w.e.f. 2020-21

UNIVERSITY INSTITUTE OF ENGINEERING AND TECHNOLOGY

(A constituent Autonomous Institute and Recognized by UGC under Section 12(B) and 2(f))

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. 2020-21)

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-101	Advanced Metal Casting	3	0	0	3	3	60	40	-	100	3
2	MTIP-103	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-111	Research Methodology and IPR	2	0	0	2	2	60	40	-	100	3
6	MTIP-117	Advanced Metal Casting Lab	0	0	4	4	2	-	40	60	100	3
7	MTIP-119	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-105	Tool Engineering
2.	MTIP-107	Advanced Engineering Materials
3.	MTIP-109	Non-Conventional Machining

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

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

Note1: The course of program elective will be offered at 1/3rd or 6 numbers of students (whichever is smaller) strength of the class.

*** **Note2:** 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.

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(CREDIT BASED) (w. e. f. 2020-21)
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-102	Mechatronics	3	0	0	3	3	60	40	-	100	3
2	MTIP-104	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-118	Mechatronics Lab	0	0	4	4	2	-	40	60	100	3
6	MTIP-120	Industrial Tribology Lab	0	0	4	4	2	-	40	60	100	3
7	#MTIP-122	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**	**340**	**120**	**700**	

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

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

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

Note1: The course of program elective will be offered at 1/3rd or 6 numbers of students (whichever is smaller) strength of the class.

***Note2:** 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.

#Note3: Mini project: During this course the student will be able to understand the contemporary/emerging technologies for various processes and systems. During the semester, the students are required to search/gather the material/information on a specific topic, comprehend it and present/discuss the same in the class. He/she will be acquainted to share knowledge effectively in oral (seminar) and written form (formulate documents) in the form of report. The student will be evaluated on the basis of viva/ seminar (40 marks) and report (60 marks).

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
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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-207	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-201	Enterprise Resource Planning
2.	MTIP-203	Design of Experiments
3.	MTIP-205	Strategic Entrepreneurship

**OPEN ELECTIVE (I&P) for 3rd Semester		
1.	MTOE-201	Business Analytics
2.	MTOE-203	Industrial Safety
3.	MTOE-205	Operations Research
4.	MTOE-207	Cost Management of Engineering Projects
5.	MTOE-209	Composite Materials
6.	MTOE-211	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-202	Dissertation Phase-II	0	0	32	32	16	-	100	200	300	--
					Total	**32**	**16**		**100**	**200**	**300**	

Total credits of all four semesters – 68

Note 1: At the end of the second semester each student is required to do his/her Dissertation work in the identified area in consent of the Guide/Supervisor. Broad area for the Dissertation Part-I is to be specified/submitted within three weeks of the beginning of the Third Semester.

Note 2: Each admitted student is required to submit the report of his/her Dissertation Part-I as per the schedule mentioned in Academic calendar for the corresponding academic session otherwise the Dissertation Part-II cannot be continued at any level.

Note 3: Each admitted student is required to submit his/her final Dissertation Part-II as per the schedule mentioned in Academic calendar for the corresponding academic session only after the publication of at least one paper in International/National reputed journals (SCI/Scopus indexed/ UGC approved journals) or reputed conferences with ISSN number.

Note 4: The course of program/open elective will be offered at 1/3rd or 6 numbers of students (whichever is smaller) strength of the class.

w.e.f. 2020-21

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

6. All questions will have equal **weightage of 12 marks.**
7. 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.**
8. 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),.
9. **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:

   i. Multiple Choice
   ii. Yes/ No choice
   iii. Fill in Blanks type
   iv. Short numerical computations
   v. Short Definitions
   vi. 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

w.e.f. 2020-21

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

MTIP–101	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	Students will be able to describe the functional requirements of moulding materials and specifications and testing of moulding sand properties.						
CO2	Students will be able to explain the phenomenon of solidification and analytics involved in solidification of molten metal in various types of mould metal combintions.						
CO3	Students will be able to design the Gating system and Riser design for getting an accurately designed defect free casting.						
CO4	Students will be able to explain 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. Mahi Sahoo and Sudhari Sahu, "Principles of Metal Casting.
4. Amitabha Ghosh, " 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–103	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	Students will be able to apply the fundamentals of computers in the field of designing and manufacturing and the transformation of geometric models.						
CO2	Students will be able to explain the concepts of G.T. and FMS.						
CO3	Students will be able to explain the systems related to process planning and shop floor control.						
CO4	Students will be able to design coding for CNC and explain the AGV.						

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

MTIP–105	TOOL ENGINEERING						
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	Students will be able to describe materials for cutting tool and design of cutting tools.						
CO2	Students will be able to explain different kinds of Gages and Work holding devices.						
CO3	Students will be able to recognize and explain Drill jigs and Fixtures.						
CO4	Students will be able to design fixtures and cutting tools 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.*

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

MTIP–107	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	Students will be able to describe and distinguish Piezoelectric and shape memory alloys.						
CO2	Students will be able to recognize different processes involved for heat resisting steel and explain the concepts of electro-caloric mechanisms and materials.						
CO3	Students will be able to explain the MEMS systems and High temperature application materials.						
CO4	Students will be able to describe the synthesis of nano-alloys and explain the different types of shape memory alloys and their effects.						

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 and Design. Marcel

Dekker Inc, New York, 1993.
9. Rama Rao, P. (ed.), Advances in Materials and their applications, Wiley Eastern 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 *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.*

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

MTIP–109	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	Students will be able to explain the non-conventional machining processes, mechanical working processes, technology, process parameters and analyze these processes for metal removal.						
CO2	Students will be able to explain and distinguish between chemical machining, electrochemical machining processes and electrochemical grinding processes,						
CO3	Students will be able to explain various kinds of Electric discharge machining processes, analyze the process parameters associated with these processes and various process characteristics.						
CO4	Students will be able to elaborate 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.*

Programme Elective-II

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

MTIP-111	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	Students will be able to describe the concept of product design, design considerations, design practiced by the industry, production and marketing, and aesthetics.						
CO2	Students will be able to explain and apply theoretically the detailed fundamental approach to several primary processes and design guidelines for manufacturing, assembly and environment.						
CO3	Students will be able to apply the human factor engineering concepts in their daily routine activities and workplace and explain the concept of value engineering.						
CO4	Students will be able to describe 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)

MTIP–113	SIMULATION OF INDUSTRIAL SYSTEMS						
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	Students will be able to explain the concept of industrial simulation systems and its models of simulation.						
CO2	Students will be able to analyze and simulate the discrete and queuing systems.						
CO3	Students will be able to analyze inventory systems and design of simulation experiments.						
CO4	Students will be able to simulate the industrial problems like reliability problems, computer time sharing problem and explain 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. Deo Narsingh, 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.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–115	SUPPLY CHAIN 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 students with the knowledge of Supply chain and different aspects of supply chain management.						
Course Outcomes							
CO1	Students will be able to explain the basics of Supply chain management and Supply chain dynamics.						
CO2	Students will be able to discuss different aspects involved in sourcing and procurement in supply chain management.						
CO3	Students will be able to explain about Evaluating performance of Supply chain and decision making about Transportation, Storage and warehousing.						
CO4	Students will be able to relate 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 quostions*, each of 12 marks. Q. No. 1 is compulsory. *The student shall attempt remaining four questions by selecting only one question from each unit.*

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

MTRM-111	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 explain the criteria of research, approaches and instruments used for the solution of research problem.						
CO 2	Student will be able to formulate a research problem and construct a research proposal.						
CO 3	Student will be able explain the Patents, Designs, Trade and Copyright information.						
CO 4	Student will be able to describe 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-117	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 processes.							
Course Outcomes								
CO1	Students will be able to evaluate the sand grades and moisture content in the moulding sand practically.							
CO2	Students will be able to construct with the different aspects involved in testing ADV, Permeability and DCS of Moulding/Core sand.							
CO3	Students will be able to determine grain size Mould Hardness and Compressive strength of the Mould.							
CO4	Students will be able 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-119	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 the knowledge of 2-D and 3-D modeling using design softwares.							
Course Outcomes								
CO1	Students will be able to apply the basic commands and tools for part designing.							
CO2	Students will be able to apply advanced features of the softwares for part designing.							
CO3	Students will be able to apply surface techniques for surface creations using softwares.							
CO4	Students will be able to design complete assembly and detailed drafting in the softwares.							

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

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Audit Course-I

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

MTAD-101	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

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

MTAD-103	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.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTAD- 105	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. Vempati Kutumbshastri, 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.

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

MTAD-107	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 judgements

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

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

MTIP-102	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	Students will be able to describe the concepts of Mechatronics, fundamental of electronics and digital circuits and electrical actuating circuits.						
CO2	Students will be able to explain hydraulic system with its practical applications.						
CO3	Students will be able to explain pneumatic system with its practical applications.						
CO4	Students will be able to describe 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.*

w.e.f. 2020-21

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

MTIP-104	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 explain the fundamentals of tribology, friction and wear processes in contacts between different materials.						
CO 2	Students will be able to recognize and describe the material requirements for tribological applications and different surface treatment techniques.						
CO 3	Students will be able to explain different types of lubricants and testing techniques.						
CO 4	Students will be able to enumerate 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, etc with 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.*

Programme

Elective-III

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

MTIP-106	ADVANCED WELDING PROCESSES						
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	Students will be able to explain various Weld metallurgy and Weld arc characteristics.						
CO2	Students will be able to describe various welding power sources and their applications.						
CO3	Students will be able to explain electrode coatings and Metal transfer phenomenon in weld metal transfer.						
CO4	Students will be able to explain 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 characleristics, 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 & Practicesll McGraw-Hill
2. R.S.Parmar, —Welding processes & Technologyll, Khanna Publishers
3. R.S.Parmar, —Welding Engineering & Technologyll, Khanna Publishers
4. S.V. Nandkarni, —Modern Arc Welding Technology, Oxford & IBH publishing Co.
5. L.M.Gourd, —Principles of Welding Technologyll, ELBS/ Edward Arnold.
6. Richard L. Little —Welding & Welding Technologyll, Mc-Graw Hill.
7. Cary, Howard —Modern Welding Technology', prentice Hall, 1998.
8. Rossi —Welding Technologyll, 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.*

w.e.f. 2020-21

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

MTIP–108	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	Students will be able to state various functional related to tools geometry.						
CO2	Students will be able to analysis the fundamental factors affecting tool forces						
CO3	Students will be able to calculate cutting tool life and mathematical modelling for wear.						
CO4	Students will be able to describe 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 woxen etc) 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-110	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	Students will be able to know the requirement of metrology and the concepts of limit, fits and gauges.						
CO2	Students will be able to explain the linear and angular measurements and the optical measurement tools and techniques.						
CO3	Students will be able to describe the use of surface roughness and thread measuring instruments.						
CO4	Students will be able to explain 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

w.e.f. 2020-21

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

MTIP–112	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	Students will be able to explain the concept of sequencing and scheduling.						
CO2	Students will be able to practice for the extension of basic models and parallel machine models.						
CO3	Students will be able to describe the concepts of the flow shop scheduling and practice for the flow shop scheduling models.						
CO4	Students will be able to solve 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 (2nd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–114	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	Students will be able to explain the statistical concepts of quality and quality statistics.						
CO2	Students will be able to analyze the quality control charts in production process and practice for its use in problem solving.						
CO3	Students will be able to explain the quality improvement tools.						
CO4	Students will be able to describe 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.*

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

MTIP–116	RELIABILITY ENGINEERING						
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	Students will be able to explain the concepts of reliability in industrial systems.						
CO2	Students will be able to explain the reliability determination methods and advanced evaluation techniques.						
CO3	Students will be able to describe various reliability prediction and evolution methods.						
CO4	Students will be able to explain and aware 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.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–118	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	Students will be able to perform experiments on PLC using PLC simulators.							
CO2	Students will be able to demonstrate and actuate the positioning using sensors, actuators and programming.							
CO3	Students will be able to perform experiments on pneumatic and electro-pneumatic training system with simulation software.							
CO4	Students will be able 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.

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

MTIP–120	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 experimentally determine the friction force and wear in contacts between metallic, ceramic and polymeric surfaces.							
CO2	Students will be able to determine the extreme pressure properties of different types of lubricants.							
CO3	Students will be able to determine the causes of tribological failures and surface roughness by surface roughness tester.							
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-122	MINI PROJECT						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	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 able to write technical reports.						
CO 2	Students will able to present and defend their work in front of technically qualified audience.						

Students can take up small problems in the field of Industrial and 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 March.

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Audit Course-II

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

MTAD- 102	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: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: 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.

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

MTAD-104	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 (2nd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTAD-106	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 Nlyam. 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" Advaita Ashrama (Publication Department), Kolkata

w.e.f. 2020-21

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

MTAD-108	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 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

i) Verses- 19,20,21,22 (wisdom)
ii) Verses- 29,31,32 (pride & heroism)
iii) Verses- 26,28,63,65 (virtue)
iv) Verses- 52,53,59 (dont's)
v) Verses- 71,73,75,78 (do's)

Approach to day to day work and duties.

Shrimad Bhagwad Geeta: 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 Bhagwad Geeta: Chapter2-Verses 56, 62, 68

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

Personality of Role model. Shrimad Bhagwad Geeta:

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 (Publication Department), Kolkata
2. P.Gopinath, "Bhartrihari's Three Satakam (Niti-sringar-vairagya) by, Rashtriya Sanskrit Sansthanam, New Delhi.

Third Semester

(Programme Elective-V)

w.e.f. 2020-21

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd. Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–201	ENTERPRISE RESOURCE PLANNING						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	0	3	60	40	100	3
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	Students will be able to explain the basic principles and models of an enterprise.						
CO2	Students will be able to describe the concepts of technology and architecture in ERP.						
CO3	Students will be able to analyze the ERP system packages.						
CO4	Students will be able to address 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 Bery Whybark, 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*. 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 Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP-203	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	Students will be able to explain and implement the design of experiment and statistical Methods.						
CO2	Students will be able to explain ANOVA and factorial design and fitting response curves and surfaces.						
CO3	Students will be able to explain the application of Taguchi Method and testing of hypothesis						
CO4	Students will be able to 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 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 Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP–205	STRATEGIC ENTREPRENEURSHIP						
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	Students will be able identify small scale industries, scopes and the causes of their sickness.						
CO2	Students will be able to explain the EDP and different government policies.						
CO3	Students will be able to explain the business incubations and its future perspectives.						
CO4	Students will be able to describe 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 (3rd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTOE-201	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.*

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTOE-203	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 (3rd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTOE-205	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.*

w.e.f. 2020-21

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTOE-207	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 centres, 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 (3rd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTOE-209	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 students with 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.*

w.e.f. 2020-21

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (3rd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTOE-211	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.
3. Challal, D. S, "Food, Feed and Fuel from Biomass", IBH Publishing Co. Pvt. Ltd., 1991.
4. 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 (3rd Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP-207	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 improve 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 (4th Sem.)
(INDUSTRIAL & PRODUCTION ENGINEERING)

MTIP-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.

2020-22

UNIVERSITY INSTITUTE OF ENGINEERING AND TECHNOLOGY

(A constituent Autonomous Institute and Recognized by UGC under Section 12(B) and 2(f))

KURUKSHETRA UNIVERSITY, KURUKSHETRA

Established by the state Legislature Act XII of 1956

('A+' Grade, NAAC Accredited)

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (CREDIT BASED)

(With specialization in Thermal Engineering)

Semester-I w.e.f. 2020-22 batch onwards

S. No.	Course No.	Course Name	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs.)
						Major Test	Minor Test	Practical	Total	
1	MTTE-101	Advanced Fluid Dynamics	3:0:0	3	3	60	40	-	100	3
2	MTTE-103	Advanced Heat Transfer	3:0:0	3	3	60	40	-	100	3
3		[1]Programme Elective - I	3:0:0	3	3	60	40	-	100	3
4		[2]Programme Elective - II	3:0:0	3	3	60	40	-	100	3
5	MTRM-111	Research Methodology and IPR	2:0:0	2	2	60	40	-	100	3
6	MTTE-117	Advanced Heat Transfer Lab	0:0:4	4	2	-	40	60	100	3
7	MTTE-119	Refrigeration and Cryogenics 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**	

[1]LIST OF PROGRAMME ELECTIVE – I (Thermal Engg.)			[2]LIST OF PROGRAMME ELECTIVE – II (Thermal Engg.)		
1.	MTTE-105	Advanced Thermodynamics	1.	MTTE-111	Refrigeration and Cryogenics
2.	MTTE-107	Design of Thermal Systems	2.	MTTE-113	Air Conditioning System Design
3.	MTTE-109	Energy Conservation and Management	3.	MTTE-115	Gas Turbines
*LIST OF AUDIT COURSES – I (Thermal Engg.)					
1.	MTAD-101	English for Research Paper Writing	3.	MTAD-105	Sanskrit for Technical Knowledge
2.	MTAD-103	Disaster Management	4.	MTAD-107	Value Education

*Audit Courses I is a mandatory course which will be non-credit subject and student has to get passing marks in order to qualify the semester. However, the marks will not be added in the total marks.

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (CREDIT BASED)
(With specialization in Thermal Engineering)
Semester-II w.e.f. 2020-22 batch onwards

S. No.	Course No.	Course Name	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs.)
						Major Test	Minor Test	Practical	Total	
1	MTTE-102	Advanced Internal Combustion Engines	3:0:0	3	3	60	40	-	100	3
2	MTTE-104	Steam Engineering	3:0:0	3	3	60	40	-	100	3
3		[3]Programme Elective - III	3:0:0	3	3	60	40	-	100	3
4		[4]Programme Elective - IV	3:0:0	3	3	60	40	-	100	3
5	MTTE-118	Advanced Internal Combustion Engines Lab	0:0:4	4	2	-	40	60	100	3
6	MTTE-120	Computational Fluid Dynamics Lab	0:0:4	4	2	-	40	60	100	3
7	MTTE-122	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**	**340**	**120**	**700**	

[3]LIST OF PROGRAMME ELECTIVE – III (Thermal Engg.)			[4]LIST OF PROGRAMME ELECTIVE – IV (Thermal Engg.)		
1.	MTTE-106	Design of Solar and Wind Systems	1.	MTTE-112	Computational Fluid Dynamics
2.	MTTE-108	Nuclear Engineering	2.	MTTE-114	Design of Heat Transfer Equipments
3.	MTTE-110	Convective Heat Transfer	3.	MTTE-116	Compressible Flow Machines

*LIST OF AUDIT COURSES – II (Thermal Engg.)					
1.	MTAD-202	Constitution of India	3.	MTAD-206	Stress Management by Yoga
2.	MTAD-204	Pedagogy Studies	4.	MTAD-208	Personality Development through Life Enlightenment Skills

*Audit Course-II is a mandatory course which will be non-credit subject and student has to get passing marks in order to qualify the semester. However, the marks will not be added in the total marks.

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (CREDIT BASED)

(With specialization in Thermal Engineering)

Semester-III w.e.f. 2020-22 batch onwards

S. No.	Course No.	Course Name	L:T:P	Hours/Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs)
						Major Test	Minor Test	Practical	Total	
1		[5]Programme Elective-V	3:0:0	3	3	60	40	-	100	3
2		[6]Open Elective	3:0:0	3	3	60	40	-	100	3
3	MTTE-207	Dissertation Phase - I	0:0:20	20	10	-	100	-	100	-
		Total		**26**	**16**	**120**	**180**	**-**	**300**	

[5]LIST OF PROGRAMME ELECTIVE – V (Thermal Engg.)		
1.	MTTE-201	Advanced Computational Fluid Dynamics
2.	MTTE-203	Finite Element Methods
3.	MTTE-205	Thermal Modeling and Analysis

[6]LIST OF OPEN ELECTIVES (Thermal Engg.)					
1.	MTOE-309	Business Analytics	4.	MTOE-315	Cost Management of Engineering Projects
2.	MTOE-311	Industrial Safety	5.	MTOE-317	Composite Materials
3.	MTOE-313	Operations Research	6.	MTOE-319	Waste to Energy

Semester-IV w.e.f. 2020-22 batch onwards

S. No.	Course No.	Course Name	L:T:P	Hours/Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs)
						Major Test	Minor Test	Practical	Total	
1	MTTE-202	Dissertation Phase - II	0:0:32	32	16	-	100	200	300	-
		Total		**32**	**16**	**-**	**100**	**200**	**300**	

w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTTE-101	ADVANCED FLUID DYNAMICS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To understand fluid flow problems & regimes, governing parameters, industrial applications, laminar, turbulent & compressible flows, experiments in the field of fluid mechanics.						
Course Outcomes							
CO1	Students will be able to understand the fluid flow problems along with range of governing parameters.						
CO2	Students will be able to understand the flow patterns and ability to differentiate between various flow regimes and its effects & take up related problems of industrial base.						
CO3	Students will be able to create an understanding about turbulent & compressible flows.						
CO4	Students will be able to understand the devise the experiments in the field of fluid mechanics.						

UNIT-I

Introduction: Review of basic concepts of fluid mechanics & related terminology; Lagrangian and Eulerian approach; Introduction to advanced fluid dynamics.

Equations of Fluid Flow: Reynold's transport theorem; application of RTT to establish continuity, momentum and energy equations; Integral & differential form of Euler's equation & Bernoulli's equation; Navier Stokes equation.

Ideal flow: Fluid flow kinematics; potential flow; source; sink; uniform flow around a source, sink and vortex; doublet; Rankine oval; flow around uniform cylinder with and without circulation; pressure distribution on the surface of Rankine half body and on cylinder with and without rotation; Magnus effect; D'Alembert's paradox, problems.

UNIT-II

Exact solution of N-S equations: Navier Stokes equation, relation between shear stress and pressure gradient; plane Poiseuille and Couette flow; Hagen- Poiseuille flow through circular pipe; elements of hydrodynamic theory of lubrication; flow with very low Reynold's numbers: Stokes flow around a sphere. problems.

Laminar Boundary layer flows: Elements of two-dimensional boundary layer theory; boundary layer thickness, displacement thickness, momentum thickness and energy thickness; Prandtl Boundary layer equation; Blasius solution for boundary layer on a flat plate; Von-Karman Integral Method; Karman-Pohlhausen integral method for obtaining approximate solutions; boundary layer separation & control. problems.

UNIT-III

Turbulent Flow: Characteristics of turbulent flow, laminar-turbulent transition, turbulent boundary layer theory and equation; effects of turbulence; classification of turbulence; intensity and scale of turbulence: time mean motion and fluctuations, Reynold's equations of turbulence; turbulence modelling. problems.

Compressible Flow: Introduction, basic thermodynamic relations; wave propagation & speed of sound: Mach number, Mach Cone, Mach Angle and Mach Line; Basic equations for one dimensional compressible flow: Continuity, momentum & energy equations; isentropic flow relations; compressibility correction factor; steady flow adiabatic index, critical & sonic conditions; effect of variable flow area, converging, diverging and converging-diverging nozzles and diffusers. problems.

w.e.f. 2020-2022 batch onwards

First Semester

UNIT-IV

Experimental Techniques: Role of experiments in fluid mechanics, sources of error in experiments, sources of error in measurement, data analysis: classification of data, analysis of random signals, fourier transform technique, probability density function approach.

Mechanical Measurement Techniques: Introduction, probes and transducers: hot wire anemometry; single & double wire measurement; laser doppler velocimetry: light sources & LDV; *Particle Image Velocimetry*: introduction, seeding arrangement for PIV, particle dynamics, generating a light sheet, synchronizer.

Reference/Text Books:

1. Muralidhar and Biswas, "Advanced Engineering Fluid Mechanics", Alpha Science International, 2005.
2. Irwin Shames, "Mechanics of Fluids", McGraw Hill, 2003
3. R.W., McDonald A.T., "Introduction to Fluid Mechanics", John Wiley and Sons Inc, 1985
4. Pijush K. Kundu, Ira M Kohen and David R. Dawaling, "Fluid Mechanics", Fifth Edition, 2005
5. I.G. Currie, "Fundamentals of Mechanics of Fluid", McGraw-Hill.
6. Yuan, "Foundation of Fluid Mechanics", Prentice Hall.
7. R.W. Fox, P.J. Pritchard & A.T. McDonald, "Introduction to Fluid Mechanics", Wiley India.
8. S.K. Som and G. Biswas, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw.
9. Gupta and Gupta, "Fluid Mechanics and its applications", Willey Easter.
10. Dr. D.S. Kumar, 'Fluid Mechanics and Fluid Power Engineering', Katson Books.

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

All questions will carry 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
(With specialization in Thermal Engineering)
Semester-I

MTTE-103	ADVANCED HEAT TRANSFER						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To understand the subject of Heat Transfer in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.						
Course Outcomes							
CO 1	The students will be able to formulate and analyze a heat transfer problem involving any of the three modes of heat transfer.						
CO 2	The students will be able to obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer						
CO 3	The students will be able to design devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.						

UNIT-I

Conductive Heat Transfer: Review of the basic laws of conduction, convection and radiation. general heat conduction equation in different co-ordinates, one dimensional steady state conduction with variable thermal conductivity and with internal distributed heat sources, critical radius of insulation, extended surfaces review, generalized equation for fins, tapered fins, design considerations.

Two and three dimensional steady-state conduction, method of separation of variables, graphical method, relaxation technique.

Transient heat conduction: lumped capacitance analysis, plane wall with convection, radial systems with convection, semi-infinite solid, periodic heating, solutions using Heisler's charts.

UNIT-II

Convective Heat Transfer: Introduction to convection boundary layers, local and average convection coefficients, laminar and turbulent flow, boundary layer equations, boundary layer similarity, boundary layer analogies – heat and mass transfer analogy, Reynold's and Colburn analogies.

Forced convection: External forced convection - empirical method, flat plate in parallel flow, cylinder in cross flow, flow over a sphere; internal forced convection – hydrodynamic and thermal considerations, energy balance, laminar flow in circular tubes, convection correlations.

Natural Convection: Physical considerations, governing equations, laminar free convection on vertical surface, empirical correlations, free convection within parallel plate channels, empirical correlations, combined free and forced convection.

UNIT-III

Boiling and Condensation: Dimensionless parameters in boiling and condensation, boiling modes, pool boiling, correlations, forced convection boiling, physical mechanism of condensation, laminar and

turbulent film condensation, film condensation in tubes, dropwise condensation. Special topics: transpiration cooling, ablation heat transfer, fluidized bed combustion.

Heat Exchangers: Basic design methodologies – LMTD and effectiveness NTU methods, overall heat transfer coefficient, fouling of heat exchangers, classification of heat exchangers according to constructional features: tubular, plate type, extended surface heat exchanger, compact heat exchangers, plate and heat pipe type heat exchangers, heat transfer enhancement - passive and active techniques.

UNIT-IV

Radiative Heat Transfer: Fundamental concepts, radiation intensity, irradiation, radiosity, black body radiation, basic laws of radiation, emission from real surfaces, absorption, reflection and transmission by real surfaces, Kirchoff's law, gray surface, radiative heat exchange between two or more surfaces, view factor, radiation exchange between opaque, diffuse, gray surface in an enclosure; net radiation exchange at a surface, radiation exchange between surfaces, blackbody radiation exchange, two-surface enclosure, radiation shields, multimode heat transfer, radiation of gases and vapour.

Mass Transfer: Physical origins and rate equations, mixture composition, Fick's law of diffusion, mass transfer in stationary media, steady state diffusion through a plane membrane, equimolal diffusion, diffusion of water vapours through air, mass transfer coefficient, convective mass transfer, correlations.

Reference/Text Books:

1. Incropera, Dewitt, Bergmann and Levine, "Fundamentals of Heat and Mass Transfer", Wiley India, 2006.
2. J.P. Holman, "Heat Transfer", McGraw Hill, 1996.
3. Y.V.C. Rao, "Heat and Mass Transfer", Universities Press, 2001.
4. D.S. Kumar, "Heat and Mass Transfer", Katson Publication, 2013.
5. Kreith and Bohn, "Principles of Heat Transfer", Cengage Learning, Inc. 7th Edition, 2009.
6. N.H. Afgan and Schliinder, "Heat Exchangers Design and Theory", McGraw Hill.

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

All questions will carry 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**

w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTRM-111	RESEARCH METHODOLOGY AND IPR						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
2	-	-	2	60	40	100	3
Objective	To familiarize the students with the research problem formulation and approach and understand the importance of Intellectual property rights.						
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.

Reference/Text 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

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTTE-117	ADVANCED HEAT TRANSFER LAB							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical Marks	Total	Time (Hrs.)
-	-	4	2	-	40	60	100	3
Objective	To design and conduct experiments, and acquire, analyze and interpret data.							
Course Outcomes								
CO 1	Students will understand the heat pipe and demonstrate its super thermal conductivity.							
CO 2	Students will determine the overall heat transfer, Biot and Fourier numbers in unsteady state heat conduction.							
CO 3	Students will be able to measure the heat transfer characteristics in convective heat transfer.							
CO 4	Students will be able to analyze and determine the heat transfer characteristics for heat exchangers and understand different heat enhancement techniques.							
CO 5	Students will be able to measure the emissivity, thermal conductivity etc.							

List of Experiments

1. To determine the emissivity of a test plate.
2. To demonstrate the super thermal conductivity of heat pipe.
3. To determine the natural convective heat transfer coefficient along a vertical test tube.
4. To find out heat transfer coefficient of drop wise and film wise condensation at various flow rates of water.
5. To study different types of heat enhancement techniques.
6. To determine the Biot number, Fourier number and heat transfer coefficient for unsteady heat transfer.
7. To find out the overall heat transfer coefficient and LMTD of a plate type heat exchanger.
8. To calculate heat transfer coefficient of the fluidized bed.
9. To find out the overall heat transfer coefficient and LMTD of a finned tube heat exchanger.
10. To determine the LMTD, overall heat transfer coefficient and effectiveness of evaporative heat exchanger.
11. To find out the heat flux and temperature difference between metal & liquid in a two phase transfer unit.
12. To determine the overall heat transfer co-efficient under unsteady state conditions at different temperatures and heat transfer coefficient at boiling point.
13. To determine the thermal conductivity of different fluids.

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

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTTE-119	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.
11. To study and perform experiments on desiccant evaporative cooling system.

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

w.e.f. 2020-2022 batch onwards

Program Elective - I

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTTE-105	ADVANCED THERMODYNAMICS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To acquaint the students with fundamentals of advanced thermodynamics.						
Course Outcomes							
CO 1	Student will get knowledge of exergy, basic laws governing energy conversion in multicomponent systems and application of chemical thermodynamics.						
CO 2	Student will be aware about advanced concepts in thermodynamics with emphasis on thermodynamic relations, equilibrium and stability of multiphase multi-component systems.						
CO 3	Students will be able to present theoretical, semi-theoretical and empirical models for the prediction of thermodynamic properties.						
CO 4	Student will acquire the confidence in analyze the motion of combusting and non-combusting fluids whilst accounting for variable specific heats, non-ideal gas properties, chemical non-equilibrium and compressibility.						

UNIT–I

Basic Concepts: Thermodynamics, Zeroth law of thermodynamics, first law of thermodynamics, limitations of first law, corollaries, concept of internal energy transient flow analysis, second law of thermodynamics, corollaries, concept of entropy, availability and unavailability, availability function of the closed system, availability of steady flow system irreversibility.

Thermodynamic Relations: Introduction, thermodynamic potentials, Maxwell relations, specific heat relations, Mayer's relation, general relations for du, dh, ds.

UNIT–II

Perfect Gases: P.V.T. surface, equations of state, real gas behavior, Vander Waal's equation, generalized compressibility factor, energy properties of real gases, vapour pressure, Clausius–Clapeyron equation, throttling, Joule–Thompson coefficient.

Non-reactive Mixture of perfect Gases: governing laws – evaluation of properties, psychrometric mixture properties and psychrometric chart – air conditioning processes – real gas mixture.

UNIT–III

Reactive Gas Mixtures: Combustion: introduction, combustion reactions, enthalpy of formation, entropy of formation, adiabatic flame temperature, first and second law analysis of reacting systems.

Thermodynamic cycles: Vapor power cycles, second law analysis of vapor power cycles, cogeneration, binary vapor cycles, and combined gas vapor power cycles. gas power cycles: ideal jet propulsion cycles- second law analysis of gas power cycles.

UNIT–IV

Statistical thermodynamics: Statistical interpretations of first and second law and entropy, Nernst heat theorem.

Kinetic theory of gases: Molecular model, Clausius equation of state, Vander waals equation of state, Maxwell Boltzmann velocity distribution. Dimensional analysis and similitude. Incompressible viscous flow, simplification of Navier stokes equation for steady incompressible flows.

Reference/Text books:

1. Cengel, "Thermodynamics", Tata McGraw Hill Co., New Delhi, 1980.
2. Howell and Dedcius, "Fundamentals of Engineering Thermodynamics", McGraw Hill Inc., U.S.A.
3. Van Wylen & Sonntag, "Thermodynamics", John Wiley and Sons Inc., U.S.A.
4. Jones and Hawkings, "Engineering Thermodynamics", John Wiley and Sons Inc., U.S.A, 2004.
5. Holman, "Thermodynamics", McGraw Hill Inc., New York, 2002.
6. Faires V.M. and Simmag, "Thermodynamics", Macmillan Publishing Co. Inc., U.S.A.
7. Rao Y.V.C., "Postulational and Statistical Thermodynamics", Allied Publishers Inc, 1994.

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTTE-107	DESIGN OF THERMAL SYSTEMS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To provide the mathematical modelling and analysis for designing the thermal systems. Also students will be able to understand the dynamic behaviour of thermal systems.						
Course Outcomes							
CO 1	Students will be able to understand the basic concepts for designing the thermal systems. Also to discuss mathematical modelling of thermal systems using computer programmes.						
CO 2	Students will be able to equip for modelling the thermal systems like heat exchangers, evaporators, condensers etc. Also to understand their solution procedures.						
CO 3	Students will able to understand the concepts of optimization and its various methods for solving the thermal problems. Also to study geometric, linear and dynamic programming.						
CO 4	Students will learn the dynamic behaviour of thermal systems. Also to learn stability analysis and non-linearity.						
CO 5	Students will able to understand the basic concepts for designing the thermal systems. Also to discuss mathematical modelling of thermal systems using computer programmes.						

UNIT-I

Design of Thermal System: Modeling of thermal system, types of models, mathematical modeling, curve fitting, linear algebraic systems, numerical model for a system, system simulation, methods of numerical simulation.

UNIT-II

Mathematical Modeling: Acceptable design of thermal system, initial design, design strategies, design of system for different application area, additional consideration for a practical system,

UNIT-III

Modeling Thermal Equipments: Economic consideration, calculation of interest, worth of money as a function of time, series of payments, raising capital, taxes, economic factor in design consideration

UNIT-IV

Systems Optimization: Problem formulation for optimization, optimization methods, optimization of thermal systems, practical aspect in optimal design, Lagrange multipliers, optimization of constrained and unconstrained problems, applicability to thermal systems, search method, single variable problem, multi-variable constrained optimization, examples of thermal systems, geometric, linear and dynamic programming, knowledge–based design and additional considerations.

Reference/Text Books:

1.Hodge, B.K. and Taylor, R. P., "Analysis and Design of Energy Systems", Prentice Hall (1999).
2.Bejan, A., Tsatsaronis, G. and Michel, M., "Thermal Design and Optimization", John Wiley and Sons (19
3.Jaluria, Y., "Design and Optimization of Thermal Systems", CRC Press (2008).
4.Ishigai, S., "Steam Power Engineering Thermal and Hydraulic Design Principle", Cambridge University

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTTE-109	ENERGY CONSERVATION AND MANAGEMENT						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To impart knowledge about Energy utilization, categorization, site selection & important aspects of Solar, wind, hydro, ocean, wave, tidal, geothermal, bio-mass & energy management.						
Course Outcomes							
CO 1	Students will be able to inculcate the methods of utilization, types, site selection & surveys etc. of Solar, Wind, Chemical, MHD sources of energy.						
CO 2	Students will have the understanding of methods of utilization, types, site selection & surveys etc. of Energy from Oceans and Hydropower.						
CO 3	Students will be able to acquire knowledge and comprehend various methods of utilization, types, site selection & surveys etc. of Bio-energy and Geothermal energy.						
CO 4	Students will be able to gain knowledge of generation of scenarios of energy consumption and predict the future trend. The student will be able to suggest and plan energy conservation solutions.						

UNIT-I

Solar Energy: Introduction; associated terminology; direct solar energy utilization; solar thermal applications.

Chemical Energy Sources: Introduction; fuel cells: design, principle, operation, classification, types.

MHD Systems: Introduction; principle of MHD power generation, MHD systems.

Wind energy: Introduction; basic principles of wind energy conversion; nature of wind; power in the wind; thrust on blades; wind energy conversion; design of windmills; wind data and energy estimation; site selection considerations; basic components of WECS.

UNIT-II

Biomass and bio-fuels: Energy plantation; biogas generation; types of biogas plants; applications of biogas; waste energy generation; biodiesel.

Energy conservation in Industries: Cogeneration; combined heating and power systems; relevant international standards and laws.

UNIT-III

Oceanic Energy: Energy from waves; wave energy conversion devices; advantages and disadvantages of wave energy; basic principles of tidal energy; tidal power generation systems; estimation of energy and power; advantages and limitations of tidal power generation; ocean thermal energy conversion (OTEC); methods of ocean thermal electric power generation.

Hydro power: Classification of small hydro power (SHP) stations; description of basic civil works design considerations; turbines and generators for SHP; advantages and limitations.

UNIT-IV

Energy Conservation & Management: Energy management; energy management planning; Pareto's model; application of Pareto's model for energy management; obtaining management support; establishing energy data base; energy economics.

Energy Audit: Conducting energy audit; Identifying, evaluating and implementing feasible energy conservation opportunities; energy audit report; monitoring, evaluating and following up energy saving measures/projects.

Reference/Text Books:

1. L.C. Witte, P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilization", Hemispherical Publication, 1988.
2. Paul W. O'Callaghan, "Design and Management for Energy Conservation" Pergamon Pr; 1st edition (December 1, 1981)
3. D.A. Reeg, "Industrial Energy Conservation", Pergamon Press, 1980.
4. T.L. Boyen, "Thermal Energy Recovery" Wiley, 1980.
5. L.J. Nagrath, "Systems Modeling and Analysis", Tata McGraw Hill, 1982.
6. W.C. Turner, "Energy Management Handbook ", Wiley, New York, 1982.
7. I.G.C. Dryden, "The Efficient Use of Energy ", Butterworth, London, 1982.
8. Godfrey Boyle (Edited by), "Renewable energy – power for sustainable future", Oxford University Press in association with the Open University, 1996.
9. S.A. Abbasi and Naseema Abbasi, "Renewable energy sources and their environmental impact" Prentice-Hall of India, 2001.
10. G.D. Rai, "Non-conventional sources of energy" Khanna Publishers, 2000.
11. G.D. Rai, "Solar energy utilization" Khanna Publishers, 2000.
12. S.L.Sah, "Renewable and novel energy sources", M. I. Publications, 1995.
13. S.Rao and B.B. Parulekar, "Energy Technology", Khanna Publishers, 1999.

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w.e.f. 2020-2022 batch onwards

Program Elective - II

10(2390)

w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTTE-111	REFRIGERATION AND CRYOGENICS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To acquaint the students with fundamentals of refrigeration and cryogenics.						
Course Outcomes							
CO 1	Students will learn the basics of refrigeration and cryogenics and its application area.						
CO 2	Students will be able to design the refrigeration systems for domestic and industrial applications like cold storages.						
CO 3	Students will learn about refrigerants and their uses for different refrigeration applications and related environment issues.						
CO 4	Students will able to design the heat based systems and the systems for the liquefaction of gases.						

Unit-I

Vapour compression system: Vapour compression refrigeration, Ewing's construction, standard rating cycle and effect on operating conditions, actual cycle, standard rating cycle for domestic refrigerator, second law efficiency.

Multi-pressure systems: Working and analysis of multi-stage compression with inter-cooling, multi-evaporator systems, cascade systems.

Unit-II

Refrigerant Compressors: Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor,

Components of Vapor compression system: Design, selection of evaporators, condensers, control systems, motor selection.

Unit-III

Refrigerants: Introduction, designation of refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, atmospheric gases as substitute for CFC refrigerants, binary and azeotropic mixtures.

Refrigeration applications: Food preservation, cooling and heating of foods, freezing of foods, freeze drying and heat drying of foods, transport refrigeration

Unit-IV

Vapour absorption system: Introduction to vapor absorption refrigeration, common refrigerant-absorbent systems, single effect and double effect systems, new mixtures for absorption system.

Gas liquefaction systems: Linde-Hampson, Linde dual pressure, Claude cycle, properties of cryogenic liquids, super fluidity, properties of solids at cryogenic temperatures

Reference/Text Books:

1. R. J. Dossat, "Principles of Refrigeration", Pearson Education Asia, 2001.
2. C. P. Arora, "Refrigeration and Air-conditioning", Tata McGraw-Hill, 2000.
3. Stoecker & Jones, "Refrigeration and Air-conditioning", McGraw Hill Book Company, New York, 1982.
4. A. R. Trott, "Refrigeration and Air-conditioning", Butterworths, 2000.
5. J. L. Threlkeld, "Thermal Environmental Engineering", Prentice Hall, 1970.

6. R. Barron, "Cryogenic systems", McGraw–Hill Company, New Yourk, 1985.
7. G. G. Hasseldon. "Cryogenic Fundamentals", Academic Press.
8. Bailey, "Advanced Cryogenics", Plenum Press, London, 1971.
9. W. F. Stoecker, "Industrial Refrigeration Handbook", McGraw-Hill, 1998.
10. John A. Corinchock, "Technician's Guide to Refrigeration systems", McGrawHill.
11. P. C. Koelet, "Industrial Refrigeration: Principles, Design and Applications", Macmillan, 1992.
12. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration.
13. Graham Walker, "Miniature Refrigerators for Cryogenic Sensors and Cold Electronics", Clarendon Press, 1989.

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w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTTE-113	AIR CONDITIONING SYSTEM DESIGN						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To acquaint the students with fundamentals of heating, ventilation and air-conditioning.						
Course Outcomes							
CO 1	Student will be able to understand construction and design features of Air-conditioning system.						
CO 2	Student will be able to understand various types and its adoptability in the various environment and application areas.						
CO 3	Student will be able to understand about the indoor air quality and various health issues related to Indoor air.						
CO 4	Student will be able to design seasonal energy efficient system						

Unit-I

Air conditioning systems: The complete air-conditioning system, system selection and arrangement, HVAC components and distribution system, all-air, air-water and all-water systems, decentralized cooling and heating.

Various air-conditioning processes: Moist air and standard atmosphere, Adiabatic saturation, classic moist air processes, Space air conditioning: design conditions, off-design conditions.

Unit-II

Comfort and health-Indoor air quality: Enthalpy deviation curve, psychrometry, SHF, dehumidified air quantity, human comfort, indoor air quality.

Heat transmission in building structures: Basic heat transfer modes, tabulated overall heat-transfer coefficient.

Unit-III

Design conditions and load calculations: Space heating load: outdoor and indoor design conditions, transmission heat losses, infiltration, heat losses from air duct. solar radiation

The cooling load: Design conditions, Internal heat gain, transient conduction heat transfer, fenestration: transmitted solar radiations.

Unit-IV

Fan and Building air distribution: Fan performance and selection, fans and variable-air-volume systems, air flow in ducts and fittings, pressure drop, duct design, & blowers, performance & selection, noise control.

Reference/Text Books:

1. ASHRAE Handbook.
2. "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co., U.S.A, 1965.
3. Norman C. Harris, "Modern Air Conditioning", McGraw-Hill, 1974.
4. Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1984.
5. Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand
6. Reinhold Co., New York, 1984. 7. Arora C.P., "Refrigeration & Air Conditioning", Tata Mc Graw Hill, 1985.
7. Manohar Prasad, "Refrigeration & Air Conditioning", New Age Publishers.
8. Stoecker, "Refrigeration & Air Conditioning", Mc Graw Hill, 1992.

9. Stoecker, "Design of Thermal Systems", Mc Graw Hill, 1992.
10. F. C. McQuiston, J. D Parker, J. D. Spitler "Heating, Ventilation and Air-conditioning", Wiley publications.

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

All questions will carry 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
(With specialization in Thermal Engineering)
Semester-I

MTTE-115	GAS TURBINES						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To design and analyze the performance of gas turbines and propulsion devices.						
Course Outcomes							
CO 1	Students will able to understand the ideal and real thermodynamic cycles of air-breathing engines and Industrial gas turbines						
CO 2	Students will able to understand design the blading, study the velocity triangles and estimate the performance of centrifugal and axial flow compressors.						
CO 3	Students will able to understand the combustion process and design the combustion chamber of a gas Turbine.						
CO 4	Students will able to understand design the blading, study the velocity triangles and estimate the performance of axial and radial in-flow turbines						
CO 5	Students will able to understand analyze the off-design performance and matching of the components of a gas turbine						

UNIT-I

Introduction: Classification of turbomachines, applications of gas turbines, assumptions for air-standard cycles, simple Brayton cycle, heat exchange cycle, inter-cooling and reheating cycle, comparison of various cycles.

Compressible flow: Energy and momentum equations for compressible fluid flows, various regions of flows, reference velocities, stagnation state, velocity of sound, critical states, Mach number, critical Mach number, types of waves, Mach cone, Mach angle, effect of Mach number on compressibility

UNIT-II

Real Cycles and their Analysis: Methods of accounting for component losses, isentropic and polytropic efficiencies, transmission and combustion efficiencies, comparative performance of practical cycles, combined cycles and cogeneration schemes.

Jet Propulsion Cycles and their Analysis: Criteria of performance, simple turbojet engine, simple turbofan engine, simple turboprop engine, turbo-shaft engine, thrust augmentation techniques.

Combustion System: Operational requirements, classification of combustion chambers, factors effecting combustion chamber design, the combustion process, flame stabilization, combustion chamber performance, some practical problems gas turbine emissions.

UNIT-III

Fundamentals of Rotating Machines: General fluid dynamic analysis, Euler's energy equation, components of energy transfer, impulse and reaction machines.

Centrifugal Compressors: Construction and principle of operation, elementary theory and velocity triangles, factors effecting stage pressure ratio, the diffuser, the compressibility effects, pre-rotation and slip factor, surging and choking, performance characteristics.

UNIT-IV

Flow Through Cascades: Cascade of blades, axial compressor cascades, lift and drag forces, cascade efficiency, cascade tunnel.

Axial Flow Compressors: Construction and principle of operation, elementary theory and velocity triangles, factors effecting stage pressure ratio, degree of reaction, work done factor, three dimensional flow, design process, blade design, stage performance, compressibility effects, off-design performance.
Axial and Radial Flow Turbines: Construction and operation, vortex theory, estimation of stage performance, overall turbine performance, turbine blade cooling, the radial flow turbine.
Off-Design Performance: Off-design performance of single shaft gas turbine, off-design performance of free turbine engine, off-design performance of the jet engine, methods of displacing the equilibrium running line.

Reference/Text Books:

1. Sarvana Muttoo, H.I.H., Rogers, G. F. C. and Cohen, H., "Gas Turbine Theory", 6th Edition, Pearson 2008.
2. Dixon, S.L., "Fluid Mechanics and Thermodynamics of Turbomachinery", 7th Edition, Elsevier, 2014.
3. Flack, R.D., "Fundamentals of Jet Propulsion with Applications", Cambridge University Press, 2011.
4. Ganesan, V., "Gas Turbines", 3rd Edition, Tata McGraw Hill, 2010.
5. Yahya, S. M., "Turbines, Compressors and Fans", 4th Edition, McGraw Hill.

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

All questions will carry 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.**

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Audit Course - I

10(2397)

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTAD-101	ENGLISH FOR RESEARCH PAPER WRITING						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
2	-	-	-	-	100	100	3
Objective	To understand how to improve writing skills and level of readability and develop skills needed for writing a good quality paper.						
Course Outcomes							
CO1	Students will understand how to improve your writing skills and level of readability.						
CO2	Learn about what to write in each section.						
CO3	Understand the skills needed when writing a Title.						
CO4	Students will be able to ensure the good quality of paper at very first-time submission.						

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

Reference/Text 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

w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTAD-103	DISASTER MANAGEMENT						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
2	-	-	-	-	100	100	3
Objective	To acquaint the students with various disasters and hazards and management.						
Course Outcomes							
CO1	Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.						
CO2	Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.						
CO3	Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.						
CO4	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.

Reference/Text 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.

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-I

MTAD- 105	SANSKRIT FOR TECHNICAL KNOWLEDGE						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
2	-	-	-	-	100	100	3
Objective	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

Reference/Text Books:

1. Dr.Vishwas, "Abhyaspustakam" Samskrita-Bharti Publication, New Delhi
2. Vempati Kutumbshastri, 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
(With specialization in Thermal Engineering)
Semester-I

MTAD-107	VALUE EDUCATION						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
2	-	-	-	-	100	100	3
Objective	Understand value of education and self- development, Imbibe good values in students and Let them know about the importance of character building.						
Course Outcomes							
CO1	Knowledge of self-development.						
CO2	Learn the importance of Human values.						
CO3	Developing the overall personality.						
CO4	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 judgements

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

Reference/Text Books:

1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

w.e.f. 2020-2022 batch onwards

Second Semester

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-II

MTTE-102	ADVANCED INTERNAL COMBUSTION ENGINES						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To enable the students to understand the modern Engine concepts, Sensor for automobiles. The course will also help the students to compare various emission norms and capability to develop capacity to identify various after treatment devices for pollution control.						
Course Outcomes							
CO 1	Students will able to develop capacity to analyse and characterise the processes working behind modern Engines based on HCCI and other modern concepts on which future I.C. Engines might be built.						
CO 2	Students will able to differentiate old Emission standards with latest emission norms in India and Internationally.						
CO 3	Students will able to recognize, describe, predict, and analyze different after-treatment technologies need to be installed in a particular type of engine for controlling different kinds of pollutants						
CO 4	Students will able to understand develop the capacity to understand basic elements of Automotive Electronic Engine control system, identify and select various sensors used for Electronic Controls of Engines.						
CO 5	Students will have the capacity to compare various alternative fuels used in Engines bases on their properties, advantages and limitations.						
CO 6	Students will able to test and evaluate quality of fuels as per International standards.						

UNIT-I

Homogeneous Charge Compression Ignition Engines: Introduction, historical background of HCCI/CAI type combustion engines, controlled auto-ignition gasoline engines, HCCI diesel engines, principle of HCCI/CAI combustion engine, performance and emission characteristics of conventional combustion and HCCI/CAI combustion.

Combustion characteristics of CAI Engines, effects of use of exhaust gases as diluents, various approaches to CAI/HCCI operation in gasoline engines, challenges facing CAI/HCCI combustion in the gasoline engine, future directions in HCCI/CAI engines, premixed charge compression Ignition (PCCI), Reactivity-Controlled Compression Ignition (RCCI)

UNIT-II

Future Mobility Solutions of Indian Automotive Industry: Evolution of emission standards in India, BS-VI emission standards, hybrid, and electric Vehicles, challenges for transport Sector, emerging engine technologies, possible solutions for future road transport sector,

Advancements in After-Treatment Technology for Internal Combustion: engines selective catalytic reduction (SCR) de-NOx after-treatment approach, use of NOx trap after-treatment device approaches,

control of particulate matter (PM) Emissions, diesel oxidation catalyst (DOC) and PM Control, diesel particulate filter (DPF) after-treatment device.

UNIT-III

Automotive Electronic Engine Control and Sensors used in cars

Basics of electronic engine control, engine mapping, air flow rate sensor, manifold absolute pressure (MAP) sensor, engine crankshaft angular position sensor, engine speed sensor, timing sensor for ignition and fuel delivery, throttle angle sensor, temperature sensor, knock sensors, electric motors for hybrid/electric vehicles.

UNIT-IV

Alternative fuels for I C Engines: Biodiesel: properties, advantages and limitations; **Bioethanol:** properties, advantages and limitations; **CNG:** properties, advantages and limitations; **Hydrogen:** Properties, advantages and limitations

Fuel Characteristics Quality Testing: ASTM and European standards for measurement of bio-fuel quality characteristics, density, API density, specific gravity, kinematic viscosity, acid value, flash point and fire point, carbon residue, oxidation stability analysis.

Text/ Reference Books:

1. Hua Zhao, "HCCI and CAI engines for the automotive industry", published by CRC Press, Woodhead Publishing Limited, Cambridge England.
2. Dhananjay Kumar Srivastava, 'Advances in Internal Combustion Engine Research 'published by Springer Nature.
3. William B. Ribbens, "Understanding automotive Electronics", published by Newnes, Elsevier Science, USA.
4. Amit Sarin, "Biodiesel: Production and Properties" Published by the Royal Society of Chemistry.
5. Ronald K. Jurgen, "Automotive Electronic Handbook" by, McGraw-Hill, USA.
6. Wiliam B. Ribbens, "Understanding Automotive Electronics", Newnes, Butterworth–Heinemann.
7. Timothy T. Maxwell, "Alternative Fuel: Emission, Economic and Performance", SAE, 1995.

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

All questions will carry 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
(With specialization in Thermal Engineering)
Semester-II

MTTE-104	STEAM ENGINEERING						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To familiarize the students with the fundamentals of steam engineering and thermal systems for energy conservation and waste heat recovery.						
Course Outcomes							
CO 1	Students will have the ability to explain working of different boilers and significance of mountings and accessories, usage of techniques, skills, and modern engineering tools necessary for boiler performance assessment.						
CO 2	Students will have a theoretical and practical background in thermal systems and will have a good understanding of energy conservation fundamentals. Students will have the ability to analyze thermal systems for energy conservation.						
CO 3	Students will have the ability to design a steam piping system, its components for a process and also design economical and effective insulation.						
CO 4	Students will have the ability to analyze a thermal system for sources of waste heat design a system for waste heat recovery. Students will have the ability to design and develop controls and instrumentation for effective monitoring of the process.						

UNIT-I

Fundamentals of steam generation: Introduction, quality of steam, use of steam table, Mollier chart.
Boilers: Types, mountings and accessories, combustion in boilers, determination of adiabatic flame temperature, quantity of flue gases, feed water and its quality, blow down; IBR, boiler standards.

UNIT-II

Steam Systems: Assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, steam engineering practices; steam based equipments / systems.
Piping & Insulation: Water line, steam line design and insulation; insulation-types and application, economic thickness of insulation, heat savings and application criteria, refractory-types, selection and application of refractory, heat loss.

UNIT-III

Boiler Performance Assessment Performance: Test codes and procedure, boiler efficiency, analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

Energy Conservation and Waste Minimization: Energy conservation options in boiler; waste minimization, methodology; economical viability of waste minimization.

UNIT-IV

Instrumentation & Control: Process instrumentation; control and monitoring. flow, pressure and temperature measuring and controlling instruments, its selection.

Reference/Text Books:

1. T. D. Estop, A. McConkey, "Applied Thermodynamics", Parson Publication.
2. Domkundwar; "A Course in Power Plant Engineering", Dhanapat Rai and Sons.
3. Yunus A. Cengel and Boles, "Engineering Thermodynamics", Tata McGraw-Hill Publishing Co. Ltd.
4. Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency.

5. Book IV - Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency.
6. Edited by J. B. Kitto & S C Stultz, "Steam: Its Generation and Use", The Babcock and Wilcox Company.
7. P. Chatopadhyay, "Boiler Operation Engineering: Questions and Answers", Tata McGraw Hill Education Pvt Ltd, N Delhi.

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-II

MTTE-118	ADVANCED INTERNAL COMBUSTION ENGINES LAB							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical Marks	Total	Time (Hrs.)
-	-	4	2	-	40	60	100	3

Objective	To develop capacity to find performance Testing of Engines and determine fuels quality characteristics using different experiments.
Course Outcomes:	
CO 1	Students will be able to test the performance of Multi Cylinder Diesel Engine and VCR Single Cylinder engine test rig.
CO 2	Students will be able to determine the exhaust emissions from engines using Smoke meter and gas analyser.
CO 4	Students will be able to find experimentally the performance of reciprocating air
CO 3	Students will have the capability to experimentally determine Viscosity, Density and Carbon residue content in a fuel.
CO 5	Students will have the ability to experimentally determine Cloud, pour point, Flash point and Fire point of any fuel.

List of Experiments

1. To perform load test on Multi cylinder Diesel engine using biodiesel blends and study its performance.
2. To analyze the performance of single cylinder VCR Diesel Engine with Electronic Control Unit [Computerised].
3. To conduct a load test on a single cylinder, 4-stroke variable compression ratio petrol engine and study its performance under various compression ratios.[Computerised].
4. To analyze the smoke emissions of a Diesel Engine using microprocessor-based Smoke meter.
5. To analyze various exhaust gases of I.C. Engines through a gas analyzer.
6. To conduct performance test on reciprocating air compressor, to determine its volumetric efficiency and Isothermal efficiency.
7. To Determine Viscosity of a fuel using Red Wood Viscometer.
8. To Determine Flash Point and Fire Point of a fuel.
9. To estimate Density, specific Gravity and API density of fuels.
10. To Determine the Carbon residue of a fuel using Ramsbottom Carbon residue apparatus
11. To perform Cloud and pour point test for a fuel.

Note: Total eight experiments are to be performed selecting at least six from the above list. Remaining two experiments can be from the above list or Teacher may design any two experiments based on the availability of the facilities in the lab.

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-II

MTTE-120	COMPUTATIONAL FLUID DYNAMICS LAB							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical Marks	Total	Time (Hrs.)
-	-	4	2	-	40	60	100	3
Objective	To acquaint the students with fundamentals of programming and simulation of 1 D and 2 D heat transfer and fluid flow problems using finite differencing and finite volume. To provide students with the necessary skills to use commercial CFD packages.							
Course Outcomes								
CO 1	Students will able to develop an understanding of the difference between dimensional and non-dimensional programming techniques.							
CO 2	Students will able to understand the fundamentals of programming/simulation of heat transfer in pin fin problems.							
CO 3	Students will able to understand the fundamentals of programming/simulation of fluid flow problems.							
CO 4	Students will able to understand the fundamentals of programming/simulation of steady and transient heat conduction problems.							

List of Experiments

1 To make and validate a computer programme for the one dimensional pin fin steady state heat conduction when fin is infinitely long in dimensional and non-dimensional form.
2 To make and validate a computer programme for the one dimensional pin fin steady state heat conduction when fin is insulated at tip in dimensional and non-dimensional form.
3 To make and validate a computer programme for the one dimensional pin fin steady state heat conduction when fin is losing heat at tip in dimensional and non-dimensional form.
4 To make and validate a computer programme for the one dimensional transient heat conduction.
5 To make and validate a computer programme for the plate in two dimensions in steady state conduction.
6 To make and validate a computer programme for the plate in two dimensions in transient state.
7 To make and validate a computer programme for the comparison of explicit, implicit, semi- implicit method of computation of heat transfer equation.
8 To make and validate a computer programme for the fully developed laminar flow in circular pipe.
9 To make and validate a computer programme for the Coutte flow.
10 To simulate and analyze the transonic flow over an airfoil.
11 To simulate vortex shedding phenomenon over a cylinder in laminar flow.
12 To simulate and analyze the flow through a venturimeter.
13 To simulate and analyze the laminar pipe flow.
14 To simulate and analyze the laminar pipe flow.
15 To simulate and analyze the compressible flow through a nozzle.

Note: Total eight experiments are to be performed selecting at least six from the above list. The programs may be validated using any software.

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
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Semester-II

MTTE-122	MINI PROJECT						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
-	-	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 design 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.

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Program Elective - III

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
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Semester-II

MTTE-106	DESIGN OF SOLAR AND WIND SYSTEMS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To acquaint the students with fundamentals of solar and wind systems and devices.						
Course Outcomes							
CO 1	Students will learn about the technological status of implementation of NCES in India						
CO 2	Student will be capable to analyze various techno economical obstacles in the commercial development of NCES in India						
CO 3	Student will be capable to conceptually model and design general NCES systems and predict the long term performance.						
CO 4	Student will suggest and plan hybrid NCES solutions to conventional energy systems						

Unit-I

Fundamental of energy science and technology: Energy, economy and social development, classification of energy sources, energy scenario in India.

Conventional sources of energy: Consumption trend of primary energy sources, energy-environment economy, Nuclear, Alternative energy sources.

Unit-II

Solar Radiation: Estimation, prediction & measurement, solar energy utilization, extraterrestrial and terrestrial radiations, spectral power distribution of solar radiation, solar time, and solar radiation geometry, Estimation of solar radiation on horizontal and tilted surface.

Solar Thermal Systems: Solar water heater, solar cooker, solar furnace, solar dryer, solar distillation, solar greenhouse.

Unit-III

Solar radiation collector: Performance of solar flat plate collectors, concentrating collectors.

Thermal storage: Sensible, latent and chemical heat storage. solar air heaters, solar air-conditioning systems, application of solar energy for drying and farm operations; water pumping, heating applications of solar energy, thermal power systems.

Unit-IV

Wind energy: Direct energy conversion- PV, magneto hydro dynamo, wind mill, site selection for wind mill.

Non-conventional Energy Technologies: Fuel cells, thermionic, thermoelectric, biomass, biogas, hydrogen, geothermal.

Reference/Text Books:

1. D.Y. Goswami, F. Kreith and J.F. Kreider, "Principle of Solar Engineering", Taylor and Francis, 2000.
2. Sukhatme S.P., "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
3. J.F. Kreider, F. Kreith, "Solar Energy Handbook", McGraw Hill, 1981

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4. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, 1991.

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

All questions will carry 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
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Semester-II

MTTE-108	NUCLEAR ENGINEERING						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To impart knowledge of Nuclear Reactor: inside processes, energy release, criticality, types, dimensions, materials, control, behavior, heat removal, safety, radiation protection, isotopes.						
Course Outcomes							
CO 1	Students will able to inculcate the basic concepts and processes taking place inside a nuclear reactor, such as nuclear fission, neutron production, scattering, diffusion, slowing down and absorption.						
CO 2	Students will get familiarized with the concepts of energy release, reactor criticality, the relationship between the dimension and fissile material concentration in a critical geometry.						
CO 3	Students will be able to explain the time dependent (transient) behavior of power reactor in non-steady state operation and will gain the knowledge about the means to control the nuclear reactor & its types.						
CO 4	Students will be able to extend the concepts of heat transfer in nuclear reactor cores. They will understand the mandatory safety precautions required in nuclear reactors and its radiations. They will gain the knowledge of applications of different radio-isotopes.						

UNIT-I

Nuclear Physics: Introduction; atom, nucleus & their structure; atomic transmutation; radioactivity detection; concepts of particle accelerator; radioactivity, radioactive decay, decay rate & half-life; nucleus interactions; transuranic elements; nuclear reactions: cross sections, nuclear fission & fusion, conversion and breeding.

Neutron transport and diffusion: Introduction; neutron transport equation; Fick's laws of diffusion: Ist and IInd Law; Solution to diffusion equation: instantaneous point source, infinite planar source; energy loss in elastic collisions, neutron slowing down.

UNIT-II

Energy and Exergy: Mass energy equivalence; mass defect; binding energy; energy release in fission & fusion; thermonuclear reaction; fusion bomb; exergy concept.

Reactor Mechanics and its governing equations: Solution of multigroup diffusion equations in one region and multi-region reactors; Concept of criticality of thermal reactors; reactor materials fissile & fertile materials; cladding & shielding materials, moderators, coolants.

UNIT-III

Reactor kinetics and Stability: Basic principles; fuel assembly; neutron balance; reactor kinetics; derivation of point kinetics equations; in-hour equation; solutions for simple cases of reactivity additions; excess reactivity; reactivity control; reactor stability; fission product poison or xenon poisoning; reactivity coefficients; burnable absorbers.

Classification of Nuclear Reactors: Pressurized water reactors; boiling water reactors; CANDU type reactors; gas cooled & liquid metal cooled reactors; fast breeder reactors.

UNIT-IV

Heat Transfer in Nuclear Reactors: Heat transfer equation solution in reactor core; temperature distribution; critical heat flux; heat balance; production & transfer of heat to the coolant; structural considerations.

Safety Precautions, Prevention & Isotopes: Reactor safety philosophy; defense in depth; units of radioactivity exposure; radiation protection standards; waste disposal hazards; plant site selection; safety measures incorporated in: plant design, accident control, disposal of nuclear waste, health physics; radio-isotopes radiation: units, hazards, prevention; preparation of radio-isotopes & their use in medicine, agriculture & industry.

Reference/Text Books:

1. M.M. El-Wakel, 'Nuclear Power Engineering". McGraw-Hill Inc., US
2. John R Lamarsh, "Introduction to nuclear engineering", Pearson Publication
3. J.J. Duderstadt, L. J. Hamilton, "Nuclear reactor analysis" Wiley publication

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

All questions will carry 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
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Semester-II

MTTE-110	CONVECTIVE HEAT TRANSFER						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To impart an In depth knowledge about the fundamentals and applications of the convective heat transfer.						
Course Outcomes							
CO 1	Students will learn the fundamentals of convective heat transfer.						
CO 2	Students will be able to understand laminar forced convection external and internal flows.						
CO 3	Students will develop an understanding of boundary layer flow in external and internal natural convection.						
CO 4	Students will be able to analyze the turbulent boundary layer and duct flows.						
CO 5	Students will understand the mechanism of phase change and convection in porous media.						

UNIT-I

Review of Governing Equations: Continuity, momentum and energy equations, second law of thermodynamics, scale analysis, concept of heat line visualization.

Laminar External Forced Convection: Boundary layer concept, velocity and thermal boundary layers, governing equations, similarity solutions, correlations, various wall heating conditions, Flow past a wedge and stagnation flow, blowing and suction, entropy generation minimization, heat lines in laminar boundary layer flow, numerical problems.

Laminar Internal Forced Convection: Fully developed laminar flow, heat transfer to fully developed duct flow, constant heat flux and constant wall temperature, heat transfer to developing flow, correlations, heat lines in fully developed duct flow.

UNIT-II

External Free Convection: Boundary layer equations, scale analysis, low and high Prandtl number fluids, integral solution, similarity solution, uniform heat wall flux, conjugate boundary layers, vertical channel flow, combined natural and forced convection, vertical walls, horizontal walls, inclined walls, horizontal and vertical cylinder, sphere, correlations, numerical problems.

Internal Free Convection: transient heating from side, boundary layer regime, isothermal and constant heat flux side walls, partially divided and triangular enclosures, and enclosures heated from below, inclined enclosures, annular space between horizontal cylinders and concentric spheres.

UNIT-III

Transition to Turbulence: empirical transition data, scaling laws of transition, buckling of inviscid streams, instability of inviscid flow.

Turbulent Boundary Layer Flow: Boundary layer equations, mixing length model, velocity distribution, heat transfer in boundary layer flow, flow over single cylinder, cross flow over array of cylinders, natural convection along vertical walls.

Turbulent duct flow: Velocity distribution, friction factor and pressure drop, heat transfer coefficient, isothermal wall, uniform wall heating, heat lines in turbulent flow near a wall, optimal channel spacing, empirical correlations for different configurations.

UNIT-IV

Convection with Change of Phase: Condensation, laminar and turbulent film on a vertical surface, film condensation, drop condensation, boiling, pool boiling regimes, nucleate boiling, film boiling and flow boiling, contact melting and lubrication, melting by natural convection.

Convection in Porous Media: Mass conservation, Darcy and Forchheimer flow models, enclosed porous media heated from side, penetrative convection, enclosed porous media heated from below.

Reference/Text Books:

1. A. Bejan, "Convection Heat Transfer", Wiley Publications.
2. Louis C. Burmeister, "Convective Heat Transfer", Wiley Publications.
3. W. M. Kays and M. E. Crawford, "Convective Heat and Mass Transfer", McGraw Hill.
4. E.R.G. Eckert and Robert M. Drake, "Analysis of heat and mass transfer", McGraw Hill.
5. S. Kakac and Y. Yener, "Convective Heat Transfer", CRC Press.

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

All questions will carry 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**

w.e.f. 2020-2022 batch onwards

Program Elective – IV

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-II

MTTE-112	COMPUTATIONAL FLUID DYNAMICS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To familiarize the students with the basic concepts of Computational Fluid Dynamics and problem solving approach using CFD.						
Course Outcomes							
CO 1	The students will develop an understanding of fundamental concepts of computational fluid dynamics.						
CO 2	The students will be able to model the basic equations which govern the fluid flow and heat transfer phenomena and analyze their mathematical behaviour.						
CO 3	The students will understand the basic concepts of discretization, error analysis and will develop the understanding of some simple CFD techniques.						
CO 4	The students will be able to analyze the steady and unsteady heat conduction & combined conduction diffusion problems using control volume formulation.						
CO 5	The students will be able to apply CFD to actual fluid flow problems.						

UNIT-I

Introduction: Introduction to C.F.D., comparison of the three basic approaches in engineering problem solving- analytical, experimental and computational.

Review of Governing Equations: models of the flow, substantial derivative, governing equations – continuity equation, momentum equation, energy equation, Navier-Stokes equation; physical boundary conditions.

Mathematical behavior of governing equations: classification of quasi linear partial differential equations, general method of determining the classification of partial differential equations, general behavior of hyperbolic, parabolic, elliptic equations.

UNIT-II

Discretization: Basic aspects of discretization, finite difference method, difference equations, explicit and implicit approaches, truncation error, round-off and discretization error, consistency and stability, convergence of a marching problem, methods for obtaining difference equations: use of Taylor series, use of polynomial fitting, integral method, finite volume method; stability analysis, grid generation, use of irregular mesh.

UNIT-III

Heat Conduction: control volume formulation of one-dimensional steady state diffusion, grid spacing, interface conductivity, non-linearity, source term linearization, boundary conditions; unsteady one-dimensional diffusion, two and three dimensional diffusion problems, over and under relaxation.

Convection & Diffusion: Steady one-dimensional convection and diffusion, central differencing scheme, upwind differencing scheme, exact solution, exponential, hybrid, and power law schemes, discretization equations for two dimensions & three dimensions, false diffusion.

UNIT-IV

Simple CFD Techniques: Lax-Wendroff technique, MacCormack's technique, space marching, relaxation technique, pressure correction technique, SIMPLE and SIMPLER algorithms.

Fluid Flow: CFD solution of subsonic-supersonic isentropic nozzle flow, solution of incompressible Couette flow problem by F.D.M., solution of Navier-Stokes equations for incompressible flows using MAC and SIMPLE methods.

Reference/Text Books:

1. Suhas V. Patankar, "Numerical Heat Transfer and Fluid Flow", CRC Press.
2. John D. Anderson, Jr, "Computational Fluid Dynamics", McGraw Hill Education.
3. H. Versteeg & W. Malalasekra, "An Introduction to Computational Fluid Dynamics", Pearson.
4. Richard H. Pletcher, John C. Tannehill, Dale Anderson, "Computational Fluid Mechanics and Heat Transfer", CRC Press.
5. Atul Sharma, "An Introduction to CFD: Development, Application & Analysis", Anc/Athena Books.
6. K. Muralidhar & T. Sundararajan, "Computational Fluid Flow & Heat Transfer", Alpha Science Intl Ltd.
7. Anil W. Date, "Introduction to Computational Fluid Dynamics" Cambridge University Press.
8. J. Blazek, "Computational Fluid Dynamics: Principles and Applications", Elsevier Science & Technology.
9. T.J. Chung, "Computational Fluid Dynamics", Cambridge University Press.

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

All questions will carry 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
(With specialization in Thermal Engineering)
Semester-II

MTTE-114	DESIGN OF HEAT TRANSFER EQUIPMENTS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To impart students with the knowledge of design considerations & operational parameters of a wide variety of Heat Transfer Equipments.						
Course Outcomes							
CO 1	Students will be able to demonstrate a general understanding of heat exchangers viz. shell-and-tube, double pipe, plate-and-frame, finned tube and plate-fin heat exchangers & Heat pipes.						
CO 2	Students will be able to select material, components, design and analyze the shell-and-tube, double pipe, hair-pin and compact plate types of heat exchangers.						
CO 3	Students will be able to demonstrate the knowledge of performance degradation of heat exchangers subject to fouling, pressure drop and surface characteristics of Heat Exchangers.						

UNIT-I

Basic Review & Classification: Introduction to heat transfer and heat transfer euipments; classification of heat transfer equipments on the basis of: heat transfer process, number of fluids, surface compactness, construction features and flow arrangement; tubular heat exchanger; plate type heat exchangers; extended surface heat exchangers; heat pipe; regenerators.

Design methodology: Heat transfer analysis: assumptions & problem formulation; E-NTU & *P*-NTU method; LMTD method; fouling: effects, categorization & fundamental processes.

UNIT-II

Double Pipe Heat Exchangers: Modes of operation; general configuration and characteristics; thermal and hydraulic design of inner tube; thermal and hydraulic analysis of annulus; total pressure drop.

Compact Heat Exchangers: Modes of operation; general configuration and characteristics; thermal and hydraulic design.

Shell & Tube heat exchangers: Modes of operation; general configuration and characteristics; Tinker's, Kern's and Bell Delaware's methods for thermal and hydraulic design.

UNIT-III

Pressure Drop Analysis: Importance of pressure drop; devices; extended surface heat exchanger pressure drop; tubular heat exchanger pressure drop; tube banks; shell and tube exchangers; plate heat exchanger pressure drop; pipe losses; non-dimensional presentation of pressure drop data.

Surface Characteristics and Techniques: Dimensionless surface characteristics; heat exchanger surface geometrical characteristics; experimental techniques for determining surface characteristics; steady-state kays and London technique; Wilson plot technique; transient test techniques; friction factor determination.

UNIT-IV

Material Selection & Design of Heat Exchangers: Selection of heat exchangers and their components; temperature difference distributions; design standards and codes; terminology in heat exchanger design; material selection, and thickness calculation for major components such as tube

sheet, shell, tubes, flanges and nozzles; Introduction to simulation and optimization of heat exchangers; flow induced vibrations.

Hair-Pin Heat Exchangers: Introduction; industrial HPHE; film coefficients in tubes and annuli; pressure drop; augmentation in performance of HPHE; series and parallel arrangements; comprehensive design algorithm; numerical problems.

Reference/Text Books:

1. Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" John Wiley & sons Inc., 2003.
2. D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.
3. Sadik Kakac and Hongton Liu, "Heat Exchangers: Selection, Rating and Thermal Design" CRC Press, 1998.
4. A .P. Frass and M.N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984
5. Afgan N. and Schlinder E.V. "Heat Exchanger Design and Theory Source Book".
6. T. Kuppan, "Hand Book of Heat Exchanger Design".
7. "T.E.M.A. Standard", New York, 1999.
8. G. Walkers, "Industrial Heat Exchangers-A Basic Guide", McGraw Hill, 1982.

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

All questions will carry 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
(With specialization in Thermal Engineering)
Semester-II

MTTE-116	COMPRESSIBLE FLOW MACHINES						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To understand the various fluid devices like turbine, compressors, pumps etc. Also to understand the concepts of shock waves and their properties.						
Course Outcomes							
CO 1	Students will able to understand the basic concepts of fluid machines. Also to learn the concepts of various turbines along with their general equations of power developed.						
CO 2	Students will able to understand the various types of pumps along with their advantages, disadvantages and applications.						
CO 3	Students will study the various compressors, diffusers & flow through variable area ducts. Also to learn the various terms and parts related to these devices.						
CO 4	Students will able to understand the basic concepts of shock waves. Also to learn the various types of shock waves through various equations.						
CO 5	Students will able to understand the basic concepts of fluid machines. Also to learn the concepts of various turbines along with their general equations of power developed.						

UNIT-I

Introduction: Introduction to fluid machines, energy transfer in fluid machines, energy transfer-impulse and reaction machines, efficiencies of fluid machines, principles of similarity in fluid machines, concept of specific speed and introduction to impulse hydraulic turbine.

Turbines: Analysis of force on the bucket of Pelton wheel and power generation, specific speed, governing and limitation of a Pelton turbine, introduction to reaction type of hydraulic turbine- a Francis turbine, analysis of force on Francis runner and power generation, axial flow machine and draft tube, governing of reaction turbine.

UNIT-II

Pumps: Introduction to rotodynamic pumps, flow and energy transfer in a centrifugal pump, characteristics of a centrifugal pump, matching of pump and system characteristics, diffuser and cavitation, axial flow pump, reciprocating pump.

UNIT-III

Compressors: Centrifugal and axial flow compressor, their characteristics.

Flow through Diffusers: Classification of diffusers, internal compression subsonic diffusers, velocity gradient, effect of friction and area change, the conical internal-compression subsonic diffusers, external compression subsonic diffusers, supersonic diffusers, normal shock supersonic diffusers, the converging diverging supersonic diffusers.

Flow through variable area ducts: Isentropic flow through variable area ducts, T-S and H-S diagrams for nozzle and diffuser flows, area ratio as a function of Mach number, mass flow rate through nozzles and diffusers, effect of friction in flow through nozzles.

UNIT-IV

Shock wave: Introduction to compressible flow, thermodynamic relations and speed of sound, disturbance propagation, stagnation and sonic properties, effects of area variation on properties in an isentropic flow, choking in a converging nozzle, isentropic flow through convergent-divergent duct, normal shock, oblique shock, introduction to expansion wave and Prandtl Meyer Flow.

Reference/Text Books:

1. S. M. Yahya, "Fundamentals of Compressible Flow", New Age International.
2. S.M. Yahya, "Turbines, Compressors and Fans", Tata McGraw Hill.
3. P.H. Oosthvizen and W.E. Carscallen, "Compressible Fluid Flow", McGraw Hill.

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

All questions will carry 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**

w.e.f. 2020-2022 batch onwards

Audit Course - II

10(2425)

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-II

MTAD- 202	CONSTITUTION OF INDIA						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
2	-	-	-	-	100	100	3
Objective	Understand the premises 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	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	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.						
CO3	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	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: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat: 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.

Reference/Text 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
(With specialization in Thermal Engineering)
Semester-II

MTAD-204	PEDAGOGY STUDIES						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
2	-	-	-	-	100	100	3
Objective	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.

References/Text 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
(With specialization in Thermal Engineering)
Semester-II

MTAD-206	STRESS MANAGEMENT BY YOGA						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
2	-	-	-	-	100	100	3
Objective	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 pranayama						

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

Reference/Text Books:

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

w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-II

MTAD-208	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
2	-	-	-	-	100	100	3
Objective	To learn 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

i) Verses- 19,20,21,22 (wisdom)
ii) Verses- 29,31,32 (pride & heroism)
iii) Verses- 26,28,63,65 (virtue)
iv) Verses- 52,53,59 (dont's)
v) Verses- 71,73,75,78 (do's)

Approach to day to day work and duties.
Shrimad Bhagwad Geeta : 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 Bhagwad Geeta: Chapter2-Verses 56, 62, 68
Chapter 12 -Verses 13, 14, 15, 16,17, 18

Personality of Role model. Shrimad Bhagwad Geeta:
Chapter 2-Verses 17,
Chapter 3-Verses 36, 37, 42,
Chapter 4-Verses 18, 38, 39
Chapter18 – Verses 37, 38, 63

Reference/Text Books:

1. Swami Swarupananda, "Srimad Bhagavad Gita" Advaita Ashram (Publication Department), Kolkata
2. P.Gopinath, "Bhartrihari's Three Satakam (Niti-sringar-vairagya) by, Rashtriya Sanskrit Sansthanam, New Delhi.

w.e.f. 2020-2022 batch onwards

Third Semester

10(2432)

w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-III

MTTE-207	DISSERTATION PHASE - I							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical Marks	Total	Time (Hrs.)
-	-	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 Thermal Engineering or interrelated fields of applications.							
Course Outcomes								
CO 1	Students will be exposed to self-learning various topics.							
CO 2	Students will learn to survey the literature such as books, national/international refereed journals and contact resource persons for the selected topic of research.							
CO 3	Students will learn to write technical reports.							
CO 4	Students will develop oral and written communication skills to present and defend their work in front of technically qualified audience.							

The Project Work will start in semester III and should preferably be a problem with research potential and should involve 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 dates 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

w.e.f. 2020-2022 batch onwards

Program Elective – V

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-III

MTTE-201	ADVANCED COMPUTATIONAL FLUID DYNAMICS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To familiarize the students with the advanced concepts of Computational Fluid Dynamics.						
Course Outcomes							
CO 1	Students will be able to develop the understanding of the modeling of turbulence and its effects.						
CO 2	Students will be able to analyze the convection diffusion problems and develop algorithms for pressure velocity coupling in steady flows and unsteady flows.						
CO 3	Students will be able to develop skills to implement and handle boundary conditions; errors and uncertainty; and complex geometries.						
CO 4	Students will be able to model the combustion phenomenon and radiative heat transfer using CFD.						

UNIT-I

Introduction: Revision of pre-requisite courses, finite differences and finite volume methods.

Turbulence and its modeling: Transition from laminar to turbulent flow, descriptors of turbulent flow, averaged equations for turbulent flow, characteristics of turbulent flow, effect of turbulent fluctuations on mean flow, turbulent flow calculations, turbulence modeling, Reylolds stress models, large-eddy simulation, direct numerical simulation.

UNIT-II

Finite volume method for convection-diffusion problems: Steady 1-D convection-diffusion, conservativeness, boundedness and transportiveness, central, upwind, hybrid and power law schemes, QUICK and TVD schemes.

Implementation of boundary conditions: Inlet, outlet, and wall boundary conditions, pressure boundary condition, cyclic or symmetric boundary condition.

Errors and uncertainty in CFD modeling: Errors and uncertainty in CFD, numerical errors, input uncertainty, physical model uncertainty, verification and validation, guide lines for best practices in CFD, reporting and documentation of CFD results.

UNIT-III

Pressure - velocity coupling in steady flows: Staggered grid, SIMPLE algorithm, assembly of a complete method, SIMPLER, SIMPLEC and PISO algorithms, worked examples of the above algorithms.

Finite volume method for unsteady flows: 1-D unsteady heat conduction, explicit, Crank-Nicolson and fully implicit schemes, transient problems with QUICK, SIMPLE schemes.

Methods for Dealing with complex geometries: Introduction, body-fitted co-ordinate grids, curvilinear grids, block structured and unstructured grids, discretization in unstructured grids, diffusion and convective term, assembly of discretized equations, pressure-velocity coupling, extension of face velocity interpolation method to unstructured meshes.

UNIT-IV

CFD modeling of combustion: Enthalpy of formation, Stoichiometry, equivalence ratio, adiabatic flame temperature, equilibrium and dissociation, governing equations of combusting flows, modeling of a laminar diffusion flame, SCRC model for turbulent combustion, probability density function approach, eddy break up model.

CFD for radiation heat transfer: Governing equations for radiation heat transfer, popular radiation calculation techniques using CFD, The Monte Carlo method, the discrete transfer method, Ray tracing, the discrete ordinates method.

Reference/Text Books:

1. H. Versteeg & W. Malalasekra, "An Introduction to Computational Fluid Dynamics", Pearson.
2. Suhas V. Patankar, "Numerical Heat Transfer and Fluid Flow", CRC Press.
3. J.C. Tannehill, D. A. Anderson and R.H. Pletcher, "Computational Fluid Mechnaics and Heat Transfer", CRC Press.
4. J. Blazek, "Computational Fluid Dynamics: Principles and Applications", Elsevier Science & Technology.
5. T.J. Chung, "Computational Fluid Dynamics", Cambridge University Press.

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

All questions will carry 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
(With specialization in Thermal Engineering)
Semester-III

MTTE-203	FINITE ELEMENT METHODS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To acquaint the students with fundamentals and various methods for solving the finite element problems. Also FDM, convergence and stability of FD scheme.						
Course Outcomes							
CO 1	Students will be able to understand the basic steps in FEM formulation. Also to study various concepts associated and assembly along with the boundary conditions in FEM formulation.						
CO 2	Students will be able to understand how FEM problem is formulated in 1-D elements. Also to discuss shape functions, h and p approximations; and various solvers associated in FEM.						
CO 3	Students will be able to understand FEM formulation of 2-D element using various methods like Galerkin approach, Weighted Residual etc. Also to understand the natural co-ordinates, numerical integration and various other concepts related to 2-D FEM formulation.						
CO 4	Students will be able to understand the axi-symmetric problems along with plane stress and plane strain problems with regards to solid mechanics. Also to discuss various elements of FEM, FEM with CI continuity and FDM problems.						

UNIT-I

Introduction to FEM: Basic Steps in FEM Formulation, General Applicability of the method; variational functional, Ritz method.

Variational FEM: Derivation of elemental equations, assembly, imposition of boundary conditions, solution of the equations.

UNIT-II

1D Elements: Shape functions, convergence criteria, h and p approximations, natural coordinates, numerical integration, gauss elimination based solvers, computer implementation: pre-processor, processor, post-processor.

UNIT-III

Alternate Formulation: Weighted residual method, Galerkin method; problems with C1 continuity: Beam Bending, Connectivity and Assembly of C1 Continuity Elements.

Variational Functional; 2-D elements (triangles and quadrilaterals) and shape functions, natural coordinates, numerical integration, elemental equations, .connectivity and assembly, imposition of boundary conditions.

UNIT-IV

Fem formulation & problems: Axisymmetric (heat conduction) problem, plane strain and plane stress solid mechanics problems, sub-parametric, iso-parametric and super-parametric elements; elements with C1 continuity, free vibration problems, formulation of Eigen value problem, FEM formulation. time-dependent problems, combination of Galerkin FEM and FDM (finite difference method), convergence and stability of FD scheme.

Reference/Text Books:

1. C. S. Krishnamoorty, "Finite element analysis", Tata McGraw Hill

2. J. N Reddy, "An introduction to Finite element method", Tata Mc. Graw Hill
3. Y. M. Desai, "Finite Element Method with applications in engineering", Pearson Education India
4. Ted Belytschko, W.K. Liu and Brian Moran, "Nonlinear Finite Elements for Continua and Structures (Paperback)" Wiley-Blackwell (16 August 2000)
5. Guido Dhondt, "The Finite Element Method for Three-Dimensional Thermomechanical Applications", Wiley; 1 edition (June 18, 2004).
6. Claes Johnson, "Numerical Solution of Partial Differential Equations by the Finite Element Method", Dover Publications (January 15, 2009).

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

All questions will carry 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
(With specialization in Thermal Engineering)
Semester-III

MTTE-205	THERMAL MODELING AND ANALYSIS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To acquaint the knowledge of mathematical modelling and analysis for designing the thermal systems. Also students can able to understand the dynamic behaviour of thermal systems.						
Course Outcomes							
CO 1	Students will be able to understand the basic concepts for designing the thermal systems. Also to discuss mathematical modelling of thermal systems using computer programmes.						
CO 2	Students will be able to equip for modelling the thermal systems like heat exchangers, evaporators, condensers etc. Also to understand their solution procedures.						
CO 3	Students will be able to understand the concepts of optimization and its various methods for solving the thermal problems. Also to study geometric, linear and dynamic programming.						
CO 4	Students will be able to learn the dynamic behaviour of thermal systems. Also to learn stability analysis and non-linearity.						
CO 5	Students will be able to understand the basic concepts for designing the thermal systems. Also to discuss optimization and mathematical modelling of thermal systems using computer programmes.						

UNIT-I

Design of Thermal System: Design principles, workable systems, optimal systems, matching of system components, economic analysis, depreciation, gradient present worth factor.

Mathematical Modeling: Equation fitting, empirical equation, regression analysis, different modes of mathematical models, selection, computer programmes for models.

UNIT-II

Modeling Thermal Equipments: Modeling heat exchangers, evaporators, condensers, absorption and rectification columns, compressor, pumps, simulation studies, information flow diagram, solution procedures.

UNIT-III

Systems Optimization: Objective function formulation, constraint equations, mathematical formulation, calculus method, dynamic programming, geometric programming, linear programming methods, solution procedures.

UNIT-IV

Dynamic Behavior of Thermal System: Steady state simulation, Laplace transformation, feedback control loops, stability analysis, non-linearties.

Optimization: Problem formulation for optimization, optimization methods, optimization of thermal systems, practical aspect in optimal design, Lagrange multipliers, optimization of constrained and unconstrained problems

Reference/Text Books:.

Hodge, B.K. and Taylor, R. P., "Analysis and Design of Energy Systems", Prentice Hall (1999).

Bejan, A., Tsatsaronis, G. and Michel, M., "Thermal Design and Optimization", John Wiley and Sons (1996).

Jaluria, Y., "Design and Optimization of Thermal Systems", McGraw-Hill (1998).

Jaluria, Y., "Design and Optimization of Thermal Systems", CRC Press (2008).

5. Ishigai S., "Steam Power Engineering Thermal and Hydraulic Design Principle", Cambridge University Press (1999).

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

All questions will carry 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**

w.e.f. 2020-2022 batch onwards

Open Elective

10(2442)

w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-III

MTOE-309	BUSINESS ANALYTICS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	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 assests.						
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.

Reference/Text 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 Short Answer or Objective Type and have contents from the entire syllabus (all Four Units).

All questions will carry 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**

w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-III

MTOE-311	INDUSTRIAL SAFETY						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To enable students to aware about the industrial safety.						
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

Reference/Text 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 Short Answer or Objective Type and have contents from the entire syllabus (all Four Units).

All questions will carry 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**

w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-III

MTOE-313	OPERATIONS RESEARCH						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To enable students to aware about the dynamic programming to solve problems of discreet 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

Reference/Text 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 Short Answer or Objective Type and have contents from the entire syllabus (all Four Units).

All questions will carry 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
(With specialization in Thermal Engineering)
Semester-III

MTOE-315	COST MANAGEMENT OF ENGINEERING PROJECTS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To enable students to make aware about the cost management for the engineering project and apply cost models 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 centres, 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.

Reference/Text 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 Short Answer or Objective Type and have contents from the entire syllabus (all Four Units).

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MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-III

MTOE-317	COMPOSITE MATERIALS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To enable students to be aware about the composite materials and their properties.						
Course Outcomes							
CO1	Students should be able to learn the Classification and characteristics of Composite materials.						
CO2	Students should be able reinforcements Composite materials.						
CO3	Students should be able to carry out the preparation of compounds.						
CO4	Student should be able to do the analysis of the composite materials.						

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. Isostrain and Isostress 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.

Reference/Text 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"

w.e.f. 2020-2022 batch onwards

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 Short Answer or Objective Type and have contents from the entire syllabus (all Four Units).

All questions will carry 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
(With specialization in Thermal Engineering)
Semester-III

MTOE-319	WASTE TO ENERGY						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To enable students to be aware about the generation of energy from the waste.						
Course Outcomes							
CO1	Students should be able to learn the Classification of waste as a fuel.						
CO2	Students should be able to learn the Manufacture of charcoal.						
CO3	Students should be able to carry out the designing of gasifiers and biomass stoves.						
CO4	Student should be able to learn the Biogas plant technology.						

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.

Reference/Text 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.
3. Challal, D. S, "Food, Feed and Fuel from Biomass", IBH Publishing Co. Pvt. Ltd., 1991.
4. 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 Short Answer or Objective Type and have contents from the entire syllabus (all Four Units).

All questions will carry 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**

w.e.f. 2020-2022 batch onwards

Fourth Semester

w.e.f. 2020-2022 batch onwards

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING
(With specialization in Thermal Engineering)
Semester-IV

MTTE-202	DISSERTATION PHASE -II							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical Marks	Total	Time (Hrs.)
-	-	32	16	-	100	200	300	-
Objective	The main objective of the course is to make the students to do some good research in the field of their interests related to Thermal Engineering or interrelated fields of applications.							
Course Outcomes								
CO 1	Students will be able to use different experimental techniques or different software/ computational/analytical tools.							
CO 2	Students will be able to design and develop an experimental set up/ equipment/test rig or set up a mathematical model.							
CO 3	Students will be able to conduct tests on existing setups/equipments or simulations and draw logical conclusions from the results after analyzing them.							
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.							
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 investigations in the field of Thermal Engg. or fields related to thermal / advanced topics etc. 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 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 or numerical details 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.

2017-2018

SEMESTER-III	Subject	L	T	P	Total	Minor Test	Major Test	Cr.	Duration of Exam (hrs)
	Elective-II	4	-	-	4	40	60	4	3
	Elective-III	4	-	-	4	40	60	4	3
MTTH-913	Synopsis	-	-	-	-	100	-	10	-
					Total	**180**	**120**		
						300		**18**	

LIST OF ELECTIVE – II (Thermal Engg.) for 3rd Semester		
1.	MTTH-915	Air Conditioning
2.	MTTH-917	Cryogenic Engineering
3.	MTTH-919	Combustion Engineering
4.	MTTH-921	Nuclear Engineering
5.	MTTH-923	Jet and Rocket Propulsion

LIST OF ELECTIVE – III (Thermal Engg.) for 3rd Semester		
1.	MTTH-925	Thermal Modeling and Analysis
2.	MTTH-927	Numerical & Optimization Methods
3.	MTTH-929	Advanced Computational Fluid Dynamics
4.	MTME-931	Gas Dynamics
5.	MTTH-933	Compressible Flow Machines

SEMESTER-IV		L	T	P	Total	Minor Test	Major Test	Cr.	Duration of Exam (hrs)
MTTH-912	Dissertation	-	-	-	-	100	200	18	-
						100	**200**		
					Total	**300**		**18**	

2017-2018

UNIVERSITY INSTITUTE OF ENGINEERING & TECHNOLOGY
(AICTE Approved)
KURUKSHETRA UNIVERSITY, KURUKSHETRA

MASTER OF TECHNOLOGY
IN
MECHANICAL ENGINEERING
(With Specialization in Thermal Engineering)
CREDIT BASED SYSTEM

SEMESTER-I	Subject	L	T	P	Total	Minor Test	Major Test	Cr.	Duration of Exam (hrs)
MTTH-901	Advanced Fluid Engineering	4	-	-	4	40	60	4	3
MTTH-903	Advanced Heat Transfer	4	-	-	4	40	60	4	3
MTTH-905	Advanced Refrigeration Engineering	4	-	-	4	40	60	4	3
MTTH-907	Design of Thermal Systems	4	-	-	4	40	60	4	3
MTME-809	Research Methodology and Optimization Techniques	4	-	-	4	40	60	4	3
MTTH-911	Advanced Heat Transfer Lab	-	-	2	2	40	60	1	-
					Total	**240**	**360**		
						600		**21**	

SEMESTER-II	Subject	L	T	P	Total	Minor Test	Major Test	Cr.	Duration of Exam (hrs)
MTTH-902	Computational Fluid Dynamics	4	-	-	4	40	60	4	3
MTTH-904	Advanced Internal Combustion Engines	4	-	-	4	40	60	4	3
MTTH-906	Finite Element Methods	4	-	-	4	40	60	4	3
MTTH-908	Solar Energy	4	-	-	4	40	60	4	3
	Elective-I	4	-	-	4	40	60	4	3
MTTH-910	Computational Fluid Dynamics Lab	-	-	2	2	40	60	1	-
					Total	**240**	**360**		
						600		**21**	

LIST OF ELECTIVE – I (Thermal Engg.) for 2nd Semester		
1.	MTTH-914	Advanced Thermodynamics
2.	MTTH-916	Renewable Energy & Energy Management
3.	MTTH-918	Convective Heat Transfer
4.	MTME-920	Measurements in Thermal Engineering
5.	MTTH-922	Design of Heat Transfer Equipments

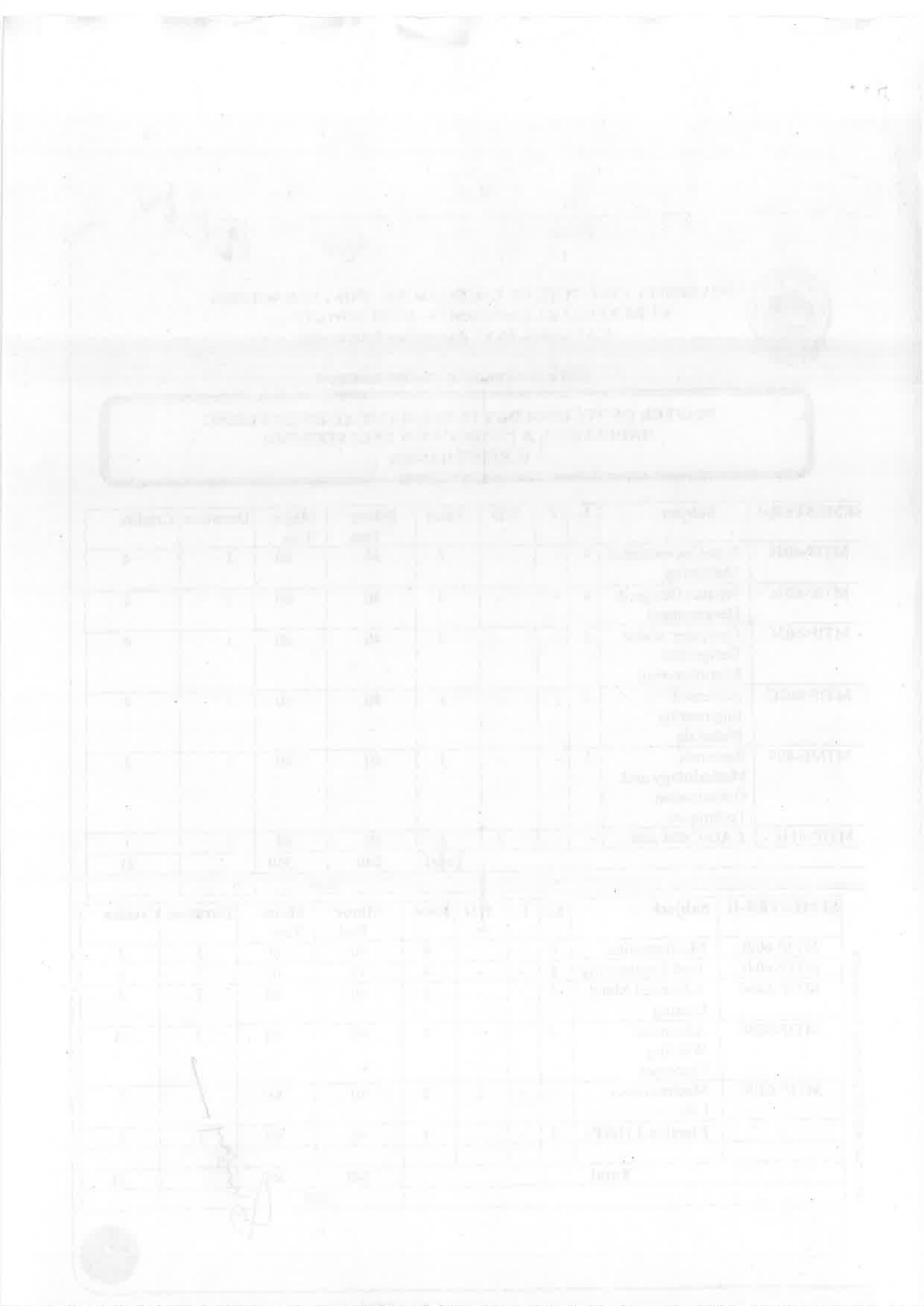
UNIVERSITY INSTITUTE OF ENGINEERING AND TECHNOLOGY
KURUKSHETRA UNIVERSITY, KURUKSHETRA
("A" Grade NAAC Accredited University)

(2015-16 onwards in phased manner)

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (INDUSTRIAL & PRODUCTION ENGINEERING) (CREDIT BASED)

SEMESTER-I	Subject	L	T	P/D	Total	Minor Test	Major Test	Duration	Credits
MTIP-601C	Non-Conventional Machining	4	-	-	4	40	60	3	4
MTIP-603C	Product Design & Development	4	-	-	4	40	60	3	4
MTIP-605C	Computer Aided Design and Manufacturing	4	-	-	4	40	60	3	4
MTIP-607C	Advanced Engineering Materials	4	-	-	4	40	60	3	4
MTME-809	Research Methodology and Optimization Techniques	4	-	-	4	40	60	3	4
MTIP-611C	CAD/CAM Lab	-	-	2	2	40	60	2	1
					Total	**240**	**360**		**21**
							600		

SEMESTER-II	Subject	L	T	P/D	Total	Minor Test	Major Test	Duration	Credits
MTIP-602C	Mechatronics	4	-	-	4	40	60	3	4
MTIP-604C	Tool Engineering	4	-	-	4	40	60	3	4
MTIP-606C	Advanced Metal Casting	4	-	-	4	40	60	3	4
MTIP-608C	Advanced Welding Processes	4	-	-	4	40	60	3	4
MTIP-610C	Mechatronics Lab	-	-	2	2	40	60	3	1
-	**Elective-I (I&P)**	4	-	-	4	40	60	3	4
Total						**240**	**360**		**21**
						600			



LIST OF ELECTIVES – I (Industrial and Production Engineering) for 2nd Semester		
1.	MTIP-612C	Advanced Metal Cutting
2.	MTIP-614C	Computational Methods in Engineering
3.	MTIP-616C	Design of Experiments
4.	MTIP-618C	Operations Management
5.	MTIP-620C	Strategic Entrepreneurship

SEMESTER-III	Subject	L	T	P	Total	Minor Test	Major Test	Duration	Credits
-	**Elective-II**	4	-	-	4	40	60	3	4
-	**Elective-III**	4	-	-	4	40	60	3	4
MTIP-613C	**Synopsis of Dissertation**	-	-	-	-	100	-	-	10
					Total	**180**	**120**		**18**
						300			

LIST OF ELECTIVES –II (Industrial and Production Engineering) for 3rd Semester		
1.	MTIP-615C	Supply Chain Management
2.	MTIP-617C	Finite Element Methods
3.	MTIP-619C	Sequencing and Scheduling
4.	MTIP-621C	Productivity Management
5.	MTIP-623C	Simulation of Industrial Systems

LIST OF ELECTIVES – III (Industrial and Production Engineering) for 3rd Semester		
1.	MTIP-625C	Smart Materials
2.	MTIP-627C	Manufacturing Optimization through Intelligent Techniques
3.	MTIP-629C	Quality Engineering and Management
4.	MTIP-631C	Enterprise Resource Planning
5.	MTIP-633C	Intellectual Property Rights and Patent Laws

SEMESTER-IV		L	T	P	Total	Minor Test	Major Test	Credits
MTIP-622C	Dissertation	-	-	-	-	100	200	18
					Total		**300**	**18**

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