CURRICULUM AND SYLLABI

M.Tech.

in

INDUSTRIAL ENGINEERING AND MANAGEMENT

(With effect from Academic Year 2018-2019)

DEPARTMENT OF MECHANICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
CALICUT - 673601

Curriculum& Syllabi
DEPARTMENT OF MECHANICAL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

Vision of the Institute
International standing of the highest calibre
Vision of the Department
To impart nationally and internationally recognized education in Mechanical Engineering, leading to well-qualified engineers who are innovative contributors to the
profession and successful in advanced studies and research.

Mission of the Institute
To develop high quality technical education and personnel with a sound footing on basic engineering principles, technical and managerial skills, innovative research capabilities, and exemplary professional conduct to lead and to use technology for the progress of mankind, adapting themselves to changing technological environment with the highest ethical values as the inner strength.

Mission of the Department
To offer high quality graduate and post graduate programs in the fields of Mechanical Engineering and to prepare students for professional career and higher studies
promoting excellence in teaching, research, entrepreneurship, collaborative activities with ethical values, making positive contributions to the society.

M. Tech. in Industrial Engineering and Management

Programme Educational Objectives

PEO 1: To train students with in-depth and advanced knowledge to become highly-skilled professionals in the areas of industrial engineering and management and allied fields, and to make capable of analysing and solving complex industrial engineering and managementproblems.

PEO 2: To enable graduates to carry out innovative and independent research work in academia/industry to enhance the knowledge base in industrial engineering and management and to disseminate the knowledge.

PEO 3: To prepare the students to exhibit a high level of professionalism, integrity, social responsibility and life-long independent learning ability.

Programme Outcomes

PO1: An ability to independently carry out research/investigation and development work to solve practical problems
PO2: An ability to write and present a substantial technical report/document
PO3: Students should be able to demonstrate a degree of mastery over the area as per the industrial engineering and managementprogramme. The mastery should be at a level higher than the requirements in the appropriate bachelor programme.
PO4: An ability to acquire and share in-depth knowledge in the area of industrial engineering and management.
PO5: An ability to analyse complex problems in the field of industrial engineering and management critically and arrive at optimal solutions.
PO6: An ability to use modern computer/software tools to model and analyse problems related to industrial engineering and management.

Curriculum for M. Tech. in Industrial Engineering and Management
(2018 Admissions)

First Semester					
Code	**Title of Course**	**L**	**T**	**P/S**	**C**
ME6101D	Decision Modelling	3	0	-	3
ME6102D	Statistics for Management	3	0	-	3
ME6103D	Inventory and Supply Chain Management	3	0	-	3
	Elective -1	3	0	-	3
	Elective -2	3	0	-	3
ME6191D	Industrial Engineering Laboratory	--	--	3	2
	Total	**15**	**0**	**3**	**17**

Second Semester					
Code	**Title of Course**	**L**	**T**	**P/S**	**C**
ME6111D	Machine Learning and Artificial Intelligence	3	0	-	3
ME6112D	Manufacturing Planning and Control	3	0	--	3
ME6113D	Accounting and Finance for Management	3	0	-	3
	Elective - 3	3	0	-	3
	Elective - 4	3	0	-	3
ME6192D	Modelling and Data Analytics Laboratory	--	-	3	2
ME6193D	Seminar/ Mini Project	--	-	2	1
	Total	**15**	**0**	**5**	**18**

Third Semester					
Code	**Title of Course**	**L**	**T**	**P**	**C**
ME7194D	Project (Part-I)	0	0	20	12
	Total	**0**	0	20	**12**

Fourth Semester					
Code	**Title of Course**	**L**	**T**	**P**	**C**
ME7195D	Project (Part-II)	0	0	20	13
	Total	**0**	0	20	**13**

L: Lecture, T: Tutorial: P, Practical, S: Seminar, C: Credit

Total Credits: 60

Stipulations

1. A minimum of 60 credits (Maximum credits permitted 62) have to be earned for the award of M. Tech. degree in this programme.
2. Students may audit the course on '*Communicative English*' in the first or second semester of the programme and this course shall not be indicated in the grade card.
3. For elective courses, students may choose any PG level course offered in the Institute with the approval from the Programme Coordinator.
4. It is desirable for students to undergo *Two Months* Industrial Training/Internship during Summer Vacation.
5. Students are permitted to audit course/s in Third and Fourth Semesters of the programme. Only a maximum of two audited courses for which a minimum pass (P) grade secured shall be recorded in the grade card.

Credit distribution	
Curricular composition	**Credits**
Theory Courses	30
Laboratory Courses	4
Seminar/Mini Project	1
Project Work	25
Total credits	**60**

List of Elective Courses

Stream-specific Elective Courses			
Sl. No.	**Code**	**Title of Course**	**C**
1	ME6121D	Marketing Management	3
2	ME6122D	Consumer Behaviour	3
3	ME6123D	Product Management	3
4	ME6124D	Human Resource Management	3
5	ME6125D	Organizational Behaviour	3
6	ME6126D	Work System Design	3
7	ME6127D	Ergonomics and Human Factors Engineering	3
8	ME6128D	Forecasting Techniques	3
9	ME6129D	Facilities Layout Planning	3
10	ME6130D	Group Technology and Flexible Manufacturing Systems	3
11	ME6131D	Industrial Scheduling	3
12	ME6132D	Lean Production Management	3
13	ME6133D	Sustainability Management	3
14	ME6134D	Advanced Computer Integrated Manufacturing	3
15	ME6135D	System Modelling and Simulation	3
16	ME6136D	Reliability Engineering and Management	3
17	ME6137D	Product Life Cycle Management	3
18	ME6138D	Soft Computing Techniques	3
19	ME6139D	Advanced Decision Modelling	3
20	ME6140D	Business Ethics	3
21	ME6141D	Computer Methods in Management	3
22	ME6142D	Data Base Management	3
23	ME6143D	Enterprise Resource Planning	3
24	ME6144D	Decision Support and Expert System	3
25	ME6145D	Information Sharing and Inventory in Supply Chain Management	3
26	ME6146D	Project Management	3
27	ME6147D	Technical Entrepreneurship	3
28	ME6148D	Management of Technology and Innovation	3
29	ME6149D	Financial Management	3
30	ME6150D	Investment Management	3
31	ME6151D	Disaster Management	3
Other Suggested Elective Courses			
Sl. No.	**Code**	**Title of Course**	**C**
1	ME6330D	Quality Engineering & Management	3
2	ME6322D	Six Sigma	3
3	ME6327D	Design of Experiments	3
4	MS6116D	Strategic Management	3
5	MS7161D	Knowledge Management	3
6	MS6105D	Micro Economics	3
7	MS6104D	Management Information Systems	3
8	MS6117D	Business Research Methods	3

Syllabi for M. Tech. in Industrial Engineering and Management
(2018 Admissions)

ME6101D DECISION MODELLING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (14 hours)
Formulation of optimization problems; Solution of linear programming problems: Simplex Method, Duality theory, Primal-dual relationships, Economic interpretation of dual variables and constraints, Dual simplex method, Sensitivity analysis.
Integer programming: Modelling optimization problems using binary variables; Solution of integer programming problems: Cutting plane method and branch-and-bound method.

Module 2: (14 hours)
Network models and solutions: Shortest route problems, Minimal spanning tree problems, Maximal flow problems.
Complexity of algorithms: Complexity classes, Complexity of algorithms for combinatorial optimization problems.
Non-linear programming problems: convex and concave functions, Theory of unconstrained optimization: Necessary and sufficient conditions for extrema; Theory of constrained optimization: Lagrangean method, Kuhn-Tucker conditions.

Module 3: (11 hours)
Algorithms for unconstrained optimization: Fibonacci search method, Golden section search method, Hooke and Jeeve's method, Newton-Raphson method, Cauchy's (Steepest descent) method.
Algorithms for constrained optimization: Penalty function methods, Quadratic programming, Separable convex programming.
Solving optimization problems using optimization software.

References
1. S. S. Rao, *Engineering Optimization: Theory and Practice*, 3rded. Wiley Eastern, 2003.
2. A. Ravindran, D. T. Philips,and J. J. Solberg, *Operations Research: Principles and Practice*, 2nd ed. John Wiley & Sons, 1987.
3. R. A. Sarker, and C. S. Newton, *Optimization Modelling: A Practical Approach*, CRC Press, 2008.
4. G. Srinivasan, *Operations Research: Principles and Applications*, 3rded. PHI Learning Private Limited, 2017.
5. H. A. Taha, *Operations Research: An Introduction*, 8thed. Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2008.
6. W. L. Winston, *Operations Research: Applications and Algorithms*, 4thed. Cengage Learning, 2003.

ME6102D STATISTICS FOR MANAGEMENT

L	T	P	C
3	0	0	3

Pre-requisites: Nil

Total hours: 39

Module 1: (13 hours)

Descriptive Statistics: Measures of Statistics, Numerical description of data, Exploratory data analysis. Probability distributions:- Introduction to probability and random variables – Discrete Distributions, Continuous Distributions; Sampling–sampling techniques, central limit theorem; Sampling distributions - Mean and Proportion.
Introducing statistical packages – working with statistical packages.

Module 2: (13 hours)

Statistical hypothesis testing: Statistical Inference: Confidence interval estimation for the mean and proportion, Hypothesis Testing for Single populations – about a population mean, variance and proportion. Two Populations – about difference in two means of independent and dependent samples, about two population proportions, about two variances. Chi-Square goodness of fit test, Chi-Square test of independence.

Module 3: (13 hours)

Analysis of Variance and Design of Experiments: Introduction to Design of Experiments, Fundamental assumptions of analysis of variance, Classification of ANOVA – One-way and Two-way classification, Fixed/random effects model – Multiple comparison test – Tukey's Honestly Significant Difference Test and Tukey-Kramer Procedure.
Non-Parametric Statistics:Mann-Whitney U Test,Wilcoxson Matched-pairs signed rank test, Kruskal-Wallis test, Friedman test, Spearman's Rank Correlation.

References

1. K. Black, *Business Statistics*. 7th Edn., Wiley Publication2012.
2. R.I. Levin, and D.S. Rubin, *Statistics for Management*. 7th Edn., Prentice-Hall Inc. Publication 2012.
3. D.C. Montgomery, and G. C.Runger, *Applied Statistics and Probability for Engineers*. 6th Edn., Wiley Asia Publication 2016.
4. D. M. Levine, D. F.Stephan, K.A. Szabat, *Statistics for Managers – Using Microsoft Excel*. 8th Edn., Pearson Publication 2017.
5. W.L. Winston, *Microsoft Excel 2016 Data Analysis and Business Modeling*, 1st Edn. Prentice-Hall Inc. Publication 2017.
6. R.E.Walpole, R.H.Myers, S.L. Myers and K. Ye, *Probability & Statistics for Engineers and Scientists*. 9th Edn.Pearson Education Publication 2014.

ME6103D INVENTORY AND SUPPLY CHAIN MANAGEMENT

Pre-requisite: Nil
Total Hours: 39

L	T	P	C
3	0	0	3

Module 1 (16 hours)
Building a strategic framework to analyse supply chains: Understanding the supply chains, Decision phases, Process view, Supply chain flows, Competitive and supply chain strategies, Strategic fit, Drivers of supply chain performance
Designing the supply chain network: Role of distribution, Factors influencing distribution network design, Design options, Value of distributors, Online sales and distribution network; Designing the network design, Factors influencing network design, Models for facility location and capacity allocation

Module 2 (11 hours)
Supply chain operation simulation using role play game: Managing inventory in supply chain, inventory costs, supply chain performance evaluation, Bullwhip effect, Information and supply chain trade-offs.
Independent demand systems (Deterministic models): Inventory problem classification, Selective control techniques; Independent Demand Systems, Fixed order size system, Deterministic models, Economic order quantity, Economic production quantity, Quantity discounts (*all units, and incremental*), Sensitivity, Economic Production Quantity for multiple items, Periodic order interval systems.

Module 3 (12 hours)
Inventory system constraints: Inventory control systems under multiple items, Inventory problems with constraints, Exchange curve (Optimal policy curve).
Independent demand systems (Probabilistic models): Single order quantities, Payoff matrix, Expected value criterion, Mathematical formulation of discrete and continuous cases; Dynamic Order Quantities, Fixed order size system, Periodic order interval systems, Mathematical modelling under known stock out costs and service levels.

References
1. S. Chopra, and P. Meindl, *Supply Chain Management: Strategy, Planning and Operations*. 6th ed. Pearson Education Ltd, 2016.
2. D. Simchi-Levi, P. Kaminsky, and E. Simchi-Levi, *Designing & Managing the Supply Chain: Concepts, Strategies & Case studies*. 3rd ed., McGraw-Hill Education, 2007.
3. R. J. Tersine, *Principles of Inventory and Materials Management*, 4th ed., Prentice-Hall Inc., New Jersey, 1994.
4. M. K. Starr, and D. W. Miller, *Inventory Control: Theory and Practice*, Prentice-Hall India, New Delhi, 1986.
5. Department of Mechanical Engineering, NITC, *Supply Chain Role Play Game: Instructor's Manual*. 2017.

ME6191D INDUSTRIAL ENGINEERING LABORATORY

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

1. Pin board assembly
2. Stop watch time study of a drill press operation
3. Experiments on development of Learning curve
4. Experiments on eye-hand coordination
5. Visual acuity test
6. Preparation of assembly chart and product structure
7. Fitting of Probability Distributions
8. Construction of X-bar and R chart
9. Experiments on the Light Measurements
10. Experiments on the assessment of Noise Exposure
11. Measurement of maximal heart rate and maximum oxygen intake level
12. Assessment of Vibration
13. Measurement of Anthropometric Data
14. Posture Analysis using OWAS, RULA and REBA.
15. Demonstration of IDEEA Minisun Gait Analysis System

References

1. A. Freivalds and B.W. Niebel,*Niebel'sMethods,Standards and Work Design*, 12th Ed., 2008.
2. R.M. Barnes, *Motion and Time Study: Design and Measurement of Work,* John Wiley & Sons, NY, 7th ed., 1980.
3. M.S. Sandersand E. J. McCormick,*Human Factors in Engineering and Design*, 6th ed., McGraw-Hill, 1987.
4. I. L.O*., Introduction to Work Study: Indian Adaptation,*3rded., New Delhi, Oxford & IBH Publishing Co. Pvt. Ltd., 2011.
5. F. Tayyariand J.L. Smith, *Occupational Ergonomics: Principles and applications*, Kluwer Academic Publishers, 1997
6. E.L. Grantand R.S. Leavenworth, *Statistical quality Control*, 7th ed., McGraw-Hill Education (Indian Edition), 2017.

ME6111D MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Pre-requisites: ME6102D or equivalent

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (14 hours)

Relation between Machine Learning and Statistics. Introduction to Algorithms in Machine Learning – Classification, Supervised machine learning – linear regression, Multiple linear regression, Logistic regression – Model representation, Discriminant Analysis, Classification Trees, Support Vector Machine.

Module 2: (11 hours)

Introduction to unsupervised learning - Clustering – types of clustering, Dimensionality Reduction, Principal Component Analysis algorithm, Factor analysis.

Module 3: (14 hours)

Era of Intelligent Systems - The Fourth Industrial Revolution Impact, The Technology of the Fourth Industrial Revolution, Introduction to Artificial Intelligence and Cognition. Application of artificial intelligence (AI) techniques: Meta-heuristics: Genetic Algorithm, Scatter Search, Tabu Search, Particle Swarm Intelligence, Ant Colony Optimization; Artificial Neural Networks; Fuzzy Logic Systems; Case based reasoning.

References

1. J.F. Hair, W.C. Black, B. J. Babin, and R.E. Anderson, *Multivariate Data Analysis*. 7thEdn. Pearson New International, 2015.
2. T. Hastie, R. Tibshirani, J. Friedman, *The elements of statistical learning*. 2nd Edn. New York: Springer, 2017.
3. E. Rich, K. Knight, S. B. Nair, *Multivariate Data Analysis*. 3rd Edn. Pearson New International, 2012.
4. M. Gardener, *Beginning R: The statistical programming language*. Wiley India Publication, 2012.
5. R.A. Johnson, and D.W. Wichern, *Applied Multivariate Statistical Analysis*. 6thEdn. Pearson New International, 2015.
6. J.S. Hurwitz, M. Kaufman, and A. Bowles, *Cognitive Computing and Big Data Analytics*, Wiley 2005.
7. M. Skilton, and F. Hovsepian, *The 4th Industrial Revolution*, Palgrave Macmillan, 2017.

ME6112D MANUFACTURING PLANNING AND CONTROL

Pre-requisite: Nil

L	T	P	C
3	0	0	3

Total Hours: 39

Module 1: (15 Hours)

Manufacturing Planning and Control (MPC): MPC systems, MPC system payoff, MPC system framework, Type of configurations of manufacturing system, Matching the MPC system with the needs of the firm.

Enterprise Resource Planning (ERP): What is ERP, ERP and functional units, How MPC fits within ERP, Performance measures to evaluate integrated system of effectiveness.

Demand Management: Demand management and MPC environment, Communicating with other MPC modules and customers, Forecasting framework; Time series analysis: Weighted moving average, Exponentially weighted moving average, Seasonal and trend adjusted exponentially weighted moving average, Forecast errors, Interval estimate, Economic indicators.

Module 2: (11 Hours)

Sales and Operation Planning: Nature of sales and operation planning, Planning process, Development and evaluation of plans, Mathematical programming approaches.

Master Production Schedule (MPS): Nature of MPS, MPS techniques, Time fencing and MPS stability, Rolling through time, Order promising and available to promise, Structuring BOM, Final assembly schedule, Managing using two level MPS.

Module 3: (13 Hours)

Material Requirement Planning (MRP): Nature of MRP, MRP records, MRP logic, Linking of MRP records, Determination of planning horizon; Technical Issues: safety stock and safety lead time, Low-level coding, Pegging, Firm planned orders, Service parts, Rolling horizon; Using the MRP system, System Dynamics, Lot sizing methods, Buffering concepts, System nervousness.

Production Activity Control: Framework, Shop floor control concepts, Basic data required, Techniques, Performance measures, Gantt chart, progress chart, schedule chart, load chart, Finite loading systems, Horizontal loading, vertical loading, Priority sequencing rules, Two-machine job shop scheduling, Runout time method scheduling.

References

1. F. Robert Jacobs, William L. Berry, D. Clay Whybark, and Thomas E. Vollmann, *Manufacturing Planning and Control for Supply Chain Management*, 6th ed., McGraw Hill Education (India) Private Limited, Chennai, 2014.
2. Edward A. Silver, David F. Pyke and Rein Peterson, *Inventory Management and Production Planning and Scheduling*, 3rd ed., John Wiley & Sons, 1998.
3. Seetharama L. Narasimhan, Dennis W. McLeavy and Peter J. Billington, *Production Planning and Inventory Control*, 2nd ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2000.
4. Richard J. Tersine, *Production/Operations Management*, Second Edition, North Holland, 1985.
5. A. C. Hax and D. Candea, *Production and Inventory Management*, Prentice-Hall, Englewood Cliffs, NJ, 1984.

ME6113D ACCOUNTING AND FINANCE FOR MANAGEMENT

Pre-requisites: Nil

Total hours: 39

L	T	P	C
3	0	0	3

Module 1: (12 Hours)
Accounting: Forms of ownership Conceptual basis of accounting – Components of Balance Sheet – Construction of a balance sheet – preparation of profit & loss account - cash flow statement.
Cost Management Concepts: Concepts of cost – cost behavior and CVP relationships – cost functions – methods of measuring cost functions – Applications

Module 2: (13 Hours)
Product Costing Systems - Job costing, process costing; variable and absorption costing; ABC costing; Costing for Decision making – Variance analysis - Short-term financial planning – working capital – Planning and management.

Module 3: (14 Hours)
Working with financial statements, ratio analysis - Time value of money- stock valuation, bond valuation
Cost of capital and long term financial policy: Raising capital, cost of capital - Capital budgeting: traditional techniques, identifying relevant cash flows, discounted cash flow techniques - Risk analysis -Financial and operating leverage - Capital structure theories, dividends theories – Foreign exchange

References

1. Khan M.Y. and Jain P.K, *Financial Management*, 3rd Edition, Tata McGraw Hill 2003.
2. Khan and Jain "*Management and Cost Accounting*" 2nd Edition, Tata McGraw Hill Delhi.2001
3. I.M. Pandey, *Financial Management*, 8th edn.,Vikas Publishing house 2003.
4. Prasanna Chandra, *Financial Management*, 4th edn., Tata McGraw Hill 2003.
5. JawaharLal, *Financial Accounting*, 2nd edn., Wheeler publishing 2000.
6. Horngreen, "*Cost Accounting – A Managerial emphasis*", 11/e Pearson Education, Asia, 2002.

ME6192D MODELLING AND DATA ANALYTICS LABORATORY

Pre-requisites: Nil

L	T	P	C
0	0	3	2

Total hours: 39

1. Problem formulation, Solution Interpretation and Sensitivity analysis using the following packages:
   (a) LINGO
   (b) AMPL
2. Programming exercise using the following software:
   (a) MATLAB
   (b) Scilab
   (c) Microsoft Excel
   (d) R
3. Manual simulation of a small production system
4. Simulation exercise using the following packages:
   (a) ARENA
   (b) WITNESS
   (c) TECNOMATIX
5. Operation simulation of a serial supply chain using Supply Chain Role Play Game (SCRPG) software package
6. Performance analysis of a four-echelon supply chain under different Inventory control policies using SCIPA software package.
7. Performance analysis of a VMI-based serial supply chain – VMI-based supply chain role play game
8. Process Layout Design
9. Rolling Horizon Based MRP analysis

References

1. F. S. Hillier and G. J. Lieberman, *Introduction to Operations Research*, 8th Ed., Tata McGraw Hill, 2005.
2. F.R. Jacobs, W.L. Berry, D.C. Whybark, and T.E. Vollmann, *Manufacturing Planning and Control for Supply Chain Management*, 6th ed., McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2015
3. J.A. Tomkins, J.A. White, Y.A. Bozer, E.H. Frazelle, J.M. A. Tanchoco and J. Trevino, *Facility Planning*, 4th ed., John Wiley & Sons, 2013.
4. J. Banks, J.S. Carson, B.L. Nelson and D.M. Nicol,*Discrete-Event System Simulation.*5th ed. Pearson Education, Inc., 2009.
5. W.L. Winston, *Microsoft Excel Data Analysis and Business Modeling*, 1st Edn. Prentice-Hall Inc. 2017.

ME6193D SEMINAR/MINI PROJECT

L	T	P	C
0	0	2	1

Total hours: 26

Students are free to select either Seminar or Mini Project after consulting with Programme Coordinator/Course Faculty.

SEMINAR

Each student shall prepare a seminar paper on any topic of interest related to the core/elective courses undergone in the first semester of the M. Tech. programme. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of the Faculty in-charge of seminar class. Every student shall participate in the seminar. Grade will be awarded on the basis of the student's paper, presentation and his/her participation in the seminar.

Course Outcomes for ME6193D Mini Project

CO1: Select a research problem pertaining to the area of specialization of the M. Tech. programme.
CO2: Choose an appropriate research methodology for solving the problem identified.
CO3: Apply the methods/tools learned to solve the problem.
CO4: Construct a report by employing the rhetoric techniques of academic writing, including invention, research, critical analysis, evaluation and revision.

MINI PROJECT

Students can select a research problem pertaining to the area of specialization of the M. Tech. programme by consulting a faculty in the department. The student has to identify an appropriate methodology and solve the problem. The student shall prepare submit a report. The mini project will be evaluated by the faculty in-charge of the mini project.

ME7194D PROJECT (PART-I)

L	T	P	C
0	0	20	12

Students are encouraged to identify the area of the project work and conduct the literature review during the second semester itself. The project work starts in the third semester. The topic shall be research and development oriented. The project work can be carried out at the institute or in an industry/research organization. Students desirous of carrying out project work in an industry or in other organizations have to fulfill the requirements as specified in the “Ordinances and Regulations for M. Tech. ”The student is expected to complete the research problem definition, formulation and preliminary work (pilot study) in the third semester. There shall be evaluations of the project work during and at the end of the third semester by a committee constituted by the department.

ME7195D PROJECT (PART-II)

L	T	P	C
0	0	20	13

Course Outcomes:
CO1: Develop algorithms/solution procedures to solve the problem.
CO2: Analyze and interpret the results using tables and figures for visualization.
CO3: Compile the problem, solution method and the findings of the project work.
CO4: Develop an extensive and independently written thesis using relevant scientific theories/methods and defend the thesis.

The project work started in the third semester will be extended to the end of the fourth semester. There shall be evaluations of the project work by a committee constituted by the department during the fourth semester. The student shall submit the thesis based on the recommendation of the departmental evaluation committee. There shall be viva-voce examination conducted by an evaluation committee with an external examiner.

ME6121D MARKETING MANAGEMENT

L	T	P	C
3	0	0	3

Prerequisite: Nil
Total Hours: 39 hours

Module 1: (15 hours)

Introduction to Marketing: Marketing defined, Marketing Concepts, Marketing functions, Marketing Environment. Marketing Planning: Planning Process, Strategic Business Units, Evaluation of SBUs. Market Segmentation and Market Targeting: Segmentation Procedure, Market Targeting, Product Positioning. Marketing Mix: Marketing mix variables and their importance. Product Development: Idea generation, Concept development and Testing, Market Testing, Commercialization. E-Marketing, latest trends in marketing.

Module 2: (13 hours)

Pricing Strategies: Meaning of pricing, Importance, Objectives, Factors influencing price determination, Demand market based pricing, Tender pricing, Product line pricing, Selecting the final price. Marketing Research: Marketing Research Process, Research objectives, Research Plan development, Collecting information, Analysis.

Module 3: (11 hours)

Consumer Behaviour: Factors influencing Consumer Behaviour, Decision making process in buying, Perceived risks. Marketing Communication: Marketing mix variables communicate, Steps in developing effective communication. Advertising Management: Purpose, Factors in advertising, Advertising Portfolio Selection, Deciding message or copy. Sales Promotion: Sales Promotion Tools, Consumer promotion tools, Business promotion tools.

References

1. Kotler, P., Keller, K.L, Koshy, A. and Jha, M. *Marketing Management*, 14th ed., Pearson, 2012.
2. Ramaswamy, V.S. and Namkumari, S., *Marketing Management - Planning, Implementation and Control,*3rd ed., Macmillan India Limited, 2002.
3. Majumdar, R., Marketing Research - Text, *Applications and Case Studies*, 2nd ed., New Age International, 2007.
4. Stanton, W.J., Etzel, M.J. and Walker, B.J., *Fundamentals of Marketing*, 10th ed., McGraw-Hill International Edition, 1994.

ME6122D CONSUMER BEHAVIOUR

L	T	P	C
3	0	0	3

Prerequisite: Marketing Management
Total Hours: 39 hours

Module 1: (13 hours)

Introduction: Diversity in the market place, consumer research, market segmentation, Market Segmentation and Market Targeting: Segmentation Procedure, Market Targeting, Product Positioning.Consumer behaviour as discipline and Science, Ethics in marketing.

Module 2: (13 hours)

Consumers as individuals: Consumer motivation, consumer perception, consumer learning, personality and life styles, attitudes, attitude change, communications and consumer behavior.Factors influencing Consumer Behavior, Decision making process in buying, Perceived risks.

Module 3: (13 hours)

Consumer influence and diffusion of innovations, consumer decision making- individual decision making, group influence and opinion leadership. Consumers in their social and cultural settings: Social class and consumer behavior, influence of culture, subculture and consumer behavior, income, Age, Ethnic, racial and religion subcultures.

References

1. Schiffman & Kanuk, *Consumer Behaviour*, 10th ed., Prentice-Hall, 2009.
2. Solomon, *Consumer Behaviuor*, 12th ed., Pearson Education, 2016.
3. Peter & Olson,*Consumer Behaviuor and Marketing Strategy*, 9th ed., Tata McGraw Hill/ Irwin, 2010
4. Arnould, Linda and Zinkhan, *Consumers*, 2nd ed., Tata McGraw Hill/ Irwin, 2004.

ME6123D PRODUCT MANAGEMENT

L	T	P	C
3	0	0	3

Prerequisite: Nil

Total Hours: 39 hours

Module 1: (13 hours)

Product Management:Introduction, role of product managers, product policy, product market, market potential, product market planning and demand forecasting, product life cycle, product portfolio analysis.

Module 2: (13 hours)

Target marketing,segmentation, product differentiation, product positioning, product recall/ deletion, managing product line, positioning errors.

Module 3: (13 hours)

New product innovation and development, stages, adoption process, diffusion, product pricing, new product launch, strategies. Brand Management, concept, naming, brand equity, brand extension, brand positioning, product packaging.

References

1.Chunawalla, *Product Management*, Himalaya Publishing House, 2010.
2. Majumdar, *Product Management*,3rd ed., Prentice-Hall of India. 2008.
3. Lehmann & Winer, *Product Management*, 4thed., Tata McGraw Hill, 2005.
4. Merle Crawford, *NewProduct Management*, 11thed.,Tata McGraw Hill, 2014.

ME6124DHUMAN RESOURCE MANAGEMENT

L	T	P	C
3	0	0	3

Prerequisite: Nil
Total Hours: 39 hours

Module 1: (13 hours)

Human Resource Management, Evolution, Topology of companies, concept of an involved employee, HR issues, Corporate and HR strategy, Linking Business and HR planning, HR instruments, Diversity issues.

Module 2: (13 hours)

Personnel Management: Personnel Functions, Personnel Management Environment in India, Manpower Planning, Recruitment, selection and Induction of Employees, Training and Development, Job Analysis and Design, Compensation Planning, Salary Administration, Job Evaluation, Merit Rating, Incentive Schemes.

Module 3: (13 hours)

Industrial Relations: Managing Industrial Relations, Labour Laws, Trade Union, Employee Discipline, Grievance handling mechanisms, Suspension, Dismissal and Retrenchment, Industrial Conflict Resolution, Collective Bargaining, Recent issues in Industrial Relations, Turnover. Organizational Development: Organizational Design, Dimensions, Restructuring Strategies, Work Organization, Organizational Development, Change Agents, Process of organizational change.

References

1. Dwivedi, R.S., *A Text Book of Human Resource Management*, Vikas Publishing House, 2007.
2. Yoder, D., and Staodohar P.D., *Personnel Management and Industrial Relations*, Prentice-Hall of India, 1986.
3. Monappa, A., and Saiyadain M. S., *Personnel Management*, 2nd ed., McGraw-Hill, 2001.
4. Kapoor, N.D., *Introduction to Commercial and Industrial Law*, 12th ed., Sultan Chand & Sons, 2013.

ME6125DORGANIZATIONAL BEHAVIOUR

L	T	P	C
3	0	0	3

Prerequisite: Nil
Total Hours: 39 hours

Module 1: (13 hours)

Introduction to Organizational Behaviour (OB): Development and challenges, assumptions of contemporary OB. Foundations of individual behaviour values, attitudes, personality, emotions, perception, abilities, motivation in organisations, work related attitudes.

Module 2: (13 hours)

Group Process: Meaning and importance of groups, reasons for group formation, Introduction to group behaviour, understanding team, communication, leadership, leadership types, power, conflict and negotiation, negotiation methods, Sources of Conflict, Types of Conflict, Conflict Management Approaches

Module 3: (13 hours)

Organisational Process: Work design and technology, organisation structure and design, basic elements of organization structure, type of organization design, organisational culture. Organisational change, stress management, decision making in organisations.

References

1. Robbins, *Organisational Behaviour*, 16th ed., Pearson Education, 2014.
2. Greenberg and Baron, *Behaviour in Organisations*, 9th ed., Pearson Education, 2008.
3. Mcshane, S. and Von Glinow, M. *Organizational Behaviour*. 6th ed. McGraw-Hill/Irwin 2012.
4. Balaschard and Johnson, *Management of Organisational Behaviour*, 10th ed., Pearson Education, 2012.

ME6126D WORK SYSTEM DESIGN

L	T	P	C
3	0	0	3

Pre-requisites: Nil
Total hours: 39

Module 1: (14 hours)
Productivity concept and definitions – productivity importance, productivity measurement approaches at the enterprise, factors contributing to productivity improvement, techniques for productivity improvement.
Work Design Decisions – Behavioral considerations – sociotechnical systems approach, Physical considerations, Methods study: Scope of work design – Procedure for methods study – Process analysis- Process charts. Manual Work design - principles of motion economy, Manual work and design guidelines – Energy expenditure, Gait Analysis, Heart rate, NIOSH lifting guidelines, Multitask lifting guidelines.

Module 2: (13 hours)
Work measurement: Time study equipment – establishment and maintenance of time standards, Allowances – constant and variable fatigue allowances, special allowances, atmospheric conditions, noise level, illumination levels, visual and mental strain, Performance rating methods, Execution of time study for a practical case and determination of standard time, Pre-determined Time Systems – Methods Time Measurement, Maynard Operation Sequence Technique, Work sampling – planning, recording and execution for a practical case.

Module 3: (12 hours)
Work environment design – Nature of man-machine systems – characteristics, Working conditions - illumination, noise, temperature, vibration, radiation, Shift work and working hours.
Workplace and systems safety – Basic philosophies of accident causation and preventions, Probability methods, Reliability, Fault Tree Analysis, Safety Legislation and Worker's Compensation, Occupational Safety and Health Administration, Job Hazard Analysis – analysis for a practical case, General Housekeeping.

Reference:

1. A. Freivalds,and B.W. Niebel,*Niebel'sMethods,Standards and Work Design*, 12th Ed., 2008.
2. R. M.Barnes, *Motion and Time Study: Design and Measurement of Work,* John Wiley & Sons, NY, 7th ed., 1980.
3. M.S. Sanders, ,and E.J. McCormick,*Human Factors in Engineering and Design*, 6th ed., McGraw-Hill, 1987.
4. G. Salvendy,*Handbook of Human Factors & Ergonomics*, Inter-science, 1997.
5. M.P. Groover, *Work Systems and the Methods, Measurement, and Management of Work*, Pearson Prentice Hall, 2007.
6. I. L.O*., Introduction to Work Study: Indian Adaptation,*3rded., New Delhi, Oxford & IBH Publishing Co. Pvt. Ltd., 2011.

ME6127D ERGONOMICS AND HUMAN FACTORS ENGINEERING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (15 hours)
Introduction to Human factors and Ergonomics – Systems description, Nature of man-machine systems and characteristics, Design of cognitive work - information theory – human information processing model, displaying information – coding of information – Information input and processing, Perception, Attention, Mental Workload. Display of Visual information – specific design principles, Display of Auditory information – specific design principles, Tactual and Olfactory Displays – Cutaneous senses – Speech communication.

Module 2: (12 hours)
Biomechanical bases of ergonomics – static biomechanical analysis and models. Work physiology – Energy and energy sources of the body, Categories of work, Respiration, Circulatory system, Metabolism, Physical work capacity – Aerobic capacity, Assessment of aerobic capacity, Fatigue and its evaluation.Posture and movement - Posture and job relation, Postural Analysis in Workspace Design - Evaluation of required body posture for a practical case. Energy expenditure and Gait Analysis - Evaluation of energy expenditure and gait analysis for a practical case , Heart rate – Estimation of the relationship between maximum oxygen intake and maximal heart rate for a practical case. Endurance in Physical work, NIOSH lifting guidelines, Multitask lifting guidelines

Module 3: (12 hours)
Engineering anthropometry and work-space design – Statistical basis of anthropometry – Use of anthropometric data in design, Principles of work design – workplace, machines, tools and equipment, Design of work surfaces – science of seating, Design for standing and seated workers, Cumulative trauma disorders- Fundamental risk factors and prevention, Work environment design – illumination, noise, temperature, ventilation, vibration, radiation, Shift work and Working hours – Work rest scheduling,Design Ergonomics in India: scope for exploration.

References

1. M.S. Sanders and E. J. McCormick, *Human Factors in Engineering and design*, 7th ed., McGraw-Hill International.
2. A. Freidvalds, *Niebel's Methods, Standards, and Work Design*, Twelfth Edition, Mc-Graw Hill Education, 2013
3. F. Tayyari, and J. L. Smith J.L., *Occupational Ergonomics: Principles and applications*, Kluwer Academic Publishers, 1997
4. S. Gavriel, *Handbook of Human Factors & Ergonomics*, Inter-science, 1997.
5. K.F.H. Murrell and H. Schnauber, *Ergonomics. Econ*, Munich, 1986.

ME6128D FORECASTING TECHNIQUES

Pre-requisite: Nil

Total Hours: 39

L	T	P	C
3	0	0	3

Module 1: (12 hours)
Introduction: Nature and uses of forecasts, Steps involving in defining forecasting problem; Anoverview of forecasting techniques: Qualitative and quantitative forecasting techniques and classification; Basic forecasting Tools: Time series data, data representation tools and statistical operations: univariate statistics, bivariate statistics, auto-correlation; Forecast accuracy and error.
Time series decomposition: Components of time series: trend, seasonal, cycle; Moving average methods, Classical decomposition: additive and multiplicative decomposition.

Module 2: (16 hours)
Exponential smoothing methods: Single exponential smoothing with one and adaptive parameter, Holt's linear method, Holt-Winters method, Pegel's classification method.
Regression methods: Simple linear regression: least square estimation, correlation coefficient, statistical testing of regression coefficient (f-test, t-test), Introduction to multiple linear regression.

Module 3: (11 hours)
The Box-Jenkins method for ARMA models: Box-Jenkins methodology to identification of stationary time series models, Examining correlation in time series data: tests to determine the statistical properties of empirical time series, Examining stationarity of time series data, ARIMA models for time series data and forecasting.

References
1. S. Makridakis, S. C. Wheelwright, and V. E. McGee, *Forecasting, Methods and Applications*. 3rd ed. Wiley India, 2003.
2. C. Montgomery Douglas and A. Johnson Lynwood, *Forecasting and Time Series Analysis*. McGraw Hill, 1976.
3. W.Enders, *Applied Econometric Time Series*. 2nd ed. John Wiley & Sons, Inc., 2004.
4. J. M.Wooldrige, *Econometric Analysis of Cross Section and Panel Data*. The MIT Press, 2002.
5. L. Porter Alan, A. Roper Thomas, Wimason Thomas, Jery Banks,A. Rossini Fredrick, *Forecasting and Management of Technology*.
6. L.Porter Alan,A. Roper Thomas, W.Mason Thomas, Frederic A.Rossini, Banks Jerry. *Forecasting and management of technology*. New York, John Wiley & Sons, Inc., 1991.

ME6129D FACILITIES LAYOUT PLANNING

Pre-requisites: Nil

Total hours: 39

L	T	P	C
3	0	0	3

Module 1: (12 Hours)
Introduction: Types of manufacturing processes, Overview of Plant Design, Plant Location - Location Factors, Location Theory, Facilities planning strategy, Nature, Significance and Scope of Facilities Layout Planning. Plant Layout: Need for Layout, Objectives, Types of Layout, Layout Design Process, Layout Design Cycle, Data Collection, Equipment Requirement, Activity Analysis, REL Diagram, Employee Requirement; Development of Layout - Block Plan, Selection, Specification, Evaluation.

Module 2: (12 hours)
Computerized Layout Planning: Basic Philosophy in Computerized Layout Planning, Construction and Improvement Algorithms, Major features of Improvement Algorithms. Major Features of Computerized Algorithms, such as ALDEP, CORELAP, CRAFT.
Formulation of Layout Problems: Quantitative, Qualitative, and multi-objective, Limitation of Computerized Layout Planning, Flow Dominance, Complexity Rating, Solution Efficiency.

Module 3: (15 hours)
Single Facility Location Problems: Rectilinear Distance Problems, Contour Lines (Iso-Cost Lines). Squared Euclidean Distance Problems and Euclidean Distance Problems
Introduction to Multi-facility Location Problems: Formulation of Problems, LP formulation with rectilinear distance, squared Euclidean distance and HAP.
Introduction to Quadratic assignment problem – Allocation problem – Warehousing problem.

References

1. Tompkins, J.A. and J.A.White, *Facilities planning*, John Wiley, 3rd edition, 2010
2. Richard Francisl. and John A.White, *Facilities layout and location - An analytical approach*, Prentice Hall of India, 3rd Edition, 2002
3. James Apple. M , *Plant layout and Material handling*, John Wiley, 2nd Edition, 1977
4. R. Panneeerselvam, *Production and Operations Management*, 3rd Edition, Prentice Hall of India, 2015

ME6130D GROUP TECHNOLOGY AND FLEXIBLE MANUFACTURING SYSTEMS

Pre-requisites: Nil

Total Hours: 39

L	T	P	C
3	0	0	3

Module 1: (13 Hours)
Introduction: Characteristics of modern production system, Ways of configuring manufacturing system
Group Technology (GT): Role of GT in Computer Aided Manufacturing (CAM), Features of GT, Cellular manufacturing, Role of similarity in GT, Composite part, Coding and classification, Similarity coefficient based clustering, Key machine approach, Binary ordering algorithm, Production flow analysis.

Module 2: (15 Hours)
Models for Cellular Manufacturing System (CMS) Design: CMS design factors, Mathematical programming approaches, Model for dynamic part population, Solution procedure using genetic algorithm.
Cellular Manufacturing: Focused factory, pull production: Conveyance kanban, Two-card pull system, Building blocks of workcell, Linked cell, Different types of cells, Cycle time, Workcell design; Worker assignment; Incentive plans; Issues in implementing cellular manufacturing.

Module 3: (11 Hours)
Process Planning: Process planning for parts and assemblies, Manual process planning; Computer aided process planning (CAPP), Approaches to process planning; Process Planning systems; Variant process planning: Development stages, Family formation, search algorithm.
Flexible Manufacturing System (FMS): Types of automation, Flexibility, Types of FMS, FMS Layout configuration, Automated workpiece flow, Material handling, and machining; Performance measures, Bottleneck model, Extended bottleneck model, Sizing of FMS

References

1. John Nicholas, *Competitive Manufacturing Management - Continuous Improvement, Lean Production, and Customer-Focused Qualities*, Tata McGraw-Hill Edition, 2001.
2. Sing, N., and Rajamani, D., *Cellular Manufacturing Systems: Design, Planning & Control*, Chapman & Hall, 1996.
3. Askin, R. G., and Standridge, C. R., *Modelling and Analysis of Manufacturing Systems*, John Wiley & sons. Inc, 1993
4. Mikell P. Groover, *Automation, Production Systems, and Computer-Integrated Manufacturing*, 2nd ed., Prentice Hall of India Private Limited, 2001.
5. David D. Bedworth, Mark R. Henderson, and Philip M. Wolfe, *Computer-Integrated Design and Manufacturing*, McGraw-Hill International Editions, 1991.
6. Tien-Chien Cheng, Richard A. Wysk, and Hsu-Pin Wang, *Computer-Aided Manufacturing*, Second Edition, Prentice Hall International, Inc., 1998.
7. Wicks, E. M., and Reasor, R. J., *Designing Cellular Manufacturing systems with dynamic part population*, IIE Transactions, Vol. 31, pp 11-20, 1999.
8. Burbidge, J. L.,*Production Flow Analysis for Planning Group Technology*, Journal of Operations Management, Vol. 10, No. 1 (January), pp 5-27, 1991.

ME6131D INDUSTRIAL SCHEDULING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (14 hours)
Importance of scheduling in implementation of production planning, Overview of scheduling models: Machine configurations, Processing characteristics and constraints, Objectives and performance measures, Computational complexity, NP complete and NP hard, Optimality of schedules.
Single machine sequencing with independent jobs: Scheduling without due dates, with due dates, Adjacent pair-wise interchange methods, Branch and bound approach, Neighborhood search techniques, Random sampling, Parallel machine models.

Module 2: (13 hours)
Flow shop scheduling: Permutation schedules, Johnson's problem, Ignall and Schrage algorithm, Dominance properties for make span problems, CDS, Palmer, Gupta heuristics, Scheduling in process industries with no waiting or work in process.
Job shop scheduling: Types of schedules, Schedule generator, Disjunctive programming and Branch and bound, Shifting bottleneck heuristic.

Module 3: (12 hours)
Dynamic job shop scheduling, Scheduling in dynamic flow systems, Use of priority disciplines. Scheduling of Flexible assembly systems; Lot sizing and scheduling; Scheduling, balancing and other aspects of design in mixed model assembly lines and flow lines.
Basic principles of scheduling problems in service systems: Airline operations, Healthcare systems.

References
1.M. Pinedo, *Scheduling: Theory, Algorithms and Systems*, 4th edn. Springer 2012.
2. K. R. Baker and D. Trietsch, *Principles of Sequencing and scheduling*, Wiley-Blackwell2009.
3. S. French, *Sequencing and Scheduling*, Elis Horwood Ltd., Chichester, U.K. 1982.
4. M. Bazargan, *Airline Operations and Scheduling*, 2nd Edn. Routledge 2010

ME6132D LEAN PRODUCTION MANAGEMENT

Pre-requisites: Nil

Total Hours: 39

L	T	P	C
3	0	0	3

Module 1: (11 Hours)
Small-Lot Production: Lot-size Basics; Lot sizing; Lot-size Reduction; Facilitating Small Lot Size.
Setup-Time reduction: Setup_Reduction Methodology; Techniques for Setup-Reduction; Setup_Reduction Projects.

Module 2: (13 Hours)
Pull Production Systems: Pull Systems and Push Systems, Conditions for Pull Production Systems, How to achieve Pull Production; Mechanisms for Signal and Control: Two-card pull production system, Signal Kanban, CONWIP.
Workcells and Cellular Manufacturing: Cell layout and Capacity Measures, Design of Workcells, Worker Assignment, Implementation Issues.

Module 3: (15 Hours)
Scheduling for Smooth Flow: Production Leveling, Levelling the master production schedule, Level Scheduling in Pull Production: Mixed model production (Heijunka); Production planning and scheduling in environment like make-to-stock, assemble-to-order, make-to-order.
Synchronising and Balancing Process: Synchronisation; Bottleneck Scheduling; Balancing; Adapting to Schedule changes.
Planning and Control in Pull Production: Centralised Planning and Control System; Decentralised planning and Control system; Adapting MRP-Based Production Planning and Control System to Pull production

References
1. J. Nicholas, *Lean Production for Competitive Advantage: A comprehensive Guide to Lean Methodologies and Management Practices*, CRC Press – Taylor & Francis Group – A Productivity Press Book, 2010
2. J. Nicholas, *Competitive Manufacturing Management – Continuous Improvement, Lean Production, and Customer-Focused Qualities*. Tata McGraw-Hill Edition, 2001.
3. R. G. Askin and J. B. Goldberg, *Design and Analysis of Lean Production Systems*. Wiley Student Edition, 2007.
4. M. G. Korgaonker, *Just In Time Manufacturing*, Macmillan Publishers India Limited, 2000.

ME 6133D SUSTAINABILITY MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1 (11 hours)

Management of sustainability: rationale and political trends - An introduction to sustainability management - International and Indian policies on sustainable development - The theoretical pillars in sustainability management studies - Corporate sustainability and responsibility - The corporate sustainability perimeter - The corporate sustainability institutional framework - The integration of sustainability into strategic planning and regular business practices - The fundamentals of stakeholder engagement.

Module 2 (14 hours)

Sustainability management: strategies and approaches: Corporate sustainability management and competitiveness- Sustainability-oriented corporate strategies, markets and competitiveness - Green Management between theory and practice - Sustainable Consumption and Green Marketing strategies.

Environmental regulation and strategic postures: Green Management approaches and tools - Eco-design and product development according to life-cycle thinking - Environmental Management Systems and Audit techniques according to EMAS and ISO 14001.

Green engineering: Clean technologies and innovation processes - Sustainable Supply Chain Management and Procurement - Inter-organizational alliances and public-private partnerships - Measurement and communication of environmental and social performance - Fundamentals of measuring and reporting on corporate sustainability – Sustainability reporting based on global sustainability standards board – Case studies on sustainability practices.

Module 3 (14 hours)

Product certification and labels: Environmental claims - Communication and environmental footprint - Performance indicators and reporting.

Sustainability and innovation: Socio-technical transitions and sustainability - Sustainable entrepreneurship - Sustainable pioneers in green market niches - Smart communities and smart specializations.

Sustainable management of resources, commodities and commons - Energy management - Water management - Waste management.

References

1. Allen, D. T. and Shonnard, D. R., *Sustainability Engineering: Concepts, Design and Case Studies*, Prentice Hall. 2011.
2. Bradley. A.S; Adebayo,A.O., Maria, P. *Engineering Applications in Sustainable Design and Development*, Cengage learning , 2016.
3. Cetinkaya, B.,Cuthbertson, R.,Ewer, G., Klaas-Wissing, T., Piotrowicz, W.,Tyssen, C.,*Sustainable Supply Chain Management: Practical Ideas for Moving Towards Best Practice*, Springer-Verlag Berlin Heidelberg 2011.
4. Daddi, T., Iraldo, F., Testa, *Environmental Certification for Organizations and Products: Management Approaches and Operational Tools*, Routledge, 2015.
5. Gerwig, K., *Greening Health Care*, Oxford University Press, 2015.
6. Morana, J., *Sustainable Supply Chain Management*, John Wiley & Sons, Inc. 2013.

ME6134DADVANCED COMPUTER INTEGRATED MANUFACTURING

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (13 hours)
Manufacturing operations: Product/production relationships, Manufacturing models and metrics; Elements of automation system, Concurrent engineering, Components of a Manufacturing system, Classification scheme for manufacturing systems, Analysis of single station systems.
Group Technology and process planning: Part families, Part classification and coding, Cellular manufacturing, Quantitative analysis in cellular manufacturing, Process planning, Process engineering, Experiment based planning.

Module 2: (13 hours)
Process capability analysis: Introduction to Computer aided process planning, Variant process planning, Generative process planning.
Material handling: Shop floor control Analysis of material transport system, Analysis of vehicle based system, Conveyor analysis.
Storage systems: Storage system performance, storage location strategies.
Automated storage systems: ASRS, Carousel storage systems.
Automatic Identification and Data capture: Bar codes and RFID.

Module 3: (13 hours)
Flexible manufacturing systems: Components, Material handling and storage system, Computer control system, Quantitative analysis, Shop floor control and simulation.
NC, CNC, DNC & CIM and Data base control systems: Computer process control, Numerical control, Fundamentals of NC technology, Application of NC - CNC, machine control of CNC- DNC, Just-in-time manufacturing systems, Internet Enabled Manufacturing, Virtual Manufacturing, and e-maintenance.

References
1. M. P. Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, 4th Edn. Pearson Education 2016.
2. J. A. Rehg and H. W. Kraebber, *Computer Integrated Manufacturing*, Pearson, 2004.
3. M. B. Zaremba and B. Prasad, *Modern Manufacturing: Information Control and Technology (Advanced Manufacturing)* Springer 2011.
4. S. K. Vajpayee, *Principles of Computer Integrated Manufacturing*, Prentice Hall India, 2003.

ME6135D SYSTEM MODELLING AND SIMULATION

Pre-requisites: Nil

Total hours: 39

L	T	P	C
3	0	0	3

Module 1: (14 hours)
System Concept: Systems and system environment, Types of system study, System modelling - Types of models; System Simulation - Technique of simulation, Comparison of simulation and analytical methods, Types of system simulation, Steps in simulation study; Monte Carlo simulation: Examples Simulation modelling and analysis of queuing systems, Inventory systems; Concepts in Discrete Event Simulation: Event scheduling/Time advance algorithm, Modelling world views; Simulation programming: Comparison and selection of simulation languages;

Module 2: (13Hours)
Random Number Generation: Linear congruential method, Test for random numbers; Random Variate Generation: Inverse transformation technique, Convolution method, Acceptance-Rejection technique; Input Modelling for Simulation: Data collection, Identifying the distribution with data, Parameter estimation, Goodness of fit tests.
Verification and Validation of Simulation Models: Verification, calibration and validation of models.
Output Analysis for a Single Model: Measures of performance and their estimation, Optimal number of replications.

Module 3: (12 Hours)
Output analysis for terminating simulations and steady state simulations.
Metamodelling: Regression models, simulation-optimization.
Simulation modelling and analysis of typical manufacturing systems, Supply chains, Healthcare systems, PERT networks.

References
1. J. Banks, J.S. Carson, B. L. Nelson, B.L. and D. M. Nicol, *Discrete-Event System Simulation*, 3rd Edn. Pearson Education, Dorling Kindersley (India) Pvt. Ltd. 2014.
2. N. Deo, *System Simulation with Digital Computer*, Prentice Hall of India, 1997.
3. A. M. Law, *Simulation Modelling and Analysis*, 4th Edn. McGraw-Hill Education, 2017.
4. M. D. Rossetti, *Simulation Modelling and ARENA,* 2nd Edn. Wiley-Blackwell, 2015.
5. S. Robinson, *Simulation: The Practice of Model Development and Use*, John Wiley & Sons Ltd. England, 2004.
6. Les Oakshott, *Business Modelling and Simulation*, Pitman Publishing, 1997.

ME6136D RELIABILITY ENGINEERING AND MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (11 hours)
Failure data analysis: Failure data, mean failure rate, Mean time to failure (MTTF), Mean time between failure, MTTF in terms of failure density; Hazard models: Constant hazard, Linearly increasing hazard, Weibull model, gamma model, nonlinear hazard model – Derivation of reliability function using Markov model

Module 2: (14 hours)
System reliability models: Systems with components in series, system with parallel components, k-out of-m systems, non-series-parallel systems, system with mixed mode failures, fault tree techniques; Redundancy techniques in system design: Component versus unit redundancy, mixed redundancy, standby redundancy, redundancy optimization, double failures and redundancy

Module 3: (14 hours)
Fault-tree analysis: Fault tree construction, calculation of reliability from fault tree, Event-tree analysis - Maintainability and availability concepts, two unit parallel system with repair; Preventive maintenance, *k-out-of-m* systems
Economics of reliability engineering: Economic issues, reliability achievement cost models, reliability utility cost models, availability-cost model for parallel systems
Reliability Management by objectives – reliability data acquisition and analysis

References

1. E Balagurusamy, *Reliability Engineering*, McGraw Hill Education India P Ltd, 17th Reprint, 2017
2. L.S Srinath, *Reliability Engineering*, East West Press, 4th Edition, 2005, Reprint 2016

ME6137D PRODUCT LIFE CYCLE MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (13 hours)
Need for Product Life cycle Management (PLM), opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study, PLM visioning – PLM Strategies Industrial strategies, strategy elements, its identification, selection and implementation, change management for PLM
Product Data Management (PDM) PDM systems and importance, reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation

Module 2: (13 hours)
Product Design Engineering: Design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model – Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product design
New Product Development: Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product

Module 3: (13 hours)
Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process.
Product conception process: Business processes, data-process relationship, from the idea to waste disposal
Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items

References
1. Stark, John. *Product Lifecycle Management: Paradigm for 21st Century Product Realisation*, Springer-Verlag,.(2004)
2. Fabio Giudice, Guido La Rosa, (2006) *Product Design for the environment-A life cycle approach*, Taylor & Francis
3. Saaksvuori Antti and Immonen Anselmie,(2005) *Product Life Cycle Management*, 2nd Edition Springer
4. Michael Grieves (2006), *Product Lifecycle Management*, Tata McGraw Hill

ME6138DSOFT COMPUTING TECHNIQUES

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (14 hours)
Genetic Algorithms: Introduction to Genetic Algorithms (GA) - Goals of optimization - Differences and similarities between genetic algorithm and traditional methods - Schemata - Terminology of GA - Strings, Structure, Parameter set - Coding - Fitness function - Data structures - GA operators - Algorithm.
Simulated Annealing: Introduction - Algorithm - Applications.

Module 2: (14 hours)
Tabu Search: Introduction - Algorithm - Applications.
Fuzzy Logic: The concept of uncertainty and associated solutions - Fuzzy sets - Basic properties and characteristics of fuzzy sets - Fuzzy set operations - Fuzzy reasoning - Major components of a fuzzy logic system - Design aspects of fuzzy systems - Applications of fuzzy logic.

Module 3: (11 hours)
Artificial Neural Networks: Basics of artificial neural networks (ANN) – Characteristics of ANN - Historical development - Terminology - Models of neuron – Topology - Basic learning laws - Overview of neural computing - Neural approaches to computing - Engineering approaches to computing - Relationship of ANNs to other technologies - ANNs Learning Approaches - Training set and Test set - Generalization - Learning curves - Applications of ANN in optimization - Simple examples.

References

1. B. Yegnanarayanan, *Artificial Neural Networks*, Prentice Hall of India, 1998
2. D. E. Goldberg, *Genetic Algorithms in Search, Optimization, and Machine Learning*, 13th ed., Addison –Wesley, 1989.
3. K. Deb, *Optimization for Engineering Design*, 2nd ed., Prentice Hall of India,2012.
4. K. Sundareswaran, *A Learner's Guide to Fuzzy Logic Systems*, Jaico Publishing House, 2006.
5. R. J. Schalkoff, *Artificial Neural Networks*, Tata McGraw Hill Companies Inc., 2011.

ME6139DADVANCED DECISION MODELLING

Pre-requisites: Nil

Total hours: 39

L	T	P	C
3	1	0	3

Module 1: (14 hours)
Introduction to Decision Making: Decision analysis, Decisions under risk, Decision trees – Decision analysis with experimentation, Utility theory, Decisions under uncertainty.
Multi-objective Decision Models: Introduction to multi-objective decision making, Concept of pareto- optimality, Goal programming formulation, The weighting method of solution, Analytic hierarchy process, Data envelopment analysis.

Module 2: (14 hours)
Sequential Decision Making (Deterministic Case): Dynamic programming, Bellman's principle of optimality, Forward recursion and backward recursion, Discrete state discrete time case.Sequential Decision Making (Stochastic Case): Stochastic processes, Markov processes, Markov chains, Markov decision problems, Algorithms for solving Markov decision problems, finite-stage models, infinite stage models.

Module 3: (14 hours)
Queuing Models for Decision Making: Application of queuing models, Features of queuing process, Characterisation of queuing models and solutions - (M/M/1):(GD/∞/∞), (M/M/1): (GD/N/∞), (M/M/c): (GD/∞/∞) models – Queuing decision models.

References

1. Ravindran., D.T. Phillips, and J.J. Solberg, Operations Research: Principles and Practice, 2nd ed., John Wiley & Sons, 1987.
2. F. S. Budnick, McLeavey and R. Mojena, *Principles of Operations Research for Management*, 2nd ed.,, Richard D. Irwin Inc., Homewood, Illinois, 1991.
3. F. S. Hillier and G. J. Liberman, *Introduction to Operations Research*, 10th ed., McGraw-Hill Education, 2014.
4. H. A. Taha, *Operations Research: An Introduction*, 9th ed.,, Pearson Education India, 2014.
5. R. Ramanathan, *An Introduction to Data Envelopment Analysis: A Tool for Performance Measurement,* SAGE Publications Pvt. Ltd, 2003.
6. S. S. Rao, *Engineering Optimization: Theory and Practice,* 2nd ed., Wiley eastern, 2009.

ME6140D BUSINESS ETHICS

Pre-requisites: Nil

Total hours: 39

L	T	P	C
3	0	0	3

Module 1: (12 Hours)

Basic principles: Meaning, Types of evil and consequences, Proportionality, Minor evils or Physical evils, Problems, Positive obligations, Rights, Cooperation in Evil, Location of responsibility, Grey areas, Economical and political considerations, Relationship between firm and employee, customers, competitors, intermediaries, and unions.

Historical perspective: culture and ethics in India, codes and culture.

Module 2: (15 Hours)

Economics and the environment - green business, ethics and competition, the ethical code, social audit; A framework for analysis and action; The sphere of personal ethics: consequences, rights and duties, virtue and character, Role of objectivity, practicability, Judgement and balancing acts, the individual and corporation.

Ethical Responsibilities of Economic Agents: role obligations, obligation to shareholder, rights and obligations to customer, obligation to pay taxes, Environmental protection, Corporate accountability, Ethical conflicts, Ethics, Government policies and laws.

Module 3: (12 Hours)

Ethical responsibilities of Organizational Leader: power, leadership, obstacles to ethical conduct, pressures for conformity, Evaluation and rewards, Job pressures and issues, organizational change, Ethics in use of Information Technology, Intellectual Property Rights, Ethics in Marketing, Ethics of advertising and sponsorship, Acquisition and merger, Multinational decision making, reconciling International norms.

References

1. J. L. Badaracco Jr.,*Business Ethics: Roles and Responsibilities*. Irwin, Chicago, 1995.
2. M. Govindarajan, S. Natarajan, and V. S. Senthilkumar, *Engineering Ethics*, PHI Learning Private Limited, New Delhi, 2004.
3. A.C. Fernando, *Business Ethics: Indian Perspective*, 2nd Edn., Pearson Education India 2013.
4. A. Crane, and D. Matten, *Business Ethics*, 4thInternational Edition, Oxford University Press2016.
5. S. K. Chakraborty, *Managerial Transformation by Values*, Sage Publications India Pvt Ltd., New Delhi 1993.
6. J. Mackey and R. Sisodia, *Conscious Capitalism*. Harvard Business Review Press Boston Massachusetts 2014.

ME6141D COMPUTER METHODS IN MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (11 hours)
Basics of Computers: Computer organization, Network and web technologies
Programming and Problem Solving: Developing algorithms and flow charts, Problem Solving strategies, top-down design, Modular programming, Object oriented concept, Steps involved in computer programming, Programming Languages.

Module 2: (14 hours)
Programming in Python: Basics-variables, data types, expressions, arithmetic operations, Control statements- conditions and looping statements, Functions-mathematical functions, user defined functions, parameters, list, dictionary, tuple, set, files, strings, exception and error handling.
Introduction to Python Packages: Numpy- arrays and matrices, Scipy and numerical computation, Matplotlib for visualization, Pandas and data frames, SymPy for symbolic computation.

Module 3: (14 hours)
Introduction to Data Structures and basic algorithms: Sorting- bubble sort, insertion sort, Searching- linear search,binary search, Hashing, Priority Queues, Graphs- Breadth First and Depth First search, Minimum Spanning tree, Dynamic Programming- shortest path problem
Computer applications in business: Framework of E-commerce, Privacy and security, Cryptography, Digital Signatures, Current Trends- Introduction to Block chain, Data Science and Business intelligence, Impact of Social Media as Business model

References

1. A. Downey, *Think Python,* 2nd ed., Oreilly publisher, 2016.
2. J.P. Tremblay and P. G. Sorenson, An Introduction to Data Structures with Applications, 2nd ed., McGraw Hill Education, 2017.
3. M. Sprankle, *Problem Solving & Programming Concepts*, 9th ed., Pearson Education India, 2013.
4. M. T. Goodrich, R. Tamassia, and M. H. Goldwasser, *Data Structures and Algorithms in Python*, Wiley, 2016.

ME6142DDATABASE MANAGEMNT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (14 hours)
Database systems - purpose - Abstraction - models, Instances and Schemes - Data independence - Data Definition Language - Data Manipulation Language.
Entity Sets - Relationship Sets - attributes - Mapping Constraints - keys - ER Diagrams. Generalisation - Aggregation.
Structure of Relational Databases - Relational algebra - Tuple relational calculus - Domain relational calculus - modifying the data base - views - SQL - Quel.

Module 2: (14 hours)
Integrity Constraints - Domain Constraints, Referential integrity - functional dependencies - assertions - triggers.
Relational Data base design - pitfalls - Normalisation's using functional, Multi-valued and join dependencies, domain key normal form - alternative approaches.
File organisation - sequential files - Mapping relational data to files - Data dictionary Storage - Buffer management – indexing – Basic concepts – B+ and B-tree index files – Static hash function – dynamic hash function – comparison of indexing and Hashing.

Module 3: (11 hours)
Query Processing - Interpretations - equivalence of expressions - Estimating cost of Query processing and access using Index.
Security and Integrity - Violations - Authorisation and views - encryption - Data validation - Multiple user access.

References
1. H.F. Korth, A. Silberschatz and S Sudharsan, *Database System Concepts*, 6nd ed., McGraw Hill Education, 2013.
2. P. O'Neil and E. O'Neil, *Data base: Principles, Programming and Performance*, 2nd ed., Morgan Kaufmann, 2000

ME6143DENTERPRISE RESOURCE PLANNING

Pre-requisites: Nil

L	T	P	C
3	1	0	3

Total hours: 39

Module 1: (14 hours)
Introduction to Enterprise Resource Planning (ERP) - History of ERP – Requirements generation to Material Requirements Planning (MRP) – Closing the MRP loop – Manufacturing Resource Planning (MRP II) – Just-In- Time to Lean manufacturing – ERP – Internet's impact on ERP – Supply chain management.

Module 2: (11 hours)
Systems and technology background – ERP systems background – ERP data input – ERP output capabilities –Reengineering - How does ERP create value – Why investigate ERP systems.

Module 3: (14 hours)
ERP Life Cycle - Deciding to go ERP - Choosing an ERP system - Designing ERP systems - Should prune processes or ERP software be changed - Choosing standard model - Artifacts and processes.
Implementing ERP systems – Big bang versus phased – After going live – training – ERP and electronic commerce – ERP Risks – Successes and failures.

References

1. Garg, V.K., and Venkitakrishnan, N.K., *Enterprise Resource Planning: Concepts and Practice*, Prentice-Hall of India Private Limited, New Delhi, 1998.
2. O'Leary, D.E., *Enterprise Resource Planning Systems: System, Life cycle, Electronic Commerce and Risk*, John Wiley & Sons, 2001.
3. Ptak, C.A., and Eli, S., ERP Tools*, Techniques and Applications for Integrating the Supply Chain*, St.Lucie Press/APICS Series on Resource Management, 2000.
4. Wallace, T.F., and Kremzar, M.H., ERP: *Making it Happen: The Implementer's Guide to Success withEnterprise Resource Planning*, John Wiley & Sons, 2001.

ME6144DDECISION SUPPORT AND EXPERT SYSTEMS

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (11 hours)
Introduction: Information systems, Human Information Processing, Newell and Simon model for human information processing-intelligence stage, decision stage, choice stage, Rasmussen model of judgment and choice, The Klein model Information and information value, Classification of decisions, Types of information systems, Decision support system.
Decision Support Systems (DSS):Subsystems in DSS-data management subsystem, model management subsystem, dialogue management subsystem, Computer Hardware for DSS, Group Decision Support Systems(GDSS).

Module 2: (14 hours)
Knowledge-Based Expert System (KBES):Introduction, What is KBES, Architecture of KBES-knowledge base, predicate logic, Production rules, Procedural programs, Inference mechanisms-backward chaining, forward chaining, inexact reasoning, non-monotonic reasoning, reasoning based on certainty factors, expert system development shell.
Search Techniques: Introduction, Problem definition and solution process, Production systems, Search techniques-breadth first search, heuristic search, agenda-driven search, Problem decomposition and AND-OR graphs.
Engineering Design Synthesis: Synthesis, Decomposition model for synthesis, building plant layout at a site-an example, Role of a synthesiser in KBES environment, An architecture for a synthesiser-a genetic tool.

Module 3: (14 hours)
Criticism and Evaluation: Methodologies used in a knowledge-based environment, A framework for critiquing and evaluation-knowledge representation framework, inference mechanism, Algorithm for overall rating of a hierarchical solution.
Applications of Decision Support Systems: Decision support in office information systems, Auditing, artificial intelligence and expert systems, Decision support systems for resource allocation.
Process Models and Knowledge-Based Systems: Expert systems for diagnosis- understanding of domain knowledge, evolution of knowledge nets, transformation of knowledge from nets to rule base, Blackboard model of problem solving-blackboard architecture, blackboard framework, integrated engineering system, an illustrative example, Conceptual Design of a Car Body Shape.
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References

1. C. S. Krishnamoorthy and S. Rajeev, *Artificial Intelligence and Expert Systems for Engineers*, CRC Press Inc., New York, 1996.
2. E. Turban, J. E. Aronson, R. V. McCarthy, *Decision Support Systems and Intelligent Systems*, 7th ed., Prentice-Hall of India, 2007.
3. V. L. Sauter, *Decision Support Systems For Business Intelligence,* 2nd ed*.,* Wiley-Blackwell , 2011.
4. V. S. Janakirama and K. Sarukesi, Decision Support Systems, Prentice Hall of India, New Delhi, 1989.
5. W. C. Holsapple, and W. B. Andrew (ed), *Decision Support Systems for Engineers: Theory and Application*, Springer-Verlag, New York, 1987.

ME 6145D INFORMATION SHARING AND INVENTORY IN SUPPLY CHAIN MANAGEMENT

Pre-requisites: ME6103D Inventory and supply chain management/ a course on supply chain management

L	T	P	C
3	0	0	3

Total Hours: 39

Module 1: (13 hours)
Supply chain information sharing: Introduction on role play based learning, Performance measures of supply chain, Basics of supply chain role play game, Operation simulation of supply chains under different types of information sharing, Statistical analysis of output of operation simulation, Identification of best performing supply chain using multi-criteria decision making method like grey relational analysis.

Module 2: (12 hours)
Vendor Managed Inventory (VMI) and collaborative supply chain: Concept of Vendor Managed Inventory (VMI), Operational simulation for analyzing effect of VMI in supply chain, Statistical and multi-criteria analyses.
Inventory management in supply chain: Concepts of inventory distribution management in supply chains, Inventory costs, Inventory management under certainty and risk, Simulation of a serial supply chain under P-system of inventory control using Excel.

Module 3: (14 hours)
Performance analysis of inventory models in supply chains: Variants of periodic inventory models, Parameter setting for performance analysis under different inventory models in serial and divergent supply chains, Performance analysis using software packages for different supply chain structures.

References
1. S. Chopra, and P. Meindl, *Supply Chain Management: Strategy, Planning and Operations*. 6th ed. Pearson Education Ltd, 2016.
2. D. Simchi-Levi, P. Kaminsky, and E. Simchi-Levi, *Designing & Managing the Supply Chain: Concepts, Strategies & Case studies*. 3rd ed., McGraw-Hill Education, 2007.
3. R. J. Tersine, *Principles of Inventory and Materials Management*, 4th ed., Prentice-Hall Inc., New Jersey, 1994.
4. Department of Mechanical Engineering, NITC, *Supply Chain Role Play Game: Instructor's Manual*. 2017.
5. K. Shah, V. R. Lakshmi Gorty and A. Phirke, (Editors),*Technology Systems and Management: Communications in Computer and Information Science,* Volume 145, Part 3, pp. 327-332, Springer-Verlag Berlin Heidelberg, 2011.
6. Fawzy Soliman (Editor), *Cloud Systems in Supply Chains*, Palgrave Macmillan, 2015.

Use of following Software Packages is proposed in this course:
1. Supply chain role play game
2. Vendor Managed Inventory (VMI)-based supply chain role play game
3. Google spreadsheet based supply chain role play game
4. Supply Chain Inventory Policy Analysis (SCIPA) software package

ME6146DPROJECT MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (12 Hours)
Project Planning: Introduction to project management, Cost of project, Social cost benefit analysis, UNIDO approach, Net benefit in terms of economic prices, Measurement of impact on distribution, Savings impact and its value, Income distribution impact, Adjustment former it and demerit, Goods Little Mirrless approach, Shadow prices.
Project Implementation**:** Development of project network, Dummy activities, Activity on node networks, Cyclic network, Forward pass and Backward pass computations, Algorithm for critical path, Total slacks, free slacks and their interpretations.

Module 2: (13 Hours)
Time-cost Trade off Procedure: Schedule related project costs, Time cost trade off, Lowest cost schedule. PERT Network: Three time estimates for activities, Estimation of mean and variance of activity times, Event oriented algorithm for critical path, Probability of meeting a schedule date.
Network Analysis: Algorithms for shortest route problems–Dijkstra's, Flyod's, Pollacks, and Dantzig's algorithms; Algorithms for minimal spanning tree–Kruskal's algorithm and Prim's algorithm; Algorithms for maximal flow problems–Ford and Fulkerson's algorithm (Labelling method), Maximum flow minimum cut explanation.

Module 3: (14 Hours)
Linear Programming Formulation of Network Problems: A flow network interpretation for determination of critical paths, Time cost trade off and maximal flow, Chance constrained linear programming for probabilistic durations of activities in PERT network.
Project Scheduling with Limited Resources**:** Complexity of project scheduling with limited resources, Levelling the demands on key resources, A simple heuristic program for resource allocation. Integer programming formulation.
Project Review and Administrative Aspects: Initial review, Performance evaluation, Abandonment analysis, Project organization, Matrix organization, Project control, Variance analysis approach, Performance analysis.

References

1. Ravindran., D.T. Phillips, and J.J. Solberg, Operations Research: Principles and Practice, 2nd ed., John Wiley & Sons, 1987.
2. J. D. Weist, and F.K. Levy, *A Management Guide to PERT/CPM*, Prentice Hall of India, New Delhi, 1994.
3. J. V. Moder, and C.R.E. Phillips, *Project Management with CPM and PERT*, 2nd ed., Van Nostrand Reinhold Company, 1964.
4. P. Chandra., *Projects: Planning, Analysis, Selection, Financing, Implementation, and Review*, 8th ed.,McGraw Hill Education (India), 2014.
5. R.W. Griffin, *Management: Principles and Applications*, Cengage Learning, 2008.

ME6147DTECHNICAL ENTREPRENEURSHIP

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (14 hours)
Introduction: Basis and challenges of entrepreneurship, Technological entrepreneurship, Innovation and entrepreneurship in technology based organizations, High Tech. Entrepreneurship, Role of technical entrepreneurs in Industrial Development, Entrepreneurial characteristics, Entrepreneurship Index and its need.
New Ventures: Concept of new ventures, Technology absorption, Appropriate technology, Networking with industries and institutions, Medium and small ventures, Product design for Rural entrepreneurs, Management concern in small and medium Enterprises.

Module 2: (14 hours)
Starting a New Technological Venture and Developing the Business: Business idea, Business plan, Marketing plan, Financial plan, Organizational plan, Financing a new venture-Sources of capital, Venture capital, Going Public.

Module 3: (11 hours)
Managing the New Technological Venture: Developing systems in new venture, managing during early operations, growth and expansion, ending the venture, Legal issues, Franchising or acquisition, Intrapreneurship, International Entrepreneurship.

References
1. B. R. Barringer, and R. D. Ireland, *Entrepreneurship: Successfully Launching New Ventures*. 5th ed., Prentice-Hall, 2016.
2. E. B. Roberts, *Entrepreneurs in High Tech- Lessons from MIT and beyond*, Oxford University Press, New York, 1991.
3. G. Vinayshil (Ed.), *Technical Entrepreneurship, Global Business Press*, New Delhi, 1992.
4. J. Timmons, *New Venture Creation: Entrepreneurship in the 1990's*, Irwin, 1998.
5. M. J. Dollinger, *Entrepreneurship: Strategies and Resources*, Irwin, Illionis, 1995.
6. R. D. Hisrich, M. P. Peters, and D. Shepherd, *Entrepreneurship*, 10th ed., Irwin Management series, McGraw-Hill Education, 2016.

ME6148D MANAGEMENT OF TECHNOLOGY AND INNOVATION

L	T	P	C
3	0	0	3

Pre-requisites: Nil

Total hours: 39

Module 1: (13 Hours)
Understanding Management of Technology, Key concepts – importance – issues. Process of technological change – Process versus product innovation in the generic product technology; Types of innovation, innovation technology evolution, Dominant design, Diffusion – methods of diffusion, factors governing diffusion. Expeditionary marketing

Module2: (13 Hours)
Managing technology: what is distinct, disruptive & strategic - Core Competence/Core Capability, Marquis anatomy of successful Innovation, strategic firm fit audit – Technology Market Matrix / Portfolio theory Technology Life Cycles – Technology and competition, technology acquisition; Integration of strategic planning and technology planning.
Key performance factors for technology management.

Module 3: (13 Hours)
Technology Strategy: - Technology intelligence – collaborative mode, Appropriation of technology Deployment in new products; simultaneous engineering; Development in the value chain.
Technology evaluation and financing – changing role of R & D, Management of manufacturing technology.

References

1. Schilling, Melissa A. *Strategic Management of Technological Innovation*, 3rd Ed. McGraw-Hill, 2010
2. Narayanan U.K., "*Managing Technology and Innovation for competitive Advantage*" Pearson Education, Asia ,2001.
3. Tarekh Khalil and Ravishankar, *Management of Technology: The key to competitiveness and wealth creation*, McGraw Hill Education; 2nd Edn. 2017
4. Burgelman et.al, *Strategic Management of Technology and Innovation* Tata Mc Graw-Hill, 2001.

ME6149D FINANCIAL MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total Hours: 39

of international taxation.

Module 1: (12 Hours)
Introduction to financial management and valuation of financial assets: corporate finance, goal of financial management, Financial management decisions; Financial statements: Working with financial statements, ratio analysis, fund flow analysis; Time value of money, Stock valuation, Bond valuation.

Module 2: (14 Hours)
Investment in long term assets: Capital budgeting decision criteria, Traditional techniques, Discounted casts flow techniques, NPV – IRR comparisons; Capital rationing, Risk analysis.
Cost of capital and long term financial policy: Raising capital, Cost of capital, Financial and operating leverage, Capital structure theories, Dividends and dividend policy, Introduction to CAPM.

Module 3: (13 Hours)
Short-term financial planning: Working capital planning and management.
Leasing: Meaning, Evaluation as an alternative source of financing.
International corporate finance: Foreign exchange, exchange rate, interest rate parity, International financing, Futures and options in corporate finance.

References
1. Van Horne, *Financial Management and policy*, 12th Ed. Prentice Hall India, (2002).
2. Breally and Myers, *Principles of corporate Finance*, 7th Ed. TMH, (2002).
3. Ross, Westerfield and Jordan, *Fundamentals of corporate Finance*, 6th Ed. TMH, (2002).
4. Damodaran, "*Corporate Finance*", John Wiley & Sons, (2002).

ME6150D INVESTMENT MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (13 hours)
Investment environment: - securities and market, investment process, capital market, primary and secondary, efficient markets. Investment theory: Portfolio selection problem

Module 2: (13 hours)
Portfolio analysis, CAPM, Factor models, Arbitrage pricing theory.
Common stocks – characteristics, financial analysis of common stocks, dividend, earnings, investment management and performance evaluation.

Module 3: (13 hours)
Fixed income securities: - Types, Bond valuations, Bond analysis and portfolio management, Mutual funds, options, futures and international investing.

References
1. Alexander, Sharpe and Bailey, *Investments*, 3rd Ed. Prentice Hall of India, 2002
2. Bodie, *Essentials of investments*, 4th Ed. Prentice Hall of India, 2001
3. Corrado and Jordan, *Fundamentals of investments*, 2nd Ed. Tata McGraw -Hill, 2001.
4. Haugen, *Modern Investment Theory*, 5th Ed. Prentice Hall of India,2002

ME6151D DISASTER MANAGEMENT

Pre-requisites: Nil

L	T	P	C
3	0	0	3

Total hours: 39

Module 1: (13 hours)
Introduction Disaster and Hazards: classification and characteristics of hazards, categorization of disasters types of disasters, biological hazard, anthropologic/technological hazards; Environmental degradation: land and soil, air and water, deforestation, desertification. Disaster risk, factors of vulnerability, methods of vulnerability, impact of disaster; Disaster preparedness – Goals and objectives of ISDR Programme- Disaster and development: Development plans and disaster management – Alternative to dominant approach – disaster-development linkages -Principle of risk partnership

Module 2: (13 hours)
Disaster Integration: Evolution of disaster management, disaster management cycle, principles of integration, hazard integration practices; Response to national disasters: reducing deforestation, sustainable forest management, dealing with the effects of climate change mitigation of floods, drought, earthquake, storms, landslide, Tsunami.
Mitigation of manmade disaster: control of gaseous contaminants, mitigation of thermal pollution, strategies for managing e-wastes, bio weapons.

Module 3: (13 hours)
Disaster preparedness, Inland disaster assistance, disaster resilience – disaster management in India - Risk identification and Risk sharing: Trigger mechanism – constitution of trigger mechanism, risk reduction by education, disaster information network, risk reduction by public awareness.
International framework in disaster management, strategy of United Nations for disaster reduction.
Implication of development planning – financial arrangements – areas of improvement –disaster preparedness – community based disaster management – emergency response.

References

1. Stark, John. *Product Lifecycle Management: Paradigm for 21st Century Product Realisation*, Springer-Verlag,2004
2. M M Sulphey, *Disaster Management*, PHI Learning, 2016
3. Fabio Giudice, Guido La Rosa, *Product Design for the environment-A life cycle approach*, Taylor & Francis,2006
4. Saaksvuori Antti and Immonen Anselmie, *Product Life Cycle Management*, 2nd Edition Springer, 2005
5. Michael Grieves, *Product Lifecycle Management*, Tata McGraw-Hill, 2006