Estd .1962
NAAC 'A' Grade
MHRD NIRF- 28 th Rank

SHIVAJI UNIVERSITY, KOLHAPUR

SYLLABUS OF

M.E.(INDUSTRIAL ENGINEERING)

(Under the Board of Studies in Production Engineering)

TO BE INTRODUCED FROM THE ACADEMIC YEAR 2016-17 ONWARDS

(Subject to the modifications to be made from time to time)

COURSE STRUCTURE FOR
M.E. (Industrial Engineering)
(Under Board of Studies in Production Engineering)
(Effective from July 2012)

M.E. (Industrial Engineering): Semester-I

Sr. No.	Name of the subject	Teaching scheme Hrs./week			Examination scheme			Total marks
		L	T	P	TP	TW	P/O	
1	Design of Experiments and Research Methodology	3	2	-	100	25	-	125
2	Work Study	3	-	-	100	-	-	100
3	Ergonomics	3	-	-	100	-	-	100
4	Elective-I	3	1	-	100	25	-	125
5	Elective-II	3	1	-	100	25	-	125
6	Work Study Laboratory	-	-	2	-	25	25	50
7	Ergonomics Laboratory	-	-	2	-	25	25	50
8	Seminar-I	-	-	1	-	25	-	25
	Total	**15**	**4**	**5**	**500**	**150**	**50**	**700**

L:Lecture, T:Tutorial, P:Practical, TP: Theory paper, TW: Term work, P/O: Practical/oral examination

List of elective subjects for Semester-I			
	Elective-I (Semester-I)		**Elective-II (Semester-I)**
1	Stochastic processes and Markov Chains	1	Multivariate Statistical Modeling-I
2	Manufacturing System Design	2	Supply Chain Management
3	Probabilistic Risk Assessment	3	Reliability Analysis and Prediction
4	Project Engineering and Network Analysis	4	Queuing Theory and Models
5	Technology Management	5	Total Quality Management

M.E. (Industrial Engineering): Semester-II

Sr. No.	Name of the subject	Teaching scheme Hrs./week			Examination scheme			Total Marks
		L	T	P	TP	TW	P/O	
1	Optimization Techniques	3	2	-	100	25	-	125
2	Human Factors Engineering	3	-	2	100	25	25	150
3	Production Planning and Inventory Control	3	-	-	100	-	-	100
4	Elective-III	3	1	-	100	25	-	125
5	Elective-IV	3	1	-	100	25	-	125
6	Programming and Simulation Laboratory	-	-	2	-	25	25	50
7	Seminar-II	-	-	1	-	25	-	25
8	Comprehensive Viva-Voce	-	-	-	-	-	50*	50
	Total	**15**	**4**	**5**	**500**	**150**	**100**	**750**

L:Lecture, T:Tutorial, P:Practical, TP: Theory paper, TW: Term work, P/O: Practical/oral examination
* Each candidate will undergo a viva-voce conducted by the University.

List of elective subjects for Semester-II			
	Elective-III (Semester-II)		**Elective-IV (Semester-II)**
1	Quality Engineering	1	Multivariate Statistical Modeling-II
2	Facility Layout and Design	2	Logistics Management
3	Maintenance Engineering	3	Industrial Safety Engineering
4	Scheduling Algorithms	4	Industrial Product Design
5	Productivity Management	5	World Class Manufacturing
		6	Open Elective*

*Open Elective: The students can choose under Open Elective, any subject from any of the University approved M.E./M.Tech. programs being run at the institute concerned.

M.E. (Industrial Engineering): Semester-III

Sr. No.	Name of the subject	Teaching scheme Hrs./week			Exam scheme			Total marks
		L	T	P	TP	TW	P/O	
1	Seminar-III	-	-	1	-	25	25	50
2	Dissertation Phase-I	-	-	2	-	50	-	50
	Total	**-**	**-**	**3**	**-**	**75**	**25**	**100**

L:Lecture, T:Tutorial, P:Practical, TP: Theory paper, TW: Term work, P/O: Practical/oral examination

M.E. (Industrial Engineering): Semester-IV

Sr. No.	Name of the subject	Teaching scheme Hrs./week			Exam scheme			Total marks
		L	T	P	TP	TW	P/O	
1	Dissertation phase-II	-	-	4	-	100	100	200
	Total	**-**	**-**	**4**	**-**	**100**	**100***	**200**
	Grand Total (Semester-I to Semester-IV)							**1750**

L:Lecture, T:Tutorial, P:Practical, TP: Theory paper, TW: Term work, P/O: Practical/oral examination
***** Each candidate shall undergo a viva-voce conducted by the university based on dissertation work.

Note for Comprehensive Viva-voce:
At the end of semester-II, the candidate will undergo a comprehensive viva-voce examination taken by the University, based on all courses and laboratories covered in semester-I and semester-II.

Note for teaching workload calculation purpose:

1. Seminar I, II, III: One hour per student per week
2. Dissertation phase I: Two hours per student per week
3. Dissertation phase II: Four hours per student per week

Note for eligibility for admission:
Eligibility for admission to M.E.(Industrial Engineering) is same as that for M.E.(Mech-Prod), M.E.(Mech-Design), and M.E.(CAD/CAM/CAE) as per the Shivaji University rules.

Note for equivalence of M.E.(Industrial Engineering) degree:
Equivalence of the degree of M.E.(Industrial Engineering) for all purposes, including eligibility for faculty position, is same as that of M.E.(Mech-Prod), M.E.(Mech-Design), and M.E.(CAD/CAM/CAE) as per the Shivaji University rules.

M.E. (Industrial Engineering): Semester-I

1. Design of Experiments and Research Methodology

Teaching scheme: Lectures: 3 hrs/week, Tutorial: 2 hrs/week

Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Introduction: Meaning and objectives of research, Types of research, Research approaches, Research process, Research problem, Selection of research problem, Defining research problem, Literature review, Meta-analysis, Effect sizes, Integrating research findings, Identification of research gaps, Errors in research
2. Research design: Meaning, need, and features of good design, Dependent, independent, and extraneous variables, Experimental and control groups, Treatments, Experiment, Research designs in exploratory studies, Research designs in descriptive studies, Experimental research designs (informal and formal), Replication, Randomization, Blocking
3. Sampling: Need for sampling, Population, Sample, Normal distribution, Steps in sampling, External validity and threats, Sampling error, Probability sampling, Random sampling, Systematic sampling, Stratified sampling, Cluster sampling, Student's t-distribution, Standard error, Determination of sample size
4. Measurement techniques: Measurement scales, Errors in measurement, Content validity, Criterion-related validity, Construct validity (convergent and discriminant), Reliability, Rating scales, Paired comparison, Differential scales, Summated scales, Cumulative scales, Factor scales
5. Data collection and analysis: Primary data collection through observations and interviews, Questionnaire surveys, Secondary data collection, Data processing, Measures of central tendency and dispersion, mean, median, mode, range, variance, standard deviation, inter-quartile range, histogram, box-plot, normal probability plot, Measures of association (simple regression analysis, association of attributes)
6. Hypothesis testing: Null and alternative hypothesis, Level of significance, Type I and type II error, Two-tailed and one-tailed tests, Procedure of hypothesis testing, Power of hypothesis test, Hypothesis testing of means, Hypothesis testing of mean difference
7. Analysis of variance: Introduction, One-way ANOVA, Two-way ANOVA, Preparation of ANOVA Table and calculation of F-ratio
8. Report writing: Interpretation of results, Techniques and precaution in interpretation, Steps in report writing, Layout of research report, Types of research report, Mechanics and precautions in writing research report, Structure of research paper, Referencing and bibliographic styles, Citations, Impact factor, Peer review, Plagiarism

Term work

1. Six assignments based on above syllabus, including quantitative assignments on data analysis, hypothesis testing, and analysis of variance.
2. Each candidate will identify major and minor research interest area, related to the field of industrial engineering, and will collect and review at least 10 journal papers in the identified major and minor interest areas. The findings of review will be submitted as part of term-work

Reference books

1. Montgomery, Douglas C. (2007) – Design & Analysis of Experiments, 5/e. (New Delhi, Wiley Student Edition, Wiley India Pvt. Ltd.) ISBN: 978-81-265-1048-1
2. Montgomery, Douglas C. & Runger, George C. (2007) – Applied Statistics & Probability for Engineers, 3/e, . (New Delhi, Wiley Student Edition, Wiley India Pvt. Ltd.), ISBN: 978-81-265-1424-3
3. Ranjit Kumar, (2006), Research Methodology- A Step-By-Step Guide for Beginners, (Pearson Education, Delhi) ISBN: 81-317-0496-3
4. Trochim, William M.K., (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press, New Delhi), ISBN: 81-7722-372-0
5. Kothari, C.K., (2004), 2/e, Research Methodology- Methods and Techniques, (New Age International, New Delhi)
6. Krishnaswamy, K. N., Sivakumar, Appa Iyer and Mathirajan, M. (2006), Management Research Methodology: Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)
7. Panneerselvam – Research Methodology, (PHI), ISBN: 81-203-2452-8

M.E. (Industrial Engineering): Semester-I
2. Work study
Teaching scheme: Lectures: 3 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks

1. Productivity and Work Study, Definition and scope, Productivity and quality of life, Evolution of work study, contribution of Taylor and Gilbreth, Work study techniques and basic procedure
2. Method study: Definition, objectives and basic procedure. Record, Examine, Develop, Evaluate, Define, Install and Maintain methods, Process chart symbols, Outline and flow process charts, Flow diagrams, Critically Examine Techniques
3. Movement of workers and material at workplace– string diagram, flow process charts: worker material and equipment type, multiple activity chart: Man – Machine, Machine-Machine chart, Travel charts for workplace
4. Principles of motion economy, Classification of movements, Two handed process chart, SIMO charts, Micro Motion study, Therbligs, Use of Therbligs in examining common industrial tasks
5. Work measurement: Objectives, basic procedure, Techniques of work measurement
6. Time study – Equipment and forms, selection of a job, steps in time study, breaking the job into elements, timing the elements; Rating in time study – standard rating and standard performance, factors affecting rate of working, standard time determination, use of time standards, allowances;
7. Work sampling – Need, procedure for work sampling, underlying statistical distribution, determining time standards by work sampling.
8. Predetermined time standards (PTS) – definition, methods time measurement (MTM), standard data from PTS, applications of PTS in different industrial situations
9. Maynard Operation Sequence Technique: Introduction, Methodology, BasicMOST, MiniMOST, MaxiMOST, Applications to industrial cases

Reference books

1. Work Study: - I L O
2. Work Study: - Curie and Faraday (ELBS)
3. Industrial Engineering Handbook, Maynard (Mc Graw Hill)
5. Time and Motion Study Design, Barnes, R.M. (John Wiley)
4. Work Study & Ergonomics, L.C. Jhamb (Everest)

M.E. (Industrial Engineering): Semester-I
3. Ergonomics
Teaching scheme: Lectures: 3 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks

1. Introduction: Brief history, Modern ergonomics, Human-machine-system interface, Leamon's model
2. Anatomy, Posture and body mechanics: Stability and support, Control of muscle function, fatigue and discomfort, musculoskeletal problems in sitting and standing, extreme postures, ergonomic risk factors
3. Anthropometry: Anthropometric data, Principles of anthropometry applied in design, Design for everyone
4. Workspace design: Workstation design, Design for standing work, Design for seated work, Work surface design, Visual display terminals
5. Design of manual tasks: Lifting, Carrying, The NIOSH approach, Slip, trips, and falls
6. Work-related musculoskeletal disorders: Injuries to upper body, Control of neck problem, Shoulder, elbow and wrist problems, Repetitive strain injuries
7. Workload and work capacity: Physical work capacity, Maximum oxygen uptake, VO_2 max and industrial work, Factors affecting work capacity, Workload, Physical fitness, and health, Calculation of rest periods, Work-rest cycle
8. Heat stress, heat stroke, heat acclimatization, Cold stress, Thermal comfort, Humidity,
9. Illumination, lighting, Glare, contrasts, and VDT, Visual fatigue, eye strain, Light, circadian rhythm, and shift work
10. Noise exposure, Noise-induced hearing loss, Reverberation, Acoustic environment, Noise insulation, Whole-body vibrations and hand-arm vibrations, Vibration and health, Vibration and work performance

Reference books

1. Introduction to Ergonomics by R S Bridger, McGraw Hill
2. Occupational Ergonomics: Principles and applications by F Tayyari and J Smith, Kluwer Academic Publishers, Boston
3. Putz-Anderson, V., 1988. Cumulative trauma disorders : A manual for musculoskeletal diseases of the upper limbs. Taylor and Francis, London.

M.E. (Industrial Engineering): Semester-I

4. Elective-I

4.1. Stochastic processes and Markov Chains

Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week

Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Probability, measure, and integration: Probability spaces and probability fields, Random variables and their expectation, Convergence of random variables, Independence, weak convergence, and uniform integrabilty, Conditional expectations and Hilbert spaces
2. Stochastic processes: General theory, Definitions, distributions, characteristic functions, Gaussian variables and processes, Sample path continuity
3. Martingales and stopping times, Discrete time martingales and filtrations, Continuous time martingales and right continuous filtrations, Stopping times and the optional stopping thermo, Martingale representations and inequalities, Martingale conversion theorems, Branching processes
4. Brownian motion, definition and construction, Reflection principle and Brownian hitting times, Smoothness and variation of the Brownian sample path
5. Markov chains and processes, Ergodicity, Eigenvalues and eigenvectors, Poisson process, Exponential inter-arrivals, Markov jump processes, Compound poisson processes

Term work

Six assignments based on above syllabus, including quantitative modeling and analysis of stochastic processes and Markov processes.

Reference books

1. A first course in stochastic processes by S Karlin and H M Taylor, 1975
2. Introduction to Operations Research, Hillier and Lieberman, Tata McGraw Hill

M.E. (Industrial Engineering): Semester-I
4. Elective-I
4.2. Manufacturing System Design
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Fundamentals: System concept and design, Hierarchical structure, Decision making procedure, System types in manufacturing environments; Manufacturing Systems: Structural aspects, transformational aspects, procedural aspects, integrated manufacturing systems; Modes of Production- Jobbing/Intermittent/ Continuous; Mass Production- Economies of Scale, Optimum production scale, Mass Customization; Multi-Product Small Batch Production- Economies of Scope with Diversification; Logistic Systems- Material flow: conversion / transportation / storage
2. Product / Process Planning and Design: Product Life Cycle, Planning of a new product, Product Design Aspects, Design cost considerations, Concurrent Engineering; Process and Operation Design- Computer Aided Process Planning, Optimum routing analysis using Dynamic Programming and Network Techniques, Criteria for line balancing.
3. Manufacturing Optimization: Criteria for Evaluation, Optimization of single stage manufacturing- Unit production time and cost; Optimization of multistage manufacturing system- Scope, basic mathematical models; Cost Estimating- Classical metal cutting cost analysis, Industrial cost estimation practices, Estimating material, setup and cycle times.
4. Information Systems in Manufacturing: Database structures, hierarchical, network, Relational- concepts, keys, relational operations, query languages; Shop Floor Data Collection Systems- Types of data, on-line and off-line data collection, Automatic data collection systems.
5. Computer Simulation in Manufacturing System Analysis: Characteristics, Models, applications of probability and statistics; Design and evaluation methodology, General framework, Analysis of situation, Setting objectives, Conceptual modeling, Detailed design, Evaluation and Decision.
6. Modern approaches in Manufacturing: Cellular Manufacturing- Group Technology, Composite part, Rank Order Clustering Technique, Hollier method for GT cell layouts; Flexible Manufacturing- Concept, components, architecture; Lean Production concept, principles, Agile Manufacturing- concept, principles and considerations for achieving agility.

Term work

Any six assignments out of the following:
1. Case Study of a manufacturing system in a small / medium organization.
2. Exercise on Concurrent Engg., Optimum routing analysis, Line Balancing
3. Exercise on Optimization of Single stage / Multi stage manufacturing system
4. Cost estimation of manufacturing a medium complex component of an assembly.
5. Creation of a relational database for a module of a manufacturing system, use of a suitable query language and generation of reports
6. Exercise on designing and analysis of GT Cell layouts
7. Simulation and performance testing of a manufacturing system

Reference books

1. Katsudo Hitomi, (1998), “Manufacturing Systems Engineering”, Viva Low Priced Student Edition, ISBN 81-85617-88-0
2. B. Wu, “Manufacturing Systems Design & Analysis: Context and Techniques” (2/e), Chapman & Hall, UK, ISBN 041258140X
3. Mikell P. Groover, (2002), “Automation, Production Systems and Computer Integrated Manufacturing”, (2/e), Pearson Education, ISBN 81-7808-511-9
4. Radhakrishan P., Subramaniyan S. and Raju V., “CAD / CAM / CIM”, (3/E), New Age International Publication
5. Luca G. Sartori,(1998), “ Manufacturing Information Systems”, Addison Wesley Publishing Co.
6. N. Viswanadhan & Y, Narhari, (1998), “Performance Modeling of Automated Manufacturing Systems”, Prentice Hall of India
7. Phillip F. Ostwald, Jairo Munez, (2002), “ Manufacturing Processes and Systems”, John Wiley & Sons (Students’ Edition), ISBN 9971-512-34-3
8. Sanjay B. Joshi, Jeffrey S. Smith ,(1994), “Computer Control of Flexible Manufacturing Systems: Research and Development”, Springer, ISBN 0412562006, 9780412562006

M.E. (Industrial Engineering): Semester-I
4. Elective-I
4.3. Probabilistic Risk Assessment
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Concept of risk, objective and scope of risk assessment, probabilistic risk, risk perception and acceptability.
2. Quantitative aspects of risk. Three levels of risk quantification
3. PRA management, preliminary hazard analysis, HAZOP, FMEA and FMECA analysis, Fault tree Analysis. Digraph and other approaches.
4. Computation of Hazard probability, unavailability and other parameters using fault tree methodology. Monte Carlo Simulation technique
5. Event tree analysis, identification of initiating events, sequence and scenario development
6. System analysis, external events and dependent failure analysis and quantification
7. Accident-consequence Analysis, uncertainty analysis, sensitivity analysis and importance measures. Bayesian approaches. Human reliability Analysis.

Term work

Six assignments based on above syllabus, including quantitative modeling and analysis of different real-life industrial hazards, development and analysis of fauly-tree and event-tree, FMEA and FMECA of industrial situations.

Reference books

1. Kumamoto, H., Henley, E., 1996. Probabilistic risk assessment and management for engineers and scientists, 2nd Edition. IEEE Press.
2. Johnson, W., 1980. MORT safety assurance systems. National Safety Council, New York
3. CPS, 1992. Guidelines for hazard evaluation procedures. Center for Chemical Process Safety, American Institute of Chemical Engineers, New York.
4. Bird, F., Loftus, R., 1976. Loss control management. Institute Press, Loganville, Georgia.
5. Bird, F., Germain, G., 1992. Practical loss control leadership. International Loss Control Institute Inc., Loganville, Georgia.
6. Bahr, N., 1997. System safety engineering and risk assessment- a practical approach. Taylor & Francis, Washington DC.
7. Henley, E., Kumamoto, H., 1981. Reliability engineering and risk assessment. Prentice-Hall Inc, New Jersey.

M.E. (Industrial Engineering): Semester-I
4. Elective-I
4.4. Project Engineering and Network Analysis
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Introduction: Foundations of Project Management, Project Life Cycle, Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure.
2. Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modeling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations
3. Network analysis: Shortest path method, minimal spanning tree, Floyd and Dijkastra algorithm
4. PERT/COST Accounting, Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Crashing
5. Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT.
6. Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress, Project Appraisal and Selection, Recent Trends in Project Management

Term work

Six assignments based on syllabus, including quantitative treatment to industrial problems.

Reference books

1. Project Management – A Managerial Approach, by Jack R. Meredith, and Samuel J. Mantel Jr., John Wiley and Sons, 2006
2. Project Management – A Systems Approach to Planning, Scheduling and Controlling, by Harold Kerzner, John Wiley and Sons, 2006
3. Introduction to Operations Research, Hillier and Lieberman, Tata McGraw Hill

M.E. (Industrial Engineering): Semester-I

4. Elective-I

4.5. Technology Management

Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week

Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Concepts of Technology Management: Description, Scope & Implications, Its relation to business management, systems Holistic Model of Management of Technology (MOT), Operational and Management Issues, Classification of Technology, Technology cycle, Industry-Institute partnership for targeted basic research.
2. Strategic Management of Technology: Technology-strategy relationship, Elements of technology strategy and formulation of a technology strategy, Integration of technology strategy and business strategy for competitive success technology, the environment and sustainable development
3. Organizational Aspects of Technology Management: Human dimension of technology and concepts of the entrepreneur, Organizational cultures and structures for promotion of creativity and innovation, the learning organization, the imperative of knowledge management
4. Acquiring Technology through Technology Transfer: Definition, Source, Model of TT, System of TT with Public and Private Enterprises, Success and failure factors in technology transfer
5. Acquiring Technology Through Research and Development: The concepts of invention and innovation, Definition and classifications of research and development, new product development, Challenges in commercializing research results
6. Intellectual Property Rights: Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents.
7. National innovation systems for facilitating technology-based development, Concepts of the national innovation system (NIS) and science and technology infrastructure, Various Government Schemes
8. Analytical Hierarchical Process (AHP): Introduction to AHP, self AHP for Technology Selection cases like Information Technology – Software & Hardware, Machine Tools, and Industrial Products.

Term work

Six assignments based on above syllabus, including industrial case studies.

Reference books

1. Hand Book of Technology Management, by Gerard H. Gaynor, McGraw Hill.
2. Strategic Management of Technological Innovation, 2/e (SIE) Authors: SCHILLING, MELISSA, Tata McGraw Hill Division: Higher Education ISBN-13: 978-0-07-066712-9 ISBN-10: 0070667128 ©2007 | 2nd Edition
3. Strategic Management Tata McGraw Hill Authors: Pearce, John; ROVINSON, RICHARD Division: Higher Education ISBN-13: 978-0-07-060393-6 ISBN-10: 0070603936 ©2005 | 9th Edition | 720 pages
4. Change Management. Tata McGraw Hill Authors: Sharma, Radha Division: Higher Education ISBN-13: 978-0-07-063586-9 ISBN-10: 0070635862 ©2006 | 1st Edition.
5. Business Policy And Strategic Management, 2E. Tata McGraw Hill Authors: Kazmi, Azhar Division: Higher Education ISBN-13: 978-0-07-044470-6 ISBN-10: 0070444706 ©2001 | 2nd Edition | 648 pages , Softcover
6. The Management Of Intellectual Property, by Satyawrat Ponkshe, Ponkshe & Bhate Publications, Pune.
7. Creating Breakthrough Products : Innovation from Product Planning to Program Approval, 1/e by Jonathan Cagan Craig M. Vogel Pearson Education ISBN 8129704927
8. Strategic Management of Technology and Innovation by Robert A. Burgelman, Clayton M. Christensen, Steven C. Wheelwright, and Modesto A. Maidique

M.E. (Industrial Engineering): Semester-I

5. Elective-II

5.1. Multivariate Statistical Modeling-I

Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week

Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Introduction, organization of multivariate data, graphical examination, missing data, outliers, Assumptions of multivariate analysis
2. Multivariate normal distribution, sampling and maximum likelihood estimation, estimation of mean vector and covariance matrix, Distribution of sample mean vector, Inferences about mean vector, Generalized T^2 statistic,
3. Comparison of several multivariate means, Paired comparisons, One-way MANOVA, Two-way MANOVA
4. Multivariate linear regression models, Least squares estimation, inferences, model checking, multivariate multiple regression
5. Principal component analysis, principal components of population, obtaining principal components, summarizing sample variation, graphical representation, interpretation of principal components, principal component regression analysis
6. Factor analysis, the orthogonal factor model, Methods of estimation: principal component method, factor rotation, factor scores, interpretations

Term work

1. Three numerical assignments based on syllabus, to be solved analytically for 2x2 matrices.
2. Three assignments based on industrial data, to be solved using the software like MATLAB, SPSS, MINITAB, or equivalent.

Reference books

1. An introduction to multivariate statistical analysis by T W Anderson, Wiley
2. Applied multivariate statistical analysis, Johnson and Wichern, Prentice Hall India
3. Multivariate data analysis by Hair, Anderson, Tatham, Black, Pearson
4. Matrices for engineers by A D Kraus, Oxford University Press
5. Multivariate Statistical Methods in Quality Management by K Yang and J Trewn, McGraw Hill

M.E. (Industrial Engineering): Semester-I
5. Elective-II
5.2. Supply Chain Management
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Introduction and overview of supply chain management, inbound and outbound logistics, supply chain as a source of competitive advantage. Definition of logistics and SCM, evolution, scope, importance and decision phases – drivers of sc performance and obstacles.
2. Supply chain network design: distribution in supply chain – factors in distribution network design –design options-network design in supply chain – framework for network decisions - managing cycle inventory and safety.
3. Sourcing, and pricing in supply chain: supplier selection and contracts - design collaboration - procurement process. Revenue management in supply chain
4. Strategic considerations for supply chain: porter's industry analysis and value-chain models, the concept of total cost of ownership, supply stream strategies, classification and development guidelines, measuring effectiveness of supply management, logistics engineering.
5. Operations research models for operational and strategic issues in supply chain management. The bullwhip effect and supply-chain management game. Coordination and technology in supply chain, effect of lack of co-ordination and obstacles – Information Technology and SCM - supply chain-IT framework. E-business and SCM. Metrics for supply chain performance

Term work

Six assignments based on above syllabus, including industrial case studies.

Reference books

1. Supply Chain Management, Strategy, Planning, and operation – Sunil Chopra and Peter Meindl-PHI, Second edition, 2007
2. Logistics, David J.Bloomberg, Stephen Lemay and Joe B.Hanna, Prentice Hall India 2002
3. Logistics and Supply Chain Management –Strategies for Reducing Cost and Improving Service. Martin Christopher, Pearson Education Asia, Second Edition
4. Modeling the supply chain, Jeremy F.Shapiro, Thomson Duxbury, 2002
5. Handbook of Supply chain management, James B.Ayers, St.Lucle Press, 2000

M.E. (Industrial Engineering): Semester-I
5. Elective-II
5.3. Reliability Analysis and Prediction
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Definitions. Causes and types of failures. Reliability expressions for constant, increasing and decreasing hazard rates.
2. Data Analysis, Probability plots for various distributions (exponential, Weibull, Normal and Gamma).
3. Series, parallel, series-parallel, standby and k-out-of-m modeling.
4. System reliability evaluation techniques, including methods of bounds, decomposition and transformation techniques.
5. Single and Multiple variable inversion techniques for minimizing system reliability expression.
6. Analysis of dependent failures. Reliability computations using similar and dissimilar stress-strength distributions (exponential, Weibull, normal and Gamma).
7. Time dependent stress-strength distributions, fatigue failures, Recent trends in reliability evaluation techniques

Term work

Six assignments based on above syllabus, covering quantitative aspects of reliability analysis.

Reference books

1. Kumamoto, H., Henley, E., 1996. Probabilistic risk assessment and management for engineers and scientists, 2nd Edition. IEEE Press.
2. Bahr, N., 1997. System safety engineering and risk assessment- a practical approach. Taylor & Francis, Washington DC.
3. Henley, E., Kumamoto, H., 1981. Reliability engineering and risk assessment. Prentice-Hall Inc, New Jersey.
4. Reliability Engineering, E Balgurusamy, Tata McGraw Hill

M.E. (Industrial Engineering): Semester-I
5. Elective-II
5.4. Queuing Theory and Models
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Introduction, description of queuing problem, characteristics, measuring system performance, Poisson process, exponential distribution, Markovian property, Stochastic processes and Markov chains, Steady state birth-death processes
2. Simple Markovian birth-death models: M/M/1 model, M/M/c model, M/M/c/K model
3. Erlang's formula (M/M/c/c model), Queues with unlimited service (M/M/∞)
4. Finite source queues, State-dependent service, Queues with impatience, Transient behavior, Busy period analyses
5. Advanced Markovian models: Bulk input, Bulk service, Erlangian models: M/E_k/1, E_k/M/1, E_j/E_k/1
6. General models: M/G/1 model, G/M/1 model, G/ E_k/1 model, G^k/M/1 model, G/G/1 model

Term work

Six assignments based on above syllabus, covering quantitative aspects of queuing models.

Reference books

1. Fundamental s of Queuing Theory, Gross and Harris, Wiley
2. Introduction to Operations Research, Hillier and Lieberman, Tata McGraw Hill

M.E. (Industrial Engineering): Semester-I
5. Elective-II
5.5. Total Quality Management
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Basic concepts, need for TQM, principles of TQM, Quality philosophies of Deming, Crosby, Juran, Ishikawa and Feigenbaum, TQM models.
2. Quality policy deployment, quality function deployment, voice of customer, quality planning
3. QC tools, problem solving methodologies, new management tools, quality circles, quality costs, prevention and appraisal costs, failure costs, models to minimize failure costs, benchmarking
4. Need for ISO 9000 system, advantages, clauses of ISO 9000, Implementation of ISO 9000, QS9000 and TS16949 systems, Introduction to EMS, quality auditing, case studies.
5. KAIZEN, 5S, JIT, POKAYOKE, Taguchi methods: Introduction to parameter and tolerance design
6. Steps in TQM implementation, national and international quality awards, case studies.

Term work

Six assignments based on above syllabus, including industrial case studies.

Reference books

1. Dale H.Besterfiled, "Total Quality Management", Pearson Education Asia
2. Rose, J.E. Total Quality Management, Kogan Page Ltd. 1993.
3. John Bank, The essence of total quality management, Prentice Hall, 1993.
4. Greg Bounds and Lyle Yorks, Beyond Total Quality Management, McGraw Hill, 1994.
5. Masaki Imami, KAIZEN, McGraw Hill, 1986.
6. Phil Crosby, Quality Without Tears, McGraw Hill

M.E. (Industrial Engineering): Semester-I
6. Work Study Laboratory
Teaching scheme: Practical: 2 hrs/week
Examination scheme: Term Work: 25 marks, Practical/Oral Examination: 25 marks

Any six experiments from the following are to be performed in the laboratory.

1. Pin-board exercise
2. Method study of an industrial job
3. Performance rating exercise (using rating films)
4. Exercise on motion economy
5. Time study of an industrial job
6. Standard time estimation of an industrial job using work sampling method
7. Standard time estimation of an industrial job using pre-determined time standards (PTS)

Practical examination will be of three hours duration, in which the candidate will carry out any one of the experiments and submit results, followed by an oral examination. Use of recorded video clips of industrial jobs for conducting time and method study in the examination is encouraged.

M.E. (Industrial Engineering): Semester-I

7. Ergonomics Laboratory

Teaching scheme: Practical: 2 hrs/week

Examination scheme: Term Work: 25 marks, Practical/Oral Examination: 25 marks

Any six experiments from the following are to be performed in the laboratory.

1. Measurement of structural and functional anthropometric parameters of a sample (min. 10 no. of persons) using anthropometer
2. Design of a standing task (manufacturing operation)
3. Design of a seated task (product assembly operation)
4. Design of industrial manual material handling task using NIOSH guidelines
5. Measurement of VO_2 max
6. Measurement of physical fatigue
7. Measurement of heat stress
8. Measurement of whole-body vibrations at work
9. Measurement of hand-arm vibrations at work

Practical examination will be of three hours duration, in which the candidate will carry out any one of the experiments and submit results, followed by an oral examination.

M.E. (Industrial Engineering): Semester-I
8. Seminar-I
Teaching scheme: Practical: 1 hrs/week
Examination scheme: Term Work: 25 marks

Seminar - I should be based on the literature survey on any topic relevant to Industrial Engineering. The literature survey may be leading to selection of a suitable topic of dissertation for the project work to be carried out in Semester-III and Semester-IV.

The students are encouraged to relate the topic of seminar to the major and minor areas of interest identified as part of the term-work for Design of Experiments and Research Methodology in Semester-I. The topic of interest should be related to latest research or developments in industrial engineering and the candidate must give references of at least 10 journal papers for the seminar report. The candidate will finalize the seminar topic in consultation of his/her guide.

Each student has to prepare the seminar write-up of about 10-12 pages in the format prescribed by the institute. The report in the necessary format shall be submitted to the department after approval by the guide and endorsement of the Head of Department.

At the end of the semester, each student shall deliver a seminar talk in front of the faculty of the department and the postgraduate class, which shall be followed by formal question-answer session. The guide shall evaluate the student for the term-work, based on the quality of work and preparation and understanding of the subject matter.

M.E. (Industrial Engineering): Semester-II

1. Optimization Techniques

Teaching scheme: Lectures: 3 hrs/week, Tutorial: 2 hrs/week

Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

A. Linear models:
   1. Linear programming-extensions: Revised simplex method, Dual Simplex method, Bounded variables method, primal-dual relationships, duality theorems, economic interpretation of dual, dual of transportation model, sensitivity analysis in LPP and transportation models, Karmarkar's interior point algorithm
   2. Dynamic programming: formulation, recursive approach, Goal programming: formulation, graphical solution, algorithm
   3. Integer programming: Formulation, Cutting plane algorithm, Branch and bound algorithm

B. Nonlinear models:
   4. Classical Optimization: Single and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers, Kuhn-Tucker Conditions
   5. Single-variable Optimization: Unrestricted Search, Exhaustive Search, Dichotomous Search, Interval-halving Method, Fibonacci Method, Golden-section Method, Quadratic Interpolation Method, Newton Method, Quasi-Newton Method, Secant Method
   6. Multi-variable Optimization: Evolutionary Optimization Method, Simplex Search Method, Pattern Search Method
   7. Conjugate Direction Method, Steepest Descent Method, Newton's Method, Conjugate Gradient Method, Davidon-Fletcher-Powell Method
   8. Introduction to Constrained Optimization: Interior Penalty Function Method, Exterior Penalty function Method

Term work

Six numerical assignments based on above syllabus.

Reference books

1. Introduction to Operations Research, Hillier and Lieberman, Tata McGraw Hill
2. Quantitative techniques in Management by N D Vohra, McGraw Hill
3. Deb K (2004). Optimization for Engineering Design: Algorithms and Examples, Prentice Hall of India.
4. Rao S (1996). Engineering optimization, Theory and Practice, New Age International Publishers
5. Ravindran A, Ragsdell K and Reklaitis G (2006). Engineering Optimization: Methods and Applications, 2nd edition, John Wiley and Sons Inc.

M.E. (Industrial Engineering): Semester-II
2. Human Factors Engineering
Teaching scheme: Lectures: 3 hrs/week, Practical: 2 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks,
Practical/Oral Examination: 25 marks

1. Human information processing, Skill, and performance, Sensation, perception, coding, cognition, Attention, Response selection and execution, Skilled and unskilled operators, Mnemonics, Verbal processing, and visual imagery, Cognitive models of human operator
2. Displays, controls, and human-machine interaction, Principles of design of visual displays, Grouping, resolution, color coding, Digital displays, multiple display configuration, Computer-generated displays, Three-dimensional displays, Design of controls, Control distinctiveness, Control-display integration, Panel design, Human-machine interaction, mental workload, human error
3. Design of codes, Design of visible language, human-computer dialogue, language comprehension
4. Cognitive ergonomics, Cognitive control of systems, modeling of human operator control strategy, Human decision making, Computer-aided decision making, decision support systems
5. Design of human-machine systems, analytic and systemic thinking, diagnosing system malfunction, System integration and evaluation
6. Work organization, motivation, job enlargement, job enrichment, job satisfaction, sociotechnical systems theory, Humanization of work, Trends in worksystem design, future of human-machine systems

Term work

Any six experiments from the following are to be performed in the laboratory.

1. Design of visual display terminal for an industrial operation
2. Design of control-display layout for an industrial operation
3. Measurement of illumination and contrast at a workstation
4. Measurement of depth perception
5. Measurement of visual fatigue
6. Measurement of mental task load
7. Measurement of noise and noise dose at a workplace

Practical examination will be of three hours duration, in which the candidate will carry out any one of the experiments and submit results, followed by an oral examination.

Reference books

1. Introduction to Ergonomics by R S Bridger, McGraw Hill
2. Occupational Ergonomics: Principles and applications by F Tayyari and J Smith, Kluwer Academic Publishers, Boston
3. Reason, J., 1990. Human error. Cambridge University Press.
4. Robins, S., 2000. Organization Theory: Structure, design, and applications. Prentice Hall of India, New Delhi.
5. Hendrick, H., 1994. Human factors in organizational design and management. Hendrick, H., Bradley, G. (Eds.), Elsevier Science

M.E. (Industrial Engineering): Semester-II
3. Production Planning and Inventory Control
Teaching scheme: Lectures: 3 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks

1. Production Planning & Control Systems, Introduction, Classification, activities
2. Forecasting models: Classification, Moving average method, exponential smoothening methods: additive model, seasonality model, mixed model, Regression models, Forecast errors, reliability of forecasts
3. Independent demand Inventory Management: Classification, EOQ models, order timing decisions, Safety Stock and reorder level decisions. Order quantity and reorder point, Continuous review systems, periodic review systems
4. Multi-item and coordinated replenishment models, Spare parts and maintenance inventory models
5. Dynamic lot sizing, Lot-for-lot method, fixed order quantity, Wagner-Whitin algorithm, Part-period balancing, Silver-Meal heuristics
6. Dependent demand Inventory Management: Material Requirements Planning and Lot Sizing, Distribution Requirement Planning
7. Aggregate Control of Inventory Systems, Exchange Curve, Coverage Analysis and Hierarchial Control Systems, Diagnostic Analysis of Inventory Systems
8. Static and Dynamic Production Planning Models, Aggregate Production Planning, Hierarchial Production Planning, Desegregation of Aggregate Plan, Master Production Scheduling
9. Scheduling of Production: Sequencing Decisions in Single Machine and Flow Shops, Job-shop Scheduling. Scheduling in parallel Machines and Networks, FMS scheduling
10. Theory of constraints, Optimized Production Technology, Drum-rope-buffer models, Constant-WIP (CONWIP) models, Planning and Control of JIT Systems

Note: Numerical treatment expected for topic no. 2,3,5,6 and 9.

Reference books

1. Inventory management and production planning and scheduling by E Silver, D Pyke and R Peterson, Wiley.
2. Principles of inventory and materials management by R Tersine, Pearson
3. The fundamentals of production planning and control by S Chapman, Prentice Hall

M.E. (Industrial Engineering): Semester-II

4. Elective-III

4.1. Quality Engineering

Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week

Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Engineering experiments, Strategy of experimentation, guidelines for designing experiments
2. Analysis of variance (ANOVA): one-way and two-way ANOVA, F-test; Bartlett test, Model adequacy checking, normality assumption, Residual plots, Regression model of ANOVA, Comparisons of means, contrasts, Kruskal-Wallis test
3. Randomized complete block design, statistical model, analysis, model adequacy checking, Latin square design
4. Factorial designs, concept, main effects, interactions, two-factor factorial design, fixed-effects model, model adequacy, fitting response curves and surfaces, blocking in factorial design
5. Response Surface Methodology (RSM), Method of steepest ascent, Analysis of second order response surface, Designs for fitting response surfaces, Evolutionary operation
6. Taguchi philosophy; Robust design, Loss function; Orthogonal arrays: Steps in designing, conducting, and analyzing an experiment
7. Parameter and tolerance design concepts: control and noise factors; Analysis of inner/outer array experiments: signal-to-noise ratio and performance measures

Term work

Six assignments based on syllabus using statistical software like SYSTAT, MINITAB, or SPSS

Reference books

1. Design and analysis of experiments, Montgomery, Wiley.
2. Ross, Philip J. (1996), 2/e, Taguchi Techniques for Quality Engineering, (McGraw Hill, New York)
3. Besterfield, Dale H. (2005), 3/e, Total Quality Management, (Pearson Education, New Delhi)
4. Dean, Angela & Voss, Daniel, - Design & Analysis of Experiments, (1999), (Springer Verlag)
5. Hinkelmann & Kempthorne – Design & Analysis of Experiments, Vol. I- Introduction to Experimental Design, (2005), (John Wiley & Sons)
6. Hinkelmann & Kempthorne – Design & Analysis of Experiments, Vol. II- Advanced Experimental Design, (2005), (John Wiley & Sons)

M.E. (Industrial Engineering): Semester-II
4. Elective-III
4.2. Facility Layout and Design
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Introduction, nature, significance and scope of facility layout and design
2. Facility location: location analysis, single-facility and multi-facility location problems, location models, set covering problems, warehouse location problems, location allocation problems
3. Facility layout: definition, significance, objectives, steps in layout planning, quantitative techniques, computerized layout planning procedures
4. Group technology, Production Flow analysis, Rank Order Clustering, design of assembly and production lines, line balancing.
5. Material handling: definition, principles of material handling, unit load concept, material handling system design, equipment types and selection, packaging requirements and containers selection
6. Storage and warehousing: functions, objectives, and principles, facility services
7. Automatic storage and retrieval systems, design principles, upcoming trends

Term work

Six assignments based on syllabus including industrial case studies.

Reference books

1. Tompkins, J.A. and J.A.White, Facilities planning, John Wiley, 2003.
2. Richard Francis.L. and John A.White, Facilities Layout and location-an analytical approach, Prentice Hall India, 2002.
3. James Apple, Plant layout and Material Handling, John Wiley, 1977.
4. Pannerselvam,R, “Production and Operations Management”, Prentice Hall India, 2007

M.E. (Industrial Engineering): Semester-II
4. Elective-III
4.3. Maintenance Engineering
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Maintained systems and various definitions associated with them. Type of Maintenance. Maintainability analysis,
2. Markov Models for reliability, availability and MTTF computations. Renewal Theory Approach. Maintainability design considerations. Life Cycle Costs.
3. Optimum Inventory Assessment. Optimal inspection, overhaul, replacement or repair strategies. Maintainability test and demonstration and warranties.
4. Preventive maintenance process, preventive maintenance role in TQM
5. Introduction to RCM, system functions and failures, proactive maintenance, failure identification, RCM approach, RCM methodology, Applications.
6. Life/durability tests of devices/ components, environmental testing of components/ circuits/ equipments, vibration and endurance tests.
7. Study of degradation characteristics, failure rates of components/ devices under environmental factors.
8. Accelerated testing, parameter estimation, accelerated testing of devices and calculation of MTTF

Term work

Six assignments based on syllabus covering analytical treatment.

Reference books

1. Andrew K.S.Jardine & Albert H.C.Tsang, “Maintenance, Replacement and Reliability”, Taylor and Francis, 2006.
2. Bikas Badhury & S.K.Basu, “Tero Technology: Reliability Engineering and Maintenance Management”, Asian Books, 2003.
3. Seichi Nakajima, “Total Productive Maintenance”, Productivity Press, 1993.
4. Sushil Kumar Srivastava, Maintenance Engineering and Management, S.Chand

M.E. (Industrial Engineering): Semester-II
4. Elective-III
4.4. Scheduling Algorithms
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Scheduling theory: Scheduling background – Scheduling function – Sequencing – Ready time – Flow time – Tardiness - Weighted flow time – Inventory – Regular measures of performance – Dominant schedules – SPT, EDD, WSPT sequences – Scheduling Theorems.
2. Single machine scheduling: Pure sequencing model – Hodgson's algorithm – Smith's rule – Wilkerson Irwin algorithm – Neighborhood search – Dynamic programming technique – Branch and Bound algorithm – Non simultaneous arrivals – Minimizing $\overline{T}$ and $\overline{F}$ for dependent jobs – Sequence dependent set up times.
3. Parallel machine scheduling: Preemptive jobs: McNaughton's algorithm – Non preemptive jobs – Heuristic procedures – Minimizing $\overline{F_w}$: H_1 & H_m heuristics – Dependent jobs: Hu's algorithm – Muntz Coffman algorithm.
4. Flow shop scheduling: Characteristics – Johnson's algorithm – Extension of Johnson's rule – Campbell Dudek Smith algorithm – Palmer's method – Start lag, stop lag – Mitten's algorithm – Ignall Schrage algorithm - Despatch index heuristic.
5. Job shop scheduling: Characteristics –Graphical tools – Jackson's algorithm – Feasible, Semi-active and Active schedules – Single pass approach – Non delay schedule – Priority dispatching rules – Heuristic schedule generation – Open shop scheduling

Term work

Six assignments based on syllabus covering analytical treatment.

Reference books

1. Kenneth R.Baker, "Introduction to sequencing and scheduling", John Wiley & Sons, New York, 2000.
2. Richard W. Conway, William L.Maxwell and Louis W. Miller, "Theory of Scheduling", Dover Publications, 2003.

M.E. (Industrial Engineering): Semester-II
4. Elective-III
4.5. Productivity Management
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Introduction: Productivity concepts - Macro and Micro factors of productivity, Productivity benefit model, productivity cycle. Productivity measurement at International, National and Organizational level, Total productivity models.
2. Productivity models: Productivity management in manufacturing and service sector. Productivity evaluation models, Productivity improvement models and techniques.
3. Organizational transformation: Principles of organizational transformation and re-engineering, fundamentals of process reengineering, preparing the workforce for transformation and reengineering, methodology, guidelines, DSMCQ and PMP model.
4. Re-engineering process improvement models: PMI models, Edosomwan model, Moen and Nolan strategy for process improvement, LMICIP model, NPRDC model. Analytical and process tools and techniques - Information and communication technology - Enabling role of IT
5. Re-engineering tools and implementation: RE-opportunities, process redesign - cases. Software methods in BPR - specification of BP, case study - Order, processing, user interfaces, maintainability and reusability.
6. Productivity improvement techniques: Productivity management cycle, problems and prospects in Indian Industries; Application of conventional Industrial Engineering techniques for productivity improvement. Incentive Plans, Job Evaluation. Business Process Reengineering.

Term work

Six assignments based on syllabus including case studies

Reference books

1. Sumanth, D.J., 'Productivity Engineering and Management', TMH, New Delhi, 1990.
2. Edosomwan, J.A., "Organisational Transformation and Process Re-engineering", Library Cataloging in Pub. Data, 1996.
3. Rastogi, P.N., "Re-engineering and Re-inventing the Enterprise", Wheeler Pub. New Delhi, 1995.
4. Premvrat, Sardana, G.D. and Sahay, B.S., "Productivity Management – A Systems Approach", Narosa Publishing House. New Delhi, 1998.

M.E. (Industrial Engineering): Semester-II

5. Elective-IV

5.1. Multivariate Statistical Modeling-II

Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week

Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Logistic regression: Concept, model, estimation of parameters, odds ratio, model adequacy, goodness of fitr measures, prediction from model,
2. Binary logistic regression, multinomial logistic regression, logistic regression with dummy variables
3. Loglinear models: Concept, cross-classification tables, Chi-squared statistic, odds ratio, Loglinear models for ordinal-ordinal variables, Loglinear models for ordinal-nominal variables
4. Discriminant analysis: Separation and classification of two populations, classification of two multivariate normal populations, Fisher's discriminant function
5. Cluster analysis: Similarity measures, Hierarchical clustering methods, Single linkage, complete linkage ad average linkage methods, Representation of clusters using dendrograms
6. Structural equation modeling: Path analysis and partitioning of variances, Developing modeling strategy, Modeling Causal relationships, Path model, Confirmatory factor analysis, Measurement model, assessment of parameters, Different goodness-of-fit indices, Incremental fit measure, parsimonious fit measures
7. Multivariate process control: Mahalanobis distance, Mahalanobis-Taguchi system, multivariate control charts

Term work

Six assignments based on industrial data, to be solved using the software like MATLAB, SPSS, MINITAB, or equivalent.

Reference books

1. An introduction to multivariate statistical analysis by T W Anderson, Wiley
2. Applied multivariate statistical analysis, Johnson and Wichern, Prentice Hall India
3. Multivariate data analysis by Hair, Anderson, Tatham, Black, Pearson
4. Matrices for engineers by A D Kraus, Oxford University Press
5. Multivariate Statistical Methods in Quality Management by K Yang and J Trewn, McGraw Hill
6. Basics of Structural Equation Modeling by G M Maruyama, Sage Publications

M.E. (Industrial Engineering): Semester-II
5. Elective-IV
5.2. Logistics Management
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Logistics Management: Definition of logistics and the concepts of logistics. Logistics Activities: Functions of the logistics system – facility location, transportation, warehousing, order processing, information handling and procurement, , Logistics environment, Logistics information systems, Logistics audit and control
2. Inbound logistics. Buyer-Vendor co-ordination, Procurement, Vendor development, reduced sourcing and supplier partnership - benefits, risks and critical success factors, multi-level supply control.
3. Distribution Management, Outbound logistics, Facility location, Classical location problems, Strategic planning models for location analysis, location models, multi objective analysis of location models.
4. Transportation alternatives and technologies; transportation performance analysis; total transportation cost analysis; fleet development and management; fleet performance indicators; routing and scheduling; shipment planning; vehicle loading; transportation management and information systems requirements.
5. Logistics Customer Service, Modeling logistics systems, Simulation of logistic systems, cost effective distribution strategies, Value of information in logistics, E-logistics, risk pooling effect, International and global issues in logistics, Integrated functional activities in logistics, Role of government in international logistics and Principal characteristics of logistics in various countries and regions
6. Logistics in different industries: Third party, and fourth party logistics, Reverse logistics, Airline Schedule Planning, Railway Networks, Postal services, the maritime industries, health care industry and other service industries

Term work

Six assignments based on syllabus including case studies

Reference books

1. David Bloomberg, Stephen LeMay, Joe Hanna: Logistics, Prentice Hall, 2002
2. Thomas Teufel, Jurgen Rohricht, Peter Willems: SAP Processes: Logistics, Addison-Wesley, 2002.
3. Julien Bramel, David Simchi-Levi. “The logic of logistics: theory, algorithms, and applications for logistics management", Springer,2006
4. Murphy, G.J. "Transport and Distribution", 2nd Edition, Business Books
5. Ballou, R.H., Business Logistics Management/Supply Chain, 5th edition, 2004, Prentice-Hall
6. Logistics and Supply Chain Management –Strategies for Reducing Cost and Improving Service. Martin Christopher, Pearson Education Asia, Second Edition

M.E. (Industrial Engineering): Semester-II

5. Elective-IV

5.3. Industrial Safety Engineering

Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week

Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Introduction to occupational health and safety, the accident problem, the occupational injury, losses due to accidents, costs of accident- to employer, to employee, to society.
2. Operational safety: Hot metal operation, boiler, pressure vessels, heat treatment shop, gas furnace operation, electroplating, hot bending pipes, safety in welding and cutting, safety in machine shop, cold bending and chamfering, metal cutting, shot blasting, grinding, painting, power press and other machines, principles of machine guarding, hand tool operations, safety in maintenance, safety in material handling, Low voltage electrical hazards, personal protective equipment
3. Control of major industrial hazards, hazard control strategies, HAZOP training, Management of toxic gases and chemicals, industrial fires, first aid, fire fighting devices, managing emergencies in industries.
4. Safety appraisal and analysis: Human side of safety, causes of accidents. measurement of safety performance, injury frequency rates, injury severity rates, plant safety inspection, accidents prevention programs, accident reporting and investigation, principles of accident prevention, accident analysis, system safety, job safety analysis, safety rules and procedures, safety sampling, safety training, safety design: criteria and principles
5. Occupational health: occupational and related diseases, prevention of diseases, toxicology: lead, nickel, chromium and manganese toxicity, gas poisoning (such as CO, Ammonia, Chlorine, SO_2, H_2S), effects of ultraviolet and infrared radiation on human.
6. Safety management: Evaluation of modern safety concepts, safety management functions, safety organization, safety department, safety committee, safety audit, employee participation in safety, safety and productivity.
7. Safety regulations: Safety and health standards – industrial hygiene – occupational diseases prevention, Factories Act 1948 and safety provisions, Legislations related to safety, Pressure Vessel Act, Indian Boiler Act, Environmental Protection Act, Explosive Act.

Term work

Six assignments based on syllabus including case studies

Reference books

1. Robertson, L., 1998. Injury epidemiology: Research and control strategies. Oxford University Press, New York.
2. Heinrich, H., Petersen, D., Ross, N., 1980. Industrial accident prevention, Fifth Edition. McGraw-Hill, New York.
3. Harms-Ringdahl, L., 1993. Safety analysis: Principles and practice in occupational safety. Elsevier Applied Science, London.
4. Haddon, W., Suchman, E., Klein, D., 1964. Accident Research: Methods and approaches. Harper & ROW, New York.
5. Ferry, T., 1988. Modern accident investigation and analysis. Wiley, New York.
6. ILO, 1988. Major hazard control- A practical manual. International Labour Organization, Geneva.
7. Lees, F., 1980. Loss prevention in the process industries. Butterworth and Co Ltd, London.
8. Mol, T., 2003. Productive safety management. Butterworth Heinemann.
9. Perrow, C., 1984. Normal accidents: Living with high-risk technologies, 2nd Edition. Princeton University Press.
10. Petersen, D., 1989. Techniques of safety management: A systems approach, 3rd Edition. Aloray Goshen, New York.
11. Industrial Safety and the Law by P.M.C Nair Publishers, Trivandrum

M.E. (Industrial Engineering): Semester-II
5. Elective-IV
5.4. Industrial Product Design
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Product methodology & the structure of Design Process , Introduction of Product methodology , methodological problems, characteristics of methods, The phases of product design process, foundations of phase models, three phase models
2. Design materials & human factors in product design, material properties, metals, plastics, rubber, woods & factors considered while designing for metals, plastics, rubber, woods etc, Anthropometry factors, physiological factors, psychology factors, anatomy factors.
3. Economic factors influencing design, product value, safety, reliability & environmental considerations, economic analysis, break even analysis, profit & competitiveness, economics of new product design.
4. Value engineering in product design, introduction, historical perspective, nature & measurement of value, importance of value, value analysis job plan, creativity, steps for solving & value analysis, value analysis tests
5. Strength considerations in product design, principal stress trajectories (force flow lines), balanced design, criteria & objective of design, material toughness, resilience, designing for uniform strength.
6. Modern approaches to product design: Concurrent Design, Quality Function Development (QFD), Rapid Prototyping

Term work

Six assignments based on syllabus including case studies

Reference books

1. S.Rosenthal, Effective product design and development, Irwin 1992.
2. Charles Gevirtz, Developing New products with TQM, McGraw – Hill International editions, 1994
3. Karal .T. Ulrich, Steven D.Eppinger, Product Design and Development, McGRAW- HILL International Editions.2003.
4. Product Design by Otto and Wood, Pearson

M.E. (Industrial Engineering): Semester-II
5. Elective-IV
5.5. World Class Manufacturing
Teaching scheme: Lectures: 3 hrs/week, Tutorial: 1 hrs/week
Examination scheme: Theory paper (3 hours): 100 marks, Term Work: 25 marks

1. Models of world class manufacturing: Hall's framework of value –added engineering, Schonberger's framework of world class manufacturing, Various models of world class manufacturing, JIPM TPM Award, EFQM Award, RBNQA Award
2. Lean Manufacturing & Services: Lean Manufacturing tools, Value Stream Mapping, implementation Roadmap.
3. Techniques related to material processing and handling: Set-up Time Reduction: SMED Methodology for Set-up reduction, Set-up Reduction Projects. Design of JIT: Flexible Manufacturing Systems (FMS), Concurrent Engineering, Design for Manufacturability and Assembly (DFMA), Collaborative Product Commerce (CPC)
4. Group Technology, Focused Factories and Cellular Manufacturing: Work cell concepts and applications, Work cell design, work cell staffing and equipment issues
5. Total Productive Maintenance: Outline of TPM, Production Efficiency, Improvement program for Zero failures, Implementation of Jishu-Hozen activities, Planned Maintenance, Initial-Phase Management, Quality Maintenance, Operation & Maintenance skill Development, Implementation of TPM in the Administrative & Indirect Departments, Zero Accidents & Zero Pollution, Small-Group activities of TPM
6. Business Process Reengineering: BPR Concepts, Practices & Philosophy. Key features and guiding principles of Reengineering, Kinds of changes that occur in reengineering, Changes required on Behavioral Side in a BPR Project, Concepts of Business and Core Processes in BPR. Different Management Audit to initiate BPR Projects.

Term work

Six assignments based on syllabus including case studies

Reference books

1. World Class Manufacturing -A strategic perspective by B.S. Sahay, Saxena, Macmillan, India
2. Hammer M. and Champy J. Re-engineering the corporation - Harper Collins.
3. TPM – New Implementation Program in Fabrication & Assembly Industries By Kunio Shirose Japan Institute of Plant Maintenance
4. Maintainability Engineering – Blanchard & Verma
5. World Class Manufacturing- Case Book-R J Schonberger (Free press)
6. World Class Manufacturing – Richard Schonberger
7. Introduction to TPM: Total Productive Maintenance by Nakajima Seiichi
8. Total Productive Maintenance by Terry Wireman (Industrial Press)
9. Management Of Industrial Maintenance By A. Kelley, M.J. Harris (Newness Butterworths)
10. Complete Handbook of Maintenance Management By J.E. Heintzelman (Prentice Hall)

M.E. (Industrial Engineering): Semester-II
6. Programming and Simulation Laboratory
Teaching scheme: Practical: 2 hrs/week
Examination scheme: Term Work: 25 marks, Practical/Oral Examination: 25 marks

A. Programming using c++ or MATLAB code for solving the following problems (any three):
    1. Dual simplex/ revised simplex method
    2. Transportation problem
    3. Traveling salesman problem using branch and bound algorithm
    4. Gomorey's cutting plane algorithm
    5. Decision theory problem
    6. Multivariate analysis of variance
    7. Principal component analysis
    8. Factor analysis

B. Simulation of the following systems using ARENA, Flexim or similar software (any two):
    1. Continuous review inventory model
    2. Periodic review inventory model
    3. Spare parts inventory model
    4. Queuing model

C. Programming using c++ or MATLAB code for solving any one industrial problem using meta-heuristic algorithm like genetic algorithm, simulation annealing, particle swarn optimization.

    The students are expected to formulate the problem with appropriate constraints and assumptions, generate the logic and use the algorithm to reach a solution.

Practical examination will be of three hours duration, in which the candidate will carry out any one of the experiments from part A or B above, and submit results, followed by an oral examination.

M.E. (Industrial Engineering): Semester-II
7. Seminar-II
Teaching scheme: Practical: 1 hrs/week
Examination scheme: Term Work: 25 marks

1. Seminar - II should be based on any topic of current research interest relevant to Industrial Engineering. Seminar-II may be a logical extension of the topic of Seminar-I selected by the student, and may be leading to selection of a suitable topic of dissertation for the project work to be carried out in Semester-III and Semester-IV.

2. The topic of interest should be related to latest research or developments in industrial engineering and the candidate must give references of at least 10 journal papers for the seminar report. The candidate will finalize the seminar topic in consultation of his/her guide.

3. Each student has to prepare the seminar write-up of about 10-12 pages in the format prescribed by the institute. The report in the necessary format shall be submitted to the department after approval by the guide and endorsement of the Head of Department.

4. At the end of the semester, each student shall deliver a seminar talk in front of the faculty of the department and the postgraduate class, which shall be followed by formal question-answer session. The guide shall evaluate the student for the term-work, based on the quality of work and preparation and understanding of the subject matter.

M.E. (Industrial Engineering): Semester-II
8. Comprehensive Viva Voce
Teaching scheme: Nil
Examination scheme: Viva-voce: 50 marks

At the end of semester-II, the candidate will undergo a comprehensive viva-voce examination conducted by the University, based on all courses and laboratories covered in semester-I and semester-II.

M.E. (Industrial Engineering): Semester-III
1. Seminar-III
Teaching scheme: Practical: 1 hrs/week
Examination scheme: Term Work: 25 marks, Oral: 25 marks

1. Seminar - III should be based on the dissertation work of the student. The topic of interest should be related to latest research or developments in industrial engineering and the candidate must give references of at least 10 journal papers for the seminar report. The candidate will finalize the seminar topic in consultation of his/her guide.

2. Each student has to prepare the seminar write-up of about 10-12 pages in the format prescribed by the institute. The report in the necessary format shall be submitted to the department after approval by the guide and endorsement of the Head of Department.

3. At the end of the semester, each student shall deliver a seminar talk in front of the faculty of the department and the postgraduate class, which shall be followed by formal question-answer session. The guide shall evaluate the student for the term-work, based on the quality of work and preparation and understanding of the subject matter.

M.E. (Industrial Engineering): Semester-III
2. Dissertation Phase-I
Teaching scheme: Practical: 2 hrs/week
Examination scheme: Term Work: 50 marks

1. The dissertation work to be carried out individually by each student commences in Semester-III and extends through Semester-IV. The topic of dissertation work related shall be related to the latest research or developments in industrial engineering and industrial engineering applications in different industrial situations. The dissertation work should reflect the candidate's ability to apply the tools and techniques learnt in the curriculum for modeling and analysis of industrial worksystems.

2. The candidate shall prepare a synopsis on his/her topic of interest in consultation with the Guide. The synopsis shall include problem statement, review of related literature, and objectives of the dissertation work. The Head of the Department shall appoint a committee comprising of the Guide and two experts, which will review the synopsis before submission to the University for approval. The candidate shall submit the synopsis to the University in the prescribed format before the due date.

3. Evaluation of dissertation phase-I shall be done on the basis of problem formulation, literature review and methodology of the proposed work. It may also include the experimental design and preliminary data collection, if applicable. The candidate shall submit a report of the work done at the end of Semester-III, which will be duly approved by the Guide and endorsed by the Head of the Department. The evaluation of dissertation phase-I shall be done by the Guide.

M.E. (Industrial Engineering): Semester-IV
2. Dissertation Phase-II
Teaching scheme: Practical: 4 hrs/week
Examination scheme: Term Work: 100 marks, Viva-voce: 100 marks

1. The candidate shall submit a thesis of the dissertation work carried out in line with the synopsis approved by the University. The thesis shall be in the prescribed format duly approved by the Guide and endorsed by the Head of the Department. The Head of the Department may appoint a committee comprising of the Guide and an expert in the area related to the dissertation work for evaluation of term work of dissertation phase-II.

2. The viva-voce of the candidate shall be conducted by the University according to University rules and regulations.

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