Scheme of Teaching and Examination for
Master of Engineering (Industrial Engineering)
Three Years Part Time Course
(Revised 2013-14)

		SEMESTER -- I								
Subject Code	**Subject**	Hours per week			Scheme of Examination					
		L	T	P	Theory (Hrs)	Credits				
						Theory	IA	Practical	Oral	Total
MIE 1.1	Principles of Industrial Engineering & Management	6	--	--	3	4	1	--	1	6
MIE 1.2	Engineering Statistics	6	--	--	3	4	1	--	1	6
MIE 1.3	Seminar I	--	4	8	--	--	2	--	4	6
	Total	12	4	8	--	8	4	--	6	18

		SEMESTER -- II								
Subject Code	**Subject**	Hours per week			Scheme of Examination					
		L	T	P	Theory (Hrs)	Credits				
						Theory	IA	Practical	Oral	Total
MIE 2.1	Applied Operations Research	6	--	--	3	4	1	--	1	6
MIE 2.2	Operations Management	6	--	--	3	4	1	--	1	6
MIE 2.3	Computer Methods in Industrial Engineering	5	--	2	3	4	1	1	--	6
	Total	17	--	2	--	12	3	1	2	18

		SEMESTER -- III								
Subject Code	**Subject**	Hours per week			Scheme of Examination					
		L	T	P	Theory (Hrs)	Credits				
						Theory	IA	Practical	Oral	Total
MIE 3.1	Elective I	5	--	2	3	4	1	--	1	6
MIE 3.2	Work System Design	6	--	--	3	4	1	--	1	6
MIE 3.3	Quality and Reliability	6	--	--	3	4	1	--	1	6
	Total	17	--	2	--	12	3	--	3	18

		SEMESTER -- IV								
Subject Code	**Subject**	Hours per week			Scheme of Examination					
		L	T	P	Theory (Hrs)	Credits				
						Theory	IA	Practical	Oral	Total
MIE 4.1	Elective II	5	--	2	3	4	1	--	1	6
MIE 4.2	Maintenance Engineering & Management	6	--	--	3	4	1	--	1	6
MIE 4.3	Seminar II	--	4	8	--	--	2	--	4	6
	Total	11	4	10	--	8	4	--	6	18

SEMESTER -- V										
Subject Code	**Subject**	Hours per week			Scheme of Examination					
		L	T	P	Theory (Hrs)	Credits				
						Theory	IA	Practical	Oral	Total
MIE 5.1	Elective III	5	--	2	3	4	1	--	1	6
MIE 5.2	Project	--	2	6	--	--	2	--	4	6
MIE 5.3	Seminar III	--	2	6	--	--	2	--	4	6
	Total	5	4	14	--	4	5	--	9	18

SEMESTER -- VI										
Subject Code	**Subject**	Hours per week			Scheme of Examination					
		L	T	P	Theory (Hrs)	Credits				
						Theory	IA	Practical	Oral	Total
MIE 6.1	Dissertation	--	4	24	--	--	8	--	12	20
	Total	--	4	24	--	--	8	--	12	20

List of Electives for Master of Engineering (Industrial Engineering)
Three Years Part Time Course:
MIE 3.1   Elective I
   3.1.1   Management Information System
   3.1.2   Marketing Management
   3.1.3   Energy Management
   3.1.4   Demand Forecasting
MIE 4.1   Elective II
   4.1.1   Facility Location and Layout planning
   4.1.2   Supply Chain Management
   4.1.3   Stochastic Modeling
   4.1.4   Industrial Scheduling
   4.1.5   Advanced Quality Management
MIE 5.1   Elective III
   5.1.1   System Simulation and Modeling
   5.1.2   Integer Programming
   5.1.3   Advanced Operations Research
   5.1.4   Advanced Maintenance Management

SUMMARY FOR ALL FOUR SEMESTERS									
Semester	Hours per week			Scheme of Examination					
	L	T	P	Theory (Hrs)	Credits				
					Theory	IA	Practical	Oral	Total
Semester - I	12	4	8	--	8	4	--	6	18
Semester - II	17	--	2	--	12	3	1	2	18
Semester - III	17	--	2	--	12	3	--	3	18
Semester - IV	11	4	10	--	8	4	--	6	18
Semester - V	5	4	14	--	4	5	--	9	18
Semester - VI	--	4	24	--	--	8	--	12	20

MIE 1.1 Principles of Industrial Engineering & Management

- **Concepts of work and productivity**   **(42 hours)**
  - Work Study: Methods study and Work measurement
  - Concept of standard time
  - Learning curve, Effect of learning on time study
  - Job evaluation: Point system, Factor comparison and Decision matrix

- **Value Engineering: concept, principles and methodology**   **(18 hours)**
  - Methods of functional analysis
  - Creativity
  - VE case studies

- **Motivation studies**   **(36 hours)**
  - Leadership
  - Organizational structure and design
  - Communication
  - Systems approach to management
  - Management by objectives

REFERENCE TEXT BOOKS:
1. Introduction to Work study by ILO, Universal Book Corporation, 4rd edition, 1999
2. Measuring and enhancing productivity of service and government organization, Mundel Marvin E., Asian Productivity Organization, 1975
3. Improving productivity and effectiveness, Mundel Marvin E., Prentice Hall, NY, 1983
4. Compendium on Value Engineering, Harold G. Tuffy, The Indo American Society, Bombay, 1983
5. Essentials of Management, Koontz, Harold and Weihrich Heinz, Tata McGraw Hill, New Delhi, 2006
6. Management, Stoner James Freeman, Edward R. and Gilbert R. Daniel, Prentice Hall, New Delhi, 6th edition, 1999
7. Effective Managerial Communication, Rasberry R. W. and Lemoine L. F., Kent Publishing Company, 1986

MIE 1.2 Engineering Statistics

- **Probability Statistics**   **(60 hours)**
    - Concept of probability, Conditional probability, Bay's theorem
    - Random variable: Discrete and continuous, Probability law and Probability density function, Function of random variable, Expectation and variance operator
    - Discrete probability distributions: Bernoulli's trial, Binomial, Geometric, Pascal, Hyper-geometric, Poisson, Multi-nominal distribution
    - Continuous probability distributions: Uniform, Exponential, Gamma, Weibull, Normal, Log-normal
    - Two dimension random vector: Joint, Marginal and Conditional probability distribution, Function of two dimensional random vector, Expectation and variance, Conditional variance, Covariance, Correlation, Independence, Application of the concepts to multi-dimensional random variables

- **Inferential Statistics**   **(36 hours)**
    - Sampling distributions: Normal, Student- t, Chi-square and F distribution
    - Point estimation
    - Interval estimation
    - Testing of hypothesis on parameters and Independence
    - Goodness of fit test
    - Linear regression
    - Analysis of variance
    - Design of experiment

REFERENCE TEXT BOOKS:
1. Applied Statistics and Probability for Engineers, Montgomery Douglas C. and George C. Runger, John Wiley and Sons, 5th edition, 2010
2. Probability and Statistical Inferences, Hogg R.V and E. A. Tanis, Prentice Hall, 8th edition, 2009
3. Probability and Statistics for Engineers, Miller Irwin and John E Freund, Prentice Hall of India, 3th edition, 1985
4. Design and Analysis of Experiments, Montgomery Douglas C., John Wiley and Sons, 8th edition, 2012

MIE 1.3 Seminar I

This shall be comprehensive study of any one topic of interest and current relevance in the field of industrial engineering, especially designed to encourage study on recent advances in the field. The seminar report shall be submitted for Term Work/ Oral examination.

MIE 2.1 Applied Operations Research

- Introduction to operations Research and Modeling   **(03 hours)**
- Linear programming (LP): Formulation, Solution methodologies, Simplex method, Two phase method, Dual simplex method and Modified simplex method   **(18 hours)**
- Duality theory   **(03 hours)**
- Post optimal analysis of LP models, Parametric linear programming
                    (12 hours)
- Transportation models, Transshipment models and Assignment models
                    (12 hours)
- Integer programming: Formulations, Cutting plane method, Branch and bound algorithm, Additive algorithm for zero one programming   **(09 hours)**
- Dynamic programming: Stages, States, Principle of optimality, Recursive relationship. Capital allocation model, Knap sack model, Traveling salesmen's model and Other related models   **(09 hours)**
- Decision theory: Decision under certainty, Risk and Uncertainty   **(03 hours)**
- Game theory: Two-person zero sum game, Graphical method, Linear-programming formulation of game   **(09 hours)**
- Queuing theory: Characteristics, Single server and Multi-server models, Self-service system, Finite population   **(09 hours)**
- Network models: Minimum spanning tree, Shortest path model, Maximal Flow   **(06 hours)**
- Introduction to goal programming   **(03 hours)**

REFERENCE TEXT BOOKS:
1. Operations Research, R. Paneerselvan, Prentice Hall of India, 2nd edition, 2003
2. Operations Research An Introduction, Hamdy A. Taha, Prentice Hall of India, 9th edition, 2011
3. Introduction to Operations Research, Hiller Frederick and Lieberman G. J., Tata McGraw Hill, 9th edition, 2010
4. Introduction to Operations Research- A computer Oriented Algorithmic approach, Billy E. Gillett, Tata McGraw Hill, 8th edition, 1976

MIE 2.2 Operations Management

- Concepts of operations planning and control for various systems in manufacturing and non-manufacturing sectors   **(06 hours)**
- Demand forecasting: Objectives, Qualitative and Quantitative techniques
                                                                 (09 hours)
- Aggregate planning and Master scheduling: Concept, Objectives, Various implementation strategies, Comparisons   **(09 hours)**
- Capacity planning, Location planning and Layout analysis   **(09 hours)**
- Assembly line balancing and Material handling   **(09 hours)**
- Group technology   **(06 hours)**
- Inventory control: Need, Systems, EOQ and Various other deterministic models, Probabilistic models   **(09 hours)**
- Material requirement planning: Dependent demand, Lot Sizing, CRP and ERP
                                                                 (09 hours)
- Concepts in JIT, Push pull system   **(03 hours)**
- Production scheduling: Single processor, Two processor flow and job shop, Three processor flow shop model   **(12 hours)**
- Project management: Gantt chart, Network models like CPM and PERT, Use of computers in project planning and monitoring   **(15 hours)**

REFERENCE TEXT BOOKS:

1. Schaum's Outline of Operations Management Joseph Monks, McGraw Hill, 1996
2. Operations Management**,** Roger G. Schroder, International Students Edition, McGraw Hill, 3rd edition, 2009
3. The Management of Operations, Jack P. Meredith, John Wiley and Sons, 5th edition.
4. Production and Operations Management, S. N. Chary, Tata McGraw Hill, 5th edition, 2012
5. Supply Chain Management, Chopra Sunil and Peter Meindl, Pearson Education Inc., 5th edition, 2012
6. Operations Management, William J. Stevenson, McGraw-Hill, 2010
7. Production and Operations management, R. Pannerselvam, Prentice Hall of India, 3rd edition, 2012

MIE 2.3 Computer Methods in Industrial Engineering

- **Non- linear Programming**   **(40 hours)**
    - Non- linear programming, Numerical methods, Classification
    - Single variable optimisation: Region elimination methods, Interpolation methods. Unrestricted search, Dichotomous method, Interval halving method, Golden section, Fibonacci search, Bisection method, Secant method, Newton–Ralphson method, Quadratic search method
    - Multivariable optimisation without constraints: Uni-variate method, Conjugate direction, Steepest descent method, Newton's method, Marquardt' method and Simplex method
    - Constraint optimisation: Random search techniques, Cutting plane method and Penalty based methods, Kuhn-Tucker conditions
    - Non-traditional optimization methods: Genetic algorithm, Simulated annealing and Tabu search, Ant colony and Particle swam optimization
- **Programming in MATLAB**   **(24 hours)**
    - m-files, Files management, Inline functions, Control flow, Trigonometry and Complex numbers, Arrays and array operations, Mathematical functions and applications, Data analysis, Selection programming, Vector, Matrices and Linear algebra, Curve fitting and interpolation, Strings, Integration and Differentiation, Symbolic processing, Programming in MATLAB

- **Implementation of various industrial engineering applications in MATLAB**   **(32 hours)**

REFERENCE TEXT BOOKS:
1. Optimization Concepts and Applications in Engineering, Ashok Belegundu and Tirupathi R. Chandrupatla, Pearson Education, 2nd edition, 2011
2. Optimization for Engineering Design, Kalyanmoy Deb, Prentice Hall of India, 2nd edition
3. Optimization Theory and Application, S. S. Rao, Wiley Eastern Limited, 2013
4. Mastering MATLAB, Duane Hanselman and Bruce Littlefield, Prentice Hall of India, 1st edition, 2011
5. MATLAB Programming for Engineers, Stephen J. Chapman, Tomson Asia Pte Ltd., 4th edition, 2007

MIE 3.1.1 Management Information System

- Introduction to information systems, Growth of hardware, Classification of software and hardware, Basics of networking topology, intranet, Internet and extranet, domain classification systems in internet. Introduction to GNU/ Linux OS, Free software, open software and proprietary software **(24 hours)**
- Various storage media, files storages, file organization. Various database structures, Logical and Physical modeling of data, Data flow diagram, Tools for analysis and modeling of processes. Tools for logical modeling of databases-entity relationship diagram, Relational databases management systems --- Definition, Data manipulation and Query, Structured Query Language (SQL), Comparisons of various RDBMS packages   **(36 hours)**
- Concepts in decision-making, Simon's model of decision-making. Concept of payoff matrix, Decision making under certainty, risk and uncertainty, Decision trees, Utilities, Ranking, Weighing   **(12 hours)**
- Concept of systems --- Classification, Coupling and Decoupling, Negative entropy, Handing of system stress   **(12 hours)**
- Expert systems --- Basic, Classification and development, MIS development –- life cycle and Prototype approach, Information system audit, Long term MIS planning   **(12 hours)**

REFERENCE TEXT BOOKS:
1. Management Information Systems, S. Sadagopan , Prentice Hall of India, 2004
2. Management Information Systems, Effy O. Z., Galgotia Publications Pvt. Ltd, 6th edition, 2008
3. Management Information Systems, Gorden Davis and Margrethe Oleson, McGraw Hill International, 2nd edition, 1985
4. Management Information Systems, Uma G. Gupta, Galgotia Publications Pvt. Ltd, 1997

MIE 3.1.2 Marketing Management

- Marketing philosophy of business   **(06 hours)**
- Consumer behavior and consumer a decision process   **(09 hours)**
- Marketing strategies and positioning products   **(09 hours)**
- Planning markets and positioning products   **(09 hours)**
- Management of existing product and development of new products

  (18 hours)
- Distribution management   **(06 hours)**
- Market oriented pricing   **(03 hours)**
- Designing the promotion mix and scale promotion   **(06 hours)**
- Managing the advertisement program   **(06 hours)**
- Scale management   **(03 hours)**
- Controlling the marketing function   **(06 hours)**
- Introduction to service marketing, marketing in non-profit organization

  (03 hours)
- Social marketing and global marketing   **(06 hours)**
- Latest trends in marketing   **(06 hours)**

REFERENCE TEXT BOOKS:
1. Marketing Management, Philip Kutter, Prentice Hall, 11th edition, 2003
2. Marketing Management, Ran Jan Saxena, Tata McGraw Hill, 4th edition, 2009
3. Marketing Management, V. S. Ramaswamy and S. Nama Kumar, Mac Millan India Ltd, 4th edition, 2009

MIE 3.1.3 Energy Management

- Elements of energy management, National energy scene with special reference to industry sector **(12 hours)**
- Energy economy relationship, Future energy supply and demand scenario and Integrated energy planning **(24 hours)**
- Physical aspect of energy: Classification, Efficiency and effectiveness of utilization in industry **(24 hours)**
- Energy demand management at plant level, Creation of energy manager, Modes of energy savings, Energy auditing, Opportunities with reference to waste heat recovery, Cogeneration **(24 hours)**
- Latest trends in energy auditing and energy conservation **(12 hours)**

REFERENCE TEXT BOOKS:
1. Industrial energy conservation, Reay A., Pergaman Press, 2nd edition 1977
2. Energy Management, Murphy and Mckay, Butterworths, 2001
3. Handbook of Energy System Engineering, Wilbur E. D., Wiley Interscience, 1985

MIE 3.1.4 Demand Forecasting

- Need and uses of forecasting   **(03 hours)**
- The features of forecasting techniques   **(03 hours)**
- Accuracy of forecasting techniques   **(03 hours)**
- Time series methods   **(24 hours)**
- Smoothing and decomposition methods   **(18 hours)**
- Regression and econometric methods   **(24 hours)**
- Box Jenkins method   **(09 hours)**
- Adaptive models   **(09 hours)**
- Integrated forecasting and planning   **(03 hours)**

REFERENCE TEXT BOOKS:

1. Statistical Methods for forecasting, Bovos Abraham and Johannes Lodolter, John Wiley and Sons, 2nd edition, 2005
2. Forecasting methods of Management, S. Makridakis , Steven Wheelwright & Victor McGee, John Wiley and Sons, 5th edition, 1989
3. Econometric Models and Economic Forecast, Robert S. Pindyck and Daniel L. Rubinfield, McGraw Hill International Book Company, International Students Edition, 4th edition, 1998

MIE 3.2 Work System Design

- **Ergonomics**   **(30 hours)**
    - Introduction to ergonomics and human factor engineering
    - Physiological basis of human performance
    - Biomechanics
    - Psychology of work and workload perception
    - Physical work environment
    - Basis of ergonomics, Problem identification and Safety
    - Case studies

- **Predetermined Motion and Time standards**   **(42 hours)**
    - Elemental motions, THERBLIGS
    - Principles of motion economy
    - MTM systems
    - Application of MTM to office and Maintenance work
    - Standard data.
    - Case studies

- **Incentive schemes**   **(24 hours)**
    - Concept, Reasons
    - Individual and Group
    - Different types of incentive schemes
    - Case studies

REFERENCE TEXT BOOKS:
1. Introduction to Ergonomics, R. S. Bridger, McGraw Hill, 3rd Edition 2008
2. Engineered work measurement, Karger D. W. and Bayha F. H., 4th edition, Industrial Press INC, NY, 1987
3. Human Factor Engineering and Design, Saunders M.S. and McCormic E. J., McGraw Hill, 7th edition, 1993
4. Handbook of Industrial Engineering, Gabriel Salvandy, John Wiley and Sons, 3rd edition, 2012
5. Fitting the task to the man, E. Grandjean, Taylor and Francis, 3rd edition, 1980

MIE 3.3 Quality and Reliability

- Definition and meaning of quality and its importance, Eight dimensions of quality, Concept and Scope of total quality, Quality systems, Quality assurance and ISO quality standards, Quality costs and Economics of quality
  (06 hours)
- ISO 9000 and its impact on quality, Six-sigma quality, TQM   **(06 hours)**
- Constant cause system and assignable causes   **(03 hours)**
- **Process Control:** Using control charts for variables and attributes, ($\overline{X}$, R) control charts, ($\overline{X}$, s) control charts, Charts with modified control limits, Warning limits and Trend. p-chart, np-chart, c-chart and u-chart **(24 hours)**
- **Acceptance Sampling**   **(24 hours)**
    - Analysis of single sampling plans, Double sampling plans, Multiple sampling Plans, Item-by-item Sampling plans
    - Design of Sampling Plans: single sampling plan using Cameron's table, using Dodge-Romig Tables, MIL STD plans
- **Reliability**   **(30 hours)**
    - Basic concept, Reliability measures, Bathtub curve, Hazard rate models, Constant hazard, Linear increasing/decreasing and non-linear hazard rate. System reliability models: Series, Parallel, Series-parallel and Complex system. Use of redundancy in design: Low level and High level. K out of n system. Reliability estimation, Reliability allocation and optimization. Life testing, Fault tree analysis, FMEA and FMECA
- Introduction to maintainability and availability   **(03 hours)**

REFERENCE TEXT BOOKS:
1. Statistical Quality Control, Grant E. L. & Levenworth R. S., McGraw Hill, 7th edition, 1996
2. Quality Planning and Analysis, Juran J. M. & Gyrna F. M., McGraw Hill, 2010
3. Total Quality Control, Armand V. Feigenbaum, McGraw Hill, 4th edition, 2005
4. Practical Reliability Engineering, P. D. T. O'Connor, John Wiley & Sons, 5th edition, 2011

MIE 4.1.1 Facility Location and Layout Planning

- Facility planning and industrial Engineering, facility location problems --- application of transportation model, Decision theory and other analytical approaches, Single/multiple facility location problems, Quadratic assignment problems, mini-max location and Covering problems, Use of simulation for location problems   **(48 hours)**
- Facility design problems – Structural design, Types of production, Types of layout, Comparisons layout design including computerized layout planning and handing system design warehouse management, Application of classical industrial engineering concepts to facilities planning, Facility planning and Technology management, Application of concepts and techniques in operation research –- Goal programming and Integer programming in facility layout   **(48 hours)**

REFERENCE TEXT BOOKS
1. Facilities Planning, J. A. Tomkins and J. A. White, John Wiley and sons 4th edition, 2010
2. Manufacturing systems Engineering, K. Hitomi, Viva Books Pvt. Ltd., 2nd edition, 1996
3. Facility layout and location – an analytical approach, Francis R. L. and J. A. White Prentice Hall Inc, 2nd edition
4. Plant Layout and Material Handling , J. M. Apple, McGraw Hill, 3rd edition, 1978

MIE 4.1.2 Supply Chain Management

- Introduction to supply chain management, Classification of inventory systems, Managing supply chain inventory, Planning demand and supply in supply chains, Managing economics of scale and uncertainty in supply chains, Lead-times, Understanding impact of uncertainty of demand and supply in supply chains, Corporate strategy   **(24 hours)**
- Supply chain design for mass customization, Design of localization and Design of customization, Managing transportation in supply-chains, Inventory transportation tradeoff, Issues in facility location in supply chains
  (24 hours)
- Network design in supply chains, Framework for facility location decisions, Operational issues in supply chains, Effect of demand and lead-times uncertainty on total costs of supply chain, Beer distribution game, Information distortion and Bullwhip effect, Performance measures of supply chains   **(24 hours)**
- Information technology and E-Business in supply chains management, Impact of sourcing of raw materials, Distribution, Supply chain macro processes (SRM, ISCM & CRM), Reverse supply chains, Case studies in supply chain management   **(24 hours)**

REFERENCE TEXTBOOKS
1. Supply Chain Management- Strategy, Planning and Operations, Sunil Chopra, Peter Meihdl Pearson Education Asia, 5th edition, 2012
2. Design and Managing the Supply chain, Simchi- Levi Kaminsky, McGraw Hill International Edition, 2nd edition, 2002
3. Strategic Logistic Management, Lambart Douglas and James Stock, Irwin McGraw Hill International Edition, 4th edition, 2000
4. Logistics and Supply Chain Management - Cases and Concepts, Raghuram G, and N. Rangaraj, McMilan India Pvt Ltd, New Delhi, 2000

MIE 4.1.3 Stochastic Modelling

- Review of probability concepts and distributions   **(09 hours)**
- Introduction to stochastic processes, Sample paths and Finite dimensional distributions, Kolmogorov's consistency conditions   **(18 hours)**
- Renewal process, Reward and cost models, Cumulative processes, Poisson process and Stopping times, Regenerative processes, Relation between a time average and mean of limiting distribution, Wald's equation, Renewal theorem
          (30 hours)
- Discrete time Markov chains, Connection with renewal theory, Communication classes and Class properties, Irreducible and Positive recurrent chains, Frequency and relative frequencies for ergodic chains, Costs and reward for ergodic chains, Transient behavior. Continuous time Markov chains, Pure- jump chains, Regular chains birth death process, Time and transition average for positive recurrent irreducible chains, Backward and forward equations, Uniformalizable chains   **(30 hours)**
- Various applications of stochastic models   **(09 hours)**

REFERENCE TEXT BOOKS
1. Modeling and analysis of Stochastic Systems, V. G. Kulkarni, Chapman and Hall London, 1995
2. Probability and Random Processes , G. R. Grimmett and D. R. Stizaker, Oxford University Press, Oxford, 3rd edition, 2001
3. An Introduction to Stochastic processes, E. Cinlar, Prentice Hall Inc, Englewood Cliffs, 2013
4. Stochastic Processes, S. M. Ross, John Wiley and Sons, New York, 2nd edition, 1995

MIE 4.1.4 Industrial Scheduling

- Importance of scheduling in implementation of production planning, Scheduling function, Common measure of performance   **(12 hours)**
- Exact solution in some one and two processor system, Heuristics in job shops and flow shop problems, Scheduling of jobs with limited resources, Dynamic flow systems, Use of priority rules   **(30 hours)**
- Scheduling, Balancing in mixed model assembly lines and flow lines, Scheduling in process industries with no wait or limited work in process

 (30 hours)

- Parallel processor, Bin pacing heuristics, GT as decomposition of job shops Vehicle scheduling problems, LP formulation of various scheduling situations, Recent development in scheduling   **(24 hours)**

REFERENCE TEXT BOOKS
1. Operation Research, R. Paneerselvan, Prentice Hall of India, 2nd edition, 2003
2. Theory of Scheduling, R. W. Conway, W. L. Maxwell and L. W. Miller, Addison Wiley, 2003
3. Machine Scheduling Problems, Classification complexity and computations , A. H. G. Rinnoooy Kan, Martums Nijhoff, The Hague, 1976
4. Introduction to sequencing, K. R. Baker, Wiley, 1974

MIE 4.1.5 Advanced Quality Management

- Review of statistical process control and acceptance sampling   **(12 hours)**
- Detailed design of sampling plans   **(12 hours)**
- **Robust Design Methodology** -- Design of Experiments, Taguchi Methods, Response Surface Methods, Case studies   **(30 hours)**
- **Six Sigma Management** -- Introduction to Six sigma, Quality tools and techniques. QFD, FMEA, DMAIC and DFSS for Manufacturing and Service sector, Case studies   **(30 hours)**
- Recent trends in quality engineering and management   **(12 hours)**

REFERENCE TEXT BOOKS

1. Design and Analysis of Experiments by Douglas C. Montgomery,   Wiley India5th edition
2. Statistical Quality Control, Grant E. L. & Levenworth R. S., McGraw Hill, 7th edition, 2000
3. Taguchi Techniques for Quality Engineering by Phillip J. Ross, Tata McGraw Hill, 2nd edition, 2005
4. Quality Engineering using Robust Design by Madhav S. Phadke, Prentice Hall, 1st edition, 1989
5. Design for Six Sigma for Green belts and Champions by Howrad Gitlow and David Levine, Pearson Education, 1st edition, 2004
6. The Six Sigma Black belt Handbook by Thomas McCarty, Lorraine Daniels, Michael Bremer and Praveen Gupta, McGraw Hill, 2010

MIE 4.2 Maintenance Engineering & Management

- Maintenance management: Objectives, Benefits and Policies, Organizational structure of maintenance system, Mechanics of maintenance system, Planning and scheduling of maintenance activities   **(06 hours)**
- Types of maintenance: Breakdown, Preventive maintenance, Predictive maintenance, Total productive maintenance, Codification and Classification, Replacement policies, Replacement models   **(12 hours)**
- Reliability models, System reliability for series, parallel and complex system, Time dependant failure rates, Reliability testing -- Non-parametric methods, Censoring and Acceleration, Parametric methods, Redundancy, Single, Multiple, Common mode failure, Redundancy allocation -- High level, Low level, Reliability optimization, Reliability allocation   **(24 hours)**
- Maintained system: Idealized maintenance, Imperfect maintenance, Age maintenance, Availability and Maintainability, Revealed failures   **(18 hours)**
- Failure interaction: State transition diagram, Reliability and availability calculations using Markov analysis of multiple components, Load-sharing system and Standby system   **(24 hours)**
- Safety analysis, Various tools of analysis   **(06 hours)**
- Computerized maintenance system, Design implementation and Operation of integrated maintenance system   **(06 hours)**

REFERENCE TEXT BOOKS:
1. Introduction to Reliability Engineering, E. E. Lewis, John Wiley and Sons, 2nd edition, 1996
2. Practical Reliability Engineering, P. D. T. O'Connor, John Wiley and Sons, 5th edition, 2011
3. Failure Modes and Effect Analysis, P. Paul, P. T. Publications, Inc. Suite C., 1995
4. An introduction to machinery Reliability Assessment, H. P. Bloch and F. K. Geitner, Van Nostrand Reinhold Inc., New York, 2nd edition, 1994

MIE 4.3 Seminar II

This shall be comprehensive study of any one topic of interest and current relevance in the field of industrial engineering, especially designed to encourage study on recent advances in the field. The work should be analytical in nature. The seminar report shall be submitted for Term work/ Oral examination.

MIE 5.1.1 System Simulation and Modeling

- Definition, Need, Modeling concepts, Types of system studies   **(06 hours)**
- Random numbers: Need, Importance and Desirable properties, Generation of random numbers with Bernoulli's Trial, Binomial, Geometric, Pascal, Exponential, Uniform, Normal, Erlang distribution   **(12 hours)**
- Testing the random numbers for the various distributions   **(06 hours)**
- Estimation of parameters   **(06 hours)**
- Next event approach, Fixed time increment approach and Process oriented approach for system simulation   **(03 hours)**
- Simulation of inventory system, Queuing system, Project network and Other discrete system, Application of simulation for solving deterministic model like evaluation of definite integral, Finding value of root, Area of circle etc., Application of simulation in simple simulation of simple management games

    (24 hours)

- **GPSS:** Introduction to various block statements and control statements such as: GENERATE, ADVANCE, SEIZE, RELEASE, QUEUE, DEPART, ENTER, DEPART, TRANSFER, MARK, TABULATE, TERMINATE, SAVEVALUE, PRIORITY, ASSIGN, GATE, LOGIC, FUNCTION, START, RESET, JOB, SIMULATE etc., Standard numeric attributes, Modeling of systems using GPSS

    (30 hours)

- Introduction to continuous simulation and CSMP   **(03 hours)**
- Analysis of simulation output: Determining the length of simulation, Effect of initial bias, Effect of auto-correlation, Variance Reduction techniques

    (06 hours)

REFERENCE TEXT BOOKS:

1. System Simulation , Geoffrey Gorden, Prentice Hall of India, New Delhi, 2nd edition, 1996
2. Digital computer simulation, Fred J. Maryanski, CBS Publishers and Distributors, 1980
3. System Simulation with Digital Computer by Narsingh Deo, 5th edition, 2004

MIE 5.1.2 Integer Programming

- Classification and Application, Capital budgeting, Multi-commodity. Distribution, Airline crew scheduling, Truck delivery problems   **(18 hours)**
- Cutting plane methods, Dual fractional integer and Mixed integer programming, Dual and Primal all integer algorithms, Brach and bound approach, Surrogate constraints, Zero one programming, Model formulation using binary variables in either or constraints K out of N Constraints, Functions with several values etc., Balas addition algorithm, Binary representation of general integer   **(48 hours)**
- Recursions for knapsack problems, Group knapsack problems, Set covering and Set partitioning   **(18 hours)**
- Genetic algorithm for integer programming   **(12 hours)**

REFERENCE TEXT BOOKS
1. Integer Programming, H. M. Salkin, Addison Wiley, 1975
2. Integer Programming, R. S. Garfinkel and G. L. Nemhauser Wiley interscience, 2012
3. Integer Programming, H. Taha, Academic Press, 1975
4. Optimization for engineering design – algorithms and examples, K. Deb, Prentice Hall of India Pvt. Ltd, New Delhi, 2nd edition, 1998

MIE 5.1.3 Advanced Operations Research

- Review of LP, Parametric linear programming, Upper bound technique, Interior point algorithm, Quadratic programming and Linear complementary problem   **(18 hours)**
- Transshipment model, Solid Transportation model, Fixed charge model, Three dimensional assignment model   **(12 hours)**
- Review of basic queuing models, Analysis of advanced queuing models, Application of queuing theory   **(12 hours)**
- Multi- objective programming: Need, Efficient solution, Concept of pareto optimality generation, Compromise solution and Solution methodologies
                                                                    (12 hours)
- Non-traditional techniques for non linear optimization like simulated annealing, Genetic algorithm, Ant colony and Particle swam methods
                                                                    (18 hours)
- Introduction to Geometric programming   **(12 hours)**
- Recent advances in optimization   **(12 hours)**

REFERENCE TEXT BOOKS
1. Operations Research, R. Paneerselvan, Prentice Hall of India, 2nd edition, 2003
2. Operations Research An Introduction, Hamdy A. Taha, Prentice Hall of India, 9th edition, 2011
3. Introduction to Operations Research, Hiller Frederick and Lieberman G. J., Tata McGraw Hill, 2010
4. Introduction to Operations Research- A computer Oriented Algorithmic approach, Billy E. Gillett, Tata McGraw Hill, 1979

MIE 5.1.4 Advanced Maintenance Management

- Probability theory --- A review: Probability space, Random variables – one dimensional and multi-variate, Conditional probability and expectation, Moments and E and V operators   **(12 hours)**
- Introduction to stochastic Process: Sample path, Finite dimensional distributions, Renewal process, Markov chains – applied to failure interactions and Reliability, Availability and Maintainability (RAM) analysis
                                                                                (24 hours)
- Analytical tools: Reliability measures and assessment using inferential statistics and Probability plots, Ranking methods – AHP with reciprocal matrix analysis, FMEA, FTA, Event tree analysis – Brinbaum's reliability important measure. Multi-attribute analysis (MAA) – Criticality importance through inter-correlation (CRITIC) method. Nonlinear optimization, Multi objective optimization, Tools to deal with conflicts – pareto optimality
                                                                                (36hours)
- Recent trend in Maintenance: Conventional classification of maintenance, Replacement policy – Selection of optimal period in PM using multi-criteria. Reliability Centered Maintenance (RCM) – Need, Historical development – Bath tub fallacy, Road map to develop RCM system, Benefits and Pitfalls, Global status with case studies. Total Productive Maintenance (TPM) – Development, Philosophy, Success with cases. Diagnostic maintenance – Condition monitoring – Development of signatures and their analysis, Debris analysis – Benefits and limitations, Application potentials with cases – Tribology   **(24 hours)**

REFERENCE TEXT BOOKS
1. An Introduction to Machinery Reliability Assessment, Bloch, H. P. and Geitner, F. K., Van Nostrand Reinhold Inc., New York, second edition, 1994
2. Design Reliability Fundamentals and applications, Dhillon B. S., CRC Press, 1st edition, 1999
3. Assurance Technologies – Principles and practices, Raheja, D. G., McGraw Hill Inc., New York, 1991
4. Reliability Centered Maintenance, Smith, A. M., McGraw Hill Inc., New York, 1993
5. Grimmet and Stizaker, Probability and Random Processes, Oxford university Press, Oxford, 3rd edition, 2011

MIE 5.2 Project

This shall include a detailed compilation of work leading to formulation of research work topic for dissertation in semester VI.

MIE 5.3 Seminar III

This shall be comprehensive study of any one topic of interest and current relevance in the field of industrial engineering, especially designed to encourage study on recent advances in the field. The seminar report shall be submitted for Term Work/ Oral examination.

MIE 6 Dissertation

This shall include a detailed and exhaustive research study on that shall contribute more towards the field of industrial engineering. The work may be analytical or experimental. Typed and three softbound project report (prepared as per guidelines) shall be submitted for Term Work/Oral examination. After successful defense, the copies with correction (if any) are to be submitted in hard bound form.