Deenbandhu Chhotu Ram University of Science & Technology, Murthal (Sonepat)
Scheme of Studies & Examinations under Choice Based Credit System
Programme: M. Tech.; Year – 1st (Semester – I); (Mechanical Engineering) Session: 2019-20

S. No.	Course Code	Course Title	Teaching Schedule			Marks of Class work	Examination Marks		Total	Credits	Duration of Exam (hrs.)
			L	T	P		Theory	Practical			
1	MEM501C	Advanced Fluid Mechanics	3	0	0	25	75	--	100	3	3
2	MEM503C	Reliability and Maintenance Engineering	3	0	0	25	75	--	100	3	3
3	---	Programme Elective - I	3	0	0	25	75	--	100	3	3
4	---	Programme Elective - II	3	0	0	25	75	--	100	3	3
5	MEM505C	Advanced Fluid Mechanics Lab	1	0	3	25	--	75	100	2½	3
6	MEM507C	Statistical Computing Lab	1	0	3	25	--	75	100	2½	3
7	MEM509C	Research Methodology and IPR	2	0	0	25	75	--	100	2	3
8	---	Audit Course-I	2	0	0	25	75	--	100	0	3
Total			**18**	0	**6**	**200**	**450**	**150**	**800**	**19**	

Programme Elective - I			**Programme Elective - II**		
S. No.	**Course Code**	**Course Title**	**S. No.**	**Course Code**	**Course Title**
1	MED531C	Multibody Dynamics	1	MED533C	Advanced Stress Analysis
2	MEI531C	Technology and Manufacturing Strategies	2	MEI533C	Quality Engineering and Management
3	MEP531C	Advanced Operations Management	3	MEP533C	Analysis of Manufacturing Processes
4	MET531C	Thermodynamics and Combustion	4	MET533C	Refrigeration and Air Conditioning Systems Design

List of Audit Courses		
S. No.	**Course Code**	**Course Title**
1	AUD531C	English for Research Paper Writing
2	AUD533C	Disaster Management
3	AUD535C	Sanskrit for Technical Knowledge
4	AUD537C	Value Education
5	AUD539C	Constitution of India
6	AUD541C	Pedagogy Studies
7	AUD543C	Stress Management by Yoga
8	AUD545C	Personality Development through Life Enlightenment Skills

Note:

1. Students will be allowed to use Non-Programmable Scientific Calculator. However, sharing of calculator will not be permitted in the examination.
2. The choice of students for any elective shall not be binding on the department to offer, if the department does not have expertise. The minimum strength of the students to opt a particular subject shall not be less than 6.
3. For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

Deenbandhu Chhotu Ram University of Science & Technology, Murthal (Sonepat)
Scheme of Studies & Examinations under Choice Based Credit System
Programme: M. Tech.; Year – 1st (Semester – II); (Mechanical Engineering) Session: 2019-20

S. No.	Course Code	Course Title	Teaching Schedule			Marks of Class work	Examination Marks		Total	Credits	Duration of Exam (hrs.)
			L	T	P		Theory	Practical			
1	MEM502C OR MEM504C	Simulation of Manufacturing Systems Design of Thermal Systems	3	0	0	25	75	--	100	3	3
2	MEM506C	Finite Element Methods	3	0	0	25	75	--	100	3	3
3	---	Programme Elective - III	3	0	0	25	75	--	100	3	3
4	---	Programme Elective - IV	3	0	0	25	75	--	100	3	3
5	MEM508C MEM510C	Simulation of Manufacturing Systems Lab OR Design of Thermal Systems Lab	1	0	3	25	--	75	100	2½	3
6	MEM512C	Finite Element Methods Lab	1	0	3	25	--	75	100	2½	3
7	---	Audit Course-II	2	0	0	25	75	--	100	0	3
8	MEM514C	Mini-Project/Seminar	0	0	4	25	--	75	100	2	3
Total			**16**	**0**	**10**	**200**	**375**	**225**	**800**	**19**	

Programme Elective - III			**Programme Elective - IV**		
S. No.	**Course Code**	**Course Title**	**S. No.**	**Course Code**	**Course Title**
1	MED530C	Advanced Vibrations and Acoustics	1	MED532C	Analysis & Synthesis of Mechanisms
2	MEI530C	Statistical Decision Making	2	MEI532C	Non Traditional Machining
3	MEP530C	Advanced Material Processing	3	MEP532C	Industrial Automation
4	MET530C	Advanced Heat Transfer	4	MET532C	Alternative Fuels

List of Audit Courses		
S. No.	**Course Code**	**Course Title**
1	AUD531C	English for Research Paper Writing
2	AUD533C	Disaster Management
3	AUD535C	Sanskrit for Technical Knowledge
4	AUD537C	Value Education
5	AUD539C	Constitution of India
6	AUD541C	Pedagogy Studies
7	AUD543C	Stress Management by Yoga
8	AUD545C	Personality Development through Life Enlightenment Skills

Note:

1. Students will be allowed to use Non-Programmable Scientific Calculator. However, the sharing of calculator will not be permitted in the examination.
2. The choice of students for any elective shall not be binding on the department to offer, if the department does not have expertise. The minimum strength of the students to opt a particular subject shall not be less than 6.
3. For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

Deenbandhu Chhotu Ram University of Science & Technology, Murthal (Sonepat)
Scheme of Studies & Examinations under Choice Based Credit System
Programme: M. Tech.; Year – 2nd (Semester – III); (Mechanical Engineering) Session: 2020-21: applicable to students admitted in 2018

S. No.	Course Code	Course Title	Teaching Schedule			Marks of Class work	Examination Marks		Total	Credits	Duration of Exam (hrs.)
			L	T	P		Theory	Practical			
1	---	Programme Elective - V	3	0	0	25	75	--	100	3	3
2	---	Open Elective - I	3	0	0	25	75	--	100	3	3
3	MEM601C	Dissertation Phase-I	0	0	20	25	--	75	100	10	3
Total			**6**	**0**	**20**	**75**	**150**	**75**	**300**	**16**	

Programme Elective - V			**Open Elective - I**		
S. No.	**Course Code**	**Course Title**	**S. No.**	**Course Code**	**Course Title**
1	MED631C	Advanced Engineering Materials	1	MTOE651C	Business Analytics
2	MEI631C	Product Design and Development	2	MTOE653C	Industrial Safety
3	MEP631C	Sustainable Manufacturing	3	MTOE655C	Operations Research
4	MET631C	IC Engines Process Modelling	4	MTOE657C	Cost Management of Engineering Projects
5	MED633C	Tribology	5	MTOE659C	Composite Materials
6	MEM631C	Mechatronics	6	MTOE661C	Waste to Energy

Note:

1. Students will be allowed to use Non-Programmable Scientific Calculator. However, the sharing of calculator will not be permitted in the examination.
2. The choice of students for any elective shall not be binding on the department to offer, if the department does not have expertise. The minimum strength of the students to opt a particular subject shall not be less than 6.
3. For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

Deenbandhu Chhotu Ram University of Science & Technology, Murthal (Sonepat)
Scheme of Studies & Examinations under Choice Based Credit System
Programme: M. Tech.; Year – 2nd (Semester – IV); (Mechanical Engineering) Session: 2020-21: applicable to students admitted in 2018

S. No.	Course Code	Course Title	Teaching Schedule			Marks of Class work	Examination Marks		Total	Credits	Duration of Exam (hrs.)
			L	T	P		Theory	Practical			
1	MEM602C	Dissertation Phase-II	0	0	32	25	--	75	100	16	3
Total			**0**	**0**	**32**	**25**	--	**75**	**100**	**16**	

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	MEM 501C						
Category	**Programme Core**						
Course Title	**Advanced Fluid Mechanics**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Review Of Basic Concept:** Concept of continuum, Types of fluids. Basic Laws In Integral Form: Reynolds's transport theorem, Integral form of continuity, momentum and Energy equations. **Potential Flow:** Uniform flow, Source & Sink, Free Vortex flow, Source & Uniform flow (flow past a half body), Source - Sink pair, Doublet, Flow past a Cylinder (Doublet & Uniform flow), Flow past a Rankine oval body (source, sink & a uniform flow), flow past a cylinder with circulation (Doublet , Vortex and uniform flow)
Unit – II	**Turbulent Flow:** Introduction, growth of instability and transition from laminar to turbulent flow, effects of turbulence, classification of turbulence, Intensity and scale of turbulence, turbulent Intensity, scale of turbulence, Isotropic and Homogenous turbulence, Reynolds Equations of turbulence. Turbulence modeling; Boussinesq Eddy Viscosity concept, Prandtl mixing length concept, von - Karman similarity concept, Empirical correlations for coefficient of Friction, Hydraulically smooth & rough pipes, Prandtl universal velocity distribution, Velocity distribution in smooth/ rough pipes, Average velocity distribution for smooth and rough pipes. Friction factor for smooth and rough pipes.
Unit – III	**Compressible Flow:** Introduction, Wave propagation and sound velocity, Mach number and compressible flow regimes. Mach Core, Mach angle and mach Line. Basic equations for one dimensional compressible flow: continuity equation, momentum equation, Energy equation, Isentropic flow relations. Compressibility correction factor, Flow from a reservoir. Variation of velocity with Area ratio. Discharge through a convergent nozzle. Nozzles of the design pressure ratio. **Normal Shock Waves:** continuity equation momentum equations & Energy equations. Flow with obligue shock wave: Nature of flow through oblige shock wave, Prandtls's equation, Rankine- Hugoniot equation.
Unit - IV	**Viscous Flow In Ducts:** Stress deformation relations, Navier- Stokes equations, Reynolds number Regimes, Internal Vs. External Viscous flow, Flow in circular pipes, Flow between parallel plates, Alternate forms of Moody Charts, Flow in Non Circular ducts, Minor losses in **pipe system:** Variation of loss coefficient with the variation in geometry (diameter ratio, opening of valve, bend shape, entrance/exit variation, diffuser angles etc.), Fluid meters – venturi, nozzles and orifices meters: International shape, discharge coefficient, variation of discharge coefficient with fluid Reynolds number/diameter ratio.

Text Books

1. Fluid Mechanics, John F Douglas, Janusz M. Gasiorek, John A, Swaffield Peason Education
2. Fluid Mechanics, Frank M. White McGraw Hill
3. Fluid Mechanics and Fluid power engineering, D.S.Kumar, SK Kataria & Sons

Reference Books

1. Fundamentals of compressible flow, S.M. Yahya, New Age International Publishers
2. Advanced Engineering Fluid Mechanics, K Muralidhar & G. Biswas
3. Viscous Fluid Flow , Frank M. White Tata McGraw Hill.

Note: For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of

students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	MEM 503C						
Category	**Programme Core**						
Course Title	**Reliability and Maintenance Engineering**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Reliability Concepts and Failure Data Analysis:** Terminology, definition, and concept (Reliability, Maintainability and Availability). Failure Rate, Mean Failure Rate, Failure Density, MTBF, MTTF, MTTR concepts, Bathtub Curve, Repairable and Non-repairable Systems. **Hazard Models:** Constant and linearly increasing hazards, Distribution function and Distribution Models: Discrete and continuous; Normal Distribution, Exponential Distribution, Weibull Distribution; Gamma Distribution, Log-normal distribution; Reliability Modeling and Model Selection.
Unit – II	**System Reliability:** Series, Parallel and mixed configurations, K-out-of-n structure, Complex Systems, System Reliability Evaluation - RBD method, Minimal Path and cut set methods, Baye's approach, Events Tree Analysis, Fault Tree Analysis. **Reliability Improvement:** Introduction, Importance of components redundancy; Elements, Unit and Standby Redundancy, Reliability optimization, Reliability-cost Trade off.
Unit – III	**Maintenance and Maintenance Management:** Importance of maintenance, objectives, duties, functions and responsibilities of maintenance engineering department, organization and structure of maintenance systems. Elements of effective maintenance management. **Maintenance Policies and Planning**: Maintenance Philosophy, Types, Predictive, Preventive and Corrective Maintenance: Concepts, advantages and disadvantages, Planned maintenance: Procedure and advantages. Reliability Centered Maintenance: Goals, Principles advantages and failures.
Unit - IV	**Total Productive Maintenance:** Introduction, Methodology of working, Concept and Road Map of TPM, Implementation of TPM. **Computer Application in Maintenance Management:** Introduction, Computerized Maintenance Management System (CMMS) – Concept and functions, Use of internet in maintenance management: Terminology, Symbols and Notation, logic Diagrams, Assigning Probabilities, Uses, FMEA/ FMECA. Overview of Reliability Management and Product Life Cycle.

Text Books

1. Reliability Engineering,L. S. Srinath, East-West Press Private Limited.
2. Reliability Engineering, E. Balagurusamy,Tata McGraw-Hill Education Pvt. Ltd.
3. Engineering Maintenance – A Modern Approach, B.S. Dhillon, CRC Press.
4. Maintenance Engineering and Management, V. Venkataraman, PHI Learning Pvt. Ltd..

Reference Books

1. An introduction to Reliability and Maintainability Engineering, Charles E. Ebeling, Tata McGraw-Hill
2. Reliability Evaluation of Engineering Systems, Roy Billington and Ronald N. Allan, Springer Publication.
3. Reliability Maintainability and Risk; Practical methods for engineers, Smith, D.J, Butterworth-Heinemann, New Delhi
4. Maintenance Fundamentals, Mobley, R.K., Butterworth-Heinemann.
5. Handbook of Reliability engineering, Pha, H., Springer Publication.

Note: For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be

made aware about the reforms.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 505C**						
Category	**Programme Core**						
Course Title	**Advanced Fluid Mechanics Lab**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	1	0	3	2.5	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

Contents

The students will be required to carry out 8 to 10 experiments from the list given below or designed & set by the department as per the scope of the syllabus MEM 501C.

LIST OF EXPERIMENTS;

1. To determine the variation of the coefficient of discharge with respect to Reynolds number for a given Venturimeter.
2. To determine the variation of the coefficient of discharge with respect to Reynolds number and diameter ratio (Orifice diameter/pipe diameter) for a given Orifice meter.
3. To study (a) Hot Wire Anemometry, (b) Laser Doppler Velocimetry and (c) Particle Image Velocimetry.
4. To demonstrate any one combined flow as mention in unit of Potential flow.
5. To study (a) Nutating disc meter, (b) Turbine – meter and (c) Ultrasonic flow meter.
6. To study hydraulic & pneumatic cylinders.
7. To study and demonstrate a hydraulic system on the hydraulic system test rig.
8. To study and demonstrate a hydraulic system using PLC on the hydraulic system test rig.
9. To study and demonstrate a pneumatic system on the pneumatic system test rig.
10. To study and demonstrate a pneumatic system using PLC on the pneumatic system test rig.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 507C**						
Category	**Programme Core Lab**						
Course Title	**Statistical Computing Lab**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	1	0	3	2.5	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

Contents

The students will be required to carry out 8 to 10 experiments from the list given below or designed & set by the department as per the scope of the subject.

List of Experiments

1. To carry out data entry, calculation of summary statistics and generating comparative statements using Excel.
2. To perform and interpret one-way and two-way Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA) on suitable data set.
3. To perform a Multivariate Analysis of Variance (MANOVA) and Multivariate Analysis of Covariance (MANCOVA) on suitable data set and draw appropriate conclusions from the results.
4. To carry out Linear Regression analysis to identify the best fit line describing the relationship between dependent and independent variables.
5. To perform a Multiple Regression Analysis. Interpret the results. Compare the results of a polynomial regression with linear regression.
6. To analyze any suitable data set performing logistic regression.
7. To carry out Discriminant analysis (Linear/Quadratic) and assess its efficacy.
8. To perform a Principal Component Analysis and to interpret and select the number of Principal Components.
9. To study the concept of Full Factorial Design by constructing a Design of Experiments matrix for 2-factor 2-level/2-factor 3-level problems.
10. To establish mathematical relationship between the response and input factors for a multivariate problem.
11. To study the concept of individual and interaction effect of input factors on the responses of a multivariate problem.

Text Books:

1. Tabachnick, B. G., & Fidell, L. S., "Using multivariate statistics", Pearson Prentice Hall.
2. Montgomery, D.C. "Design and Analysis of Experiments", John Wiley and Sons.
3. Sabine Landau and Brian S. Everitt, "A Handbook of Statistical Analyses Using SPSS", Chapman and Hall/CRC.

Reference Books:

1. Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. "Multivariate data analysis", Pearson India.

2. Hicks, C.R. “Fundamental concepts in the Design of Experiments”, Holt, Rinehort and Winston.
3. Gujarati, D. N. , “Basic Econometrics”, Tata McGraw-Hill Education.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 509C**						
Category	**Programme Core**						
Course Title	**Research Methodology and IPR**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	2	0	0	2	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Introduction To Research Methodology:** Chapter 1: Meaning of research, Importance of research, types of research, motivation in research, qualities of a good researcher/research, Effective literature studies approaches, Plagiarism and research ethics Chapter 2: Defining a research problem, sources of research problem, characteristics of a good research problem, and errors in selecting a research problem, scope and objectives of research problem, practical/industrial significance of the research problem.
Unit – II	**Data Collection, Presentation, Analysis and Interpretation** Chapter 3: Methods and techniques of data collection, data processing, presentation, necessary instrumentations. Chapter 4: Overview of Modeling and analysis of research problems.
Unit – III	**Writing Skills** Chapter 5: Developing a research proposal, format of Research proposal, Substance of reports, thesis/dissertation organization Chapter 6: Effective technical writing of reports, research papers etc.; Presentation of report etc.
Unit - IV	**Intellectual Property Rights** Chapter 7: Patents, designs, trade and copyright, process of patenting and development: technological research, innovation, patenting, and development, International Scenario: International cooperation on Intellectual Property, procedure for grants of patents, patenting under PCT Chapter 8: 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 IITs.

Text Books

1. Research Methodology: Methods and Techniques, C R Kothari, New Age International
2. Intellectual Property in New Technological Age, Robert P. Merges, Peter S Menell, Mark A Lemley, Wolters Kluwer

Reference Books

1. Research Methodology: an Introduction for science and engineering students, Staurt Melville and Wayne Goddard, Juta Education
2. Resisting Intellectual Property, Halbert, Taylor and Francis Ltd.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 502C**						
Category	**Programme Core**						
Course Title	**Simulation of Manufacturing Systems**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	

Detailed Contents

S. No.	Contents
Unit - I	**Introduction:** Concept of Simulation as a tool for analysis, different simulation terminologies, Application area for Discrete Simulation Modelling, Role of simulation in Model evaluation and studies, Illustration of Discrete Simulation through Hand simulation of a single server queue. Steps in a simulation study, Verification, Validation and Credibility of simulation models, Advantages, disadvantages and pitfalls of simulation. **Input Modelling and Output Analysis:** Statistical models in simulation, Brief review of Probability distribution functions, estimation of statistical parameters, Transient and Steady-State Behaviour of a Stochastic Process, Statistical Analysis for Terminating Simulations: Estimating Means, and other statistical Measures of Performance, Statistical Analysis for Steady-State Parameters: Replication/Deletion Approach for Means. Brief review of Design of Experiment and Factor setting for simulation experiments. **Discrete Simulation Languages:** Advantages and limitations of Simulation modelling through general purpose programming languages and its limitations, Brief review of important simulation packages, importance & limitations of special purpose simulation Application platforms.
Unit – II	**Models for Manufacturing Systems Planning:** Types of Manufacturing system, their characteristics and performance measures, Facility location and its models, Layout planning and its models, Strategic planning and forecasting, its types and models, and its relevance, Aggregate planning and models, Product design process & Quality Function Deployment.
Unit – III	**Simulation of Inventory Systems:** Master production schedule, Material requirement planning systems and its models. Continuous and Periodic Inventory control systems, (s, S) and (s, Q) Inventory control policies, Estimation of inventory parameters: Ordering period, Order Quantity and Safety Stock under static and probabilistic conditions of demand and lead times, Considerations for inventory costs and confidence level.
Unit - IV	**Simulation of Job Shops:** Criteria and objective functions for job shop scheduling, Different Scheduling rules. Simulation of a Single server Job Shop Scheduling through case example. Simulation of Flow Shops: Common Flow shop scheduling rules, Johnson Algorithm,

	Extension of Johnson algorithm for three machine flow shop. Simulation of a Flow Shop Scheduling through a case example. Illustration of simulation of Process layout/Batch Manufacturing, Flexible Manufacturing Systems and Manufacturing supply Chains.

Text Books

1. Simulation Modeling and Analysis, A.M. Law and W.D.Kelton, Tata McGraw-Hill
2. Modern Production /Operations Management, E.S. Buffa and R.K. Sarin, John Wiley

Reference Books

1. Simulation with Arena, W.D. Kelton, R.P. Sadowski and N.B. Swets, McGraw-Hill
2. Production & Operations Management, R.B. Chase, N.J. Aquilano & F.R. Jacobs, Tata McGraw Hill
3. Analysis and Control of Production Systems, E.A. Elsayed and T.O. Boucher, Printice Hall Publication
4. Designing and Managing the Supply Chain, Simchi-Levi, Kaminsky, E.Simchi-Levi, R.Shankar , TMH

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 504C**						
Category	**Programme Core**						
Course Title	**Design of Thermal Systems**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Background:** Design vs. Analysis, synthesis for design, selection vs. design; Introducingengineering design; thermal systems vs. energy systems, designing a thermal system; hardware of thermal systems, general characteristics of thermal systems. **Concept of Engineering Design:** Engineering design types: mechanical design, thermal design, thermodynamic design; formulation ofdesign problem.Engineering design process: Initial design, conceptual design, acceptable design and optimal design; computer sided design, material selection and its properties.
Unit – II	**Statistical Modeling:** methods of non-dimensional, its importance in empirical modeling; interpolation vs. regression; methods of interpolation and regressions, exact fit versus best fit, the art of curve fitting; goodness of fit; development of performance characteristics of system-components based on empirical technique; an overview of statistical modeling. Mathematical modeling: conversion ofphysical system into mathematical model,modeling of thermal/energy system based components and equipments.Principles of modeling,governing equations, handling of boundary conditions,Overview.
Unit – III	**Numerical analysis:** Solution procedure of simultaneous algebraic/differential equations, and linear/non-linear equations; numerical modeling and analysis. Simulation of thermal/energy system: Information flow diagrams; Classes of simulation, methods of system simulation; principles of modeling and simulation, implementation to various thermal/energy systems;Overview of system simulation. **Knowledge-based system design:** Introduction to knowledge based system, Expert knowledge, and material data base and design methodologies. Computer-aided knowledge based optimum design to thermal/energy systems..
Unit - IV	**Economic consideration:** Calculation of interest; Time value of money; Raising capital; Taxes; Economic factor in design; Application to engineering systems, Numerical problems. Optimization: Conventional optimization techniques: Lagrange multiplier methods, Search

	methods, geometric and dynamic programming; Stochastic methods – Genetic Algorithms, Simulated annealing and Monte-Carlo methods.Some case studies based on optimization of thermal system

Text/Reference Books

1. Design of Thermal Systems, W.F. Stockers, MH, New York.
2. Design & Optimization of Thermal Systems, Yogesh Jaluria, MH, New York.
3. Analysis & Design of Energy Systems.,Hodge BK, Prentice Hall, 1990, New Jersey.
4. Optimization Methods for Engineering Design, Fox RL, Addison-Wersley Reading, MA.
5. Elements of Thermal-Fluid System Design, Burmeister LC, Prentice Hall, 1998.
6. Principles of Design, N.P. Suh, Oxford Univ. New York.
7. Numerical Methods, Hornbeck, R.W, PH, Anglewood, New York.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 506C**						
Category	**Programme Core**						
Course Title	**Finite Element Method**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Introduction:** Classification of problems- Dimensionality, time dependence, Boundary Value problems, Initial value problems, Linear/Non-linear, etc. Differential equation as the starting point for FEM, steps in finite element method, discretization, types of elements used, Shape functions- Linear Elements, Local and Global coordinates, Coordinate transformation and Gauss-Legendre scheme of numerical integration, Nodal degrees of freedom.
Unit – II	**Finite element formulation, Direct Stiffness Method:** Nodal Equilibrium equations, Element Stiffness Matrix, Assembly of Global Stiffness Matrix. Variational method, Weighted residuals methods: Point collocation, Sub domain collocation, Least Squares, Galerkin, and virtual work methods.
Unit – III	**1-D problems from Structural Mechanics:** Bar, One-Dimensional Heat conduction problems. 2-D problems from Structural Mechanics: Plane stress and plane strain problems, Axisymmetric problems - Axi-symmetric forces and geometry
Unit - IV	**Computer implementation, higher order elements**- triangular, rectangular, quadrilateral, tetrahedral and brick element, iso-parametric formulation. Eigen-value problems, consistent and lumped mass matrices, Natural vibration of bars and beams, Methods to find eigen-values and eigen-vectors.

Text Books

1. Using multivariate statistics, Tabachnick, B. G., &Fidell, L. S., Pearson Prentice Hall.
2. Design and Analysis of Experiments, Montgomery, D.C., John Wiley and Sons

Reference Books

1. Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu, Prentice Hall of India Pvt.

Ltd.
2. A First Course in Finite Element Method, Logan Deryl L, Thomson Brook/Cole.
3. Basic Econometrics, Gujarati, D. N., Tata McGraw-Hill Education.
4. Marketing research: An applied orientation, Malhotra, N. K., Pearson Education India.
5. Applied multiple regression/correlation analysis for the behavioral sciences, Cohen, J., Cohen, P., West, S. G., & Aiken, L. S., Routledge.
6. Data mining: concepts and techniques: concepts and techniques, Han, J., Kamber, M., & Pei, J., Elsevier.

Note: For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 508C**						
Category	**Programme Core Lab**						
Course Title	**Simulation of Manufacturing Systems Lab**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	1	0	3	2.5	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							
Detailed Contents							
Content							

The students will be required to carry out 8 to 10 experiments from the list given below or designed & set by the department as per the scope of the subject.

List of Experiments

1 To evaluate performance of a single server system through discrete simulation.
2 To simulate a 2-machine n-job system for Johnson job sequencing rule.
3 To simulate a Continuous Review Inventory System with stochastic demand and lead times.
4 To estimate the warm-up period and number of replication for inventory system with random variables.
5 Optimization of (s, Q) type inventory system with stochastic parameters.
6 Optimization of (s, S) type inventory system with stochastic parameters.
7 To simulate a Process layout based Manufacturing Systems for multiple products.
8 Performance evaluation of a Flexible Manufacturing System.
9 To evaluate Factor effects on performance of a Manufacturing system through design of simulation

experiments.

10 Simulation of a Simple Manufacturing Supply Chain.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 510C**						
Category	**Programme Core**						
Course Title	**Design of Thermal Systems Lab**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	1	0	3	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

The students will be required to carry out at least 7 laboratory projects as given below based on theory course Design of Thermal Systems (MEM 504C).

List of Experiments:

1 Plotting the graphs in 2-dimensional on Microsoft Office Excel spreadsheet/MATLAB tool

2	Exercise on equation fit and testing the goodness of fit.
3	Exercise on IC Engine Simulation code (FIRE & BOOST software)
4	Simulation of a given configuration of a thermal system
5	Simulation of a given energy system
6	Optimization of a typical thermal system
7	Optimization of a typical energy system
8	Development of Knowledge based system for optimization of thermal/energy system.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 512C**						
Category	**Programme Elective - II**						
Course Title	**Finite Element Method Lab**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	0	0	4	2	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

Contents

The students will be required to carry out 8 to 10 experiments from the list given below or designed & set by the department as per the scope of the subject.

List of Experiments:

1 Write a programme for one dimensional stress analysis using direct approach: It includes-Input data file or interactive input, Element stiffness matrix and assembly, Modification for Boundary conditions, Solver for bounded symmetric stiffness matrix, Results-output data file, Validate the code, use the validated code for solving different problems

2 Write a programme for One Dimensional Thermal stress problem. It includes interactive input for program variables, Element Stiffness matrix and assembly, Modification for boundary conditions, Solver for simultaneous system equations, Stress calculation, Reaction calculation, and output data file, Validate the code, use the validated code for solving different problems.

3 Write a programme for One Dimensional Heat Conduction problem. It includes interactive input, Calculate and input nodal Heat Source vector, Element Stiffness matrix and assembly, Account for boundary conditions, Solver for simultaneous system equations, output data file, Validate the code, use the validated code for solving different problems

4 Write a programme for Two Dimensional stress problem by Galerkin's Method. Interactive input, Shape functions for 1D and 2D elements, Jacobian Matrix, Gauss Quadrature, element stiffness matrix, Global Stiffness matrix, Modification for boundary conditions, System equations solving, Results output to a data file Validate the code, use the validated code for solving different problems.

5 Write a programme to determine the natural frequency of a bar using FEM.

6 Using open source software or commercial software for Implementation of FEM for stress analyses that involve the features of pre-processing, processing and post processing.

7 Using open source software or commercial software for Implementation of FEM to obtain stress concentration due to a small hole in a rectangular plate subjected to traction on edges and concentrated loads at points on the edges and prescribed boundary conditions

8 Using open source software or commercial software for Implementation of FEM for axis-symmetric problems.

9 Using open source software or commercial software for Implementation of FEM for transient problems.

10 Other experiments may be covered from the syllabus of Finite Element Method theory subject.

Text Books

1. Introduction to Finite Elements in Engineering, Chandrupatla and Belegundu, PHI, ND.
2. A First Course in Finite Element Method, Logan Deryl L, Thomson Brook/Cole,5th Ed. 12
3. Concepts and applications of finite element analysis, Cook R.D., Wiley, New York, 4th Ed. 02.
4. Finite element Method, Reddy J N.,Tata McGraw Hill publishing Co Ltd, New Delhi, 3rd Ed., 05
5. Finite Element Procedures in Engineering Analysis, Bathe K.J., Cliffs, N.J., PHI Learning, EEE Ed., 9.
6. Finite Element Analysis, G R Buchanan, R Rudramoorthy, McGraw-Hill, Schaum's outlines
7. The Finite Element Method in Engineers, S. S. Rao, Elsevier Science & Technology Books
8. Finite Element Method, O.C. Zinckewitcz, McGraw Hills

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 601C**						
Category	**Programme Core**						
Course Title	**Dissertation (Phase-I)**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	0	0	20	10	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

Contents

The objective of this course is to develop in students the capacity for analysis & judgment and the ability to carry out independent investigation in design/development through a dissertation work involving creativity, innovation and ingenuity. The work should start with comprehensive literature search and critical appreciation thereof so as to select a research problem and finalize the topic of dissertation.

Each student will carry out an independent dissertation under the supervision of a supervisor; in no case, more than two supervisors may be associated with one dissertation work. The first supervisor must be from the department, however, for interdisciplinary research work,the second supervisor may be from the other department of the university/ outside the university/industry. In the latter case, a consent of the second supervisor with justification thereof needs to be submitted to the dissertation coordinator.

The Dissertation (Phase-I) involving literature survey and problem formulation along with data collection (if required) commences in 3rd semester & will be completed as Dissertation (Phase-II) in 4th semester. Each student will be required to present two seminar talks, first towards the beginning of the Dissertation (Phase-I) to present the scope of the work and to finalize the topic, and the second towards the end of the semester, presenting the progress report containing literature survey, partial results (if any) of the work carried out by him/her in the semester. The student will be required to submit one copy of spiral-bound progress report to the M. Tech. Coordinator.

Internal evaluation of Dissertation (Phase-I) will be done by following committee:

1. Chairperson / Head of Department / Nominee : Chairperson
2. M.Tech. Coordinator/Senior Faculty : Member-Secretary
3. Respective Dissertation Supervisor(s) : Member(s)

Final exam will be conducted by the internal examiner (M. Tech. Coordinator/Faculty nominated by Chairperson) &an external examiner to be appointed by Controller of Examinations from a panel of examiners submitted by the Dept.

For this course, M. Tech. coordinator will be assigned a load of 1 hour per week excluding his/ her own guiding load. Dissertation supervisor (guiding teacher) will be assigned a load of 1 hour per week for the first student and additional 1 hour per week (for their own department only) for the subsequent student(s) subject to a maximum load of 2 hours. Workload allocated for the joint supervision within the department will be treated as half for each supervisor.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 602C**						
Category	**Programme Core**						
Course Title	**Dissertation (Phase-II)**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	0	0	32	16	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

Contents

The Dissertation (Phase-II) shall be the extension of Dissertation (Phase-I) carried out in 3rd semester. Each student will be required to present three seminar talks, first at the beginning of the semester to present the progress made during the winter break; second in the middle of the semester involving partial results obtained and comparative analysis; and third towards the end of the semester, presenting the dissertation report of the work carried out. Each student will be required to submit two copies of dissertation report to M.Tech. Coordinator. The committee constituted by the Chairperson of the department will screen all the presentations so as to award the sessional marks.

INTERNAL ASSESSMENT:

The internal assessment (Class-work evaluation) will be effected through presentation and discussion thereon by the following committee:

1. Chairperson/Head of Department / Nominee : Chairperson
2. M.Tech. Coordinator/Senior Faculty : Member-Secretary
3. Respective Dissertation Supervisor(s) : Member(s)

EXTERNAL ASSESSMENT:

Dissertation will be evaluated by the following committee:

1. Chairperson/Head of the Department / Nominee : Chairperson
2. Respective Dissertation Supervisor(s) : Member(s)
3. External Expert : To be appointed by the University.

For this course, supervisor(s) will be assigned a load of 2hours per week for the first student and additional 1 hour per week for the subsequent student(s) subject to a maximum load of 3 hours. Workload allocated for the joint supervision within the department will be treated as half for each supervisor.

NOTE: There is a desirable requirement of one publication in a UGC-listed journal / unpaid journal. The external expert must be from the respective area of the specialization. Chairperson & M.Tech. Coordinator in mutual consultation will divide the submitted dissertations into groups depending upon area of specialization and recommend the list of experts for each group separately to the Vice-Chancellor for selecting the examiners (*one examiner for not more than four students of a group*).

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MED 531C**						
Category	**Programme Elective – I**						
Course Title	**Multi-body Dynamics**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	

Detailed Contents

S. No.	Contents
Unit - I	**Dynamics of Multi-Body in Plane**: The Method of Constraints for Planar Kinematic Analysis; Revolute, Prismatic, Gear and Cam Pairs are Considered together with Other 2 Degrees-of-Freedom Types of Constraints; The Automatic Assembly of the Systems of Equations for Position, Velocity and Acceleration Analysis; The Principle of Virtual Work and Lagrange's Equations; Dynamics of Planar Systems; Systematic Computation and Assembly of Mass Matrix; Computation of Planar Generalized Forces for External Forces and for Actuator-Spring-Damper Element; Simple Applications of Inverse and Forward Dynamic Analysis; Numerical Integration of First-Order Initial Value Problems; The Method of Baumgarte for the Solution of Mixed Differential-Algebraic Equations of Motion; The Use of Coordinates Partitioning, QR and Singular Value Decomposition (SVD)Decomposition for the Orthogonalization of Constraints.
Unit – II	**Kinematics of Rigid Bodies in Space:** Reference Frames for the Location of a Body in Space; Euler Angles and Euler Parameters; The Formula of Rodrigues; Screw Motion in Space;Velocity, Acceleration and Angular Velocity; Relationship between the Angular Velocity Vector and the Time Derivatives of Euler Parameters.
Unit – III	**Kinematic Analysis of Spatial Systems:** Basic Kinematic Constraints; Joint Definition Frames; The Constraints Required for the Description in Space of Common Kinematic Pairs (Revolute, Prismatic, Cylindrical, Spherical); Equations of Motion of Constrained Spatial Systems.
Unit - IV	**Computation of Forces**: Computation of Spatial Generalized Forces for External Forces and for Actuator-Spring-Damper Element. Computation of Reaction Forces From Lagrange's Multi- Pliers.

Text Books

1. Dynamics of Systems of Rigid Bodies, Wittenburg, J., B.G. Teubner, Stuttgart
2. *Dynamics: Theory and Applications*, Kane, T.R, Levinson, D.A., McGraw-Hill Book Co.

Reference Books

1. Computer Aided Analysis of Mechanical Systems, Nikravesh, P.E, Prentice-Hall Inc., Englewood Cliffs, NJ
2. Dynamics of Multibody Systems Roberson, R.E., Schwertassek, R, Springer-Verlag, Berlin
3. Computer-Aided Kinematics and Dynamics of Mechanical Systems-Basic Methods, Haug, E.J., Allyn and Bacon
4. Multibody Dynamics, Huston, R.L Butterworth-Heinemann, 1990.
5. Multibody Systems Handbook, , Schielen, W. *ed.* Springer-Verlag, Berlin, 1990.
6. Computational Dynamics, Shabana, A.A., John Wiley & Sons, 1994.

Note: For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of

students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEI 531C**						
Category	**Programme Elective – I**						
Course Title	**Technology and Manufacturing Strategies**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Competitive Strategy Planning:** Levels of Strategy, Formulation of Corporate Strategy- Identification, Development Implementation and Monitoring Phase, **Manufacturing Competitiveness**: Performance Objectives of Manufacturing Competitiveness, Internal and External Effect of Performance Objectives, Manufacturing Focus and Segmentation, Scenarios Planning- PEST Analysis, Porter Five Force Model
Unit – II	**Manufacturing Strategy:** Manufacturing Strategy, Perspective of Manufacturing Strategy, Linking of Manufacturing Strategy with Corporate Strategy, Structural and Infrastructural Issues, Content and Process Approach of Manufacturing Strategy, Order Winning and Qualifying Competitive Factors, Process of Formulating & Implementing Manufacturing Strategy. **New Manufacturing Philosophies:** Core Constituent Systems of World Class Manufacturing, Directions of Development in WCM, Six Sigma and its Methodology, Brief Concept of Industrial Wastes, Lean Manufacturing Techniques, JIT, TQM, Reverse Engineering and Industry 4.0 Concept
Unit – III	**Strategic Technology Management:** Manufacturing Technology, Technology Strategy and Technology Management, Business Strategy and Technology Management. Dimensions of Technology Management, Role of Chief Technology Manager, Competitive Importance of Strategic Management of Technology **Technology Development:** Product Development Cycle & Its Problems, Managing Technology for New Product, Managing Product Development Capability, Technological Innovation - Context and Opportunities, Technology Absorption and Structure, Technology Fusion- Its Principles
Unit - IV	**Organizational Support Systems:** Organization Culture, Organization Structure for Technology Management, Organizational Flexibility-Need, Nature and Its Attributes, Content and Essence of Organizational Culture, Culture Building, Managerial Style and Practices, Role of Manager in Organization Design, Strategic Issues of Organization Culture - Creative Miller's Theory, Learning Organization- Senge's Theory, Phases of Learning

Text Books

1. Management of Technology & Innovation, P.N. Rastogi, Sage Publiation
2. Operations Management, Nigel Slack and Michael Lewis, Pearson Publications

Reference Books

1. The Essence of International Business, Taggart & McDermott, PHI, New Delhi
2. Manufacturing Strategy, T.Hill , Macimillan
3. Operations Management, Schroeder, McGraw Hill, ISE
4. Manufacturing - The Formidable competitive Weapon, W. Skinner, Wiley
5. Manufacturing Advantage , Nigel Slack, Viva Books, New Delhi
6. The Essence of Competitive Strategy, Faulkner & Bowman, PHI, New Delhi

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEP 531C**						
Category	**Programme Elective – I**						
Course Title	**Advanced Operations Management**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Introduction:** Operations management and its domain, Brief review of Operations strategy and competitiveness, Measures of manufacturing performance, Types, characteristics and performance metrics of manufacturing systems. **Facility Planning and Design:** Objectives, parameters and methodology for plant location decision, Methodologies for Process and Product based layout design, Computerized layout Planning, Assembly line balancing, Group Technology and methodologies for GT based layout planning; Production flow analysis, Economic analysis of facility alternatives, Numerical Problems
Unit – II	**Product Design Process:** Strategies for new product introduction, Brief review of Product development process, Modular product design and its advantages, Case example of product and process design through Quality function development (QFD). **Demand Management:** Role of Forecasting in Operations function, Strategic Capacity Planning, Types of forecasting, quantitative technique in forecasting, time series analysis, Regression models and focus forecasting, Forecast accuracy and its importance in enterprise performance. **Operations Planning:** Different Operations Planning Activities, Aggregate planning: Objectives, strategies and models, Master Production schedule (MPS) and methodologies for MPS, Different operations scheduling techniques. Role of Simulation in operations scheduling.
Unit – III	**Materials Management:** Brief review of inventory control policies, inventory management technique and various Inventory costs, Models for inventory control under stochastic demand and lead times, Materials Requirement Planning (MRP) Manufacturing Resource Planning (MRP II) and ERP, Case example on MRP, Use of Simulation in Inventory control. **Performance Improvement Tools in Manufacturing:** JIT manufacturing philosophy and its implementation tools, Concept of single and Double KANBANS Systems, Design of number and size of KANBANS, Brief review of Concepts of TOC, Lean and Agile Manufacturing.
Unit - IV	**Supply Chain Management:** SC and its objectives, Decisions domains and phases in SC, Competitiveness and Supply Chain Strategies, Obstacles in achieving Strategic Fit, Drivers of Supply Chain Performance, Role of Forecasting in Supply Chains. Brief review of analytic models for cycle and Safety inventory in supply chain. Use of Simulation in SC decisions. **SC Initiatives:** Evaluation of Cycle and Safety Inventory and their role in SC, Issues in SC Logistics, The Role of Sourcing in Supply Chain performance, Third- and Fourth-Party Logistics, Coordination in Supply Chain and Bullwhip Effect, Continuous Replenishment and its benefits, Vendor-Managed Inventory, Collaborative Planning, Forecasting, and Replenishment (CPFR), Role of IT in SC Coordination, Core competence, Customization, Outsourcing and Postponement as SC initiatives, other SC paradigms

Text Books

1. Production & Operations Management, R.B. Chase, N.J. Aquilano & F.R. Jacobs, Tata McGraw Hill
2. Supply Chain Management, Sunil Chopra, Peter Meindl, D.V. Kalra, Pearson Education Asia, New Delhi

Reference Books

1. Production and Operations Management, B. Mahadevan, Pearson Education Asia, New Delhi
2. Manufacturing Planning and Control Systems, T.E. Vollmann, W.L. Berry and D.C. Whybark, Irwin, Illionois, USA
3. Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies, David Simchi-Levi, Philip , Kaminsky, Edith Simchi-Levi, Ravi Shankar, Tata McGraw Hill
4. Modern production /Operations Management, E.S. Buffa and R.K.Sarin , John Wiley

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MET 531C**						
Category	**Programme Elective**						
Course Title	**Thermodynamics and Combustion**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Introduction:** Review of first and second law of thermodynamics, Maxwell equations, Joule-Thompson experiment, irreversibility and availability, exergy analysis.
Unit – II	**Phase transition:** First and second order phase transition; types of equilibrium and stability, multi-component and multi-phase systems, equations of state. **Reaction thermodynamics**: chemical reaction, Gibbs function; fugacity, activity and enthalpy of formation; absolute entropy and Third law of thermodynamics.
Unit – III	**Combustion**: Types of reactions, reaction rate, effect of composition and temperature on reaction rates. Arrhenius law, kinetics of chain reactions, steady state reaction rate. **Detonation:**—waves in gases. Hurgoniet curve, detonation velocity. Detonation theories, Factors influencing detonation. Adiabatic Explosion in constant volume bombs. Flame propagation-Theories, structure of Laminar flame, flame velocity and its estimation, factors controlling flame velocity, diffusion in laminar and turbulent flames, stabilization of flame. Introduction to Ignition theory, Ignition energy, factors affecting ignition
Unit - IV	**Kinetic Theory of Gases:** introduction, basic assumption, molecular flux, collisions with a moving wall, principle of equipartition of energy, classical theory of specific heat capacity. **Transport Phenomena:** intermolecular forces, The Vander Waals equation of state, collision cross section, mean free path. Statistical thermodynamics- introduction. Application of statistics to gases-mono-atomic ideal gas.

Text Books

1. Advanced Engineering Thermodynamics 3rd edition, A. Bejan, John Wiley and sons, 2006.
2. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, F.W.Sears and G. L. Salinger,, Narosa Publishing House, New Delhi, 3rd edition, 1998.
3. Heat and Thermodynamics, M. W. Zemansky and R. H. Dittman, Mc Graw Hill International Editions, 7th edition, 2007

Reference Books

1. Fundamentals Of Engineering Thermodynamics, M.J.Moran and H.N.Shapiro, John Wiley and Sons.
2. Advanced Engineering Thermodynamics, I. K. Puri and K. Annamalai, CRC Press, 2001.
3. Fundamentals of Classical Thermodynamics, Wylen and Sontag, Wiley Eastern Limited, New Delhi.
4. Combustion engineering, Gary L. Borman, Kenneth W. Ragland, McGraw-Hill, 1998.
5. An introduction to combustion, Stephans R Turns, McGrawHill,1996.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MED 533C**						
Category	**Programme Elective – II**						
Course Title	**Advanced Stress Analysis**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	Concept of stress and State of stress at a point and its tensor representation; stress equations of equilibrium in Cartesian coordinates. Concept of strain and State of strain representation in tensor form; Concept of stress field, strain field, and displacement field; Constitutive relations among them; Equilibrium in terms of strains and displacements; Types of Boundary conditions; solution of equilibrium equations for plane stress and plane strain cases.
Unit – II	Transformation of stresses using elementary tetrahedran, principal stresses and 3D Mohr's circle,Theories of static failure in terms of principal stresses –normal stress, shear stress, distortion energy, and Von Mises (octahedral stress). Compatibility – concept, need and physical significance, equations of compatibility; compatibility equations for plane stress and plane strain cases.
Unit – III	Critical review of pure torsion, simple bending, buckling and deflection formulae with simple applications; Limitations of simple bending formula, Unsymmetrical bending: concept of shear centre, deflection under unsymmetrical bending. Limitations of Euler's buckling; beam-column equation.
Unit - IV	Axisymmetric problems: Equilibrium equations in cylindrical coordinates for axisymmetric cases; Stresses in thick walled cylinder under internal and external pressure Lame's Problems, Stresses in rotating disk, cylinder and shaft; Stresses in composite tubes- shrink fits.

Text Books

1. Using multivariate statistics, Tabachnick, B. G., &Fidell, L. S., Pearson Prentice Hall.
2. Design and Analysis of Experiments, Montgomery, D.C., John Wiley and Sons

Reference Books

1. Advance Mechanics of Solids, Srinath, TMH
2. Theory of Elasticity, Timoshenko and Goodier, McGaw Hill Intl Publication, 3rd edition.
3. Mechanics of Solids, Popov

Note: For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEI 533C**						
Category	**Programme Elective – II**						
Course Title	**Quality Engineering and Management**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Quality Management:** **Quality of products and services:** meaning of quality, importance of quality, evolution of total quality control, contribution of Deming, Juran and others in the field of quality, Quality: Responsibility to society, Quality challenges facing industry. Demand for quality, productivity, technology and the internationalization of quality, factors controlling quality. **Quality Improvement:** Old tools for quality, six sigma introduction, DMAIC etc., Quality costs, Systems approach to quality, establishing quality system, TQM or Total Quality control, Quality awards, ISO 9000 quality system standards etc., Design for quality
Unit – II	**Managerial Concepts:** **Process management:** Functional Vs process management, selection of processes, organize the process team, planning phase of process management, transferring and managing the new process, impact of process management on an organization, Organizing for quality: evolution of organization for quality, organization for quality activities, role of upper management, role of director, role of middle management, workforce, teams, selection and training etc. **Strategic Quality Control:** Elements of strategic quality management, integrating quality into strategic management, new tools for quality, Developing a quality culture, achieving commitment to quality: Technology and culture, theories of motivation, corporate culture, Quality culture, provide quality goals and measurement at all levels, management leadership, self development and empowerment, etc.
Unit – III	**Functional Applications:** **Understanding customer needs:** Identify the customers, customer behavior, scope of human needs and expectations, sources of market quality information, market research in quality, measuring customer satisfaction, Designing for quality: Design for basic functional requirements (QFD), designing for reliability, safety, manufacturability, cost and product performance, design review, concurrent engineering, etc. **Supply chain management:** Supplier relations – a revolution, scope of activities for supplier quality, supplier selection, assessment of supplier capability, supply chain quality planning, quality control and improvement, Quality in Manufacturing Sector and service sector- Comparison, service quality model.
Unit - IV	**Statistical Technology for Quality:** **Descriptive statistics:** data collection and presentation, measures of central tendency, probability distributions; Inferential Statistics: Drawing conclusions on product and process quality- Sampling distribution, estimation of product and process parameters- point estimation, interval estimation. Hypothesis testing. **Control Charts:** causes of variation, control charts for variables and attributes, Sampling: advantages and disadvantages of sampling, Operating characteristic curve, Process capability: Introduction, specification limits and control limits, process capability indices, six sigma, and Taguchi robust technique.

Text Books

1. Quality planning and analysis, J M Juran and Frank M Gryna, Tata McGraw Hill

Reference Books

1. Fundamentals of Quality Control and Improvement,Amitava Mitra, Printice Hall Inc.
2. Managing for Total Quality, N. Logothetis, Prentice Hall; International Edition

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEP 533C**						
Category	**Programme Elective – II**						
Course Title	**Analysis of Manufacturing Processes**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Advance Tools and Materials for Manufacturing** Cutting Tools and Materials: Advances in cutting tool material, Coating characteristics, Selection and application of advance materials in manufacturing. **Machinability of Materials:** Mechanics of metal cutting, Cutting fluids and lubrication system, Analysis of cutting forces, Machinability of materials, Surface integrity of machined surface, Micro machining, Economics of Machining, problems
Unit – II	**Bulk Deformation Processes** Introduction: Introduction to metal forming, Classification of metal forming, Plastic deformation and yield criteria, Friction and lubrication in metal forming, Defects in metal forming. **Mechanics and analysis of forming processes:** Forging, Rolling, Extrusion and Wire drawing processes, problems.
Unit – III	**Metal Casting** **Introduction:** Introduction to casting process, Solidification of Metals, Progressive and directional solidification, Rate of solidification, Chvorinov's rule, Residual stresses in casting, Inspection of casting. **Gating Systems:** Gating systems and their characteristics, Analysis of gating and riser system design, problems.
Unit - IV	**Welding Technology and Metallurgy** **Introduction:** Welding Techniques and their emerging Trends. Weldability: Factors affecting weldability of materials. Heat affected zone and its characteristics, Residual stresses, Pre and post welding treatments, Welding joint design, Principles of sound weld design. **Testing of weldments:** Destructive and Non-destructive testing for weldments.

Text Books

1. Manufacturing Science, A. Ghosh, and A. K. Mallik, Affiliated East-West Press Pvt. Ltd. New Delhi.
2. Metal Cutting Principles, M.C. Shaw, Oxford Clarendon Press
3. Welding Engineering and Technology, R. S. Parmar, Khanna Publishsers

Reference Books

1. Metal Cutting Theory and Practice, Bhattacharya , New Central Book Agency
2. Fundamentals of Metal Cutting and Machine Tools, B.L. Juneja and G.S. Sekhon,
3. Principles of Manufacturing Materials & Processes, J. S.Campbell , Publisher Mc Graw Hill
4. Meta Casting: Principles and Practice, TV Rammana Rao,
5. Principle of Metal casting, Rosenthal

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MET 533C**						
Category	**Programme Elective**						
Course Title	**Refrigeration and Air Conditioning Systems Design**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Refrigeration:** Environmental impact of HVAC systems; Alternative, green Refrigerants and mixed refrigerants; their selection and properties. Analysis of VCR cycle-multistage, multi-evaporator and cascade systems. ;manufacturing of dry ice; Advanced refrigeration cycles like dedicated and integrated mechanical sub-cooling etc.
Unit – II	**Thermal Design:** Compressors; evaporators –DX type etc, Condenser – water and air cooled, Capillary design. **Analysis of vapour absorption cycles**: Aqua ammonia and LiBr-water cycles. Absorber and Generator design of vapor absorption system.
Unit – III	**Air Conditioning**: Psychometric processes, air conditioning calculations; design conditions, solar heat gains through structures. ASHRE simplified calculation procedure for Cooling and heating load calculations for design of Summer and winter air conditioning. Comfort air conditioning, comfort scales. **Design of air conditioning equipments:** cooling and dehumidifying coils. Air distribution systems - duct design, air handling units, Energy recovery and thermal storage, Indore air quality, various dehumidification technologies, commercial software used for air conditioning load calculations
Unit - IV	**Refrigeration and Air-Conditioning Technologies:** Vortex tube; thermo-electric, thermo-acoustics; desiccant cooling- solid and liquid systems; steam jet refrigeration.

Text Books

1. Refrigeration and Air-conditioning ,,CP Arora, Tata-Mc Graw Hill.
2. Refrigeration and Air-conditioning, W.F. Stockers Tata-Mc Graw Hill.
3. Design of Thermal Systems, W.F. Stockers, MH, New York

Reference Books

1. Heating , Ventilating &Air Conditioning Analysis and Design, McQuiston Parker, Wiley
2. ASHRE Handbook, American Society of heating, refrigerating and Air-Conditioning Engineers, ASHRE

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Department	Mechanical Engineering					
Program Name	Master of Technology in Mechanical Engineering					
Program Level	PG					
Course Code	**MED 530C**					
Category	**Programme Elective - III**					
Course Title	**Advanced Vibrations and Acoustics**					
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**	
	3	0	0	3	3 hours	
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**
	As per Ordinance			**Total**		
				25	75	100

Detailed Contents

S. No.	Contents
Unit - I	**Introduction to Vibrations:** Concept of free and forced vibration using spring mass model, governing equation and response to an initial disturbance for an undamped spring mass system; Concept of linear and non-linear vibratory system. Damping models with stress on viscous damping; energy methods for determining natural frequency Response To Harmonic Excitations: Harmonic Excitations of Undamped and damped systems, Base excitations,Rotating unbalance
Unit – II	**Multi Degree Freedom System :** Concept of mode shape through 2- DOF system model Eigen value problems close coupled system and far coupled system;orthogonality of mode shapes.Dunkerieys lower bound approximation, Rayleighs upper bound approximation; Vibration Isolation And Control : Acceptable levels of vibration, vibration isolation: active and passive isolation,Vibration absorbers, critical speed of rotating disc,
Unit – III	**Vibration Measurement:** Basic vibration measuring set up amplitude and phase measurement; vibration pick- ups general construction and working principle of piezoelectric accelerometer and eddy current based displacement probe; filters- unfiltered and filtered signals; Display devices- vibration analyzer and oscilloscope; generalconstruction and working principle of electro-dynamic vibration shaker. **Condition Monitoring :** Fourier series &Fourier Transforms, Fast Fourier Transform (FFT), concept of time domain and frequency domain.Condition Monitoring Philosophy its need and types; concept of 1X, 2X, 3X, ---vibration signals in a rotating machines
Unit - IV	**Introduction to Acoustics:** Plane acoustic waves, Sound speed, characteristic acoustic impedance of elastic media, sound intensity, dB scale, Transmission Phenomena, transmission from one fluid medium to another,sound power,determination of sound power and intensity levels at a point due to a simple source. **Psychoacoustics:** Speech, mechanism of hearing, thresholds of the ear -sound intensity andfrequency, loudness, equal loudness levels, loudness, pitch and timbre, beats, masking by puretones, masking by noise.

Text Books

1. Theory and Practice of Mechanical Vibrations, Rao J S and Gupta K, New Age Publication.
2. Theory of Vibration with applications, William T Thomson, Pearson

Reference Books

1. Mechanical Vibrations, S S Rao , Pearson Education
2. Fundamentals of Acoustics, Lawrence E. Kinsler, Wiley india Pvt. Ltd
3. Fundamental of Vibration, L Meirowitch , McGraw-Hill Education

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students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEI 530C**						
Category	**Programme Elective - III**						
Course Title	**Statistical Decision Making**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Probability and Probability Distributions:** Basic concepts of Probability, Discrete Probability, Distributions, Continuous Probability Distributions. Basic Concepts Concerning Testing of Hypothesis, Procedure of Hypothesis Testing, Tests of Hypothesis, Important Parametric Tests, Limitations of The Tests of Hypothesis, Chi Square Test, Problems
Unit – II	**Measurement scales, source of error in measurement, tests of sound measurement, scaling:** meaning and classification, Scaling techniques **Sampling:** Definitions, Need and Distributions, Sampling Theory, Sample Size and its Determination, Sample Survey, Sample Selection and Sampling Procedure; Sampling Design: Types, Characteristics and Implications, Steps in Sampling Design, Problems.
Unit – III	**Multivariate Techniques:** Growth, Characteristics and Applications, Classification of Multivariate Techniques, Variables in Multivariate Analysis, Factor Analysis: Important Methods and Rotation, R-Type and Q-Type Factor Analysis, Path Analysis, Problems. Important Non Parametric Tests and Their Characteristics, Relationship Between Spearman's R's and Kendall's W.
Unit - IV	**Design and analysis of experiments:** Need, Terminology, Strategy of Experiments, Basic Principles, Guidelines for Designing Experiments, Introduction to Randomization, Blocking and Confounding **Factor Design:** Basic Definitions and Principals, Advantage of Factorials, 2- Factor Factorial Design, General Factorial Design, Problems.

Text Books:

1. Tabachnick, B. G., & Fidell, L. S., "Using multivariate statistics", Pearson Prentice Hall.
2. Montgomery, D.C. "Design and Analysis of Experiments", John Wiley and Sons.

Reference Books:

1 Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. "Multivariate data analysis", Pearson India.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEP 530C**						
Category	**Programme Elective - III**						
Course Title	**Advanced Material Processing**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Classification and characteristics of Materials:** Metals, Ceramics, Polymers and composites. **Composites :** Definition, classification and characteristics of composite materials - volume fraction - laminated composites particulate composites, fibrous composites - types of reinforcements, their shape and size - production and properties of fiber reinforced plastics, metal matrix composites and ceramic matrix composites - applications.
Unit – II	**Powder Metallurgy:** Introduction, recent advances in powder metallurgy, powder testing and evaluation, mixing and blending, compacting, advances in sintering, hot isostatic pressing, spark discharge sintering, gravity sintering, induction sintering, sinter hip process, ceracon process, ospney process, metal inspction molding, design ofpowder metallurgy parts, property of powder metallurgy product, advantages and disadvantages of powder metallurgy
Unit – III	**Additive Manufacturing processes:** Introduction, additive manufacturing technology in product development-materials for additive manufacturing technology, tooling, rapid prototyping (RP) processes, fundamentals of rapid prototyping, classification of R.P, process parameters, capability and products, application of various methods. rapid protyping and direct digital manufacturing, layerwise manufacturing, liquid, powder and deposition based process application of r.p. in manufacturing and rapid tooling.
Unit - IV	**Selection,Treatment and properties of alloy steels**: Selection and application of steel, Heat treatment of alloy steels, tools and dies steels, stainless steels creep resistance, Ultra high strength steels, Heat treatment of carbon steels, various types of tool steels, high speed steels, maraging steels and die steels, Transformations on heating and cooling, influence of alloying elements, general principles of heat treatment of steels, isothermal and continuous cooling transformations in steels.

Text Books

1. Material and processes in Manufacturing, JT Black, Wiley publication

Reference Books

1. Fundamental of Modern manufacturing, MP Groover, Wiley Publication
2. Modern material and manufacturing processes, R.Gregg Bruce, Pearson publication

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MET 530C**						
Category	**Programme Core**						
Course Title	**Advanced Heat Transfer**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Introduction:** Reviews of basic laws of Conduction, Convection and Radiation, Steady State Heat Conduction: Thermal insulation problem, Extended surfaces- Fins with uniform cross-sectional area, Fins variable cross-sectional area- circumferential, triangular and parabolic shape, Fin effectiveness and efficiency, thermal contact resistance. Methods for the solution of the Multi-Dimensional heat conduction problem: Analytical Method of momentam and energy equation, Electrical Analogy, Numerical Methods, Numericals.
Unit – II	**External Flow And Forced Convection:** Introduction, Exact and approximate integral solutions for the flow over flat plate, hydrodynamic & thermal boundary layer, boundary layer thickness, drag coefficient , mean drag coefficient, The local & average heat transfer coefficient, mass flow through the boundary, Turbulent flow over flat plate, Reynolds analogy, Reynolds-Colburn analogy, Drag & heat transfer in mixed boundary layer, Flow over curved surfaces, Cylinder, Sphere, Cross flow over banks of tubes, Numericals.
Unit – III	**Internal Flow And Forced Convection**: Introduction, Entrance region, Fully developed region, Mean velocity, Mean temperature, Governing differential equation and velocity profile for fully developed laminar tube flow, Hagen-Poiseuille equation, Fanning friction coefficient, Heat transfer for fully developed laminar tube flow: Governing differential equation, heat transfer coefficient for constant wall temperature and constant wall heat flux boundary conditions, Velocity distribution in turbulent flow through pipe, Fluid friction, Convection Correlations for turbulent flow in tubes: Reynolds Analogy, Reynolds-Colburn analogy, Dittus- Boelter equation, Sieder and Tate equation, Petukhov expression, Numericals. Two Phase Heat Transfer: Heat Transfer with Change of Phase: Laminar film condensation on a vertical plate, Drop-wise condensation, Boiling regimes, Nucleate and film boiling, Heat pipe.
Unit - IV	**Heat Exchangers:** Classification and selection of heat exchangers, Some important definitions, Heat Exchanger Analysis: Use of LMTD, Multipass heat exchangers, Effectiveness – NTU Method, Plate heat exchanger, evaporative tubular heat exchanger, Evaporative Effectiveness, Dryout heat flux, Simulation of heat exchangers, Pressure drop and Pumping power, Optimisation of heat exchanger size, Numericals. **Thermal Radiation:** Review of basic laws for radiation-, Black body concept, gray body radiation, Solar radiations, Radiation between surfaces- Shape factor and correlations, Radiation exchange between surfaces in black enclosure, Network representation, Radiation exchange in gray enclosure, apparent emissivity of a cavity, Radiation shields, Radiations in emitting and absorbing media.

Text Books

1. Fundamentals of Heat and Mass Transfer, Frank P. Incropera, John Wiley & Sons, New York
2. Fundamentals of Engineering Heat and Mass Transfer, R C Sachdev, New Age International (P) Limited, New Delhi
3. A Course in Heat and Mass Transfer, Arora and Domkundwar, Dhanpat rai publication

Reference Books

1. Fundamentals of Heat and Mass Transfer, Sarit K. Dass, Narosa Publishing House, New Delhi
2. Heat & Mass Transfer, P.K. Nag, Tata-McGrawhill, New Delhi.
3. Heat Transfer, J.P. Holman, Tata-McGrawhill, New Delhi.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MED 532C**						
Category	**Programme Elective - IV**						
Course Title	**Analysis and Synthesis of Mechanisms**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Kinematics of Planar Mechanism:** Basic Concepts; Definitions and Assumptions; Planar and Spatial Mechanisms; Kinematic Pairs; Degree of Freedom; Equivalent Mechanisms; Kinematic Analysis of Planar Mechanisms. Graphical and Analytical Methods of Velocity and Acceleration Analysis of Mechanisms, Corioli's Acceleration.
Unit – II	**Mechanism Synthesis-I:** Number Synthesis; Dimensional Synthesis; Kinematic Synthesis of Planar Mechanisms; Accuracy (Precision) Points; Chebesychev Spacing; Types of Errors; Graphical Synthesis For Function Generation and Rigid Body Guidance With Two, Three And Four Accuracy Points Using Pole Method; Centre and Circle Point Curves; Analytical Synthesis of Four-Bar and Slider-Crank Mechanisms.
Unit – III	**Mechanism Synthesis-II:** Freudenstein's Equation; Synthesis for Four and Five Accuracy Points; Compatibility Condition; Synthesis of Four-Bar for Prescribed Angular Velocities and Accelerations Using Complex Numbers; Three Accuracy Point Synthesis Using Complex Numbers.
Unit - IV	**Kinematics of Spatial Mechanism:** Kinematic Analysis of Spatial Mechanisms; Denavit-Hartenberg Parameters; Matrix Method of Analysis of Spatial Mechanisms.

Text Books

1. Kinematic Synthesis of Linkages, R.S. Hartenberg and J. Denavit, McGraw-Hill, NewYork,
2. Design of Machinery, Robert L.Nortan, Tata McGraw Hill Edition

Reference Books

1. Mechanisms and Dynamics of Machinery, Hamilton H.Mabie, John Wiley and sons NewYork.
2. Mechanisms for Engineering Design, S.B.Tuttle, John Wiley and sons New York
3. Theory of Machines and Mechanisms, A. Ghosh and A.K. Mallik, Affiliated East-West Press, New Delhi, 1988.
4. Mechanism Design – Analysis and Synthesis, (Vol. 1and 2) , A.G. Erdman and G.N. Sandor, Prentice Hall India, 1988.
5. Kinematics and Linkage Design , A.S. Hall, Prentice Hall of India.
6. Theory of Machines and Mechanisms, J.E. Shigley and J.J. Uicker, McGraw-Hill, 1995.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEI 532C**						
Category	**Programme Elective - IV**						
Course Title	**Non Traditional Machining**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Introduction to Non Traditional Machining** **Introduction:** Introduction, classification, characteristics, applications, limitations & need of non -traditional machining processes. **Mechanical Processes:** introduction to ultrasonic machining, elements of process, brief review of cutting tool system design, mechanics of cutting, effects of process parameters, economics consideration. Introduction to abrasive jet machining, variables in AJM, analysis of, material removal rate, applications, brief review of water jet machining, problems.
Unit – II	**Thermal Metal Removal Processes** **Electric Discharge Machining:** Introduction to electric discharge machining, spark erosion machining process, analysis of metal removal rate, dielectric fluid, electrode feed control, selection of electrode material, electrode design, surface effects and accuracy, machine tool selection, application. **Electron Beam Machining:** Theory of electron beam machining, generation and control of electron beam, Controlling parameters and focal distance, Process capability and limitations, Application.
Unit – III	**Electro Chemical Metal Removal Process** **Electrochemical Machining**: Elements of ECM, Analysis of Metal removal rate, tool design, accuracy, surface finish and other work material characteristics, economics of ECM. **Electrochemical grinding and electrochemical deburring**: Introduction, special characteristics as compared to other processes, advantages, limitations and applications.
Unit - IV	**Micro-Machining** **Micromachining:** Introduction to micromachining, classification of micromachining, mechanical advanced micromachining processes. Principles, mechanism of material removal, process parameters and applications of ultrasonic micro machining, thermal advanced micromachining processes, electro discharge micromachining and abrasive jet micro machining.

Text Books

1. Non-Conventional Machining, P. K. Mishra, Narosa Publication
2. Manufacturing Science, A. Ghosh, A. K. Mallick, East West Publication

Reference Books

1. Modern Machines Process, P. C. Pandey, H. S. Shan, Tata McGraw Hill
2. Advanced Methods of Machining, J.A. McGeough, Springer International Edition
3. Advanced Machining Processes, H El-Hofy, McGraw Hill Publication

4. Introduction to Micromachining, V.K.jain, Narosa publishing House, New Delhi
5. Micromachining Using Electrochemical Discharge Phenomenon, R. Wuthrich, William Andrew

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEP 532C**						
Category	**Programme Elective - IV**						
Course Title	**Industrial Automation**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Introduction to Automation:** Definition, Introduction to Automation-Definition, Types, Merits and Criticism, Architecture of Industrial Automation Systems, Manufacturing Plants and Operations Automation Strategies, Basic Elements of Automated System, Advanced Automation Functions, Levels of Automation
Unit – II	**Industrial Control Systems:** Process and Discrete Manufacturing Industries, Continuous and Discrete Control Systems, An Overview of Computer Process Control, Fundamentals of Numerical Control Technology, Computers and Numerical Control, Actuators & Sensors, Analog-Digital Conversions, Input and Output Data Devices for Discrete Data, Analysis of Positioning Systems, NC Part Programming
Unit – III	**Industrial Robotics:** Robot Anatomy and Related Attributes, Robot Control Systems, End Effectors, Application of Industrial Robot, Classification of Robots, Robot Programming, Robot Accuracy and Repeatability **Material Handling and identification:** Overview of Material Handling, Material Transport Equipments, Analysis of Material Transport Systems, Introduction to Storage Systems, Conventional Storage Methods and Equipments, Automated Storage Systems, Analysis of Storage Systems, Overview of Automatic Identification Systems, Bar Code Technology
Unit - IV	**Manufacturing Systems:** Components of Manufacturing System, Types of Manufacturing Systems, Single Station Automated Cells, Analysis of Single Station Cells, Fundamentals of Automated Production Lines, Application of Automated Production Lines, Analysis of Transfer Lines, Fundamentals of Automated Assembly Systems, Cellular Manufacturing, Analysis of Cellular Manufacturing, FMS Components, Analysis of Flexible Manufacturing Systems, Automated Inspections, Analysis of Inspection system

Text Books

1. Automation, Production systems and Computer integrated Manufacturing, Mikell. P Groover, Prearson Publication India
2. Introduction to Robotics, Mechanics and control, John J Craig, Addison – Wesley

Reference Books

1. Introduction to Robotics, Analysis, Systems and applications, Saeed B Niku, Prentice Hall India
2. Fundamentals of Robotics, Analysis and Control, Robert J Schilling, PHI 1996
3. Robotics and Control, R.K.Mittal and I.J.Nagarath, Tata McGraw Hill
3. CAD/CAM-Computer Aided Design and manufacturing, Mikel.P Groover, Printice Hall India

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MET 532C**						
Category	**Programme Elective**						
Course Title	**Alternative Fuels**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Background:** Fossil fuels and their limitations; engine requirements; potential alternative liquid fuels (i.e., vegetable oils, biodiesel, di-methyl ether, pyro-oils, emulsified fuel), gaseous alternative fuels (i.e., hydrogen, compressed natural gas, liquefied petroleum gas, producer gas and biogas) & solid fuels (Biomass, coal, MSW and RDF), hybrid fuels, advantages and limitations, choice of alternative fuel. Characteristics of alternative fuels: Liquid, gaseous & solid fuels as above.
Unit – II	**Liquid and gaseous fuels for SI Engine mode:** Mechanical conversion systems, Electronic conversion systems, engine modifications, carburetor or induction system,vehicle modifications; engine performance – thermal (fuel economy) and emissions in single fuel mode, safety aspects, Use of additives to improve the performance with alternative fuels.
Unit – III	**Liquid and gaseous fuels for CI Engine:** Dedicated fuel operation: conversion to dual fuel operation fumigation;engine performance – thermal and emissions in dual fuel mode, safety aspects. Conversion of vegetable oils to biodiesel and its effect on engine performance. **Utilization in gas-engines:** Engine modifications, specially designed induction system, gasifier-engine system operation, problem associated with their utilization, performance and emissions, safety aspects with utilization of gaseous fuels like producer gas, biogas, LPG, hydrogen, natural gas.
Unit - IV	**Solid Biomass and forestry bio-fuels:** Feedstock preparation, gasification technologies - thermochemical conversion route for generation of producer gas/syngas, bio-fuel availability, feedstock preparation, biochemical conversion route for biogas, principle, potential and status of bioconversion technologies; Processing of gaseous fuels for utilization to IC engines. Hybrid systems: Series hybrid, parallel hybrid; hybrid power plants and fuel cell, hybrid bike, hybrid electric vehicle.

Text Books

1. Alternative Fuels: Emissions, Economics, and Performance, Timothy T. Maxwell and Jesse C. Jones, SAE International.
2. Alternative Fuel, Maximino Manzanera,, InTech Open Access Publisher Copyright © 2011 InTech

Reference Books

1. Renewable energy : Sources for fuels and electricity, Thomas B. Johansson, Henery Kelly, Amulya , .N. Reddy, Robert H. Williams and Laurie Burnham, Earthscan Publications Ltd. London.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MED 631C**						
Category	**Programme Elective - V**						
Course Title	**Advanced Engineering Materials**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Appreciative review of Material science:** Historical perspective of Materials, Classification of materials, Atomic structure, Crystal structures, Miller indices, atomic packing factor, density computations, anisotropy, crystal Imperfections:Point defects, Line defects, and Interfacial defects and volume defects. Deformation in materials: basic concepts, plastic deformation mechanisms,Strengthening Mechanisms in metals, Elastic deformation. Recovery, recrystallization and grain growth
Unit – II	**Failure of metals:** fundamentals of fracture Ductile fracture, brittle fracture. Fracture mechanics. Impact fracture.Ductile brittle transition.Fatigue, factors affecting fatigue life, creep behavior and its mechanism. Fracture of polymers, Mechanism of deformation of polymers Corrosion and degradations: electrochemical considerations, corrosion rates, passivity, forms of corrosion and its prevention, corrosion of ceramic materials, degradation of polymers
Unit – III	**Phase Diagrams:** Basic concepts, Phase, microstcture,unary and binary phase diagrams, development of microstructure in isomorphous, eutectic systems, eutectoid and peritectic reactions, iron-iron carbide Phase diagrams and development of Microstructure in iron-iron carbide Phase diagrams Introduction to diffusion and its mechanism; phase Transformations: kinetics of phase transformation, TTT diagram for eutectoid steel, Heat treatment and surface hardening processes
Unit - IV	**Advanced Materials:** semiconductors, biomaterials, smart materials, Composite materials: Particle reinforced composites. Fibre reinforced composites. Structural composites, hybrid composites, MMC, sandwich panel **Materials for Space applications:** space programme, structural materials and their properties, system requirements, extreme high temperature materials, materials for thermal protections, pressure vessels, lubrication, electronic components **Modern techniques for material studies:** optical microscopy, electron microscopy, magnetic, Transmission Electron Microscope, Scanning Electron Microscope

Text Books

1. Principles of Material Science and Engineering, William F. Smith, McGraw-Hill Book Co.
2. Material Science and Engineering an Introduction William D. Callister, Jr., John, Wiley and Sons Inc., William D. , Callister, Jr, John Wiley and Sons
3. Material Science, Metallurgyand Engineering Materials, Gupta,K.M , Umesh Publications

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEI 631C**						
Category	**Programme Elective - V**						
Course Title	**Product Design and Development**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	Journeys in Product Development, Product Development Process Tools. Scoping Product Developments: Technical & Business Concerns. Understanding Customer Need
Unit – II	Establishing Product Function, Product Teardown & Experimentation Benchmarking & Establishing Engineering Specifications, Product Portfolios & Portfolio Architecture, Product Architecture
Unit – III	Generating Concepts, Concept Selection, Concept Embodiment. Modeling of Product Metrics, Design for Manufacture & Assembly
Unit - IV	Design for the Environment, Analytical & Numerical Model Solution. Physical Prototypes, Physical Models & Experimentation, Design for Robustness

Text Books

1. Product Design & Development, Techniques in Reverse Engineering and New Product Development, Kevin Otto & Kristin Wood, Pearson Education, Low Price Edition

Reference Books

1. Innovation Management & New Product Development, Paul Trott, Pearson Education, Low Price Edition

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEP 631C**						
Category	**Programme Elective - V**						
Course Title	**Sustainable Manufacturing**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Introduction:** Definition of Sustainable Manufacturing (SM), Role of operations function in manufacturing sustainability, Chronology of development in Manufacturing philosophies and initiatives, concept of environment, economy and society triad in sustainability issues, Comparison of Sustainability with Traditional, Lean and Green Manufacturing. **SM drivers and barriers**: Role of competitiveness among firms, legislative regulations regarding sustainable practices, availability of green technologies, Supply Chain pressure, Societal pressure and tax incentives towards sustainable industrial practices, SM Barriers and stakeholders, Framework for driver prioritization and barriers ranking.
Unit – II	**Design Consideration in Manufacturing Sustainability**: Eco-innovation, design for environment, design for disposal, design for energy efficiency, design for material efficiency, sustainable materials, and sustainable energy. **Industrial practices towards SM:** Recycling, remanufacturing, reuse, resource efficiency, 3R vs 6R, Energy efficiency in machine tools and process chains.
Unit – III	**Life Cycle Assessment:** Strategic and operational evaluation of technologies using life cycle concept, MET analysis, environmental impact assessment, various impact assessment models, life cycle costing **End Of Life (Eol) Strategies:** End-of-life strategies for product, Concept of Dust-to-Dust, Green Supply Chain (GSC) Management: Carbon footprints, GSC techniques and implementation issues and Reverse Logistics Network Design for recycle, reuse and remanufacture.
Unit - IV	**Modern Approaches for Sustainable Manufacturing**: Toxic substances in industry, and need of Renewable sources, Renewable Sources of Energy, Industry cooperation for reducing Carbon footprint. **Green Manufacturing Techniques:** Dry and near-dry machining, edible oil-based cutting fluids, cryogenic machining, improving work environment, of lean manufacturing, Lean

	techniques for green manufacturing and strategies for waste reduction in green manufacturing.

Text Books

1. Green manufacturing: fundamentals and applications, D.A. Dornfeld ed, Springer Science & Business Media

Reference Books

1. Advances in sustainable manufacturing, G. Seliger, M.M. Khraisheh and I.S. Jawahir eds., Springer Science & Business Media
2. Sustainability in the process industry., J. Klemeš, McGraw-Hill Inc.
3. The Lean Sustainable Supply Chain: How to Create a Green Infrastructure with Lean Technologies, Robert , Palevich FT Press

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MET 631C**						
Category	**Programme Elective**						
Course Title	**IC Engines Process Modelling**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Fundamentals:** Overview and historical perspective on development of IC Engines. **Stoichiometry and thermochemistry:** Combustion stoichiometry and thermochemistry of air-fuel mixtures, chemical equilibrium and chemical kinetics. Properties of working fluid, air-standard cycle, fuel-air cycle, real cycle, availability analysis of engine processes.
Unit – II	**Engine processes and Combustion:** Inlet and exhaust processes in four stroke cycle, gas exchange through valves, volumetric efficiency, flow through valves, essential features of combustion process in I.C. Engines; exhaust gas recirculation, heat release, adiabatic flame temperature. Engine processes Modeling:knock models, modeling spray models, approaches of modeling, intake and exhaust flow model, thermodynamic based in-cylinder model, fluid mechanic based multidimensional models
Unit – III	**Simulation of SI combustion processes:** Flame propagation,auto-ignition, burning speed. Simulation of Otto cycles at full throttle, part throttle and super charged conditions. Progressive combustion, single zone models, and their comparative evaluation, estimation of the composition and properties of unburned and burned mixtures. **Simulation of CI combustion processes:** Progressive and spray combustion processes with reference to homogeneous and heterogeneous charge engines.
Unit - IV	**Modeling and simulation of engine exhaust:** Modeling pollutant formation in SI and CI engines – Models for NOx, CO and soot formation, unburned hydrocarbon combustion. **Computer Routines:**Introduction to generic software ANSYS, FLUENT and dedicated software to FIRE and BOOST for simulation IC Engine simulation application

Text Books

1. Internal Combustion Engine Fundamentals, Heywood, JB,, McGraw Hill.
2. Modeling Engine Spray and Combustion Processes, Stiesch G, Springer-Verlag.
3. Combustion: Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, Warnatz J, Mass U, and Dirbble RW, 4th Ed., Springer-Verlag
4. Internal Combustion Engine modeling, Hemisphere publishing company, Ramos J,
5. Internal Combustion Engine, Ganeshan.V., Tata Mcgraw Hill,
6. Modeling Diesel Combustion, Lakshminarayanan PA and Aghav YV, Springer-Verlag
7. Fluid Dynamics and Transport of Droplets and Sprays, Sirignano WA, Cambridge University Press.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MED 633C**						
Category	**Programme Elective - V**						
Course Title	**Tribology**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Definition and Scope of tribology, Principles and applications of tribology:** macroscopic and microscopic viewpoints, the challenge of tribology; Recent developments in tribology **Friction, theories of friction, Friction control, Surface topography:** Surface texture and measurement, genesis of friction, instabilities and stick-slip motion
Unit – II	**Wear:** Types of wear and their mechanisms, theories of wear, wear prevention. Tribological properties of bearing materials and Properties and testing of lubricants, Effect of temperature and pressure on lubricants, tribodesign aspects of mechanical seals
Unit – III	Lubrication regims, Reynolds's equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow) journal bearings, lightly loaded infinitely long journal bearing-Petroff's solution, Finite journal Bearings, Boundary conditions: Sommerfeld condition, Half Sommerfeld condition, Reynold's condition, Oil film thickness, load carrying capacity and attitude angle, oil flow; Design of hydrodynamic journal bearings- Raimondi and Boyd method
Unit - IV	**Hydrostatic Lubrication** - Basic concept - Advantages and limitations - Viscous flow through rectangular slot - Load carrying capacity and flow requirement - Energy losses - Optimum design, Squeeze Film Lubrication: Basic concept - Squeeze action between circular and rectangular plates - Squeeze action under variable and alternating loads, application to journal bearings, piston pin lubrications. **Elasto-hydrodynamic lubrication-** pressure viscosity term in Reynolds's equation, Hertz' theory, Ertel-Grubin equation, lubrication of spheres, gear teeth and rolling element bearings, Air lubricated bearings: Introduction, Merits, Demerits and Applications; Tilting pad bearings

Text Books

1. Basic Lubrication Theory, Cameron, Ellis Horwood Ltd
2. Principles in Tribology, J. Halling,

Reference Books

1. Fundamentals of Fluid Film Lubrication, B. J. Hamrock. McGraw-Hill International
2. Theory and Practice of Lubrication for Engineers, D.D. Fuller, John Wiley and Sons
3. Fundamentals of Friction and wear of Materials, American Society of Metals,
4. Introduction to Tribology of Bearings, B. C. Majumdar, A. H. Wheeler &co. pvt. ltd
5. Tribology in Machine Design, T.A. Stolarski, Butterworth-Heimemann.
6. Principles and Applications of Tribology, Desmond F. Moore, Pergamon Press
7. Applied Tribology (Bearing Design and Lubrication), Michael M Khonsari, John Wiley & Sons

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MEM 631C**						
Category	**Programme Elective - V**						
Course Title	**Mechatronics**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Mechatronics:** Appreciate what Mechatronics is about. Comprehend the various forms and elements of control systems. Integrated design issues in Mechatronics. Mechatronics key elements. The Mechatronics design process. Advanced Approaches in Mechatronics Sensors & transducers, signal conditioning and data presentation system: Describe the performance of commonly used sensors. Evaluate sensors used in the measurements of: displacement, position and proximity; velocity & motion; force; fluid pressure; liquid flow; liquid level; temperature; light. Selection of sensors, inputting data by switches. Explain the requirements for signal conditioning. Explain how operational amplifiers can be used, the requirements for protection and filtering, the principle of the Wheatstone bridge and, in particular, how it is used with strain gauges, the principles and main methods of analogue-to-digital and digital-to-analogue converters, multiplexers and data acquisition using DAQ boards. Explain the principle of digital signal processing. Explain the principle of pulse-modulation. Explain the problem of loading. Describe the basic principles of use of commonly used data presentation elements: meters, analogue chart recorders, oscilloscopes, visual display units, printers. Explain the principles of magnetic recording on floppy and hard disk. Explain the principles of displays and in particular, the use of LED seven-segment and dot matrix displays and the use of driver circuits. Explain how data presentation can occur with the use of DAQ boards. Design measurement systems.
Unit – II	**Pneumatic & hydraulic, mechanical and electrical actuation systems:** Interpret system drawings, and design simple systems, for sequential control systems involving valves and cylinders. Explain the principle of process control valves, their characteristics and sizing.

	Evaluate mechanical systems involving linkages, cams, gears, ratchet and pawl, belt and chain drives, and bearing. Evaluate the operational characteristics of electrical actuation systems: relays, solid-state switches (thyristors, bipolar transistors and MOSFETs, solenoid actuated systems, DC motors, AC motors and steppers motors).
Unit – III	**System transfer functions, frequency response:** Define the transfer function and determine the responses of systems to simple inputs by its means, using Laplace transforms. Identify the effect of pole location on transient response. Explain the use of MATLAB and SIMULINK to model systems. Analyse the frequency response of systems subject to sinusoidal inputs. Plot and interpret Bode plots. **Closed-Loop Controllers:** Predict the behaviour of systems with proportional, integral, derivative, proportional plus integral, proportional plus derivative and PID control. Explain how such modes of control can be realised with operational amplifiers and digital controllers and controller settings determined. Explain what is meant by velocity feedback and adaptive control.
Unit - IV	**Digital Logic, Microprocessors:** Use the binary, octal, hexadecimal and binary coded decimal number systems; explain how numbers can be signed and the twos complement methods of handling negative numbers. Explain the advantages of the Gray code. Describe parity methods of error detection. Recognize the symbols and Boolean representation of, write truth tables for and use in applications, the logic gates of AND, OR, NOT, NAND, NOR AND XOR. Use Boolean algebra to simplify Boolean expressions and present them in the form of sums of products or product of sums. Use Karnaugh maps to determine the Boolean expressions to represent truth tables. Explain how SR, JK and D flip-flops can be used in control systems. Describe the basic structure of a microcomputer, a microprocessor and a microcontroller. Explain how program can be developed using flow charts or pseudo-code. Input/output systems, programmable logic controllers, communication systems, fault finding, design and mechatronics: Identify interface requirements and how they can be realised; in particular buffers, handshaking, polling and serial interfacing. Explain the function of peripheral interface adapters and program them for particular situations. Explain the function of asynchronous communications interface adapters. Describe the basic structure of PLCs. Program a PLC, recognising how the logic functions, latching and sequencing can be realised. Develop programs involving timers, internal relays, counters, shift registers, master relays, jumps and data handling.Describe centralised, hierarchical and distributed control systems, network configurations and methods of transmitting data, describing protocols used in the transmission of data. Describe the open systems Interconnection communication model. Describe commonly used communication interfaces: RS-232,Centronics, IEEE-488, personal computer buses, VXI bus, and I2C bus. Recognize the techniques used to identify faults in microprocessor-based systems, including both hardware and software. Explain the use of emulation and simulation. Compare and contrast possible solutions to design problems when considered from the traditional and the mechatronic point of view. Analyse case studies of Mechatronics solutions. Design Mechatronics solutions to problems.

Reference Books:

1. Mechatronics by W. Bolton, published by Pearson Education Asia
2. Mechatronics by David G. Alciatore and Michael B. Histand, Published by Tata McGraw-Hill
1. Publishing company Limited
2. Mechatronics System Design by Devdas Shetty and Richard A. Kolk, Published by Vikas Publishing House
3. Introduction to Mechatronics by Appuu Kuttan K. K. Published by Oxford University Press.
4. Mechatronics: Integrated Technologies for Intelligent Machines by A. Smaili, F. Mrad published by Oxford University Press.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MTOE 651C**						
Category	**Open Elective - I**						
Course Title	**Business Analytics**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	
Prerequisites (if any)							

Detailed Contents

Sr. No.	Contents
Unit - I	**Business analytics:** Overview of Business analytics, Scope of Business, analytics, Business Analytics Process, Relationship of Business Analytics, Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.
Unit – II	**Trendiness and Regression Analysis:** Modelling Relationships and Trends in Data, simple Linear Regression, Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.
Unit – III	Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.
Unit - IV	**Decision Analysis:** Formulating Decision Problems, Decision Strategies, with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making. Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time.

Text /Reference Books

1. Project Management: The Managerial Process by Erik Larson and, Clifford Gray
2. Business Analysis by James Cadle et al.
3. Bajpai Naval, Business Statistics, Pearson, New Delhi.
4. Whigham David, Business Data Analysis, Oxford University, Press, Delhi.
5. Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie or Die. Eric Siegel.
6. Big Data, Analytics and the Future of Marketing and Sales. McKinsey.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MTOE 653C**						
Category	**Open Elective - I**						
Course Title	**Industrial Safety**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							
Detailed Contents							

S. No.	Contents
Unit - I	**Industrial safety:** Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe the 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 the maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation to replacement economy, Service life of the 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 trees 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

Text Books

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services
2. Maintenance Engineering, H. P. Garg, S. Chand and Company

Reference Books

1. Pump-hydraulic Compressors, Audels, Mcgraw Hill Publication
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MTOE 655C**						
Category	**Open Elective - I**						
Course Title	**Operation Research**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Linear optimization methods:** General mathematical model formation of L.P.P, its solution by Graphical method, Simplex method, big –M method, two phase method sensitivity analysis (change in cj, bj&aij's) Revised Simplex method.Concept of duality, formation of Dual L.P.P, advantage of Duality, dual simplex method, parametric programming.
Unit – II	**Non liner programming:** NLPP Mathematical formulation and solution with equally constraints, Lagrange's method, Graphical method, Kuhn—Tucker necessary &sufficient conditions for the optimality of objective function in GNLP problem. Dynamic programming: Kuhn –Tucker condition's, Wolfe's and Bcale's method.
Unit – III	**Deterministic inventory control models:** Meaning & function role of inventory control, reason for carrying inventory, single item inventory control model with & without shortages. **Probabilistic inventory control models:** Inventory control models without set up cost and with set up cost.
Unit - IV	Project management; PERT and CPM, Basic difference between PERT & CPM, Phases up project management PERT /CPM network component & precedence relationships, critical path analyses, projects scheduling with uncertain activity times, project time –cost trade-off.

	Sequencing problem: Processing an jobs through two machines, three machines and through m-machines. Theory of games: Two- person zero –sum games,pure strategies (with saddle points) mixed strategies (without saddle point), algebraic method only.

Text/Reference Books

1. H.A Taha, Operations Research, An introduction, PHI, 2008
2. H.M.Wanger, Principles of Operation Research PHI, Delhi, 1982
3. J.K.Sharma, Operations Research, Mcmillan India. Ltd,1990
4. S.D.Sharma, Operations Research, KedarnathRamnath publication,1985
5. P.K.Gupta and D.S Hira, Operations Research, S.Chand& Co.,1987
6. Pannerselvam, Operations Research; PHI, 2010
7. Harvey M Wanger , Principles of Operations Research; PHI, 2010

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MTOE 657C**						
Category	**Open Elective - I**						
Course Title	**Cost Management of Engineering Projects**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**					**End Term Examination**	**Grand Total**
	As per Ordinance				**Total**		
					25	75	100

Detailed Contents

S. No.	Contents
Unit - I	**Introduction and Overview** **Chapter 1:** Introduction, basic economic concepts, interest formulae, present worth, rate of return. Elements of financial accounting: depreciation, taxes & their impact in economic studies **Chapter 2:** Cost concepts in decision making; elements of cost, relevant cost, overheads, differential cost, incremental cost and opportunity cost, objectives of a costing system, inventory valuation, creation of a data base for operational control, provision of data for decision making.
Unit – II	**Project** **Chapter 3:** Meaning, different types, why to manage, cost overrun centres, various stages of project execution, concept to commissioning. Project execution as conglomeration of technical and non technical activities. Detailed engineering activities, Pre project execution main clearances and documents project team: Role of each member. **Chapter 4:** Importance Project site: Data required with significance. Project contracts. Types and contents. Project cost control. Bar charts and network diagram. Project commissioning: Mechanical and process. Project appraisal and selection, recent trends in project management
Unit – III	**Economic Analysis For Engineering Projects** **Chapter 5:** Cost behavior and profit planning, Marginal costing, distinction between marginal

	costing and absorption costing, Break even analysis, cost volume profit relationship, various decision making problems. Standard costing and variance analysis, pricing strategies Pareto analysis, Target analysis, life cycle costing, Costing of the service sector. **Chapter 6:** Just in time approach, material requirement planning, enterprise resource planning, Total Quality management and theory of constraints, Activity based cost management, Benchmarking, Balanced scorecard, value chain analysis, Budgetory control, Flexible budget, Performane budget, Zero based budget, Measurement of divisional profitability pricing decisions including transfer pricing.
Unit - IV	**Quantitative Techniques For Cost Management** **Chapter 7:** PERT CPM; Activity networks, basic PERT/CPM calculations, Planning and scheduling of activity networks, Assumptions in PERT modeling, time cost tradeoffs, PERT/ cost accounting, Scheduling with limited resources, Generalized activity networks GERT, **Prospects of PERT/CPM** **Chapter 8**: Linear programming, Transportation problems, Assignment problems, Simulation, Learning curve theory.

Text Books

1. Cost Accounting: A Managerial Emphasis, Charles T. Horngren, Srikant M. Datar, Madhav V. Rajan, Pearson Edu.
2. Fundamentals of Financial Management, Prasanna Chandra, Tata McGraw Hill
3. Quantitative Techniques in Management , N D Vohra, Tata McGraw Hill

Reference Books

1. Principles and Practice of cost accounting, Ashish K Bhattacharya, A H Wheeler
2. Principles of engineering economy, E L Grant et al., John Wiley and Sons, New York.

Note: For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MTOE 659C**						
Category	**Open Elective - I**						
Course Title	**Composite Materials**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
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.

Text/Reference Books

1. Material Science and Technology – Vol 13 – Composites by R.W.Ca hn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.
3. Hand Book of Composite Materials-ed-Lubin.
4. Composite Materials – K.K.Chawla.
5. Composite Materials Science and Applications – Deborah D.L. Chung.
6. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

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Department	Mechanical Engineering						
Program Name	Master of Technology in Mechanical Engineering						
Program Level	PG						
Course Code	**MTOE 661C**						
Category	**Open Elective - I**						
Course Title	**Waste to Energy**						
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Duration of Examination**		
	3	0	0	3	3 hours		
Evaluation System	**Sessional**				**End Term Examination**	**Grand Total**	
	As per Ordinance			**Total**			
				25	75	100	
Prerequisites (if any)							

Detailed Contents

S. No.	Contents
Unit - I	**Introduction:** Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment. Various Methods of using solar energy –Photothermal, Photovoltaic, Photosynthesis, Present & Future Scope of Solar energy.
Unit – II	**Introduction to Energy from Waste:** Classification of waste as fuel – Agro based, Forest residue, Industrial waste, MSW
Unit – III	**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, Types of biogas Plants, Applications.
Unit - IV	**Thermo-chemical Conversion:** Pyrolysis, Combustion, Gasification, Liquification. Bio-Chemical Conversion: Aerobic and Anaerobic conversion, Fermentation etc. Bio-fuels: Importance, Production and applications. Bio-fuels: Types of Bio-fuels, Production processes and technologies, Bio fuel applications, Ethanol as a fuel for I.C. engines, Relevance with Indian Economy.

Text/Reference Books

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

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AUD531C: ENGLISH FOR RESEARCH PAPER WRITING (AUDIT COURSE 1 & 2)

M. Tech. Semester – I/II (Biomedical Engineering)

L	P	Credits			
2	--	--	Class Work	:	25Marks
			Examination	:	75 Marks
			Total	:	100 Marks
			Duration of Examination	:	3 Hours

Course Objectives:

Students will be able to:

1. Understand that how to improve your writing skills and level of readability,
2. Learn about what to write in each section,
3. Understand the skills needed when writing a Title, and
4. Ensure the good quality of paper at very first-time submission

Course Outcomes:

The Students will become conscious citizens of India aware of their duties, rights and functions of various bodies of governance and welfare; thereby well equipped to contribute to India.

Syllabus contents:

UNIT I: Basics of Writing Skills:

Subject Verb Agreements; Parallelism; Structuring Paragraphs and Sentences; Being Concise and Removing Redundancy; Avoiding Ambiguity and Vagueness; Dangling Modifiers

UNIT II: Reviewing and Citation:

Clarifying Who Did What; Highlighting Your Findings from Literature; Hedging and Critiquing; Paraphrasing; Avoiding Plagiarism; Formatting and Citation (Publication Manual of the American Psychological Association)

UNIT III: Sections of a Research Paper:

Writing Effective and Impressive Abstract; Writing Introduction; Review of Literature; Defining Objectives of the Study; Methodology Adopted; Results Obtained; Discussion and Conclusion; Editing and Proof Reading to Ensure Quality of paper

UNIT IV: Oral Presentation for Academic Purposes:

Oral Presentation for Seminars, Conferences and Symposiums; Poster Presentation; Choosing AppropriateMedium; Interaction and Persuasion

TEXT / REFERENCE BOOKS:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books).
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press.
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer, New York Dordrecht Heidelberg London, 2011
5. Mc Murrey,David A. and Joanne Buckley. Handbook for Technical Writing. New Delhi: Cengage Learning, 2008.

Note: For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

AUD533C: DISASTER MANAGEMENT (AUDIT COURSE 1 & 2)

M. Tech. Semester – I/II (Biomedical Engineering)

L	P	Credits			
2	--	--	Class Work	:	25Marks
			Examination	:	75 Marks
			Total	:	100 Marks
			Duration of Examination	:	3 Hours

Course Objectives:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
4. Critically understand different aspects of disaster management

Course Outcomes:

A student will be able to:

1. Know the significance of disaster management,
2. Study the occurrences, reasons and mechanism of various types of disaster
3. Learn the preventive measures as Civil Engineer with latest codal provisions
4. Apply the latest technology in mitigation of disasters

Syllabus contents:

UNIT I: **Introduction to Disaster Management:** Definitions: Disaster, Emergency, Hazard, Mitigation, Disaster Prevention, Preparedness and Rehabilitation, Risk and Vulnerability, Classification of Disaster, Natural and Man made Disasters, Disaster Management Act 2005, Role of NDMA, NDRF, NIDM

Risk and Vulnerability to disaster mitigation and management options: Concept and Elements, Risk Assessment, Vulnerability, Warning and Forecasting.

UNIT II: **Hydro-meteorological based disasters I:** Tropical Cyclones, Floods, droughts, mechanism, Causes, role of Indian Metrological Department, Central Water Commission, structure and their impacts, classifications, vulnerability, Early Warning System, Forecasting, Flood Warning System, Drought Indicators, recurrence and declaration, Structural and Non-structural Measures.

Hydro-meteorological based disasters II: Desertification Zones, causes and impacts of desertification, Characteristics, Vulnerability to India and Steps taken to combat desertification, Prevention.

UNIT III: **Geological based disasters:** Earthquake, Reasons, Direct and Indirect Impact of Earthquake; Seismic Zones in India, Factors, Prevention and Preparedness for Earthquake, Tsunamis, Landslides and avalanches: Definition, causes and structure; past lesson learnt and measures taken; their Characteristic features, Impact and prevention, structural and non-structural measures.

UNIT IV: **Manmade Disasters I:** Chemical Industrial hazards; causes and factors, pre- and post disaster measures; control ; Indian Standard Guidelines and Compliance; Oil Slicks and Spills, Outbreak of Disease and Epidemics, Traffic accidents; classification and impact, War and Conflicts; Fire risk assessment; Escape routes; fire fighting equipment;
Use of remote sensing and GIS in disaster mitigation and management.

TEXT / REFERENCE BOOKS:

1. Thomas D. Schneid., Disaster Management and Preparedness, CRC Publication, USA, 2001
2. Patrick Leon Abbott, Natural Disasters, Amazon Publications, 2002
3. Ben Wisner., At Risk: Natural Hazards, People vulnerability and Disaster, Amazon Publications, 2001
4. Oosterom, Petervan, Zlatanova, Siyka, Fendel, Elfriede M., "Geo-information for Disaster Management", Springer Publications, 2005
5. Savindra Singh and Jeetendra Singh, Disaster Management, Pravalika Publications, Allahabad
6. Nidhi GaubaDhawan and AmbrinaSardar Khan, Disaster Management and Preparedness, CBS Publishers & Distribution
7. Selected Resources Published by the National Disaster Management Institute of Home Affairs, Govt. of India, New Delhi.

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AUD535C: SANSKRIT FOR TECHNICAL KNOWLEDGE (AUDIT COURSE 1 & 2)

M. Tech. Semester – I/II (Biomedical Engineering)

L	P	Credits			
2	--	--	Class Work	:	25Marks
			Examination	:	75 Marks
			Total	:	100 Marks
			Duration of Examination	:	3 Hours

Course Objectives:

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in Mathematics, Science & other subjects
4. Enhancing the memory power

Course Outcomes:

Students will be able to

1. Understand basic Sanskrit language
2. Understand Ancient Sanskrit literature about science and technology
3. Get equipped with Sanskrit and explore the huge knowledge from ancient literature

	Audit 1 and 2: Sanskrit for Technical Knowledge	
Unit	Content	
I.	Nominative Forms of Pronouns– अस्मद्,युस्मद् एतत् एवं तत् के रूप– पुल्लिग,नपुंसकलिंग एवं स्त्रीलिंग अकारान्त षब्दरूप पुल्लिग एवं नपुंसकलिंग में धातुएं– पठ्,खाद्,लिख्,गम् (पांच लकारों में) सामान्य वाक्य बनाना	06
II.	आकरान्त (यथा–रमा) ईकरान्त (यथा – नदी) षब्दों का प्रायोग तत्,एतत्,यत्,किम्– षब्दों का सभी कारकों में वाक्य में प्रयोग,	06
III.	विसर्ग सन्धि,स्वर सन्धि,अयादि सन्धि,	06
IV.	प्रत्ययों का प्रयोग – षतृ,षानच्,क्तवतु, कत,कतृवाच्य से कर्मवाच्य में परिवर्तन – (क्त एवं क्तवतु) केवल प्रथम पुरूष का वाच्य परिवर्तन	06

TEXT / REFERENCE BOOKS:

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

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AUD537C: VALUE EDUCATION (AUDIT COURSE 1 & 2)

M. Tech. Semester – I/II (Biomedical Engineering)

L	P	Credits			
2	--	--	Class Work	:	25Marks
			Examination	:	75 Marks
			Total	:	100 Marks
			Duration of Examination	:	3 Hours

Course Objectives:

The students will be able to

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Course Outcomes:

The students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality
4. Strengthen the "EQ"

Syllabus contents:

Unit I: Hierarchy and Classification of values,
Values and Belief Systems, Competence in professional ethics,
Value judgment based on cultural, tradition and interdependence.

Unit II: Need for value education
Sense of duty.Devotion, Self-reliance.
Honesty, Humanity, trust.Patriotism and national Unity.
Harmony in the nature and realization of coexistence
Vision of better India

Unit III: Understanding the meaning and realizing the effect of the following:

Aware of self- destructive habits, Knowledge, Acceptance, Love, Situations, happiness, Bliss, Peace,Power, Purity , Realization, Assertiveness, Regard, Respect, Sensitive, Divinity, emotions, Repentance, hurt, Ego, Attachment, worry, Resentment, Fear, Anxiety, Greed, Criticism, Tension, Frustration, Expectation, Irritation, Anger, Guilt, Jealous, Pear Pressure, True Friendship, Cooperation -Coordination- competition.

Enhancing self esteem and personality.

Unit IV: Hinduism, Jainism, Buddhism, Christianity, Islam, Sikhism.
Self-management and Good health (Role, Responsibility, Relation, Routine, Requirements, Resources)
My True self and Original qualities.Supreme-soul- source of values.
What Scientists say about super power?

TEXT / REFERENCE BOOKS:

1. Chakroborty, S.K. Values and Ethics for organizations Theory and practice. Oxford University Press, New Delhi.
2. R R Gaur, R Sangal, G P Singh.Human Values and Professional Ethics. Excell Books, New Delhi.
3. Value Education in Spirituality- Course-I, course -II by Brahma Kumaris Education Wing, RajyogaEducation & Research Foundation, Mount Abu, Rajasthan.
4. True Management: I K International Publication 2018.

Note: For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.

AUD539C: CONSTITUTION OF INDIA (AUDIT COURSE 1 & 2)

M. Tech. Semester – I/II (Biomedical Engineering)

L	P	Credits			
2	--	--	Class Work	:	25Marks
			Examination	:	75 Marks
			Total	:	100 Marks
			Duration of Examination	:	3 Hours

Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. 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.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes:

The Students will become conscious citizens of India aware of their duties, rights and functions of various bodies of governance and welfare; thereby well equipped to contribute to India.

Syllabus contents:

Unit I: **Making of the Indian Constitution and its Philosophy**

Sources of Indian Constitution, its Preamble and Salient Features.

Unit II: **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

Fundamental Duties

Unit III: **Organs of Governance**

Legislature: Parliament and its Composition; Qualifications and Disqualifications of Its members
Executive: President, Governor and Council of Ministers
Judiciary: Appointments, Qualifications, Powers and Functions of judges

Unit IV: **Local Administration and institutes for welfare**

District Administration Head: Role and Importance; Municipalities: Introduction, Mayor and role of Elected Representative
Panchayati Raj Institutions: Introduction, Gram Panchayat, Panchayat Samiti and Zila Panchayat
Institutes and Bodies for the welfare of SC/ST/OBC and women

TEXT / REFERENCE 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 Ed., Lexis Nexis, 2014

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AUD541C: PEDAGOGICAL STUDIES (AUDIT COURSE 1 & 2)

M. Tech. Semester – I/II (Biomedical Engineering)

L	P	Credits			
2	--	--	Class Work	:	25Marks
			Examination	:	75 Marks
			Total	:	100 Marks
			Duration of Examination	:	3 Hours

Course Objectives:

The course will enable the student teachers:

1. To understand the concept of pedagogy and conceptual framework.
2. To gain insight on the meaning and nature of different pedagogies.
3. To determine aims and strategies of teaching- learning.
4. To understand the principals, maxims of successful teaching and the different methods of teaching.
5. Comprehend the need and importance of various devices of teaching and learning and their relationship between the two.
6. Point out and illustrate the difference between teaching and learning and their relationship between the two.
7. To appreciate that science/ engineering is a dynamic and expanding body of knowledge.

Course Outcomes:

Students will be able to understand:

1. It will improve teaching effectiveness of prospective teachers.
2. A prospective teacher will be able to design curriculum and assess the curriculum of their discipline in an effective way by understating the needs of the learners.
3. How can teacher education, school curriculum and guidance support effective pedagogy?
4. It will be functional for professional development among teachers.

Syllabus contents:

Unit I: Introduction and Methodology

- Aims and Rationale, Conceptual Framework, Terminology related to Pedagogy
- Contexts, Research Questions
- Theories of Learning, Curriculum, Scope of Pedagogy

Unit II: Teaching

- Meaning and importance of Behavioral Objectives
- Writing of Objectives in Behavioral Terms
- Phases and Variables of Teaching
- Principles, levels and maxims off teaching
- Relationship between Teaching and Learning

Unit III: Methods of Teaching

- Methods: Inductive, Deductive, Project, Analytic, Synthetic, Brain Storming, Case Discussion
- Concept and Significance of Individualized and Cooperative Teaching-Language Laboratory, Tutorials, Keller's Plan (PSI), Computer Supporting Collaborative Learning
- Mastery Learning: Concept, Basic Elements, Components and Types of Mastery Learning Strategies

Unit IV: Evaluation Strategies

- Evaluation in Teaching: Concept of Evaluation, Relationship between Teaching and Evaluation, Types of Evaluation (Formative and Summative)
- Methods of Evaluation through Essay Type. Objective Type and Oral Method, Comparative merits and demerits of evaluation methods
- Latest Trends in Evaluation

TEXT / REFERENCE BOOKS:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) 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 (2013) 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 (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.
8. Dyer C (2008) Early years literacy in Indian urban schools: Structural, social and pedagogical issues, Language and Education, 22 (5): 237-253.
9. Sharma N (2013) An exploration of teachers' beliefs and understanding of their pedagogy, MPhil thesis, Mumbai: TATA Institute of Social Sciences.
10. Zeichner K, Liston D (1987) Teaching student teachers to reflect, Harvard Educational Review, 56 (1): 23-48.
11. Watkins C, Mortimore P (1999) Pedagogy: What do we know? In Mortimore P (ed.) Understanding pedagogy and its impact on learning. London: Paul Chapman Publishing.
12. Tyler R (1949) Basic principles of curriculum and instruction. Chicago: Chicago University Press.
13. Arends, R.1. (1 994) Learning to Teach, New York: McGraw-Hill.
14. Lunenberg M, Korthagen F, Swennen A (2007) The teacher educator as a role model, Teaching and Teacher Education, 23: 586-601.
15. Meena . Wilberforce E. Curriculum Innovation in Teacher Education: Exploring Conceptions among Tanzanian Teacher Educators. ÅBO AKADEMI UNIVERSITY PRESS, 2009.
16. Cooley, W. W., and Lohnes, P. R. (1976). Evaluation research in education. New York: Irvington.
17. Hassard, Jack, 2004, The Art of Teaching Science, Oxford Univesity Press.
18. Joyce, B., Weil, M., Calhoun, E. : (2000). Models of teaching, 6th edition, Allyn & Bacon.
19. Kyriacou, C. (2007) Effective teaching in schools – theory and practice. Cheltenham: Nelson Thornes.
20. Nye, B., Konstantopoulos, S. & Hedges, L.V. (2004) 'How large are teacher effects?' Educational evaluation and policy analysis, 26(3), 237-257.
21. National Staff Development Council. (2001). NSDC's standards for staff development. Oxford, OH: Author.
22. Serpell, Z. & Bozeman, L. (1999). Beginning teacher induction: A report on beginning teacher effectiveness and retention. Washington, DC: National Partnership for Excellence and Accountability in Teaching.

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AUD543C: STRESS MANAGEMENT BY YOGA (AUDIT COURSE 1 & 2)

M. Tech. Semester – I/II (Biomedical Engineering)

L	P	Credits			
2	--	--	Class Work	:	25Marks
			Examination	:	75 Marks
			Total	:	100 Marks
			Duration of Examination	:	3 Hours

Course Objectives:

1. To achieve overall health of body and mind
2. To overcome stress

Course Outcomes:

Students will be able to:

1. Develop healthy mind and healthy body thus improving social health also
2. Improve efficiency
3. Improving "SQ"

Syllabus contents:

Unit I:

1. Causes of stress, consequences of stress, diagnosis of stress, solution of reducing stress.
2. Difference and relation b/w Yog and Yoga,
3. benefits of meditation and Yoga,
4. Rules and Regulation of Yog and Yoga.
5. Empowerment of Soul and fitness of body.

Unit II:

1. Do`s and Don't's in life.
2. How to be and not to be?
3. Understanding spirituality and materials.
4. Impact of: Truth at mouth/ Truth in thoughts
   Non Violence outside / Compassion in thoughts, Celibacy (kamnayn- desire), purity of mind, non-covetousness, Cleanliness, satisfaction, self study and surrender to almighty, Austerity, Penance

Unit III:

Role of Meditation in reducing Stress.
Role of Yoga in reducing Stress.
Pranyama: AnulomVilom ,Ujjai, Costal Breathing, Abdominal Breathing, Sunyak, Kumbhak

Unit IV:

Asan: Sukhasana, Vajrasana, Padmasana, Swastik Asana, Ling Mudra, Gorakshasana, Talasana, Konasana, Trikonasana, Chakrasana, Utkatasana, Dhurva Asana, Garuda Asana, Bhadrasana, Parvatasana, Yoga Mudra, Paschimottasana, Vakrasana, Gomukhasana, Bakasana, Tulasana, Matsyasana, Mayuri Asana, Bhujagasana, DhanurVakrasana,

PavanMuktasana, Viprtkarani, Makarasana, Shavasana, Dridasana, Yonimudra, Nauli, Dhenu Mudra.

TEXT / REFERENCE BOOKS:

1. 'Yogic Asanas for Group Tarining-Part-I": Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama, (Publication Department), Kolkata
3. "Value Education in Spirituality- Course-IV" by Brahma Kumaries Education Wing, Rajyoga Education Research Foundation, Mount Abu, Rajasthan.
4. "Stress Management for Dummies" by Allen Elkin, IDG Books India (P) Ltd.
5. "Yoga Courses for All" by Dr Hansraj Yadav, BhartyaVidyaBhawan, Mumbai

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AUD545C: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (AUDIT COURSE 1 & 2)

M. Tech. Semester – I/II (Biomedical Engineering)

L	P	Credits			
2	--	--	Class Work	:	25Marks
			Examination	:	75 Marks
			Total	:	100 Marks
			Duration of Examination	:	3 Hours

Course Objectives:

Students will be able to:

1. To learn and achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Course Outcomes:

1. The study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life.
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity.
3. Study of Neetishatakam will help in developing versatile personality of students.

Syllabus contents:

Unit I: **Holistic Development of Personality**

Neetisatakam-Verses-19,20,21,22 (Wisdom), Verses-29, 31 32 (Pride and Heroism) ,Verses-26,28,63,65 (Virtue)

Unit II: **Approach to Day to Day Work and Duties**

Shrimad BhagwadGeeta: Chapter 2 (Verses- 41, 47, 48), Chapter 3 (Verses- 13, 21, 27, 35), Chapter 6 (Verses- 05, 13, 17, 23, 35), Chapter 18 (Verses- 45, 46, 48)

Unit III: **Statements of Basic Knowledge**

Shrimad BhagwadGeeta: Chapter 2 (Verses- 56, 62,68), Chapter 12 (Verses- 13, 14, 15, 16, 17, 18)

Unit IV: **Personality of a Role Model**

Shrimad BhagwadGeeta: Chapter 2 (Verses- 17), Chapter 3 (Verses 36, 37, 42), Chapter 4 (Verses 18, 38, 39), Chapter 18 (Verses 37, 38 63)

TEXT / REFERENCE BOOKS:

1. Srimad Bhagavad Gita by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.
3. BhagvadGeeta- Prof. Satyavrata Siddhantalankar, Orient Publishing.

Note: For student admitted in M. Tech. 1st Semester (C-Scheme) in 2019 and all trailing students, Examinations and evaluation of students shall be conducted as per guidelines AICTE Examinations Reforms covering the entire syllabus. The students shall be made aware about the reforms.