DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
CHHATRAPATI SAMBHAJINAGAR.

CIRCULAR NO.SU/Engg./ME/NEP-2020/44/2024

It is hereby inform to all concerned that, the syllabus prepared by the Board of Studies and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted the **Following Syllabus as per National Education Policy-2020** run at Affiliated Colleges, in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Courses	Semester
1.	M.E. Computer Science & Engineering	Ist to IV
2.	M.E. Mechanical Engineering	Ist to IV

This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.SU/2024/8693-701
Date:- 14.10.2024.

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Deputy Registrar,
Academic Section

Copy forwarded with compliments to :-

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,
2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] The Director, Board of Examinations & Evaluation, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
2] The Section Officer,[Engg.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.
7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

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SCHEME AND DETAILED SYLLABUS

ME (MECHANICAL ENGINEERING)

(Effective From Academic Year 2024-2025 & Onwards)

Dr. Santosh Bhosle
Chairman

Dr. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, CHHATRAPATI SAMBHAJINAGAR

Dean
Faculty of Sci. & Tech.

F. Y. M. E. Syllabus Structure w. e. f. 2024-25 (NEP 2020 Based Curriculum)															
Mechanical Engineering															
Semester-I															
Course Code	Course Name	Teaching Scheme Contact (Hours/Week)			Examination Scheme and Marks							Credits			
		Theory	Tutorial	Practical	MSE-I	MSE-II	TA	ESE	TW	PR/OR	Total	TH	TW/PR	TUT	Total
MME 601	Research Methodology and IPR	3	1	-	15	15	10	60	-	-	100	3	-	1	4
MME 602	Advanced Engineering Materials	3	1	-	15	15	10	60	-	-	100	3	-	1	4
MME 603	Advanced Optimization Techniques	3	1	-	15	15	10	60	-	-	100	3	-	1	4
MME 604	Product Design and Development	3	1	-	15	15	10	60	-	-	100	3	-	1	4
MME 605	Program Elective -I	3	-	-	15	15	10	60	-	-	100	3	-	-	3
MME 621	Lab –I (Optimization Programming or software)	-	-	2	-	-	-	-	25	-	25	-	1	-	1
MME 622	Lab –II (MATLAB)	-	-	2	-	-	-	-	25	-	25	-	1	-	1
MME 623	Lab- III (Software Modeling/Analysis)	-	-	2	-	-	-	-	-	25	25	-	1	-	1
MME 624	Seminar-I	-	-	4	-	-	-	-	-	50	50	-	2	-	2
Total (Semester-I)		**15**	**4**	**10**	**75**	**75**	**50**	**300**	**50**	**75**	**625**	**15**	**5**	**4**	**24**

***Elective Course**

Program Elective-I	Group A: Design	Group B; Production	Group C: Heat and Power	Group D: Industry Elective
Program Elective-I (MME 605 A,B,C,D)	Computational Modeling and Simulation (CMS)	Maintenance and Reliability Engineering	Advanced Thermodynamics	Course As Per the need of Industry

***Note: Candidates are required to opt the elective course (Program Elective I, II) from the same group as mentioned above.**

F. Y. M. E. Syllabus Structure w. e. f. 2024-25 (NEP 2020 Based Curriculum)															
Mechanical Engineering															
Semester-II															
Course Code	Course Name	Teaching Scheme Contact (Hours/Week)			Examination Scheme and Marks							Credits			
		Theory	Tutorial	Practical	MSE-I	MSE-II	TA	ESE	TW	PR/OR	Total	TH	TW/PR	TUT	Total
MME 651	Advanced Machine Design	3	1	-	15	15	10	60	-	-	100	3	-	1	4
MME 652	Hybrid Vehicles	3	1	-	15	15	10	60	-	-	100	3	-	1	4
MME 653	Advanced Manufacturing Techniques	3	1	-	15	15	10	60	-	-	100	3	-	1	4
MME 654	Program Elective -II	3	-	-	15	15	10	60	-	-	100	3	-	-	3
MME 655	Open Elective	3	-	-	15	15	10	60	-	-	100	3	-	-	3
MME 671	Lab –III (Assignments)	-	-	2	-	-	-	-	25	-	25	-	1	-	1
MME 672	Lab -IV	-	-	2	-	-	-	-	-	25	25	-	1	-	1
MME 673	Lab –VI (Advance MATLAB)	-	-	4	-	-	-	-	-	50	-	-	2	-	2
MME 674	Seminar-II	-	-	4	-	-	-	-	-	50	50	-	2	-	2
Total (Semester-II)		**15**	**3**	**12**	**75**	**75**	**50**	**300**	**25**	**125**	**650**	**15**	**4**	**3**	**24**

***Elective Course**

Program Elective-II	Group A: Design	Group B; Production	Group C: Heat and Power	Group D: Industry Elective
Program Elective-II (MME 654 A,B,C,D)	Finite Element Methods (FEM)	Computer Integrated Manufacturing (CIM)	Computational Fluid Dynamics (CFD)	Course As Per the need of Industry
***Note: Candidates are required to opt the elective course (Program Elective I, II) from the same group as mentioned above.**				

Open Elective			
Open Elective- (MME 655 A, B, C)	Robotics and Automation	Industry 4.0	Artificial Intelligence and Machine Learning

S. Y. M. E. Syllabus Structure w.e.f. 2024-25 (NEP 2020 Based Curriculum)															
Mechanical Engineering															
Semester-III															
Course Code	Course Name	Teaching Scheme Contact (Hours/Week)			Examination Scheme and Marks							Credits			
		Theory	Tutorial	Practical	MSE-I	MSE-II	TA	ESE	TW	PR/OR	Total	TH	TW/PR	TUT	Total
MME 701	MOOC Course	3	-	-	-	-	-	-	-	-	100	3	-	-	3
MME 731	Dissertation Part 1	-	-	18	-	-	-	-	50	150	200	-	9	-	9
Total (Semester-III)		**0**	**0**	**18**	**-**	**-**	**-**	**-**	**50**	**150**	**300**	**3**	**9**	**-**	**12**

S. Y. M. E. Syllabus Structure w.e.f. 2024-25 (NEP 2020 Based Curriculum)															
Mechanical Engineering															
Semester-IV															
Course Code	Course Name	Teaching Scheme Contact (Hours/Week)			Examination Scheme and Marks							Credits			
		Theory	Tutorial	Practical	MSE-I	MSE-II	TA	ESE	TW	PR/OR	Total	TH	TW/PR	TUT	Total
MME 781	Dissertation Part 2	-	-	24	-	-	-	-	100	200	300	-	12	-	12
Total (Semester-IV)		**0**	**0**	**24**	**0**	**0**	**0**	**0**	**100**	**200**	**300**	**0**	**12**	**0**	**12**

MSE- Mid Semester Exam, ESE- End Semester Examination, TH-Theory, OR- Oral, TA-Teacher Assessment, TW-Term Work, PR- Practical, Tut- Tutorial

Total Credits = SEM I + SEM II + SEM III + SEM IV

= 24 + 24 + 12 +12

= 72

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 601 Course: Research Methodology and IPR Teaching Scheme: Theory: 03 Hrs/week Tutorial: 01 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisite: Basic understanding about research and IPR.

Course objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections and several parametric tests of hypotheses.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights.

Unit Contents Hrs

1. Research Problems and Research Design

Meaning of research, types of research, steps in involved in research process, criteria of good research, importance of ethics in research, codes and policies for research ethics. Selection of research problem, steps involved in defining research problem, need for research design, types of research designs, basic principles of experimental design, formal and informal experimental design. **(06)**

2. Sampling Design

Need for sampling, steps in sampling design, different types of sampling designs, sampling distributions, concept of central limit and standard error, sources of errors, population mean and proportion, sample size calculations, tests of measurements for validity, reliability and practicality. **(06)**

3. Data collection, Processing and Analysis

Methods for collection of data, selection of data collection method, data processing operations, statistics in research, confidence level, measures of central tendency, dispersion, asymmetry and relationship.

Spearman's and Pearson's coefficient of correlation, simple & multiple regression analysis, analysis of variance (ANOVA), factor analysis method **(08)**

4. Hypothesis Test and Report Writing

Concept of research hypothesis, concept of testing of hypothesis, Parametric tests (z, t, F and chi-square tests), Hypothesis testing of means and correlation coefficient, Non parametric tests, significance of research report writing, types of reports, structure of the research report, steps in report writing, precautions and ethics in writing report.**(08)**

5. Introduction to IPR and patents

Origin and evolution of IPR to its present form and use, Different Tools of IPR and what is the nature of these rights, Balancing Rights and Responsibilities, Societal implications of IPR. **(04)**

6. Patents

Concept of inventions/discoveries, patents protect; benchmarks for patentability of inventions; Exceptions to patentability; Patenting issues in Biotechnology and computer based inventions, process to apply for patents in India and in other countries around the world, The steps to granting of a patent; Opposing grant of a patent; term of a patent; rights of a patent holder; challenging validity of a patent licensing of patent rights; using patent rights in the market place; compulsory license. **(08 Hrs)**

Reference Books:

1. C.R.Kothari and G. Garg 'ResearchMethodology: Methods and Techniques'
2. R. Pannerselvam 'Research Methodology'
3. D. Napoleon&B.Narayan 'Research Methodology- As Theoretical Approach'
4. Bernard C. Beins& MaureenA. McCarthy 'Research Methods and Statistics'
5. Stuart MacDonald & Nicola Headlam 'Research Methods Handbook'
6. Ganguli Prabuddha 'Intellectual PropertyRights—Unleashingthe Knowledge Economy'
7. Neeraj Pandey and Khushdeep Dharni, 'Intellectual Property Rights'
8. Ramakrishna B, 'Fundamentals of Intellectual Property Rights'

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 602 Course: Advanced Engineering Materials Teaching Scheme: Theory: 03 Hrs/week Tutorial: 01 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Basic knowledge of engineering material and metallurgy.
Knowledge of various alloys and metallurgical processes.

Course Objectives:

- To develop an understanding of the basis of physical metallurgy and correlate structure of materials with their properties for engineering applications.
- To introduce the importance of non-conventional processing routes for different materials and its importance for advanced materials manufacturing.
- To know the fundamental concepts of nanomaterials, synthesizing methods, their properties at nanoscale and possible technological applications in various fields of engineering.
- To understand various material characterization methods and its scope in engineering.
- To understand various waste management and recycling methods.

Units Contents Hrs

1. Powder Metallurgy

Development and scope of powder metallurgy, characterization of metal powders, relationship between physical properties and particle size/ shape, particle interaction and size control, powder manufacturing techniques, powder mixing and blending, dry and colloidal processing, reduction, electrolysis and atomization processes, compacting and sintering and other consolidation techniques**(08)**

2. Composite Materials and their Engineering Applications

Types of composites and their advantages. Types of reinforcements: glass, boron, carbon, organic and ceramic fibers, their structure, properties and processing. Types of matrix materials: polymer, metal and ceramic matrices, their structure, properties and processing. Wettability and interface bonding. Composite manufacturing and processing techniques. Introduction to Nano-composites and applications. Mechanical properties, thermal properties and load transfer in composites. Elastic behavior, Fracture, fatigue and creep behavior of composites. Tribological and electrical performance of composites. Degradation of composites due to various environmental conditions and corrosion resistance of composites. Designing with composites. Engineering applications of composites **(10)**

3. Functional Materials

Definition of functional materials. Light-sensitive (photochromic) materials, Temperature-sensitive (thermochroic) materials, Chemical-sensitive (chemo chromic) materials, Self-healing materials, Magnetic-sensitive materials and magnetorheological fluids, Shape-Memory Alloys, Invar alloys. Functional materials for computer memory devices and optical media storage devices, Multiferroic materials and their applications in sensors and actuators, Carbon based materials: CNTs, CQD, Fullerenes, Graphite, RGO, GNP.**(06)**

4. Application of Nanomaterials and Nanocomposites

Applications in Biomedical, Solar and Energy storage
Biomedical-Drug delivery, Bone replacement; Sensors – gas sensor, Metal adsorption and recovery, Bio-molecule detectors; Energy storage and conversion - Super capacitors, Solar cells, Energy generators; Electronics; Self-cleaning & Self-healing paints, Nano-engineering of cement- based materials, Agricultural Nanotechnologies. **(06)**

5. Materials Characterization

Scope and methods used for materials characterization. Need, working principle, Components, Description and Applications of different characterization techniques such as Microscopy, Compositional analysis, Chemical analysis, Structural analysis, Thermal analysis, Mechanical property evaluation, Fractography. **(06)**

6. Materials Recycling and Waste Management

Recycling of different classes of materials, Solid Waste Regulations, Waste generation, Waste characterization, Physical properties of Waste, Waste separation and processing: Composting, Landfills, Incineration, etc. **(04)**

Reference Books:

1. Material Science and Engineering: An Introduction by William D. Callister Jr. and David G. Rethwich, Wiley Ltd.
2. Concise Encyclopedia of Magnetic and Superconducting Materials (Advances in Materials Sciences and Engineering)by J. Evetts (ed.), Perganon Press
3. Advances in Materials and their applications by Rama Rao P. (ed)., Wiley Eastern Ltd.
4. Nano: The essentials by Pradeep T., McGraw Hill
5. Nano Technology by Wilson M. et al, Overseas Press

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 603 Course: Advanced Optimization Techniques Teaching Scheme: Theory: 03 Hrs/week Tutorial: 01 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: **Basics of optimization techniques.**
Linear programming models

Course Objectives:

- Know the basics of different evolutionary algorithms.
- Study and understand the principles of Traditional optimization techniques and Non Traditional optimization techniques.
- Apply the concept of Traditional optimization techniques and Non Traditional optimization techniques in practical engineering applications for optimization.

Units Contents Hrs

1. **Introduction**

Optimal Problem Formulation, engineering optimizations Problems, Optimization Algorithms **Single Variable Optimization Algorithms:** Optimality criteria, bracketing methods, region elimination methods, point estimation methods, gradient base methods, root finding using optimization Techniques **(06)**

2. **Multivariable optimization Algorithms**

Optimality criteria, unidirectional search, direct search methods, gradient based methods **(06)**

3. **Constrained Optimization Algorithms**

Kuhn-Tucker conditions, transformation methods, Sensitivity Analysis, direct search for constrained minimization, linearized search techniques, feasible direction method, generalized reduced gradient method, gradient projection method **(08)**

4. **Fuzzy Logic**

Introduction to Fuzzy logic: Fuzzy sets and membership functions, operations on fuzzy sets, fuzzy relations, rules, propositions, implications and inferences, defuzzification techniques, fuzzy logic controller design, some applications of fuzzy logic. **(08)**

5. Special Optimization Algorithms

Integer programming, geometric programming, Genetic Algorithm, Simulated annealing, Global optimization, ant colony optimization. **(06)**

6. Optimization in Operations Research

Linear Programming Problems, simplex method, artificial variable technique, dual phase method, sensitivity analysis. **(06)**

Reference Books

1. Deb Kalyanmoy, "Optimization in Engineering Design", PHI, New Delhi.
2. Rao S.S., "Engineering Optimization", John Wiley, New Delhi
3. Deb Kalyanmoy, " Multi-Objective Algorithms using Evolutionay Algorithms", John Wiley, New Delhi.
4. Paplambross P. Y. and Wilde D. J., "Principls of Optimum Design: Modelling and Computation, Cambridge University Press, UK
5. Chandupatla, "Optimization in Design", PHI New Delhi.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 604 Course: Product Design and Development Teaching Scheme: Theory: 03 Hrs/week Tutorial: 01 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Basic knowledge of production and manufacturing field.

Course Outcomes:

1. To describe the characteristics used for product design and development.
2. To assess the customer requirements in product design.
3. To apply structural approach to concept generation, selection and testing.
4. To identify various aspects of design such as industrial design, design for manufacture, assembly, service and quality and product architecture.
5. To explain various principles and technologies used for the preparation of prototype.

Unit Contents Hrs

1. Introduction

Characteristics of successful product development, design and development of products, duration, and cost of product development, the challenges of product development. Development Processes and Organizations: Generic development process, concept development: the frontend process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization**(06)**

2. Product planning

Product planning process, identify opportunities, evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process Identifying customer needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process. **(08)**

3. Concept Generation

Activities of concept generation, need for systems level thinking, TRIZ and its comparison with brainstorming and lateral thinking, TRIZ tools Ideality and IFR, problem formulation and functional analysis, use of 40 principles to solve contradiction, use of S-curves and technology evolution trends. **(06)**

4. Concept selection and testing

Overview of methodology, concept screening, and concept scoring, Pugh matrix and its application. Concept testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, and reflect on the results and the process, Failure Mode Effect Analysis (DFMEA and PFMEA) Design for X (DFX): Design for manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors, design for assembly, service and quality. **(08)**

5. Product architecture

Implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, and related system level design issues. Industrial design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design. **(06)**

6. Prototyping

Prototyping basics, principles of prototyping, technologies, planning for prototypes Product development economics: Elements of economic analysis, base case financial mode, sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. **(06)**

TEXT BOOKS:

1. A K Chitale and R C Gupta, Product Design and Manufacturing, 6th Edition, PHI, New Delhi, 2003.
2. Karl.T.Ulrich and Steven D Eppinger Irwin, Product Design and Development, 5th Edition, McGraw- Hill, 2011.

REFERENCE BOOKS:

1. George E Deiter, Engineering Design, 5th Edition, McGraw-Hill , 2012 .
2. Boothroyd G, Dewhurst P and Knight W, Product Design for Manufacture and Assembly, 2nd Edition, Marcel Dekker, New York, 2002.
3. G Altshuller, H Altov, Lev Shulyak, And Suddenly the Inventor Appeared: TRIZ, The theory of Inventive Problem Solving, Technical Innovation Centre, 2nd Edition, May 1996.
4. Vladimir Petrov, Theory of Inventive Problem Solving, Level 1, Springer Series, 2019, ISBN: 978-3-030-04253-0.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 605 A Course: Program Elective –I Computational Modeling and Simulation (CMS) Teaching Scheme: Theory: 03 Hrs/week Tutorial: 00 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Introductory Calculus, Probability and Statistics, Introductory Computational Physics and Numerical and computational methods.
Some experience with scientific computing and programming in Python would be beneficial.

Course Objectives:

- To explain the Role of Modeling and simulation
- To utilize the Modeling Process to identify the key parameters of a model, estimate model outcomes, utilize a computational tool.
- Construct difference-based computer models
- Examine mathematical representations of functions

Units Contents Hrs

1. **Introduction to simulation**

   System and system environment, Components of the system, type of systems, type of models, steps in simulation, study advantages and disadvantages of simulations, concept of discrete simulation, time advance mechanisms, components and organization of a discrete -event simulation model. **(10)**

2. **Statistical models in simulation**

   Useful statistical models, discrete distributions, continuous distribution, Poisson process, empirical distribution. **(04)**

3. **Random number generation**

   Random number generation, Properties random numbers, generation pseudo random numbers, techniques for random numbers generation, tests for random numbers. **(06)**

4. **Random variate generation**

   Inverse transforms techniques, convolution method, acceptance rejection techniques. **(04)**

5. **Input Modeling**

Data collection, identifying the distribution of data, parameter estimation, and goodness of fit tests, selection of input model without data, multivariate and time series input model. Verification and validation of simulation model: length of simulation runs, validation. **(08)**

6. **Output analysis for a single model**
Types of simulation with respect to output analysis, stochastic nature of output data, measure of performance and their estimation, output analysis of terminating simulation, output analysis of steady state simulation, case study in simulation, orientation of simulation software such as GPSS. **(08)**

Reference Books

1. Law A.W., Kelton D., "Simulation Modeling and analysis", Tata McGraw Hill, 2003
2. Gordon Geoffrey, "System Simulation", 2nd Ed. PHI, New Delhi, 1990
3. Deo Nassingh, "System Simulation with digital computers", PHI, New Delhi, 1989
4. Zeigler B., Prachofer H., Kim T.G., "Theory of Modeling and Simulation", Academic Press
5. Body Donald W., "System analysis and Modeling", Academic press Harcourt India
6. Banks Jerry, Carson John, Nelson Barry, Nicole David, "Discrete Event Simulation"
7. Kelton W.D., Sadowski R., Sadowski D., "Simulation with Arena" McGraw Hill Publications

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 605 B Course: Program Elective –I Maintenance and Reliability Engineering Teaching Scheme: Theory: 03 Hrs/week Tutorial: 00 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites:
A rudimentary understanding of probability and statistics is recommended. Basic high school/college-level algebra will be helpful to understand statistical concepts.

Course Objectives:

- Understand the concepts of reliability engineering
- Understand probability distributions to measure and model times to failure data
- Understand the relationship between the time to failure distribution, the reliability function, and the hazard rate
- Use the design tools necessary to ensure a reliable product/system
- Understand the differences in analyzing the reliability of repairable and a non-repairable systems

Unit Contents Hrs

1. Introduction

Reliability concepts and patterns of failure, reliability Management, reliability, for system effectiveness. Reliability and hazard rates: Failure data, reliability function, failure rate and hazard rate, common distributions in failure mechanisms experimental, Welbull, gamma, method, failure model, failure mechanism. Normal, log normal, extreme value, model selection for components failure, failure analysis. **(08)**

2. Reliability prediction and analysis

Reliability prediction based on exponential distribution, system reliability analysis block diagram method, fault tree and success tree methods, event tree**(06)**

3. Reliability design

Design for reliability, design process, assessment methodology, reliability allocation, reliability improvement, selection of components to improve system reliability. **(06)**

4. Maintenance in context

Maintenance and profitability, terro-technology, application of terro- technology. Principles: the structure of plant, reason for nature of maintenance work, the production maintenance system a dynamic model. **(08)**

5. Establishing a maintenance plan-preliminary consideration

Items, classification of items, maintenance procedure, guidelines for machine procedures to items. **(04)**

6. Maintenance planning and control

Basic requirements, Management information, labour costs, computer based Management information system, work planning and work control, basic rules for success. **(08)**

Reference Books:

1. L. S. Srinath, "Concepts in Reliability in Engineering", Affiliated East West Press.
2. K. C. Kapur and L. R. Lumbersome, "Reliability in Engineering Design", John Willey and sons. 3. C. Singh and B. S. Dhillon, "Engineering Reliability-New Techniques and Applications", John
Wiley and sons. 4. F. J. Henley, "Designing for reliability and safety control", Hiromitsu
5. Kumamoto, "System reliability", PHI Pub.
6. B Bhadury and S.K. Basu, "Terotechnology: Reliability Engineering and Maintenance Management", Asian Books, New Delhi 2002.
7. Kelly, "Maintenance Planning and Control", A Buttersworth & Co.
8. Krishnan G., "Maintenance and Spare parts Management", Prentice Hall 1991
9. A.K.Gupta, "Reliability Maintenance and Safety Engineering", Laxmi Pub.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 605 C Course: Program Elective – I Advanced Thermodynamics Teaching Scheme: Theory: 03 Hrs/week Tutorial: 00 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Basic knowledge of thermodynamics and processes related to it.

Course Objectives:

- Apply the principles of thermodynamics to advanced chemical engineering processes.
- Identify differences in thermodynamic properties using equations of state, charts, and tabulated data.
- Solve problems involving multi-phase chemical systems and reactive systems
- Justify and apply the molecular basis of thermodynamics using the formalism of equilibrium statistical mechanics.

Unit Contents Hrs

1. **Equation of State**

State postulate for Simple System and equation of state, Ideal gas equation, Deviation from ideal gas, Equation of state for real gases, generalized Compressibility chart, Law of corresponding states Properties of Pure Substances: Phase change process of pure substances, PVT surface, P-v &PT diagrams, Use of steam tables and charts in common use. **(08)**

2. **Laws of thermodynamics**

Laws of thermodynamics, 2nd law Analysis for Engg. Systems, Entropy flow & entropy generation, Increase of entropy principle, entropy change of pure sub, T-ds relations, entropy generation, thermo electricity, Onsager equation. Exergy analysis of thermal systems, decrease of Exergy principle and Exergy destruction. **(06)**

3. **Thermodynamic Property Relations**

Partial Differentials, Maxwell relations, Clapeyron equation, general relations for du, dh, ds, and Cv and Cp, Joule Thomson Coefficient, Ah, Au, As of real gases. **(06)**

4. Chemical Thermodynamics

Chemical Thermodynamics Chemical reaction Fuels and combustion, Enthalpy of formation and enthalpy of combustion, First law analysis of reacting systems, adiabatic flame temperature **(04)**

5. Chemical and Phase equilibrium.

Chemical and Phase equilibrium Criterion for chemical equilibrium, equilibrium constant for ideal gas mixtures, some remarks about Kp of Ideal-gas mixtures, fugacity and activity, Simultaneous relations, Variation of Kp with Temperature, Phase equilibrium, Gibb's phase rule, Third law of thermodynamics, Nerst heat theorem and heat death of universe. **(08)**

6. Gas Mixtures

Gas Mixtures - Mass & mole fractions, Dalton's law of partial pressure, Amagat's law, Kay's rule. Statistical Thermodynamics- Fundamentals, equilibrium distribution, Significance of Lagrangian multipliers, Partition function for Canonical Ensemble, partition function for an ideal monatomic gas, equipartition of energy, Bose Einstein statistics, Fermi- Dirac statistics. **(08)**

Reference Books:

1. Cengel, "Thermodynamics", TMH
2. Nag P.K., "Basic & Applied Thermodynamics", TMH, New Delhi.
3. Kalyan Annamalai, Ishwar K. Puri, "Advanced Thermodynamics Engineering", CCRC PRESS
4. Holman, "Thermodynamics", 4th edition, McGraw Hill
5. Rao, Y.V.C., "Postulational and Stastistical thermodynamics", Allied Pub. Inc.
6. Jones and Hawkings, "engineering Thermodynamics", John Wiley & Sons, Inc. USA 7. Faires V. M. and Simmag, "Thermodynamics", McMillan Pub. Co. Inc. USA
8. Stephen Turns, "Thermodynamics- Concepts and Applications", Cambridge University Press

Faculty of Engineering & Technology **Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)**	
Course Code: MME 605 D Course: Elective – I Industry Elective Teaching Scheme: Theory: 03 Hrs/week Tutorial: 00 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

*The Course content shall be based on the requirement and need of the industry with whom the collaboration is done.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 621 Course: Lab-I (Optimization Programming or software) Teaching Scheme: Practical:02Hrs/week	Credits: 0-0-1 Term Work: 25Marks

Prerequisite: Knowledge of optimization techniques.

Course Objective:

- Inculcate modelling skills necessary to describe and formulate optimization problems in mechanical engineering.

Content:

Part-A: Selection of a case study on design of experiment

Part-B: Optimization of the experiment using any DOE software such as Minitab, SPSS etc.

The assessment of term work shall be done based on the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 622 Course: Lab-II (Analysis/Modeling Software) Teaching Scheme: Practical:02Hrs/week	Credits: 0-0-1 Term Work:25Marks

Prerequisite: None
Course Objective:
To be able to analyze and perform experiment on analysis or modeling softwares.

Content:

The lab work consists of the assignments/experiments related to any analysis or modeling software such as ANSYS, Solidworks etc.

The assessment of term work shall be done based on the following.

- Continuous assessment
- Performing the experiments in the laboratory
- Oral examination conducted on the syllabus and term work mentioned above.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 623 Course: Lab-III (MATLAB) Teaching Scheme: Practical:02Hrs/week	Credits: 0-0-1 Practical Oral:25Marks

Course Objective: To understand MATLAB software.
Course Content:

Introduction to MATLAB Software

1. MATLABwindow:Commandwindow,Workspace,Commandhistory,settingdirecto ry, Working with the MATLAB user interface
2. Basic commands, Assigning variables, Operations with variables
3. Data Types:Characterandstring,Arraysandvectors,Columnvectors,Rowvectors
4. Basic Mathematics: BODMAS Rules, Arithmetic operations, Operators and special characters, Mathematical and logical operators, Solving arithmetic equations
5. Operations on matrix: Crating rows and columns Matrix, Matrix operations, Finding transpose, determinant and inverse, Solving matrix
6. Other operations: Trigonometric functions, Complex numbers, fractions, Real numbers, Complex numbers
7. Plots: Plotting vector and matrix data, Plot labeling, curve labeling and editing, 2D plots: Basic Plotting Functions, Creating a Plot, Plotting Multiple Data Sets in One Graph, SpecifyingLineStylesandColors,GraphingImaginaryandComplexData,FigureWin dows,DisplayingMultiplePlotsinOne Figure Controlling the Axes

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 624 Course: Seminar-I Teaching Scheme: Practical:04 Hrs/week	Credits: 0-0-2 Practical Oral:50Marks

Course Objective: To create a basis for research project.

Seminar I: It shall be based on the literature survey on any topic, which may lead to dissertation in that area. It will be submitted as a report.
The candidate will have to deliver a seminar presentation before the examiners, one of them will be guide and the other will be examiner appointed by the university.

SEMESTER-II

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 651 Course: Advanced Machine Design Teaching Scheme: Theory: 03 Hrs/week Tutorial: 01 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Design of machine elements

Course Objectives:

- To study design concepts in order to enhance the basic design.
- To study behavior of mechanical components under fatigue and creep. To study statistical techniques and its applications in mechanical design.

1. Fundamentals of Design Considerations

Principal Planes and Principal Stresses, tri-axial state of stresses, Mohr's circle for tri-axial state of stresses and strains, volumetric strains, Principal stresses computed from Principal strains, Principal strains due to perpendicular stresses and shear stresses.**(08)**

2. Mechanical Springs

Design of square or rectangular bar helical springs, Belleville springs, ring springs, torsion bar springs, theory of square or rectangular bars helical springs under axial loading, cone, or flat disc spring theory. **(06)**

3. Shafts and Axles

Introduction, Causes of failure in Shafts and Axles and Stresses in Shafts, Materials for Shafts and Axles, Methods of Manufacturing of Shafts, Designing of Straight Shafts, Pure Torsional Load, Designing for Rigidity and Stiffness, Design of Axles, Flexible Shafts. **(06)**

4. Cams

Basic curves, cam size determination, calculating cam profiles, advance curves, polydyne cams, dynamics of high speed cam systems, surface materials, stresses, and accuracy, ramps. **(06)**

5. Fracture and Creep

Fracture Mechanics approach to design, Causes and Interpretation of failures, Creep behavior; rupture theory; creep in high temperature low cycle fatigue; designing against creep. **(06)**

6. Computer Aided Machine Design

Philosophy of Computer Aided Machine Design, Interactive design software, Basic advantage of analysis Software, Design of machine components (springs, gears, temporary fasteners, permanent fasteners, belts and ropes) through Interactive programming. **(08)**

Reference Books:

1. L.S. Srinath, "Advanced Solid Mechanics ", TMH Publications
2. V Ramamurti, "Computer Aided Machine Design and Analysis", Third edition, Tata McGraw Hill Publications
3. Wahl A.M., " Mechanical Springs" .
4. Rothbart John, "Cam" Wiley and sons
5. Sidebottom Borosi, " Advanced Mechanics of Materials" John wily and sons Pub.
6. Smith Seely , " Advanced Mechanics of Materials" John wily and sons Pub
7. Timoshenko, " Strength of Materials"
8. Kocanda " Fatigue Failure of Metals", Sijthoff & Noordhoff International Publication
9. Behan & Crawford, " Mechanics of Engineering Materials", John wily and sons Pub.
10. Spotts M.F., "Mechanical Design Analysis", PHI Publications, New Delhi.
11. R.C. Juvinall, "Fundamentals of Machine Component Design".

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester I)	
Course Code: MME 652 Course: Hybrid Vehicles Teaching Scheme: Theory: 03 Hrs/week Tutorial: 01 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Basic of automatic Control Systems and Electrical Machines
Basic of transmission system and vehicle design.

Course Objectives:

- To understand the basic concepts of Conventional, Electric, Hybrid Electric vehicles.
- Describe different configurations of electric and hybrid electric drive trains
- Discuss the propulsion unit for electric and hybrid vehicles
- Compare various energy storage and EV charging systems
- To study drive systems and various communication protocols for hybrid vehicles

Unit Content Hrs

1. **NEED FOR ALTERNATIVE SYSTEM**

   Need of electric vehicles hybrid vehicles – comparative study of diesel, petrol, pure electric and hybrid vehicles. Limitations of electric vehicles. Specification of some electric and hybrid vehicles **(08)**

2. **INTRODUCTION TO HYBRID VEHICLES**

   Types of Hybrid- Series, parallel, split – parallel, series - parallel - Advantages and Disadvantages. Power split device – Energy Management System - Design consideration - Economy of hybrid vehicles **(06)**

3. **BASIC CONCEPT OF HYBRID TRACTION**

   Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis, braking fundamentals and regenerative braking in EVs. **(06)**

4. **ENERGY SOURCES**

   BATTERIES AND FUEL CELLS Battery Parameters-Power requirement of electric vehicles- Different types of batteries - Lead acid- Nickel based-Sodium based-Lithium

based- Metal Air based. Battery charging- Charger design- Quick charging devices- Battery Modeling. Different type of energy storage – Solar, wind, compressed fluid. Fuel Cell- Fuel cell characteristics- Fuel cell types-Hydrogen fuel cell- Connecting cell in series- water management in the PEM fuel cell- Thermal Management of the PEM fuel cell **(08)**

5. PROPULSION MOTORS AND CONTROLLERS

Characteristic of permanent magnet and separately exited DC motors. AC single phase and 3-phase motor – inverters – DC and AC motor speed controllers. **(06)**

6. VEHICLE DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES

Aerodynamic-Rolling resistance- Transmission efficiency- Vehicle mass- Electric vehicle chassis and Body design considerations- Heating and cooling systems- Controllers- Power steering- Tyre choice- Wing Mirror, Aerials and Luggage racks **(06)**

REFERENCE BOOKS:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
2. Iqbal Husain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
3. MehrdadEhsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRC Press,2005
4. Chris Mi, M A Masrur, D W Gao, " Hybrid Electric Vehicles – Principles and applications with practical perspectives," Wiley, 2011
5. Anderson JM, Nidhi K, Stanley KD, Sorensen P, Samaras C, Oluwatola OA, Autonomous vehicle technology: A guide for policymakers, Rand Corporation,2014

REFERENCES:

1. Ron HodKinson, "light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication,2005
2. Lino Guzzella, "Vehicle Propulsion System" Springer Publications,2005

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 653 Course: Advanced manufacturing Techniques Teaching Scheme: Theory: 03 Hrs/week Tutorial: 01 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites:

Production Technology, Machine Tools, Metal Cutting, Material Science.

Course Objectives:

- To make acquainted the various unconventional manufacturing techniques
- To know about the applications of advanced manufacturing techniques (which are exceptional).
- To encourage the students for developing the models of Advanced Manufacturing techniques

Unit Content Hrs

1. **Advanced Casting Processes**

Vacuum mould casting, Evaporative pattern casting, ceramic shell casting, Counter-gravity flow - pressure casting, Semisolid metal casting, Rheocasting. **(06)**

2. **Advanced Metal Forming Processes**

Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming, electro-hydraulic forming, stretch forming, contour roll forming. **(06)**

3. **Advanced Welding Process**

EBW, LBW, USW, Explosion welding, ESW and EGW, Cold pressure welding, FSW, UWW: wet and dry. Automation in welding, remote welding, Robotic welding, Gravity welding and Fire cracker welding, selecting welding system. **(08)**

4. **Surface Treatment**

Scope, Cleaners, Methods of cleaning, Surface coating types, Economics of coating, CVD, PVD, Thermal spray coating, Ion implantation, Diffusion coating, Diamond coating and cladding**(06)**

5. **Non-conventional Machining Processes**

Introduction, Need, Process capabilities, Parametric analysis, Advantages and Disadvantages, Applications of: AJM, WJM, USM, EDM, WEDM, LBM, ECM, ECG, CHM, PAM. **(08)**

6. High-end Manufacturing Processes

E-manufacturing, Nano-technology, Etching techniques: wet etch and dry etch, Lithography, Micromachining, HSM, Additive Manufacturing, 3-D Printing. **(06)**

Reference Books:

1. Manufacturing Processes for Engineering Materials by Serope Kalpakjian and Steven R. Schmid, Pearson Education India.
2. Manufacturing Processes and Systems by Philip F. Ostwald and Jairo Munoz, Wiley Student Edition.
3. Manufacturing Technology: Foundry, Forming and Welding by P. N. Rao, McGraw Hill Education.
4. The 3D Printing Handbook: Technologies, Design and Applications by 3D Hubs.
5. Handbook of Hard Coatings by Elsevier.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 654 A Course: Program Elective –II Finite Element Methods (FEM) Teaching Scheme: Theory: 03 Hrs/week Tutorial: 00 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Numerical Methods and CAD

Course Objectives:

- Familiarize with the fundamental concepts of finite element method
- Inculcate the formulation of finite element models by selecting a suitable element, developing element matrices & vectors, and incorporating boundary conditions
- Familiarize with finite element procedures to solve structural, thermal, and fluid flow problems using commercial finite element packages

Unit Content Hrs

1. Introduction

Introduction to Finite Difference Method and Finite Element Method, Advantages and disadvantages, Mathematical formulation of FEM, Variational (Rayleigh-Ritz) Method, Potential Energy Method, Weighted Residual (Galerkin) Approach, Weighted Residual (Least Squares) Approach.

2. Shape functions and Coordinate system

Shape functions, Natural co-ordinate system, Element and global stiffness matrix, Boundary conditions Errors, Convergence and patch test, higher order elements.

3. Structural Applications

Applcation problems of structural mechanics and solid mechanics, Plane stress and plane strain problem, 3-D problems. Torsion, bending of plates and shells,

4. FE formulation

FE formulation for vibration, heat transfer, and fluid flow problems.

5. Application to field Problems

Application of the method to materially non-linear bending of straight beams and elastic plates problems, associated flowcharts and computer programming, Data preparation and mesh generation through computer graphics, Numerical techniques, 3D problems.

6. FEM Software

FEM an essential components of CAD, Use of commercial FEM packages, ANSYS Software and MATLAB Programs for Finite Element Analysis, Comparison with conventional analysis.

Reference Books:

1. Introduction to Finite Elements in Engineering, T.R. Chandrupatla & A.D. Belegundu, Prentice Hall India.
2. An Introduction to the Finite Element Method, Reddy.J.N, McGraw-Hill
3. The Finite Element Method, O.C.Zienkiewicz, R.L.Taylor, McGraw-Hill
4. The Finite Element Method in Engineering, S.S.Rao, Elmsford, Pergamon, Butterworth– Heinemann publications.
5. Introduction to the Finite Element Method: A Numerical Method for Engineering Analysis, Desai.C.S and Abel.J.F
6. Concepts and application of Finite Element Analysis, R.D.Cook, D.S.Malcus and M.E. Plesha, John Wiley

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 654 B Course: Program Elective –II Computer Integrated Manufacturing (CIM) Teaching Scheme: Theory: 03 Hrs/week Tutorial: 01 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Basic knowledge on machining, machine tools and manufacturing

Course Objectives:

- To introduce computer integration in all aspects of production system.
- To identify the features of CAM and CAPP.
- To provide an eye opening to the present scenario of a manufacturing plant so that the student can better understand their future job roles.
- To familiarize with the automation related to material handling, storage, inspection and manufacturing system

Unit Contents Hrs

1. **Introduction**

The meaning and origin of CIM- the changing manufacturing and management scene External communication islands of automation and software-dedicated and open systems-manufacturing automation protocol - product related activities of a company- marketing engineering production planning - plant operations - physical distribution- business and financial management. **(08)**

2. **Group Technology**

History of group technology- role of G.T. in CAD/CAM integration part families' classification and coding DCLASS and MICLASS and OPITZ coding systems-facility design using G.T. benefits of G.T. cellular manufacturing. **(06)**

3. **Computer Aided Process Planning**

Process planning - role of process planning in CAD/CAM integration approaches to computer aided process planning variant approach and generative approaches CAPP and CMPP process planning systems. **(06)**

4. **Shop Floor Control and Introduction of FMS**

Shop floor control-phases -factory data collection system -automatic identification methods- Bar code technology-automated data collection system. FMS-components of FMS-types -FMS workstation -material handling and storage systems- FMS layout-computer control systems-application and benefits. **(06)**

5. CIM Implementation and Data Communication

CIM and company strategy system modeling tools -IDEF models - activity cycle diagram CIM open system architecture (CIMOSA) - manufacturing enterprise wheel-CIM architecture- Product data management-CIM implementation software. Communication fundamentals- local area networks -topology -LAN implementations network management and installations. **(08)**

6. Open System and Database for CIM

Open systems-open system inter connection manufacturing automations protocol and technical office protocol (MAP/TOP) Development of databases -database terminology-architecture of database systems-data modeling and data associations -relational data bases database operators advantages of data base and relational database. **(06)**

Reference Books:

1. David D.Bedworth, Mark R.Hendersan, Phillip M. Wolfe "Computer Integrated Design and Manufacturing", McGraw-Hill Inc.
2. Yorem Koren, "Computer Integrated Manufacturing System", MeGraw-Hill, 1983.
3. Mikell.P.Groover "Automation, Production Systems and computer integrated manufacturing", Pearson Education 2001.
4. Ranky, Paul G., "Computer Integrated Manufacturing", Prentice Hall International, 1986.
5. Roger Hanman "Computer Intergrated Manufacturing", Addison-Wesley, 1997.
6. Mikell.P.Groover and Emory Zimmers Jr., "CAD/CAM", Prentice Hall of India Pvt. Ltd., New Delhi-1, 1998.
7. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India, 2003.
8. Radhakrishnan P, Subramanyan S.and Raju V., "CAD/CAM/CIM", 2nd Edition New Age International (P) Ltd., New Delhi, 2000.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 654 C Course: Program Elective –II Computational Fluid Dynamics (CFD) Teaching Scheme: Theory: 03 Hrs/week Tutorial: 01 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisite: Basic knowledge of fluid mechanics, linear algebra, partial differential equations and average programming skills.

Course Objectives:

- To study various methods of CFD and compare with experimental and theoretical analysis.
- To formulate the governing equations and solve the numerical problem
- To derive finite volume method and apply to 2-D and 3-D problems.
- To discuss practical aspects of computational modeling of flow domains and grid generation.

Unit Content Hrs

1. Introduction

Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description. Classification and Overview of Numerical Methods: Classification into various types of equation; parabolic elliptic.

2. Classification of Physical Behavior

Classification of fluid flow equations, auxiliary conditions for viscous fluid flow equations. Implementation of boundary condition Turbulence and its Modelling: Transition from laminar to turbulent flow, effect of turbulence on time averaged Navier Stoke equation, Characteristics of simple turbulent flow, Free turbulent flows, Flat plate boundary layer, pipe flow, Turbulence model Mixing length model, k-omega, and k-epsilon model.

3. Numerical Grid Generation

General principles of grid generation Numerical grid generation and types; basic ideas of transformation and mapping. Elliptic grid generation, algorithm, Grid clustering, Grid refinement, Adaptive grids, Moving grids.

4. Finite difference discretization

Finite difference discretization Elementary finite difference coefficients, basic aspects of finite difference equations, consistency, explicit and implicit methods, errors and stability analysis. Fundamentals of fluid flow modeling-conservative property, upwind scheme, transporting property. Finite difference applications in heat transfer – conduction, convection.

5. Finite Volume Method

Introduction, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Finite volume methods for unsteady problems – explicit schemes, implicit schemes.

6. Errors and its types

Validation of CFD Code, Application of CFD in Automobile, Aviation, biomedical engineering, combustion, food industry etc. and basic governing equations, Introduction to various commercial software ANSYS, COMSOL Multiphysics, Autodesk CFD.

Reference Books:

1. Ferziger J. H., Springer P.M, "Computational Methods for fluid Dynamics", Verlag Berlin
2. Anderson J. D. JR, "Computational fluid Dynamics", Mc Graw Hill Inc, 1995
3. Introduction to Computational Fluid dynamics – Finite Volume Method – H.S. Versteeg and W. Malalasekera, Pearson, Prentice Hall 2007.
4. Patankar S. P, "Numerical Heat Transfer & Fluid flow"
5. Sunderarajan M.K., "Computational Fluid Flow and Heat Transfer", 2nd Ed, Narosa Publishing

References

1. Computational Fluid Dynamics and Heat Transfer - by Tenehill J C and Pletcher R H
2. Computational Fluid Dynamics Paperback by Gautam Biswas and Somenath Mukherjee
3. Computational Fluid Dynamics: A Practical Approach- by Tu A Practical Approach Kindle Edition by Jiyuan Tu, Guan Heng Yeoh and Chaoqun Liu
4. Fluid Dynamics: Part 1: Classical Fluid Dynamics- by Anatoly I Ruban and Jitesh S B Gajjar.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 654 D Course: Program Elective – II Industry Elective Teaching Scheme: Theory: 03 Hrs/week Tutorial: 00 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

*The Course content shall be based on the requirement and need of the industry with whom the collaboration is done.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 655 A Course: Open Elective – Robotics and Automation Teaching Scheme: Theory: 03 Hrs/week Tutorial: 00 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Engineering Mechanisms and their Application,

Course Objectives:

- To provide an introduction to Robotics and Automation including robot classification, design and selection, analysis and applications in industry.
- To provide information on various types of end effectors, their design, interfacing and selection.
- To provide the details of operations for a variety of sensory devices that are used on robot , the meaning of sensing, classification of sensor, that measure position, velocity & acceleration of robot joint.
- To familiarize the basic concepts of transformations performed by robot.
- To perform kinematics and to gain knowledge on programming of robots.

Unit Content Hrs

1. Introduction

Definition, automation principles and strategies - scope of automation - socioeconomic consideration, low cost automation - Production concepts and automation strategies - Fixed Automation: Automated Flow lines, Methods of Work part Transport. **(06)**

2. Transfer Mechanism

Transfer Mechanism - Continuous transfer, intermittent transfer - Indexing mechanism Automation for Machining Operations, Design and Fabrication Considerations. Analysis of Automated Flow Lines: General Terminology and Analysis. **(06)**

3. Trajectory planning

Mathematical representation of Robots - Position and orientation – Homogeneous transformation-Various joints- Representation using the Denavit Hattenberg parameters -Degrees of freedom-Direct kinematics-Inverse kinematics- Linear and angular velocities-Manipulator Jacobian-Prismatic and rotary joints–Inverse -Wrist and arm singularity - Static analysis - Force and moment Balance- Trajectory planning, Pick and place operations, Continuous path motion, Interpolated motion, Straight line motion**(08)**

4. Material handling

Concepts of material handling, principles and considerations in material handling systems design, conventional material handling systems - industrial trucks, rail guided vehicles, conveyor systems, advanced material handling systems, automated guided vehicle systems, automated storage and retrieval systems(ASRS), Work-in-process Storage, Interfacing Handling and Storage with Manufacturing **(08)**

5. Automated Inspection and Testing

Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods. Robotic vision systems, image representation, object recognition and categorization, depth measurement, image data compression, visual inspection **(06)**

6. Other applications: Application of Robots in welding, Spray painting, assembly operation, cleaning, robot for underwater applications. Gripper force analysis and gripper design for typical applications, design of multiple degrees of freedom, active and passive grippers Factors influencing the choice of a robot, robot performance testing- Impact of robot on industry and society. **(06)**

Reference Books:

1. Stephen J. Derby, "Design of Automatic Machinery", Special Indian Edition, Marcel Decker, New York, Yesdee publishing Pvt. Ltd, Chennai, 2004.
2. J J Craig, —Introduction to Robotics: Mechanics and Control, Prentice Hall, 2004. 3. R M Murray, Z. Li and S S Sastry, "A Mathematical Introduction to Robotic Manipulation", CRC Press, 1994.

Text Books:

1. Ashitava Ghoshal, Robotics-Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. Richaerd D Klafter, Thomas Achmielewski and MickaelNegin, "Robotic Engineering – An integrated Approach" Prentice Hall India, New Delhi, 2001.
3. Deb S R and Deb S, —Robotics Technology and Flexible Automation, Tata McGraw Hill Education Pvt. Ltd, 2010.
4. Mikell P Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", Pearson Education, 2015.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 655B Course: Open Elective – Industry 4.0 Teaching Scheme: Theory: 03 Hrs/week Tutorial: 00 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Basics industrial engineering

Course Objectives:

- To impart basic idea in Industry 4.0.
- To explain Design thinking principles and its usage for problem solution
- To use various tools and technologies.
- Learn the design and analysis of Industry 4.0 systems for engineering application.

Unit Contents Hrs

1. **Introduction 4.0 Industry**

   Introduction to Sensing & Actuation, Industry 4.0: Globalization and Emerging Issues, The Fourth Revolution, LEAN Production Systems, Smart and Connected business perspective. Industry 4.0:Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Artificial Intelligence, Big Data and Advanced Analysis, Introduction to FDM machine, 3D printing demonstration **(10)**

2. **Cloud Computing Technologies**

   Introduction to Cloud Technologies, Study of top cloud services providers platforms and their real life use cases exploration (AWS, Azure, GCP), Hands-on using platforms **(06)**

3. **Augmented Reality and Virtual Reality**

   Introduction to AR and VR, Hands-on using UNITY, Industry use cases of AR and VR **(04)**

4. **Design thinking as a Problem-Solving Process:** Describe the principles of Design Thinking. - Describe the Design Thinking process for problem solution. Listening and Empathizing Techniques – observation – structured open ended approach. **(06)**

5. **Design Thinking Frameworks**

   Design Thinking Frameworks, Ideation tools – brainstorming, innovation heuristics, behaviour models, overcoming cognitive fixedness. Use of Diagrams and Maps in Design Thinking – Empathy map. Affinity diagram, mind map, journey map, combining ideas into complex innovation concepts **(06)**

6. **Basics of Industrial Internet of Things (IIOT):** Introduction, Industrial Internet system, Industrial process, Key enablers of IIOT, Cyber Security. Case Studies: Real time use cases from different Industries like OIL, Chemical and Pharma and Uses of UAV in industries **(08)**

Reference Books:

1. Virtual and Rapid Manufacturing: Advanced Research in Virtual and Rapid Prototyping, By Bartolo, P J, Taylor and Francis
2. Rapid Manufacturing: An Industrial Revolution for a Digital Age By Hopkinson, N, Haque, R., and Dickens, P., Wiley
3. Make: 3D Printing By Anna Kaziunas France
4. The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics By Christoph Jan Bartodziej
5. Industry 4.0: Entrepreneurship and Structural Change in the New Digital Landscape, By Springer

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 655 C Course: Open Elective – Artificial Intelligence and Machine Learning Teaching Scheme: Theory: 03 Hrs/week Tutorial: 00 Hr/week	Credits: 3-1-0 Mid Semester Examination-I: 15 Marks Mid Semester Examination-II: 15 Marks Teacher Assessment: 10 Marks End Semester Examination: 60 Marks End Semester Examination (Duration): 2 Hrs

Prerequisites: Linear Algebra, Probability, Statistics, Logical Reasoning

Course Objectives:

- To acquaint with fundamentals of artificial intelligence and machine learning.
- To learn feature extraction and selection techniques for processing data set.
- To understand basic algorithms used in classification and regression problems.
- To outline steps involved in development of machine learning model.
- To familiarize with concepts of reinforced and deep learning.
- To implement and analyze machine learning model in mechanical engineering problems.

Unit Contents Hrs

1. **Introduction to AI & ML**

   History of AI, Comparison of AI with Data Science, Need of AI in Mechanical Engineering, Introduction to Machine Learning. Basics: Reasoning, problem solving, Knowledge representation, Planning, Learning, Perception, Motion and manipulation. **Approaches to AI:** Cybernetics and brain simulation, Symbolic, Sub-symbolic, Statistical. **Approaches to ML:** Supervised learning, Unsupervised learning, Reinforcement learning**. (06)**

2. **Feature Extraction and Selection**

   Feature extraction: Statistical features, Principal Component Analysis. **Feature selection:** Ranking, Decision tree - Entropy reduction and information gain, Exhaustive, best first, Greedy forward & backward, Applications of feature extraction and selection algorithms in Mechanical Engineering. **(07)**

3. **Classification & Regression: Classification**

   Decision tree, Random forest, Naive Bayes, Support vector machine. **Regression:** Logistic Regression, Support Vector Regression. **Regression trees:** Decision tree,

random forest, K-Means, K-Nearest Neighbor (KNN). Applications of classification and regression algorithms in Mechanical Engineering. **(07)**

4. **Development of ML Model: Problem identification**

   Classification, clustering, regression, And ranking. Steps in ML modelling, Data Collection, Data pre-processing, Model Selection, Model training (Training, Testing, K-fold Cross Validation), Model evaluation (understanding and interpretation of confusion matrix, Accuracy, Precision, Recall, True positive, false positive etc.), Hyper parameter Tuning, Predictions. **(07)**

5. **Reinforced and Deep Learning: Characteristics of reinforced learning; Algorithms**

   Value Based, Policy Based, Model Based; Positive vs Negative Reinforced Learning; Models: Markov Decision Process, Q Learning. Characteristics of Deep Learning, Artificial Neural Network, Convolution Neural Network. Application of Reinforced and Deep Learning in Mechanical Engineering. **(07)**

6. **Applications**

   Human Machine Interaction, Predictive Maintenance and Health Management, Fault Detection, Dynamic System Order Reduction, Image based part classification, Process Optimization, Material Inspection, Tuning of control algorithms. **(06)**

References Books:

1. Solanki, Kumar, Nayyar, Emerging Trends and Applications of Machine Learning, IGI Global, 2018.

2. Mohri, Rostamizdeh, Talwalkar, Foundations of Machine Learning, MIT Press, 2018.

3. Kumar, Zindani, Davim, Artificial Intelligence in Mechanical and Industrial Engineering, CRC Press, 2021.

4. Zsolt Nagy - Artificial Intelligence and Machine Learning Fundamentals-Apress (2018)

5. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair, TMH

Text Books:

1. Deisenroth, Faisal, Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.

2. B Joshi, Machine Learning and Artificial Intelligence, Springer, 2020.

3. Parag Kulkarni and Prachi Joshi, "Artificial Intelligence – Building Intelligent Systems", PHI learning Pvt. Ltd., ISBN – 978-81-203-5046-5, 2015

4. Stuart Russell and Peter Norvig (1995), "Artificial Intelligence: A Modern Approach," Third edition, Pearson, 2003.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 671 Course: Lab-IV(Assignments) Teaching Scheme: Practical:02Hrs/week	Credits: 0-0-1 Term Work:25Marks

Course Objective: To gain aadditional insites of the courses.

Assignments shall be based on five theory course of semester II (two on each course) The marks shall be awarded by concerned course teacher.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 672 Course: Lab-V Teaching Scheme: Practical:02Hrs/week	Credits: 0-0-1 Practical Oral:25Marks

The Lab-V work consists of the process analysis using relevant software through, Product Identification Appropriate process selection Process details Verification Analysis The candidate will deliver the work in front of two examiners (one internal and other appointed by the university)

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 673 Course: Lab-VI (Advance MATLAB) Teaching Scheme: Practical:02Hrs/week	Credits: 0-0-2 Term Work: 50Marks

Course Objective: To gain aadditional knowledge of the MATLAB Software

Course Content:

The lab work consists of the assignments/experiments related to Programming in MATLAB Software

1. GUI Design: Introduction of Graphical User Interface, GUI Function Property, GUI Component Design, GUI Container, Writing the code of GUI Callback
2. MATLAB Programming: Automating commands with scripts, Writing programs with logic and flow control, Writing functions, Control statement Programming, Conditional Statement Programming, Examples
3. Loops and Conditional Statements: Control Flow Conditional Control — if, else, switch Loop Control — for, while, continue, break
   Program Termination — return
4. Functions: Writing user defined functions, Built in Function, Function calling, Return Value, Types of Functions, Global Variables
5. MATLAB Toolbox: Optimization Toolbox, Fuzzy logic Toolbox, Global Optimization Toolbox, Neural Network Toolbox, Statistics and Machine Learning Tool Box.
6. Introduction to Simulink

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester II)	
Course Code: MME 674 Course: Seminar- II Teaching Scheme: Practical:02Hrs/week	Credits: 0-0-2 Practical Oral:50Marks

Course Objective: To create a basis for research project.

Seminar II: It should in continuation/advancement with seminar I and it shall be based on the literature survey on any topic, which may lead to dissertation in that area. It will be submitted as a report.
The candidate will have to deliver a seminar presentation before the examiners, one of them will be guide and the other will be examiner appointed by the university.

Faculty of Engineering & Technology Syllabus of F. Y. M.E (Mechanical Engineering) (Semester III)	
Course Code: MME 701 Course: MOOC Course Teaching Scheme: Theory: 03 Hrs/week Tutorial: 00 Hr/week	Credits: 3-1-0 End Semester Examination: 100 Marks End Semester Examination (Duration): 3 Hrs

It is mandatory for the student to complete one MOOC course related to the program of study. The student will have to complete the MOOC course which will be available on the SWAYAM portal (Free online education portal). Registered MOOC courses should not have similar or overlapping content to that of the regular courses in the curriculum of the program. The credits can be given to the students after successful completion of the MOOC course of 12 weeks or more. The credits will be transferred by the evaluation in terms of assignments or examinations or viva-voce.
In case the student is unable to clear MOOC Course examination, the student will have to appear for an Institute-level examination for the respective MOOC course.

Faculty of Engineering & Technology Syllabus of S. Y. M.E (Mechanical Engineering) (Semester III)	
Course Code: MME 731 Course: Dissertation Part I Teaching Scheme: Practical:18Hrs/week	Credits: 0-0-12 Term work: 50 Marks Practical Oral:150Marks

Course Objective:

This course is focused to facilitate student to carry out extensive research and development project or technical project at place of work through problem and gap identification, development of methodology for problem solving, interpretation of findings, presentation of results and discussion of findings in context of national and international research. The overall goal of the dissertation is for the student to display the knowledge and capability required for independent work.

The dissertation shall consist of a report on any research work done by the candidate or a comprehensive and critical review of any recent development in the subject or detailed report of the project work consisting of a design and / or development work that the candidate has executed. The report must include comprehensive litterateur work on the topic selected for dissertation.

Term work:

The dissertation part I will be in the form of seminar report on the project work being carried out by the candidate and will be assessed by two examiners appointed by the university, one of whom will be the guide and other will be a senior faculty member from the department.

Viva-voce:

The dissertation part I will be in the form of seminar report on the project work being carried out by the candidate and will be assessed by two examiners appointed by the university, one of whom will be the guide and other will be an external examiner.

Faculty of Engineering & Technology Syllabus of S. Y. M.E (Mechanical Engineering) (Semester IV)	
Course Code: MME 781 Course: Dissertation Part II Teaching Scheme: Practical:24 Hrs/week	Credits: 0-0-20 Term work: 100 Marks Practical Oral: 200 Marks

Course Objective:

This course is focused to facilitate student to carry out extensive research and development project or technical project at place of work through problem and gap identification, development of methodology for problem solving, interpretation of findings, presentation of results and discussion of findings in context of national and international research. The overall goal of the dissertation is for the student to display the knowledge and capability required for independent work.

The dissertation part II will be in continuation of dissertation part - I and shall consist of a report on the research work done by the candidate or a comprehensive and critical review of any recent development in the subject or detailed report of the project work consisting of a design and / or development work that the candidate has executed. The examinee shall submit the dissertation in triplicate to the head of the institution duly certified by the guide and the concerned head of department and the Principal that the work has been satisfactorily completed.

Term work:

The dissertation will be assessed by two internal examiners appointed by the Institute, one of whom will be the guide and other will be a senior faculty member from the department.

Viva-voce:

It shall consist of a defense presented by the examinee on his work in the presence of examiners appointed by the university, one of whom will be the guide and other will be an external examiner.

Question Paper structure for All Theory Courses shall be as per following format

Q. 1 shall be based on complete syllabus and should have MCQs, Fill in the blank, one sentence, Match the pair, type of questions for 10 marks. It should be compulsory question

Remaining 7 Questions shall be of 10 Marks each. Out of these 7 questions 5 questions should be solved.

These questions may have one question of 10M or two questions of 5M each based on the syllabus.