
CO3	To impart knowledge to students about Gating system design and Riser design for getting an accurately designed defect free casting.						
CO4	To let student understand some special casting processes and testing of casting.						

UNIT-I

Functional Requirement of Moulding Materials: Principal ingredients of moulding Sands; Different Types of Sands; Clays, Different types of Clay structures, Moisture; Theories of Clay sand bonding, Sand system equipment, Flow of sand in a mechanized foundry, The Requirement of core sands,.

Specification and testing of Moulding Sands
Grain Size, Grain Shape, Clay content, Moisture Content, Bulk Density and Specific Surface Area, Acid Demand Value (ADV), Fines Content, Sintering Temperature, Mould hardness, Permeability, Strength, Deformation & toughness, Compactability, Mouldability, High Temperature Characteristics.

UNIT-II

Solidifications of Metals, Nucleation, free energy concept, critical radius of nucleus, Distribution coefficient and Constitutional Undercooling, Solidification in Pure Metals and Alloys, Directional Solidification, Casting Characteristics related to Solidification; Fluidity, Dendritic Growth, Dendrite coherency, Segregation, Inverse Segregation, Hot tearing, Hipping, Solidification under pressure.

Heat Transfer during casting process: Resistance to Heat Transfer, Centerline Feeding Resistance, Rate of solidification, Solidification of Large casting in an insulating mould, Solidification with predominant interface resistance, Solidification with constant casting surface temperature, Solidification with predominant resistance in mould and solidified Metal, Solidification Time and Chvorinov rule, Numerical Exercises.

UNIT-III

Gating System Design: Gating system defined, Types of Gating Systems, Types of Gates, Elements of Gating System, Gating System design, Factors involved in Gating design, Pouring time, Choke Area, Sprue design, Gating Ratio, Sprue runner gate ratio, Elimination of Slag and Dross, Filtration, Numerical exercises.

Riser Design: Need for riser, Basic requirements of an effective feeding system for a casting, Feeding Efficiency, Types of Risers, Effective feeding distances for simple and complex shapes. Use of chills, Directional solidification, Stresses in castings, Metal Mould reactions, Claine's Method, Modulus Method, Naval Research Laboratory (NRL) Method, Pouring rate and Temperature, Padding, Use of exothermic materials, Chills, Feeding Aids, Numerical exercises.

UNIT-IV

Special casting Processes: Shell Moulding, Investment Casting, Permanent Mould Casting, Diecasting, Centrifugal casting.

Inspection and testing of casting: Visual, Optical, Dimensional inspection, Laser Scanning, White light scanning, Radiographic Inspection, ultrasonic testing, Magnetic Particle Testing, dye penetration, Casting Defects; Classification, Causes and remedies.

RECOMMENDED BOOKS:

1. H.F. Taylor, "Foundry Engineering", John Wiley and Sons.
2. P.L. Jain, "Principles of Foundry Technology", Mc-Graw Hill.
3. MahiSahoo and SudhariSahu, "Principles of Metal Casting.
4. AmitabhaGhosh, " Manufacuring Science", Affliated East West Press.
5. P.N Rao, "Manufacturing Technology: Foundry, Forming and Welding" TMH.
6. K.P. Sinha,"Foundry Technology", Standard Publishers, Delhi.

7. Flinn, "Fundamentals of Metals Casting", Addison Wesley.
8. Heine Loper and Resenthal, "Principles of Metal Casting", Mc-Graw Hill.
9. Hielel and Draper, "Product Design & Process Engineering", Mc-Graw Hill.
10. Salman &Simans, "Foundry Practice", Issac Pitman.
11. ASME, "Metals Handbook- Metal Casting."
12. P.C. Mukharjee, Fundamentals of Metal casting Technology, Oxford, IBH.
13. P.R.Beeley, Foundry Technology , Butterworth Heinmann

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.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–103A	COMPUTER AIDED DESIGN AND MANUFACTURING						
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 geometricmodels.						
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 andTiwari, 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.*

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–109A	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, Modelling 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, Elctro-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.*

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

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 (1st Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

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.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP-117A	ADVANCED METAL CASTING LAB							
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Practical	Total	Time
0	0	4	2	-	40	60	100	3 hrs
Objective	The main objective of the course is to impart the students with the knowledge of foundry shop							
Course Outcomes								
CO1	To impart knowledge of practical evaluation of sand grades and moisture content in the moulding sand.							
CO2	To acquaint students with the different aspects involved in testing ADV, Permeability and DCS of Moulding/Core sand.							
CO3	To impart knowledge to students about determining grain size Mould Hardness and Compressive strength of the Mould.							
CO4	To let student understand how to prepare MMCs using Stir Casting process.							

List of Experiments:

1. To perform grading of sand for foundry purpose.
2. Determination of optimum moisture content in Green Sand Practice.
3. Determination of DCS of core sand.
4. Determination of permeability for molding sand mixtures.
5. Determination of acid demand value in a moulding sand sample.
6. To determine mould hardness.
7. To determine grain size and gran fines content in moulding Sand.
8. To determine compressive strength of the given mould sample
9. To determine grain size distribution and grain fines number for a sand mix.
10. To prepare advanced Metal Matrix Composites using Stir Casting.

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.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

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 &Untrim
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

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (1st Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

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.

w.e.f. 2018-19

KURUKSHETRA UNIVERSITY, KURUKSHETRA
Established by the State Legislature Act XII of 1956
('A+' Grade, NAAC Accredited)
MASTER OF TECHNOLOGYINMECHANICAL ENGINEERING
(CREDIT BASED) (w. e. f. 2018-19)
SPECIALIZATION: INDUSTRIAL & PRODUCTION ENGINEERING
SEMESTER-II

Sr. No.	Course Code	Course Name	L	T	P	Hrs./ Week	Credits	Major Test	Minor Test	Practical	Total	Duration of Exam (Hrs.)
1	MTIP-102A	Mechatronics	3	0	0	3	3	60	40	-	100	3
2	MTIP-104A	Industrial Tribology	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	MTIP-118A	Mechatronics Lab	0	0	4	4	2	-	40	60	100	3
6	MTIP-120A	Industrial Tribology Lab	0	0	4	4	2	-	40	60	100	3
7	MTIP-122A	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	

*PROGRAMME ELECTIVE-III (I&P) for 2nd Semester		
1.	MTIP-106A	Advanced Welding Processes
2.	MTIP-108A	Advanced Metal Cutting
3.	MTIP-110A	Metrology

**PROGRAMME ELECTIVE - IV (I&P) for 2nd Semester		
1.	MTIP-112A	Sequencing and Scheduling
2.	MTIP-114A	Quality Engineering and Management
3.	MTIP-116A	Reliability Engineering

***AUDIT COURSE–II for 2nd Semester (I&P)		
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. ***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.

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP-102A	MECHATRONICS						
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 acquaint the knowledge of electronic devices and electromechanical systems, hydraulic and pneumatic systems, CNC, Robotics and PLC's.						
Course Outcomes							
CO1	To understand the concepts of Mechatronics, fundamental of electronics and digital circuits and electrical actuating circuits.						
CO2	To acquaint the knowledge of hydraulic system with its practical applications.						
CO3	To acquaint the knowledge of pneumatic system with its practical applications.						
CO4	To study the fundamentals of CNC, Robotics and programmable logic controllers (PLC's) and their use.						

UNIT-I

Introduction: The Mechatronics approach: A methodology for integrated design of Mechanical, Electronics and Electrical Control, Computer and Instrumentation.

Fundamentals of Electronics and digital circuits: Number systems: Binary, Octal, Hexadecimal, Conversion from Binary to Decimal, Octal and Hexadecimal and vice–versa, Binary arithmetic: Addition, subtraction, Multiplication and division, Boolean Algebra: Laws, De-Morgan's laws, Logic Gates, Truth tables, Karnaugh maps and logic circuits. Generation of Boolean function from truth tables and simplification, **Electrical actuating system:** Basic principle of electrical switching, Solenoids, Electrical relays, Representation of output devices, Electrical motors: A.C. motors, Stepper motors, Induction motor speed control.

UNIT-II

HYDRAULIC SYSTEMS:

Direction Control Valves: Poppet Valve, Spool Valve, Sliding Spool type DCV, Check Valve, Pilot operated check valve, Restriction check valve, 2 Way vale, 3 way valve, 4 way valve, Manually actuated valve, Mechanically actuated valve, Pilot operated DCV, Solenoid Actuated valve, Rotary Valve, Centre flow path configurations for three position four way valve, Shuttle valve

Pressure Control Valve: Simple and compound pressure Relief Valve, Pressure Reducing Valve, Unloading valve, sequence valve, counterbalance valve, Brake Valve

Flow Control Valves: Fixed and non-adjustable valve, adjustable, throttling, non-pressure compensated pressure control valve, Pressure/temperature compensated flow control valve, Shuttle and Fast exhaust valve, Time delay valve, Flow Control Valves, Fluid Conditioners, Hydraulic Symbols (ANSI),Hydraulic Circuit design: Control of Single and double acting cylinders, double pump Hydraulic System

UNIT-III

PNEUMATIC SYSTEM:

Air Generation and distribution: Air compressors, Air Receiver, Filters, intercoolers, After-coolers, Relief Valve, Air dryers, Primary and secondary lines, Piping layouts, Air Filters, Air Regulators, Air Lubricator, Actuators and output devices, Direction control valves, Flow control valves, junction elements, Pneumatic circuits, Control of Single and double acting cylinders.

UNIT-IV

INTRODUCTION TO CNC MACHINES AND ROBOTICS:

CNC Machines: NC machines, CNC machines, DNC machines, Machine structure, Slidways, Guideways, Slide Drives, Spindle, Robotics:Components of robots, Classification of robots, Robots application

PROGRAMMABLE LOGIC CONTROLLERS

Introduction - Principles of operation - PLC Architecture and specifications - PLC hardware Components, Analog & digital I/O modules, CPU & memory module - Programming devices - PLC ladder diagram, Converting simple relay ladder diagram in to PLC relay ladder diagram. PLC programming Simple instructions - Manually operated switches - Mechanically operated Proximity switches - Latching relays, Applications of PLC.

RECOMMENDED BOOKS:

1. W. Bolton,Mechatronics, Pearson Education.
2. Majumdar,Pneumatic system, TMH.
3. Andrew Parr, Hydraulic and Pneumatic systems,TMH.
4. M.P. Groover,Automation, Production systems and computer integrated manufacturing, TMH.
5. Shetty and Kolk,Mechatronics system design, Thomson learning.
6. Mahalik,Mechatronics, TMH.
7. Anthony Esposito,Fluid power with application,Pearson Education.
8. K.P Ramachandran, M.S Balasundaram,Mechatronics, Wiley India.

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 (2nd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP-104A	Industrial Tribology						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time (Hrs.)
3	0	0	3	60	40	100	3
Objective	To develop a solution oriented approach by in depth knowledge of Industrial Tribology and address the underlying concepts, methods and application of Industrial Tribology.						
Course Outcomes							
CO 1	Students will be able to understand the fundamentals of tribology, friction and wear processes in contacts between different materials.						
CO 2	Students will be able to understand the material requirements for tribological applications and different surface treatment techniques.						
CO 3	Students will be able to study different types of lubricants and testing techniques.						
CO 4	Students will be able to study the maintenance and conservation techniques, testing specifications and standards.						

UNIT-I

Fundamentals of Tribology: Introduction to tribology and its historical background, Economic Importance of Tribology.**Friction and Wear:**Genesis of friction, friction in contacting rough surfaces, sliding and rolling friction, various laws and theory of friction. Stick-slip friction behavior, frictional heating and temperature rise. Friction measurement techniques.

Wear and wear types. Mechanisms of wear - Adhesive, abrasive, corrosive, erosion, fatigue, fretting, etc., Wear of metals and non-metals. Wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage. Wear in various mechanical components, wear controlling techniques.

UNIT-II

Materials for Tribological Applications: An overview of engineering materials having potential for tribological application. Characterization and evaluation of Ferrous and non-ferrous materials for tribological requirements/applications, Composite materials (PM, CMC and MMC) for tribological applications.

Surface treatment techniques: Surface treatment techniques such as carburising, nitriding, induction hardening, hard facing, laser surface treatments, etcwith applications, Surface coating techniques such as electrochemical depositions, anodizing, thermal spraying, Chemical Vapour Deposition (CVD), Physical Vapour Deposition (PVD), etc. and their applications.

UNIT-III

Lubrication and lubricants: Boundary Lubrication, Mixed Lubrication, Full Fluid Film Lubrication, Hydrodynamic, Elastohydrodynamic lubrication, Primary role of lubricants in mitigation of friction and wear & heat transfer medium, Composition and properties of lubricants, Fundamentals - Mineral oil based liquid lubricants, Synthetic liquid lubricants, Solid lubricants, greases and smart lubricants, Characteristics of lubricants and greases, Rheology of lubricants, Evaluation and testing of lubricants.

UNIT-IV

Lubricants additives and application: Introduction to lubricant additives, Antioxidants and bearing corrosion inhibitors, Rust inhibitors, Viscosity improvers, Extreme pressure additives.

Consumption and conservation of lubricants: Lubricants for industrial machinery, Maintenance and conservation of lubricating oils, Storage and Handling of lubricants, Used lubricating oil, Environment and health hazards, Disposability and Recycling, Technical regulation for lubricants, Test specifications and standards for maintenance and management of industrial lubricants including greases and used oils, Selection of optimum lubricant for given application.

RECOMMENDED BOOKS:

1. I.M. Hutchings, Tribology, "Friction and Wear of Engineering Material ", Edward Arnold.

2. Gwidon W. Stachowiak, Andrew W. Batchelor, "Engineering Tribology" Butter worth, Heinemann.
3. T.A. Stolarski, "Tribology in Machine Design ", Industrial Press Inc.
4. E.P. Bowden and Tabor. D., "Friction and Lubrication ", Heinemann Educational Books Ltd.
5. A. Cameron, "Basic Lubrication theory ", Longman, U.K.
6. M.J. Neale (Editor), "Tribology Handbook ", Newnes. Butter worth, Heinemann, U.K.

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.*

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.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–108A	ADVANCED METAL CUTTING						
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.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–114A	QUALITY ENGINEERING AND MANAGEMENT						
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 chartsin 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 (2nd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–118A	MECHATRONICS LAB							
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Practical	Total	Time
0	0	4	2	-	40	60	100	3 hrs
Objective	To practice on electrical circuits, hydraulic and pneumatic systems and PLC's for their practical implications.							
Course Outcomes								
CO1	To understand the PLC using PLC simulators.							
CO2	To demonstrate and actuate the positioning using sensors, actuators and programming.							
CO3	To study the pneumatic and electro-pneumatic training system with simulation software.							
CO4	To design and test on hydraulic and pneumatic circuits.							

List of Experiments

1. To study and conduct exercises on PLC Simulator.
2. Control of conveyor manually and through programming, also programming using sensors and conveyor.
3. To study and conduct exercise on CNC lathe.
4. To study and conduct exercises on Robotic simulation software.
5. To study and conduct exercises on Pneumatic & Electro-Pneumatic Training System.
6. To study the stepper motor interface with PLC.
7. **Design and testing of hydraulic circuits such as**
   i) Pressure control
   ii) Flow control
   iii) Direction control
   iv)Design of circuit with programmed logic sequence, using an optional PLC in hydraulic.
   Electro hydraulic Trainer.
8. **Design and testing of pneumatic circuits such as**
   i. Pressure control
   ii. Flow control
   iii. Direction control
   iv. Circuits with logic controls
   v. Circuits with timers
   vi. Circuits with multiple cylinder sequences in Pneumatic Electro pneumatic Trainer.
9. To perform exercises on process control trainer.

Note: At least eight experiments should be performed from the above list.

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–120A	INDUSTRIAL TRIBOLOGY LAB							
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Practical	Total	Time
0	0	4	2	-	40	60	100	3 hrs
Objective	To study friction, wear mechanism of materials and performance of lubricants under various test conditions using concepts, methods and application of Industrial Tribology.							
Course Outcomes								
CO1	Students will be able to explain the friction phenomena and different wear processes in contacts between metallic, ceramic and polymeric surfaces.							
CO2	Students will be able to determine different types of lubricants, their grades, test standards and different properties of lubricants.							
CO3	Students will be able to understand the causes of tribological failures and surface characterization.							
CO4	Students will be able to use different types of tribo-test equipments and design of wear and friction test.							

List of Experiments

1. To study the friction and wear properties of a specimen (metallic/polymeric/ceramic surfaces) using wear and friction monitoring apparatus under dry sliding conditions.
2. To study the friction and wear properties of a specimen (metallic/polymeric/ceramic surfaces) using wear and friction monitoring apparatus under wet sliding conditions.
3. To study the effect of temperature on the friction and wear performance of composite materials using high temperature pin/ball on disc tester.
4. To study the variation of viscosity of lubricants with temperature.
5. To evaluate the wear and extreme pressure properties of a lubricating oil/ grease using four ball tester.
6. To study the surface characterization of wear components.
7. To study different types of industrial abrasives materials, properties and applications.
8. To determine abrasion index of a material with the help of dry abrasion test rig.
9. To access the adhesion and scratch resistance of surface coatings (hard or soft) using Scratch Tester.
10. To determine the erosive wear rate of different materials using Air Jet Erosion Tester under different conditions.
11. To demonstrate the pressure distribution of a lubricant in a journal bearing.

Note: At least eight experiments should be performed from the above list.

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP-122A	MINI PROJECT							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical	Total	Time (Hrs.)
0	0	4	2	-	-	100	100	3
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 Industrialand Production 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.

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (2nd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

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.

w.e.f. 2018-19

KURUKSHETRA UNIVERSITY, KURUKSHETRA
Established by the State Legislature Act XII of 1956
('A+' Grade, NAAC Accredited)
MASTER OF TECHNOLOGYINMECHANICAL ENGINEERING
(CREDIT BASED) (w. e. f. 2018-19)
SPECIALIZATION: INDUSTRIAL & PRODUCTION ENGINEERING

SEMESTER-III

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	MTIP-207A	Dissertation Phase-I	0	0	20	20	10	-	100	-	100	--
					Total	26	16	120	180		300	

*PROGRAMME ELECTIVE-V (I&P) for 3rd Semester		
1.	MTIP-201A	Enterprise Resource Planning
2.	MTIP-203A	Design of Experiments
3.	MTIP-205A	Strategic Entrepreneurship

**OPEN ELECTIVE(I&P) for 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

SEMESTER-IV

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

Total credits=68

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING(3rd semester)

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

SPECIALIZATION: INDUSTRIAL & PRODUCTION ENGINEERING

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

IntroductiontoDesignedExperiments: Introduction,Strategyofexperimentation,Sometypicalapplicationsofexperimentaldesign, 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 2^1 Factorial Experiment, The 2^2 Factorial Experiment, The 2^3 Factorial Design, Addition of Centre Cells to 2^k Designs. General Procedure for Analysis of 2^k designs. 2^k 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, 3^k 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*. 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(3rd semester)

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

SPECIALIZATION: INDUSTRIAL & PRODUCTION ENGINEERING

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 Optimisation: 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(3rd semester)

(CREDIT BASED) (w. e. f. 2018-19)
SPECIALIZATION: INDUSTRIAL & PRODUCTION ENGINEERING

MTIP-[illegible]	DISSERTATION PHASE – I							
[illegible]	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.**

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING(4th semester)

(CREDIT BASED) (w. e. f. 2018-19)
SPECIALIZATION: INDUSTRIAL & PRODUCTION ENGINEERING

MTIP-202A	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.