UNIVERSITY OF KERALA
REGULATIONS, SCHEME AND SYLLABUS

For
M.Tech. Degree Programme
In
MECHANICAL ENGINEERING
(2013 Scheme)

Stream: INDUSTRIAL ENGINEERING
# M.Tech Programme

Mechanical Engineering - Industrial Engineering

Curriculum and Scheme of Examination

## SEMESTER I

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name of Subject</th>
<th>Credits</th>
<th>Hrs/week</th>
<th>End Sem Exam hours</th>
<th>Marks</th>
<th>Remarks</th>
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<td>MIM 1001</td>
<td>Probability and Stochastic Processes</td>
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Of the 40 marks of internal assessment, 25 marks for test and 15 marks for assignment. End sem exam is conducted by the university.
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No End Sem Examinations

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Seven hours departmental assistance
## SEMESTER II

<table>
<thead>
<tr>
<th>Code No.</th>
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Students can select a subject from the subjects listed under stream/department electives for the second semester as advised by the course coordinator.
## STREAM ELECTIVES FOR SEMESTER II

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<tr>
<th>Stream Elective I</th>
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### SEMESTER III

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* Students can select a subject from the subjects listed under stream electives for the third semester as advised by the course coordinator.

** Student can select a subject from the subjects listed under Interdisciplinary electives for the third semester as advised by the course coordinator.
STREAM ELECTIVES OFFERED IN INDUSTRIAL ENGINEERING
FOR SEMESTER III

<table>
<thead>
<tr>
<th>Stream Elective III</th>
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<tbody>
<tr>
<td>MIE 3001 : Enterprise Resource Planning</td>
<td>MIE 3005 : Heuristics for Decision Making</td>
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<tr>
<td>MIE 3002 : Inventory Models</td>
<td>MIE 3006 : Econometrics</td>
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<tr>
<td>MIE 3003 : Design thinking and Management</td>
<td>MIE 3007 : Industrial Scheduling</td>
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<tr>
<td>MIE 3004 : Design of Algorithms</td>
<td>MIE 3008 : Management of Projects</td>
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SEMESTER IV

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DEPARTMENTAL ELECTIVES FOR SEMESTER II

1. MID 2001 Reliability Engineering
2. MID 2002 Modern Information System
3. MDD 2001 Computational Plasticity
4. MDD 2002 Bio Mechanics
5. MDD 2003 Introduction to Signal Processing
6. MPD 2001 Finite volume method for fluid flow and heat transfer
7. MPD 2002 Transport Phenomena
9. MTD 2002 Cryogenics Engineering
M.TECH – INDUSTRIAL ENGINEERING
SYLLABUS
FIRST SEMESTER
MIM 1001: PROBABILITY AND STOCHASTIC PROCESSES 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credit: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objectives

- To introduce basic probability theory and probability distributions which are essential tools for modeling random phenomena.
- To provide some theory of stochastic processes and indicate its diverse range of applications.
- To Give the student some probabilistic intuition and insight in thinking about problems

Learning Outcomes

- After successful completion of the course, the students are expected to.
- View processes from a probabilistic instead of an analytic point of view.
- Appreciate the applicability of probability concepts to real, everyday problems and situations.
- Utilize the same for their future project and research works.

Review:

Probabilities defined on events, Conditional probabilities, Independent events, Bayes formula, Discrete and Continuous random variables, Probability Density Functions, expectations.

Module I

Multiple random variables: Joint and Marginal distributions, Independence of random variables, Covariance, Correlation, Conditional probability distributions, Conditional expectations, Distributions of sum of two random variables. Limit theorems: Central limit theorem and Law of large numbers.

Module II


Module III

References:

2. S.M.Ross, Introduction to probability models, Elsevier.
3. S.M.Ross, Stochastic processes, John Wiley and Sons.

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MIC 1001: INDUSTRIAL STATISTICS 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

The course aims to provide students with an introduction to statistical techniques and their applications in the context of business and management problems. At the end of the course students should be able to:

- Make sense out of data by constructing appropriate summary measures, tables, and displays.
- Apply single and multi-variable measures to make decisions.
- Work with probability distributions and their summary measures to analyze unknowns.
- Apply sampling techniques to make projections about a population.
- Perform and interpret elementary statistical inferences (such as confidence intervals and hypothesis tests).
- Understand key concepts for quantifying and managing uncertainty and random variations in business and management problems.
- Develop decision making and analytical skills.
- Apply technology tools to business management and administrative support functions

Learning Outcomes

- Perform data analysis, trend analysis, and regression analysis on data series, create appropriate displays, and explore what-if scenarios and possible solutions.
- Apply techniques for analyzing and interpreting data to real-world datasets relevant to varied fields of business and industry.
- Critically evaluate reports presenting statistical data and translate and communicate the results of statistical analyses.
- Utilize the same for their future project and research works

Module I

Collection of statistical data, Classification and tabulation, Measures of central tendency, Measures of dispersion, Chebyshev’s theorem, Skewness, Moments and Kurtosis, Sampling and Sampling distributions.

Module II

Estimation and Confidence Intervals – Point estimation, Interval estimation; Hypothesis Testing.

Non-parametric tests: One sample tests – Chi-square test, K-S test; Two-sample tests – Two samples Median test, Mann-Whitney U-test; K-samples tests – K- samples Median test, Kruskal-Wallis test.
Module III

Correlation Analysis – Karl Pearson’s correlation coefficient, Spearman’s rank correlation coefficient, Auto-correlation coefficient

Linear regression, Partial and Multiple regression analysis, Analysis of Variance.

Multivariate Analysis - Discriminant analysis, Factor analysis, Cluster analysis, Multidimensional scaling and Conjoint analysis (Overview only)

References:

3. F. E. Brown, Marketing Research: A structure for decision making, Addison-Wesley publishing Co., California.

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MIC 1002: FINANCIAL MANAGEMENT 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

At the end of the course students should be able to:

- Understand the use of basic financial management concepts.
- Understand and use the tools of analysis such as valuation, risk-return relationships, financial statement analysis, capital budgeting, cost of capital, capital structure and working capital management.

Become familiar with the various types of financing available to a firm

Learning Outcomes

After successful completion of the course, the students are able to:

- Obtain an overview of Indian financial system.
- Analyze financial statements using standard financial ratios.
- Apply techniques to project financial statements for forecasting long-term financial needs.
- Explain the role of short-term financial needs.
- Apply time value, risk, and return concepts.
- Obtain an overview of international financial management.

Module I


International financial management: World monetary system, foreign exchange markets and rates, financing foreign operations.

Module II

Working capital management: importance, objectives, inventory management, receivables management, credit policy, cash management.

Module III

Sources of finance: Long term-equity capital-debenture capital-term loans, deferred credit-government subsidies -leasing and hire purchase, Short term financing-accruals-trade credit-short term bank finance public deposit-commercial paper.


References:

1) Corporate Finance – Berely&Mayers
2) Financial Management Theory and Practice – Prasannachandra – TMH
3) Financial Management – Van Horne – Pearson Education
4) Financial Management – Khan & Jain – TMH
5) Financial Management – S. N. Maheswary – Himalaya
6) Investment Analysis – Preethi Singh – Himalaya

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students
MIC 1003: OPERATIONS PLANNING AND CONTROL 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

• Should develop knowledge on product and process related operation systems and models.
• Should be able to use the operations planning tools for real life applications like facility location etc.
• Should acquire advanced knowledge on latest operation planning and control systems and approaches

Learning Outcomes

• Understand various product and process related operation systems and models.
• Understand the use of operations planning tools for real life applications.
• Understand latest operation planning and control systems and approaches.

Module I


Module II


Module III


References:

1. Naramsimhan et.al, Production Planning and Inventory Control
2. Lee J.Krajewski et.al, Operations Management - Pearson Education
3. R. Paneesrselvam, Production and Opeartions Management. PHI
4. Silver, Pyke, Peterson, Inventory Management and Production Planning and Scheduling, John Willey & Sons
5. R. P. Mohanthy, Advanced Production Planning - Pearson Education.

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MIC 1004: ADVANCED OPERATIONS RESEARCH  3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

The main objectives of this course are:-

- To introduce the students to advanced topics in Operations Research.
- To enhance problem solving skills to more advanced levels.
- To experiment with real life problems and promote decision making skills.

Learning Outcomes

The expected outcomes of the course are:-

- The students will have a knowledge of various applications of Operations research in different types of industries
- The students will have the skill to model and solve real life problems.

Module I

History; Definition; OR models; Linear Programming models- model formulation, Graphical solutions, simplex method-two phase method, Big M method, duality and sensitivity analysis; Revised simplex method; Dual Simplex method.

Module II

Integer linear programming: Branch and Bound technique, Cutting plane algorithm, zero-one implicit enumeration algorithm, Deterministic dynamic programming: Forward and backward recursion, Applications of DP, Classical Optimization techniques: Single variable optimization, Multivariable optimization with no constraints, with equality constraints and with inequality constraints, Non linear programming: One dimensional minimization methods, Unconstrained and Constrained algorithms, Geometric programming.
Module III


References:

5. Gross and Harris, Fundamentals of Queuing Theory, John Wiley & Sons

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MIC 1005: METHODS AND SYSTEMS DESIGN (N)  3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- Explain the basic concepts of ‘work study’ (WS) : method study and work measurement
- Explain/Use the tools and techniques of ‘method study’ (charts/diagrams, micro-motion studies and principles of motion economy)
- Explain/Use the tools and techniques of ‘ work measurement’ (WM). (basic concept of WM and various techniques of WM)
- Design, perform and analyze the studies/experiments related to WS (eg process analysis, time study, operation analysis, time study, pre-determined motion systems (PMTS), standard data and work sampling with statistical analysis).
- Apply methods engineering and ergonomics or human factors design principles to the analysis and redesign of an existing work station, work task, piece of equipment, work environment etc.

Learning Outcomes

The students who succeed this course

- Will be able to understand the reasons and logic behind work station design
- Will be able to model work systems using standard techniques, such as flow diagrams, process charts, operation charts, activities charts and block diagrams for purpose of work system documentation, analysis and design.
- Will be able to apply a structured engineering process (analysis/requirements development, design, implementation, operation) to worksystem development.
- Will be able to determine the time required to do a job using standard data, activity sampling, time study and pre-determined time systems.
- Will be able to recognize and constructively address ethical, social and environmental issues that arise in a work systems engineering project.
- Will be able to recognize the human indicators of fatigue and stress.

Module I

Introduction, definition, concept, objectives and need for work study. Work-study and productivity, Productivity Measures – Total and Partial productivity Measures.
Method study: Definition – steps in method study, process analysis, process chart, process chart symbols, outline process chart, flow process charts, multiple activity charts, two handed process charts, flow diagram, string diagram and travel chart. Micro motion and memo motion analysis. Operation Analysis – basic procedure.
Module II

Work Measurement: Definition, Objectives and concept of work measurement, work measurement technique, Stop watch time study, Time study equipments, selecting the job to be timed, selection of workers for time study, for time study, performance Rating, Systems of Rating, Predetermined motion time systems, Methods Time Measurement(MTM), MTM systems, Use of MTM Tables, Work factor systems, Maynard Operation Sequence Technique (MOST) – Use of BasicMOSTDatacard, Work sampling, Use of control chart (P-chart) in work sampling, applications of work measurement techniques. Relationship of Work Study to Incentive Schemes, Wage Incentive Plans.

Module III


References:

2. ILO, Introduction to Work Study.

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MIC 1101: INDUSTRIAL ENGINEERING LAB - 1 0-0-2-1

Methods Engineering & Optimization Lab

Structure of the Course

Practical: 2 hrs. / Week  Credits: 1
Internal Continuous Assessment : 100 Marks

Course Objectives

• Should develop knowledge on methods engineering and optimization techniques.
• Should be able to prove methods engineering principles through lab experiments.
• Should acquire knowledge on working of data analysis and optimization software packages.

Learning Outcomes

• Understand various methods engineering and optimization techniques.
• Understand methods engineering principles through lab experiments.
• Understand working of data analysis and optimization software packages

a) Methods Engineering Lab
Experiments on
1. Method Analysis
2. Micro motion study
3. Work Measurement
4. Facility layout design
5. Ergonomics

b) Optimization Lab
1. Data Analysis using software packages
   a. Excel
   b. SPSS
   c. Systat
   d. SAS

2. Solving optimization problems using software packages.
   a. Excel Solver
   b. IBM ILOGCPLEX
   c. GUROBI
   d. MPL
   e. AIMMS
   f. GAMS
MIC 1102  SEMINAR  0-0-2-2

Structure of the Course

Credits: 2
Seminar : 2 hrs/week
Internal Continuous Assessment : 100 Marks

The student has to present a seminar in one of the current topics in the stream of specialization. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject, present the seminar and submit seminar report at the end of the semester.

Marks:

  Report Evaluation : 50
  Presentation : 50
SECOND SEMESTER
Structure of the Course

Lecture: 3 hrs/ Week  
Credits: 3  
Internal Continuous Assessment : 40 Marks  
End Semester Examination : 60 Marks

Course Objectives

- Should develop knowledge on foundations, phases and types of six sigma.  
- Should be able to understand the measure, analysis, improve and control tools of six sigma.  
- Should acquire advanced knowledge on latest quality engineering tools and techniques

Learning Outcomes

- Understand the foundations, phases and types of six sigma.  
- Understand the measure, analysis, improve and control tools of six sigma.  
- Understand knowledge on latest quality engineering tools and techniques.

Module I


Module II


Module III

References:

6. Amitava Mithra, Fundamentals of Quality Control and Improvement, Pearson Education
7. E. L. Grant, Statistical Quality Control, McGraw Hill
8. Montgomery, Introduction to Statistical Quality Control, John Wiley & Sons

Structure of the Question Paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

Lecture: 3 hrs/ Week  
Credits: 3  
Internal Continuous Assessment : 40 Marks  
End Semester Examination : 60 Marks

Course Objectives

- Should develop knowledge on structures, decision phases, measures and tools of supply chains.  
- Should develop understanding on the strategic, tactical and operational decision tools of supply chains.  
- Should acquire knowledge on logistics management and related advanced tools and techniques

Learning Outcomes

- Understand the structures, decision phases, measures and tools of supply chains.  
- Understand the strategic, tactical and operational decision tools of supply chains.  
- Understand knowledge on logistics management and related advanced tools and techniques

Module I


Module II


Module III

References:

2. G. Sreenivasan, Quantitative Models in Operations and Supply Chain Management, PHI
3. Donald J. Bowersox & David J. Closs, Logistical Management, TMH.
4. Martin Christopher, Logistics and supply chain management, Financial times management.

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

Lecture : 2 hrs/ Week  
Credits : 2  
Internal Continuous Assessment : 40 Marks  
End Semester Examination : 60 Marks

Course Objective:

To formulate a viable research question  
To distinguish probabilistic from deterministic explanations  
To analyze the benefits and drawbacks of different methodologies  
To understand how to prepare and execute a feasible research project

Outcome

Students are exposed to the research concepts in terms of identifying the research problem, collecting relevant data pertaining to the problem, to carry out the research and writing research papers/thesis/dissertation.

Module 1

Introduction to Research Methodology - Objectives and types of research: Motivation towards research - Research methods vs. Methodology. Type of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, and Conceptual vs. Empirical.  
Research Formulation - Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem. Literature review: Primary and secondary sources - reviews, treatise, monographs, patents. Web as a source: searching the web. Critical literature review - Identifying gap areas from literature review - Development of working hypothesis.

Module 2


Module 3

Reporting and thesis writing - Structure and components of scientific reports - Types of report - Technical reports and thesis - Significance - Different steps in the preparation, Layout, structure and Language of typical reports, Illustrations and tables, Bibliography, referencing and footnotes. Presentation; Oral presentation - Planning - Preparation - Practice - Making presentation - Use of audio-visual aids - Importance of effective communication.
Application of results of research outcome: Environmental impacts - Professional ethics - Ethical issues - ethical committees. Commercialization of the work - Copy right - royalty - Intellectual property rights and patent law - Trade Related aspects of Intellectual Property Rights - Reproduction of published material - Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

References:

1. C.R Kothari, Research Methodology, Sultan Chand & Sons, New Delhi, 1990
Quality Control & Simulation Laboratory

Course Objectives

● Should develop knowledge on statistical quality control (SQC), non-destructive evaluation (NDE) and simulation techniques.
● Should be able to familiarize SQC techniques and NDE through lab experiments.
● Should acquire knowledge on simulation model building and simulation through software packages.

Learning Outcomes

● Understand various SQC, non-destructive evaluation (NDE) and simulation techniques.
● Understand and familiarize SQC techniques and NDE through lab experiments.
● Understand simulation model building and simulation through software packages

a) Quality Control Lab

1. Verification of central limit theorem for various populations
2. Study and construction of control charts
3. Study and construction of OC curve of a sampling plan.
4. Study and Demonstration of NDT equipment

b) Simulation Lab

Simulation model building and conducting simulation experiments using

a. C++
b. Simul8
c. Simio
d. WITNESS
e. Vensim
f. ARENA
The main objective of thesis is to provide an opportunity to each student to do original and independent study and research on the area of specialization. The student is required to explore in-depth and develop a topic of his/her own choice, which adds significantly to the body of knowledge existing in the relevant field. The thesis has three parts (Part I in semester-2 and Part-2 in semester -3 & Part-3 in semester -4). The thesis can be conveniently divided into three parts as advised by the guide and the first part is to be completed in this semester. The student has to present a seminar before the evaluation committee at the end of the semester that would highlight the topic, objectives, methodology and expected results and submit a report of the work completed in soft bounded form.
Structure of the Course

Credits: 2
Seminar: 2 hrs/week
Internal Continuous Assessment: 100 Marks

The student has to present a seminar in one of the current topics in the stream of specialization. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject, present the seminar and submit seminar report at the end of the semester.

Marks:

  Report Evaluation : 50
  Presentation : 50
SECOND SEMESTER
STREAM ELECTIVES
MIE 2001: SYSTEM SIMULATION AND SYSTEM DYNAMICS  3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

The main objective of the course is to:
- apply system concepts to solve problems in industrial and business organizations,
- review different parametric discrete and continuous probability functions,
- generate random numbers and random variates from parametric and empirical distributions,
- model discrete event simulation models for different systems,
- study the tools for modeling dynamic systems,
- get introduced to softwares for SD modeling and simulation

Learning Outcomes

After successful completion of the course:
- the students have an understanding of real life systems with interacting components, elements and sub-systems, modeling and analysis of these interacting components and elements in a system and the system as a whole,
- the students are able to apply the simulation modeling and analysis concepts in various industrial and business situations,
- the students are able to analyze the output of the simulations and to make conclusions about the model outcomes which benefits the students to build valid system models for simulation, the students are able to conduct experiments on the system models and to predict the system behavior at different environments and input states and parameter settings and to find out the best suited system parameter settings to meet the predefined objectives

Module I

System approach to problem solving, steps in simulation study. Comparison of simulation and numerical methods. Use of Monte Carlo method to find area under curves, value of π.
Discrete and continuous probability functions, uniformly distributed random numbers, properties of random numbers, generation of Pseudo-Random numbers, random number generators, tests for random numbers, frequency, gap, run, and Poker tests, tests for autocorrelation.

Module II

Generation of random deviates for Exponential, Uniform, Weibull, Triangular, and discrete distributions, Inverse Transformation method, Direct transformation method for the Normal and Lognormal distributions. Acceptance-rejection technique: Poisson and Gamma distributions. Input modeling: data collection, identifying the distribution with the collected data, goodness of fit tests, selecting input models without data.
and Validation of simulation models. Variance reduction techniques, statistical analysis of outputs, and optimization of parameters.

**Module III**

Structure and Behavior of Dynamic systems: fundamental modes of dynamic behavior – Exponential growth, goal seeking, oscillation and process point – interactions of fundamental modes.

Tools for systems thinking: - Causal loop diagramming. Behavior of low order systems-analytical approach. Elements of System Dynamics Modeling, physical flows, information flows, level & rate variables, flow diagrams, delays, information smoothing, table functions and table function multipliers. First order positive and negative feedback systems, second order systems.

Steps in system dynamics modeling:- problem identification/conceptualization, fixing model aggregates and boundary, principles of simulation modeling, developing model equations, algorithm for Euler integration, hand simulation of system dynamics models.

Computer simulation languages, packages, and their application (Overview only).

**References:**

1. Geoffrey Gordon, System Simulation, PHI
2. NarsinghDeo, System Simulation with Digital Computer, PHI
3. J. Banks, Discrete Event System Simulation, Pearson Education
6. System Dynamics – Mohapatra – PHI
7. System Dynamics – Ogata – Pearson Education.

**Structure of the Question paper**

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MIE 2002: MARKOV DECISION PROCESSES

Structure of the Course

Lecture: 3 hrs/Week  
Credits: 3

Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To understand Markov decision process models
- To learn how to make sequential decisions when outcomes are uncertain
- To understand methods to solve optimality equation using value iteration, policy iteration, modified policy iteration and linear programming.

Learning Outcomes

- The students are expected to have knowledge of various Markov decision process models and applications of the same in diverse fields in engg..
- The students will have the skill to model and solve research problems.

Module I

Overview of decision making in the context of stochastic systems evolving over time examples. Framework and some types of cost criteria: Expected total cost, Discounted cost and Average cost. Finite horizon models; Some classes of policies; Optimality of Markov policies; Dynamic programming principle and algorithm.

Module II


Module III

References:

4. E. Altman, Constrained Markov Decision Processes, Chapman Hall/CRC, 1999
7. Open Literature

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students
MIE2003: MULTI-CRITERIA DECISION MAKING 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

The main objectives of this course are:-

- To introduce the students to various tools used in multi criteria decision making.
- To have experience in practical decision making with the help of suitable tools.

Learning Outcomes

- The students will have the knowledge of tools and will have the experience in practical decision making situations where multiple criteria are involved.

Module I

Multi criteria decision making - objectives. SMART- categorization, criterion weights and aggregation
Theory of vector optimization: Solution concepts, vector variational inequalities and vector equilibria, multi criteria fractional programming, multicriteria control problems. Goal programming: Classification of GP, Integration and combination of GP with other techniques - applications.

Module II

AHP, pairwise comparisons, criterion weights and aggregation, consistency etc. Evolutionary algorithms and multiple objective optimizations: Definitions, Pareto based and Non-Pareto based techniques - applications. Data Envelopment Analysis in multi criteria decision making: Basic DEA models, GDEA.

Module III

References:

1. Multiple criteria Optimization - Arakawa, Billaut - Kluwer

Structure of the Question paper
For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students
MIE 2004: FINANCIAL ENGINEERING

Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

At the end of the course students should be able to:

- Use fundamental economic principles and finance theory coupled with state-of-the-art mathematical methods and computational tools,
- Understand the essential ideas of investment science – such as present value, portfolio immunization, factor models etc,
- Understand the language of investment science, which is largely mathematical,
- Understand the emerging issues associated with new financial instruments, risk assessment, risk measurement and optimization.

Learning Outcomes

After successful completion of the course, the students are able to:

- Formulate and solve realistic and challenging investment problems,
- Understand how statistical models can measure the risk involved with new financial instruments,
- Use financial engineering techniques in investment banks, mutual funds and insurance companies,
- Prepare for master project work and research in the field.

Module I


Module II

Forwards, Futures and Swaps: Forward contracts, Forward prices, Value of a Forward contract, Basics of Futures contracts, Futures prices, Swaps.

Module III

Options: Option concepts, Option strategies, Put-Call parity, European and American options, Asian and other path dependent options, Factors determining option values, Binomial model for option valuation, Black and Scholes model.

References:

4. John C. Hull, Options, Futures, and Other Derivatives, Prentice-Hall Inc.

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MIE 2005: SOFTWARE ENGINEERING  3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To understand different phases and its importance in software development.
- To get introduced to software process and software process models.
- To understand different dimensions of system dependability, availability, reliability, safety and security
- To study the factors contributing to software quality and to understand quality policy

Learning Outcomes

On completion of this course, students are expected to have
- Knowledge and logic behind software development
- An understanding of a structured engineering process for software development
- Will be able to recognize and address ethical and professional issues that are important to software engg.

Module I

Introduction to software engineering, Emergence and scope of software engineering-historical aspects, economic aspects, maintenance aspects, specification and design aspects, team programming aspects. Software engineering layered technology-processes, methods and tools. Software processes models-prototyping model, incremental models, spiral model, waterfall model. Phases in Software development – requirement analysis, Planning phase-project planning, objective, project scope, staffing and personal planning. Project size estimation matrices- Line of code, function point, project estimation techniques- empirical estimation, models, COCOMO, single variable models

Module II

Risk management- risks, identification, risk projection, project planning and risk management. Software configuration management- configuration, identification, configuration control, and software configuration management plans. Design phase- design objectives, principles, data flow analysis, toptopdown, bottomup strategies, design methodology. Coding- programming practice, verification, size measures, complexity analysis, coding standards. Testing-fundamentals, white box testing, control structure testing, black box testing, basis path testing, Levels of testing- unit, integration, system validation and acceptance testing.
Module III

Dependability, critical systems, availability and reliability, safety, security, critical systems specification, critical system development, software maintenance. Software re-engineering. Software quality factors, software quality assurance standards, CMM, ISO, six sigma quality factors, quality policy

Textbooks:


References:

1. Ian Sommerville, Software Engineering, 7/e, Pearson edition Asia Ed.
4. Rajiv Mall- FUNDAMENTALS OF Software Engineering, PHI.

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students
Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- The ability to apply the concepts of various manufacturing systems in organizations with solutions for issues in design, production flow analysis, operator allocation etc.
- Should be able to use the concepts of FMS with emphasis on automated material handling and storage.
- Ability to apply the techniques such as Synchronous, Agile and Lean manufacturing in organizations.

Learning Outcomes

- Understand various manufacturing systems with solutions for issues in their implementation.
- Understand capabilities of FMS with design of conveyor and AGV systems.
- Understand the concepts of Synchronous, Agile and Lean manufacturing and their implementation in organizations.

Module I


Module II

Flexible Manufacturing systems: Overview, Development and implementation of an FMS, Automated material handling and storage: Functions – types – analysis of material handling equipments. Design of conveyor &AGV systems. Design issues and algorithms.

Module III

References:

2) SA Irani (Editor), Handbook of Cellular Manufacturing, Wiley International, 1998.
3) JT Black, The factory of the future.
4) Goldratt, E, The Goal
5) Rouf and Ahmed (Editors) Flexible Manufacturing Systems

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students
MIE 2007: HUMAN ASPECTS OF MANAGEMENT  3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week  
Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- The ability to manage human resources not only to compete but to survive.
- Ability to use innovative techniques to better build up the human relations.
- Should be familiar with Human Resource Management with a complete Personal management concepts and techniques.

Learning Outcomes

- Understand the various dimensions of human behavior to build up the personal relationship and to avoid personal conflict.
- Understand the need of the organizational change and organizational culture for the development of organizations.
- Understand the concepts of Human Resources Management to manage people in organizations to meet organizational objectives

Module I

Dimensions of human behaviour: self development, perception, motivation ,learning, personality and leadership - concepts, theories and applications. Modes of values, beliefs, attitudes and intelligence in determining human behaviour.Group dynamics-nature of groups and group decision making,Interactive conflict and negotiation skills. Transactional Analysis.

Module II

Organizational Development: Concepts of QWL, Organizational change, Goals of organizational change and organizational development, OD techniques. Concept of organizational climate, health and effectiveness. Organizational culture: types nature and characteristic, motivation of person across cultures, managerial leadership across cultures.

Module III

References:

1) Jerry I. Gray, Frederick A. Stark, Organisational Behaviour concepts and applications
2) Fred Luthans, Organizational Behaviour, McGraw Hill
3) Stephen P. Robbins, Organizational Behaviour, Pearson Education.
4) Uma Sekharan, Organizational Behaviour- Text and Cases, TMH
5) Gary Dessler, Human Resource Management, PHI.
6) Scott, Personnel Management, TMH

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students
Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- After completion of the course, the student should understand the technologies and concepts which are key to the implementation of the various automation schemes in industries. The student should also be able to select suitable schemes and design them for automating various processes in production industries.
- After the completion of first module, the student shall understand the evolution of the various automation concepts and schemes. The student also gets thorough knowledge on the basic principles of the sensors and transducers used for industrial and process automation.
- After the second module the student gets an in depth knowledge about the basic components of automations schemes like CNC machines, Robots etc and about their working. It also exposes the student to the material handling systems and their coordination using various methodologies.
- The third module gives exposure to the modern automations schemes using PLCs and gives an in depth exposure to the optimization and programming of these devices. It also gives an in depth knowledge about the various schemes and technologies used in automating inspection and quality control.

Learning Outcomes

- An indepth knowledge on automation schemes
- Knowledge of CNC and robot systems
- Ability to understand various sensors and select them based on the requirements
- Optimize the automation schemes using mapping techniques
- Programming of PLC systems
- Knowledge of online inspection and measurement systems.

Module I


Sensors and measuring systems: Classification of position and motion sensors, inductive type, electromechanical switches, rotary position sensors – resolver, synchros, encoders, integrated motion systems, fundamental sensor methodologies, LVDT, RVDT, photo electric, thermo electric, capacitive, magnetic detectors, impedance type gauging transducers, linear potentiometer, strain gauges. Practical examples on design, selection and implementation of sensor systems, calibration of sensors.
Module II

**Elements of CNC systems:** servomotor and servo system design trends, stepper motors and controls, adaptive control, balls crews, preloading, and selection of drives for CNC machines. Industrial Robot Configurations – robot technology fundamentals. Fundamentals of CNC part-programming. Practical examples of cnc programming on trainers and simulators.

**Pneumatic automation:** Actuators, control valves – direction, pressure and flow, sequential control of single /multiple actuator systems, cascade and KarnaughVeitch map methods, step-counter systems. Electro pneumatic automation: Symbols: Basic electrical elements – relay, solenoid, timers; pneumatic – electrical converters, design of circuits and hands on models on material handling systems.

Module III

**Automation Control:** Sequence control and programmable controllers – logic control and sequencing elements, ladder diagram, PLC, programming the PLC. Practical Examples on PLC ladder programming.

**Inspection automation:** Inspection automation, off-line and on-line inspections, computerized co-ordinate measuring machine – CMM construction, online inspection systems., laser interferometer, non-contact inspection methods. Automatic gauging and size control systems, thickness measurement, machine vision systems.

**References:**


**Structure of the Question paper**

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the student.
THIRD SEMESTER
The student has to continue the thesis work done in the second semester in the same area. The student has to present two seminars. The first seminar shall be conducted in the first half of this semester mainly to highlight the progress of the work for the midterm evaluation and second seminar towards the end of the semester to access the quality and quantum of work done in this semester. The student has to submit a report of the work completed in soft bounded form. The seminars and the report shall be evaluated by the evaluation committee.

**Evaluation of marks for the Thesis-Preliminary Part II**

Evaluation of the Thesis-Preliminary work by the guide - 100 Marks  
Evaluation of the Thesis–Preliminary by the Evaluation Committee-100 Marks
THIRD SEMESTER
STREAM ELECTIVES
Structure of the Course

Lecture: 3 hrs/Week  
Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objectives

- The student should be able to acquire knowledge in ERP architecture and different packages.
- Should have exposure to latest trends in ERP.
- Ability to identify important issues pertaining to implementation of ERP software in an industrial scenario

Learning Outcomes

- Understand the importance of ERP in modern management arena.
- Understand capabilities of ERP for productivity improvement of an organization.
- Understand the correct choice of an ERP package for the selected industry.

Module I


Module II


Module III

ERP System Packages: SAP, People soft, BAAN, Oracle and Open source ERP packages. Comparison, Integration of different ERP applications. ERP as sales force automation, Integration of ERP and Internet, ERP Implementation strategies, Organizational and social issues. Oracle: Overview, Architecture, AIM, applications, Oracle SCM. SAP: Overview, Architecture, applications, Before and after Y2K, critical issues – Training on various modules of IBCS. Basic idea of ABAP.
References:


Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students
MIE 3002: INVENTORY MODELS

Structure of the Course

Lecture: 3 hrs/Week  Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

The objectives of this course are:

- To teach the students the essential elements of inventory control and the relevant costs of inventory
- To equip the students to understand the different aspects of a good inventory control system
- To enrich the understanding of the students with the basic as well as the advanced topics in inventory control under different system characteristics such as the lead time, demand, etc.
- To help students to understand the decision making situations in inventory systems under different control policies.

Course Outcomes

The successful completion of the course, the students:

- know the essential elements of inventory control and the relevant costs of inventory
- possess the understanding of the different aspects of a good inventory control system
- Possess sound knowledge in basic as well as the advanced topics in inventory control under different system characteristics such as the lead time, demand, etc.
- Know the decision making situations in inventory systems under different control policies.

Module I

Concept of inventory, elements of inventory systems, classification of inventory systems, importance and functions of inventory control, concept of relevant costs, different costs of inventory, comparison of inventory costs and simple problems in relevant costs, inventory as a strategy, production system components and functions, inventory control in production systems, make-to-order and make-to-stock systems. Type of inventory systems: periodic and continuous systems. One item with constant demand rate. Economic order quantity (EOQ) model of inventory: motivation, the model, assumptions, performance criteria, optimal policy, sensitivity analysis. Inventory systems with back orders, performance criteria, optimal policy, sensitivity analysis. Planned back orders and constrained stock outs, costs of back order systems and stock out costs. Systems with finite production rate: optimal policy. Quantity discounts, imperfect quality, perishable products, present value criterion.
Module II

Time varying demands. Extreme cases, dynamic economic lot size model, model formulation, Wagner-Whitin procedure, modeling and implementation issues, discounted costs, continuously accumulating costs, limited capacity, back orders, quantity discounts, linear decision rule.

Uncertainties in production-inventory systems, managing uncertainties: forecasting, methods of forecasting, forecasting models, with trend and seasonality, concepts of service levels, different service level measures, design problems of inventory systems based on service levels. Safety stock for fast-moving and slow-moving items.

Module III

Stochastic demand system – one item with constant lead time: demand models, policy evaluation for Poisson demand, base stock policies, performance evaluation, news vendor problem, solution and interpretations, back orders and waiting times, world-driven demand, approximations, base stock policies with different approximations, general (r, q) policies, optimization modeling of continuous and discrete approximations. Lumpy demand, expected present value criterion, optimization. Several items with stochastic demands: base stock policies, general (r, q) policies, series systems, echelon based calculations, base stock policy optimization, different demand supply systems.

Stochastic lead times: Model structure, taxonomy, independent stochastic lead times with different demand processes, limited capacity supply systems, flexible capacity, lost sales, exogenous sequential supply systems, lead time demand distributions.

Advances in production-inventory control systems: order-up-to (OUT) policies and variants, generalized OUT in discrete and continuous domains. Concepts of inventory system stability, design problems in OUT models.

Text Book:


References:

1. Sven Axsäter, Inventory Control, Kluwer Acdemic Publishers, Boston, 2004
2. Silver, Pyke, Peterson, Inventory Management and Production Planning and Scheduling, John Willey & Sons

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MIE 3003: DESIGN THINKING AND MANAGEMENT 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

At the end of the course students should be able to:

- Understand design’s role in business and the importance of design as a way of creating value in an organization.
- Identify and create the conditions in which design projects can be proposed, commissioned and promoted.
- Demonstrate how strategy can be made visible and tangible through design.
- Understand design management where design projects and outcomes are delivered

Learning Outcomes

After successful completion of the course, the students are able to:

- Investigate the skills required in managing client relations and guiding design decisions.
- Lead design agendas, projects and possibilities.
- Investigate the skills required when managing creative projects.

Module I

Introduction to Design Management, Importance of design management, Power of Design Thinking, Managing the design strategy – Identifying opportunities for design, Understanding the audience and market, Interpreting client and customer needs, Auditing the use of design; Establishing, Promoting and Selling design strategy, Planning for long term growth; Case studies

Module II

Managing the Design Process – Business strategy, Increasing awareness with design, Expressing the Brand through design, Initiating design projects, Design methods, Design processes, Competitive advantage through design; Case studies

Module III

Design Implementation – The Project management process, Social and Environmental responsibilities, Design Activism, Design policies, procedures and guidelines, Translation of Global to Local design, Measurement of design success, Review of design strategy; Case studies.
References:

5. Thomas Lockwood, Design Thinking: Integrating Innovation, Customer Experience, and Brand Value, Allworth Press, USA.

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MIE3004: DESIGN OF ALGORITHMS

Structure of the Course

Lecture: 3 hrs/ Week          Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- To have basic knowledge of commonly used algorithms.
- To develop algorithms to suit specific needs
- To write programs on the application of algorithms.

Learning Outcomes

- The students will have a basic knowledge on the design and development of algorithms for various applications.

Module I

Algorithms, basic steps in development. Basic tools: Top down, Structured programming, networks, data structure. Review of any one of the structured languages.

Module II

Sub goals, hill climbing and working backward, heuristics, back track programming, Branch and bound recursion process, program testing, documentation, Meta heuristics.

Module III

Development of Algorithms for problems like, Sorting, Searching, Combinatorial problems shortest path, Probabilities algorithms etc.

References:


Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
MIE 3005: HEURISTICS FOR DECISION MAKING 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objectives

The main objectives of this course are:
- To introduce the students to heuristic solution techniques.
- To enhance problem solving skills to more advanced levels.
- To experiment with real life problems and promote decision making skills.
- To demonstrate various meta-heuristic solution techniques which provide faster heuristic solutions as against time consuming exact algorithms.

Learning Outcomes

- The students will have knowledge of various heuristic solution techniques and applications of the same.
- The students will have the skill to model and solve real life problems.

Module I

Introduction to evolutionary computation: Biological and artificial evolution, Evolutionary computation and AI-different historical branches of EC.

Module II

Module III

Local Search Algorithms, Tabu Search - Neighborhood, Candidate list - Short term and Long term memory, Threshold Accepting, Application of TS in solving facility location problem, Quadratic Assignment problem etc. Simulated Annealing - Main Components of Simulated Annealing, Homogenous vs. Inhomogenous Simulated Annealing, Annealing Schedules Applications in sequencing and scheduling, Travelling salesman problem etc.

Multi objective evolutionary optimization: Pareto optimality, Multiobjective evolutionary algorithms.

References:

7. Fred Glover, Tabu Search.

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

Lecture: 3 hrs/ Week                Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination        : 60 Marks

Course Objectives

- To introduce the students to the importance and applications of econometric models.
- To provide students hands on experience on econometric software in addition to theory classes.

Learning Outcomes

- The students will have the knowledge of econometric models.
- The students will show the ability to apply theory into practical situations.
- The students will have the experience on the use of econometric software.

Module I

Introduction to econometrics, classical linear regression models assumptions and diagnostic tests:
- Multicollinearity-Parameter stability tests.
- Univariate time series modeling and forecasting: Moving average process, Auto regressive process, ARMA process, forecasting in econometrics.

Module II

Multivariate models: Exogeneity, Vector autoregressive models(VAR).
- Stationarity and Unit Root testing- Cointegration.
- Modeling volatility and correlation: ARCH, GARCH,GJR, EGARCH models.
- Forecasting covariances and Correlations, multivariate GARCH model

Module III

Switching models:Modeling Seasonality, Markov switching model, Threshold auto regressive models.
- Panel data: The fixed effects model, the time-fixed effects model, random effects model.
- Limited dependent variable model: linear probability model, Logit model, Probit model.
- Ordered Response dependant variable model -Multinomial linear dependant variable, Censored and Truncated variable.
- Dynamic Econometric models- Granger Causality test
References:

1. Introductory Econometrics for Finance- Chris Brooks-Cambridge.
2. Basic Econometrics- Gujarati-McGraHill
4. An Introduction to Econometrics - G.S.Maddala - Wiley
5. Introduction to Econometrics - Stock - Pearson
6. Econometric Analysis - Greene – Pearson

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students
MIE3007: INDUSTRIAL SCHEDULING 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week  
Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

The course aims to provide students, a basis to use quantitative methods to allocate an organization’s limited resources to the activities that have to be performed. At the end of the course students should be able to:

- Have an overview of the planning and scheduling objectives and requirements in manufacturing and services.
- Understand the nature of production or service systems and apply mathematical as well as applied methods in finite scheduling problems.
- Get an introduction to the recent developments in the field of scheduling such as the relevance of combinatorial optimization, in addition to specialized techniques of sequencing and scheduling.
- Comprehend a variety of problem-solving approaches for Flow shop and Job shop problems from various methodological disciplines.
- Develop computational, conceptual and algorithmic skills.

Learning Outcomes

Through continuous assessment of the students by tests, quizzes, individual/group assessments and presentations the students are able to:

- Relate the planning and scheduling to the functions in an enterprise
- Understand the practices as well as apply planning and scheduling techniques in different application domains such as assembly systems, process industries, entertainment business, transportation etc.
- Develop planning and scheduling approaches for real-life problems in manufacturing and services.

Module I

Introduction to scheduling, role of scheduling, Terminologies involved in scheduling.
Single Machine Models:- Problems without due dates – Minimizing mean flow time, Minimizing weighted mean flow time. Problems with due dates – Lateness criteria, Minimizing the number of Tardy jobs, Hodgson’s Algorithm, minimizing Mean Tardiness, The Wilkerson-Irwin Algorithm.
General Purpose methodologies for single machine problems:- Dynamic Programming approach, Branch & Bound Approach, Neighborhood search techniques.
Module II

Parallel Machine Models:- Parallel Identical processors and Independent jobs, Parallel Identical processors and Dependent jobs.

Module III

Job Shop Scheduling:- Types of schedules, Schedule generation, Branch & Bound Approach, Heuristic procedures, Integer Programming Approach.
Simulation studies of the Dynamic Job shop (Overview only)
Case studies on Scheduling systems.

References:

1. Introduction to Sequencing and Scheduling – Kenneth R. Baker – John Wiley

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students
MIE 3008: MANAGEMENT OF PROJECTS

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

- Should develop knowledge on screening and analysis of project ideas.
- Should be able to understand project risk analysis and financing sources and methods.
- Should acquire knowledge on project implementation planning tools & techniques.

Learning Outcomes

- Understand screening and analysis techniques of project ideas.
- Understand the project risk analysis and financing sources or methods.
- Understand knowledge on project implementation planning tools & techniques.

Module I


Module II

Project Risk analysis - Sensitivity, Scenario, Break-even, Simulation and Decision Tree Analysis. Multiple Projects and Constraints – Method of Ranking, Mathematical Programming Approach, Valuation of Real Options, Project Financing - Multilateral Project Financing, Sources of Finance, Consortium Financing, Venture Capital, Fund and Non-fund Based Credits.

Module III

References:

1. Prasannachandra, Projects - planning, analysis, selection, financing, implementation and review, Tata McGraw Hill
3. Choudhary, Project Management, Tata McGraw Hill
5. P. Gopalakrishnan et al, A Text Book of Project Management, Macmillan

Structure of the Question paper

For the End Semester Examination there will be three questions from each module out of which two questions are to be answered by the students
FOURTH SEMESTER
The student has to continue the thesis work done in the second and third semester. There shall be two seminars (a midterm evaluation on the progress of the work and pre submission seminar to assess the quality and quantum of the work). At least one technical paper is to be prepared for possible publication in journals / conferences. The final evaluation of the thesis shall be an external evaluation. The marks for the Thesis-Final may be proportionally distributed between external and internal evaluation as follows.

**Distribution of marks allotted for the Thesis**

Internal Evaluation of the Thesis work by the guide - 150 Marks  
Internal Evaluation of the Thesis by the Evaluation Committee - 150 Marks  
Final Evaluation of the Thesis work by the Internal and External Examiners:  
(Evaluation of Thesis: 200 marks + Viva Voce: 100 marks) - 300 Marks
DEPARTMENTAL ELECTIVES IN MECHANICAL ENGINEERING FOR SEMESTER II
Objective:

The objective of this course is to understand the theories and their practical uses with real-world examples and problems to solve. The course focuses on system reliability estimation for time independent and failure dependent models. It helps the students in assembling necessary components and configuring them to achieve desired reliability objectives, conducting reliability tests on components, and using field data from similar components. Also to provide more complex aspects regarding both the Maintainability, Availability and some fundamental techniques such as FMECA (Failure Mode, Effects, and Criticality Analysis) and FTA (Fault Tree Analysis) with examples.

Outcome

After the completion of the course one should be able to know:

- Reliability and Hazard Functions
- System Reliability Evaluation
- Time- and Failure-Dependent Reliability
- Estimation Methods of the Parameters of Failure-Time Distributions
- Parametric Reliability Models
- Models for Accelerated Life Testing
- Renewal Processes and Expected Number of Failures
- Preventive Maintenance and Inspection


Module I

Introduction to reliability: definition, Reliability and Quality, failure and failure modes

Failure data analysis: Reliability and rates of failure, Reliability function, expected life, failure rate, hazard function, constant and time dependent hazard models, state dependent hazard models, Markov Analysis.

Module II

System Reliability models – Series, parallel, mixed configurations, k-out-of-m models
Redundancy techniques – component vs unit redundancy, mixed redundancy, Standby redundancy, weakest link technique
Reliability improvement, Reliability allocation
Module III

Fault tree analysis, use of Boolean algebra, Load strength analysis. Understanding of FMECA. Maintainability- Definition, relationship between reliability and maintainability
Availability- Definition, relationship between reliability and availability, simple Markov models.

Case studies from industries demonstrating Reliability aspects. Computer softwares in reliability.

References

1) Charles E Eblings – An Introduction to Reliability and Maintainability Engineering, McGraw Hill
3) L S Srinath – Reliability Engineering, East West Press

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
Course Objectives

- To learn about different information systems.
- To effectively use and manage information technology in today’s network enterprises.
- To study interconnected networks of information systems for end user collaboration.
- To learn systems for making timely decisions based on organized informations.

Learning Outcomes

After the completion of the course the student is expected to

- Widen his knowledge about information technology that will enable him to solve management problems.
- Explore full potential of computer as a problem solving tool.

Module I

Introduction to information systems, Types and examples of information systems, information technology infrastructure. System concepts, system design, development and analysis

Module II

Decision support systems: Overview, Data Mining and Warehousing, Modeling and Analysis, Knowledge based DSS. Model management, modeling processes, modeling languages.

Module III

Neural computing, applications, advanced artificial intelligent systems and applications. Intelligent software agents, Impact of Management support systems.
References

2. Burch John.GJr and Others, Information Systems theory And Practice, John wiley&Sons
5. Marakas, Decision Support System, Pearson Education

Structure of the Question paper

For the End semester Examination there will be three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

Lecture: 3 hrs/ Week  
Credits: 3  
Internal Continuous Assessment : 40 Marks  
End Semester Examination : 60 Marks

Course Objectives:

At the end of this course, the students will

- gain insight into the behavior of metals under loading and heating conditions,
- be able to use elementary theory of plasticity to formulate bulk forming processes,
- be able to master the basic formulations and their applications to sheet forming processes,
- be able to master and apply the basic theory of metal cutting,
- have the basic knowledge about the cutting tools, cutting fluids and the cutting parameters and how they affect the cutting performance,
- be able to optimize metal cutting operations for the selected criteria

Learning Outcomes:

At the completion of the course, students will be able to...

- Predict the changes in the mechanical behavior of materials due to thermo-mechanical processing based finite element modeling.
- Interpret and quantitatively determine elastoplastic behavior of metals.

Module I

Elements of continuum mechanics and thermodynamics – Kinematics of deformation - Infinitesimal deformations - Forces, Stress Measures - Fundamental laws of thermodynamics - Constitutive theory - Weak equilibrium. The principle of virtual work - The quasi-static initial boundary value problemThe finite element method in quasi-static nonlinear solid mechanics - Displacement - based finite elements - Path-dependent materials. The incremental finite element procedure – Large strain formulation - Unstable equilibrium. The arc-length method

Module II

Overview of the program structure of FEM for plasticity
The mathematical theory of plasticity – Phenomenological aspects - One-dimensional constitutive model - General elastoplastic constitutive model - Classical yield criteria – Plastic flow rules - Hardening laws
Module III

Finite elements in small-strain plasticity problems – Preliminary implementation aspects - General numerical integration algorithm for elastoplastic constitutive equations - Application: integration algorithm for the isotropically hardening vonMises model - The consistent tangent modulus – Numerical examples with the vonMises model - Further application: the von Mises model with nonlinear mixed hardening

References:

1. Eduardo de Souza Neto, DjordjePeric, David Owens, Computational methods for plasticity : theory and applications - 2008 John Wiley & Sons Ltd
2. A. Anandarajah, Computational Methods in Elasticity and Plasticity – 2010 Springer
3. Han-Chin Wu, Continuum mechanics and plasticity - CRC Press
5. Jacob Lubliner, Plasticity theory – 2006
7. D W A Rees, Basic engineering plasticity an introduction with engineering and manufacturing applications - BH

Structure of the Question paper

For the End Semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
MDD 2002: BIO MECHANICS

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Objective:

➢ To gain knowledge of bio mechanics
➢ To gain knowledge of designing of artificial implants
➢ To gain knowledge of viscoelastic material modeling
➢ Understand various bio materials

Outcome:

➢ Students will understand how the theory is used in analyzing human body and motions
➢ At the end of the course students will know the different bio materials

Industrial relevance:

This course is having direct application to industry.
In medical field, implementation of theory of mechanics will help in implementing various designs

Module I

Human Anatomy & physiology: Anatomy & Physiology of major systems of the body Basic Terminology-Major Joints - Major Muscle Groups -Tissue Biomechanics -Hard and Soft -Bones -Bone Cells and Microstructure- Physical Properties of Bone- Bone Failure (Fracture and Osteoporosis)- Muscle Tissue-Cartilage-Ligaments- Scalp, Skull, and Brain -Skin Tissue

Module II

Kinetics of Human Body -Forces Exerted across Articulating Joints -Contact Forces across Joints -Ligament and Tendon Forces- Joint Articulation
Rheology of body material-Viscoelasticity-Definition of Viscoelasticity 1D Linear Viscoelasticity (Differential Form Based on Mechanical Circuit Models- Maxwell Fluid-Kelvin–Voigt Solid- 1-D Linear Viscoelasticity (Integral Formulation)- 3-D Linear Viscoelasticity -Dynamic Behavior of Viscoelastic Materials

Module III

References:

1. Principles of Biomechanics by Ronald L Huston-CRC Press
2. Introduction to continuum biomechanics by Kyriacos A. Athanasiou and Roman M. Natoli-Morgan & Claypool
3. Duane Knudson Fundamentals of Biomechanics –Springer

Structure of the Question paper

For the End semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

➢ Understand Fundamentals of DSP and its use in Noise and Vibration Enhancement
➢ Understand how to correctly implement and use the results of an FFT
➢ Interpretation of common Frequency Domain Measurements
➢ Understand the fundamentals and applications of Digital Filters
➢ Application and interpretation of Order Tracking analysis

Learning Outcomes:

As an outcome of completing this course, students will be able to:

➢ Understand how the combination of A/D conversion, digital filtering, and D/A conversion may be used to filter analog signals such as speech and music (1-D), and images (2-D).
➢ Understand the role of oversampling in A/D and D/A conversion.
➢ Understand the roles of downsampling and upsampling in digital processing of analog signals.
➢ Understand the respective roles of the magnitude and phase response of a digital filter.
➢ Understand the concepts of phase delay and group delay of a digital filter.
➢ Understand the relations between the DTFT, the DFT, and the FFT.
➢ Understand the computational issues in the implementation of digital filters.
➢ Understand the notion of random signals as an aid to filter design.
➢ Design FIR filters using the Windowing Method.
➢ Write reports on filter design and DSP applications projects
➢ Assess the societal impact of DSP, and the engineer's responsibilities in this regard.

Module I

Introduction to Signal Processing: Descriptions of Physical Data (Signals), Classification of Data.
Module II


Module III


Reference:

3. Digital Signal Processing, Alan V. Oppenheim, Ronald W. Schafer, Prentice hall

Structure of the Question paper

For the End Semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
MPD 2001: FINITE VOLUME METHOD FOR FLUID FLOW AND HEAT TRANSFER

Structure of the Course

Lecture : 3 hrs/ Week Credits :3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives:

➤ A number of physical problems related to Propulsion Engineering and Thermal Engineering can be modeled as partial differential equation and often non-linear. These equations cab not be solved by analytical methods and suitable numerical techniques are to be applied. The objective this stream elective is to give the students the necessary fundamentals ideas and their applications for real problems. An exposure to open source computational tools is also aimed. Reading and understanding at least two Journal Publications dealing with later developments in solution algorithms for flow and heat transfer.

Learning Outcomes:

➤ Mathematical formulation of physical problems and their solution.
➤ Capability to write computer programs based on the techniques learned.
➤ Development of a directory containing the basic and applied computer programs, tutorials and their document.

Module I

Governing equations of fluid flow and heat transfer-Programming in object oriented C++, Classes, Structures and Union (Portions up to this is for study by students themselves. Questions may be asked for the examinations). Governing equations in primitive variables – general scalar form for incompressible flow-conservative vector form for compressible flow-Linearisation -Jacobian- Mathematical nature of governing equations- Governing equations in terms of stream function and vorticity (2D and 3D).

Finite difference approximations for differential coefficients, order of accuracy, numerical examples- Stability, convergence and consistency of numerical schemes - Von-Neumann analysis for stability-Courant-Friedrich-Lewi criterion.

Module II

Module III


References:

1. Applied finite element analysis, Larry J. Segerlind
2. Numerical heat transfer and fluid flow, Suhas V. Patankar
3. Computational fluid dynamics: the basics with applications, John D. Anderson
5. Introduction to Computational Fluid Dynamics, Anil W. Date

Structure of the Question paper

For the End Semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
MPD 2002: TRANSPORT PHENOMENA

Structure of the Course

Lecture: 3 hrs/ Week Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

1. To develop and detailed understanding of the physics behind transport phenomena in engineering systems.
2. To learn solution techniques in advanced transport phenomena.

Learning Outcomes

1. Student will be capable of applying theoretical knowledge in various industrial and academic situations
2. They will be in a position to develop models for a particular problem involving heat and mass transfer.

Module I


Diffusivity and the mechanism of mass transport- definitions of concentrations, velocities and mass fluxes-Fick’s law of diffusion- temperature and pressure dependence of mass diffusivity- theory of ordinary diffusion in gases at low density- theories of ordinary diffusion in liquids.

Module II

Shell balance for momentum, energy and mass, boundary conditions, Adjacent flow of two immiscible fluids- heat conduction with a nuclear heat source-diffusion through a stagnant gas film-diffusion with heterogeneous chemical reaction- diffusion with homogeneous chemical reaction-diffusion into a falling liquid film: Forced convection mass transfer-diffusion and chemical reaction inside a porous catalyst; the “Effectiveness factor”.
The equations of change for isothermal, non isothermal and multi component systems- the equations of continuity of species A in curvilinear co-ordinates-dimensional analysis of the equations of change for a binary isothermal mixture.
Module III

Concentration distributions in turbulent flow - concentration fluctuations and the time smoothed concentration-time smoothing of the equations of continuity of A.

Inter phase transport in multi component systems - definition of binary mass transfer coefficients in one phase – correlations of binary mass transfer coefficients in one phase at low mass transfer rates- definition of binary mass transfer coefficients in two phases at low mass transfer rates- definition of the transfer coefficients for high mass transfer rates.

Macroscopic balances for multi component systems - the macroscopic mass, momentum, energy and mechanical energy balance - use of the macroscopic balances to solve steady state problem.

References:

Text book: Transport Phenomena Bird R B, Stewart W E and Lightfoot F N

Note: Use of approved charts & tables are permitted in the examinations.

Structure of the Question paper

There will be three questions from each module out of which two questions are to be answered by the students.
MTD2001: FINITE ELEMENT ANALYSIS FOR HEAT TRANSFER 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objectives

To impart an awareness regarding various types of equations and their methods of solving
To analyse a given situation to find out the temperature profiles and rate of heat transfer

Learning Outcomes

The students will be capable of analyzing theoretically any heat transfer problems by using FEM

Module I

Review of the fundamentals of the three modes of heat transfer. Governing differential equations. Initial and boundary conditions.

Review of the numerical techniques for the solution of matrix equations.
Basic concepts of Finite Element method. Mesh generation-

Module II

Steps involved in a thermal analysis. Analysis of linear and nonlinear conduction problems in steady and transient heat transfer. 1D, 2D and 3D analysis with simple examples. Axisymmetric heat transfer. Finite element solution in the time domain.


Module III


Computer programming and implementation of FEM. Introduction to general purpose FEM packages.
References:

2. H C Huang and A Usmani: Finite Element Analysis for Heat Transfer
3. L J Segerland: Applied Finite Element Analysis

Structure of the Question paper

For the End semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
MTD 2002: CRYOGENIC ENGINEERING 3-0-0-3

Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination  : 60 Marks

Course Objectives

- To impart a basic concepts of low temperature production and utilization
- To study various systems for low temperature production

Learning Outcomes

- The students will be capable of designing a liquefaction system
- They will be able to produce liquefaction systems with minimum energy consumption

Module I

Introduction: Historical development-present areas involving cryogenic engineering. Low temperature properties of engineering materials-Mechanical properties-Thermal properties-Electric and magnetic properties-Properties of cryogenic fluids.

Module II


Module III

Cryogenic fluid storage and transfer systems: Cryogenic fluid storage vessels-Insulation-Cryogenic fluid transfer systems. Applications of Cryogenics: Super conducting devices-Cryogenics in Space Technology- Cryogenics in biology and medicine.

References:

1. Cryogenic Systems – Randall Barron
2. Cryogenic Engineering- R.B.Scott

Structure of the Question paper

For the End semester Examination There will be three questions from each module out of which two questions are to be answered by the students.