

DELHI TECHNOLOGICAL UNIVERSITY

SCHEME OF TEACHING AND EVALUATION

MASTER OF TECHNOLOGY IN INDUSTRIAL ENGINEERING AND MANAGEMENT(IEM)

Semester-I	
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Semester-II

	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
	1	IEM 502	Supply Chain Management	Core	4	3	0	2	15	25	20	40	-	24
	2	IEM 504	Advanced Operations Research	Core	4	3	0	2	15	25	20	40	-	
	3	IEM 506	Department Elective 2	Elective	4	3/4	0	2/0	15/20	25/0	20/30	40/50	-	
	4	IEM 508	Department Elective 3	Elective	4	3/4	0	2/0	15/20	25/0	20/30	40/50	-	
	5	IEM 510	Research Methodology & IPR (Online)_	-	4	3	0	2	15	25	20	40		
	6	IEM 512	Skill Enhancement Course 2/Industrial Training (Online)	-	4	-	-	-	-	50	-		50	

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Semester-III														
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
	1	IEM 601	Industrial Economics & Management	Core	4	3	0	2	15	25	20	40	-	16
	2	IEM 602	Open Elective 1 (Online)		4	3/4	0	2/0	15/20	25/0	20/30	40/50		
	3	IEM 603	Minor Project/Research Thesis/Patent		8	-	-	-	-	-	-	-		
Semester-IV														
	S.No.	Course Code	Course Name	Type/Area	Cr	L	T	P	CWS	PRS	MTE	ETE	PRE	Total Credits
	1	IEM 604	Major Project/Research Thesis/Patent	Core	16	0	0	16	0	-	0	100	-	16

List of Electives

THE 509 Department Elective 1	THE 506 Department Elective 2	THE 508 Department Elective 3	THE 603Open Elective 1
IEM 5091 Product Design & Development	IEM 5061Work study and Ergonomics	IEM 5081 Value Engineering	IEM 6021Supply Chain Analytics
IEM 5092 Modelling & Simulation	IEM 5062 Industrial Waste Management	IEM 5082 Live Industry Project	IEM 6022 Logistics & Warehousing Management
IEM 5093 AI/ML in Industrial Engineering and Management	IEM 5063 Computer Integrated Manufacturing & Robotics	IEM 5083 Management Information Systems	IEM 6023 Knowledge Management
IEM 5094 Decision Science Modelling	IEM 5064 Enterprise Resource Planning	IEM 5084 Principles of Management	IEM 6024Reliability Engineering
IEM 5095 Design of Experiments	IEM 5065 Innovation and Entrepreneurship	IEM 5085 Maintenance Management	IEM 6025Safety and Disaster Management
			IEM 6026 Optimization Techniques

Semester I

IEM-501:DataAnalytics

Probability Theory: Sample Spaces- Events - Axioms – Counting - Conditional Probability and Bayes’ Theorem – The Binomial Theorem – Random variable and distributions: Mean and Variance of a Random Variable-Binomial-Poisson-Exponential and Normal distributions.

Curve Fitting and Principles of Least Squares- Regression and correlation. Sampling Distributions & Descriptive Statistics: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Sampling distributions (Chi-Square, t, F, z).

Test of Hypothesis- Testing for Attributes – Mean of Normal Population – One-tailed and two-tailed tests, F-test and Chi-Square test, Analysis of variance ANOVA – One way and two-way classifications. Tabular data- Power and the computation of sample size- Advanced data handling

Multiple regression- Linear models- Logistic regression-Rates and Poisson regression

Nonlinear curve fitting. Density Estimation- Recursive Partitioning- Smoothers and Generalised Additive Models - Survival Analysis- Analysing Longitudinal Data- Simultaneous Inference and Multiple Comparisons- Meta-Analysis- Principal Component Analysis- Multidimensional Scaling Cluster Analysis.

Introduction to R- Packages- Scientific Calculator- Inspecting Variables- Vectors Matrices and Arrays- Lists and Data Frames- Functions- Strings and Factors- Flow Control and Loops- Advanced Looping- Date and Times.

Introduction to Python Packages- Fundamentals of Python- Inserting and Exporting Data- Data Cleansing Checking and Filling Missing Data- Merging Data- Operations- Joins.

Books:

1. Richard Cotton, "Learning R", O'Reilly, 2013.
2. Dalgaard, Peter, "Introductory Statistics with R", Springer Science & Business Media, 2008.
3. Brian S. Everitt, "A Handbook of Statistical Analysis Using R", Second Edition, LLC, 2014.
4. Samir Madhavan, "Mastering Python for Data Science", Packt, 2015.
5. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, 4th edition, Academic Press; 2009.
6. Paul Teetor, "R Cookbook", O'Reilly, 2011. 7. Mark Lutz, "Learning Python", O'Reilly, 5th Edition, 2013

IEM-503: Production & Operations Management

Managing operations; planning and design of production and operations systems. Service characteristics. Facilities planning location, layout, and movement of materials. Line balancing. Analytical tools and techniques for facilities planning and design. Production forecasting. Aggregate planning and operations scheduling, Production Planning and Control. Purchasing, Materials Management, and Inventory control and JIT Material Requirements Planning. MRP II, ERP, Optimization techniques applications. Work-Study, Value Engineering, Total quality & statistical process control. Maintenance management and equipment policies. Network planning and control. World-class manufacturing and factories of the future, Case studies.

Books:

1. Operations Management by Jay Heizer and Barry Render, Pearson Learning.
2. Operations Management by Russell and Taylor, John Wiley and Sons

IEM-505: Industry 4.0 & Smart Manufacturing

Introduction to Industry 4.0: Definition of Industry 4.0, The Various Industrial Revolutions, Digitalisation, and the Networked Economy, Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation

Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services Cyber-Physical Systems (CPS) and Cyber-Physical Production Systems (CPPS): cyber-physical systems (Definitions, demarcation to embedded systems, ubiquitous computing, etc.), Core elements of Cyber-Physical Systems and Cyber-Physical Production Systems, Control theory, and real-time requirements, Self-organization principles ("Self-X", autonomy, negotiations), Communication in cyber-physical systems, Design Methods for Cyber-physical Systems (Modelling, Programming, Model-Integrated Development),

Applications for cyber- physical systems.

Cloud Manufacturing and the connected factory: Virtualization, Cloud Platforms, Big data in production, Cloud-based ERP and MES solutions, Connected factory applications, IT security for cloud applications.

Big Data Analytics: Introduction to the technology used for Big Data analytics and applications in various fields.

3D printing: Introduction to 3D printing and its Applications.

Robotic Automation and Collaborative Robots, Support System for Industry 4.0, Mobile Computing, Related Disciplines, Cyber Security

Business issues in Industry 4.0: Opportunities and Challenges, Future of Work and Skills for Workers in the Industry 4.0 Era, Strategies for competing in an Industry 4.0 world.

Books: (Refer various research articles)

1. Industry 4.0: The Industrial Internet of Things by Alasdair Gilchrist, APRESS.
2. Handbook of Industry 4.0 and SMART Systems by Diego Galar, Pascual Pasquale Daponte, Uday Kumar, CRC Press

IEM-507: Advanced Operations Research

Introduction, Classification of optimization problems, Applications of optimization, concepts of design vector, Design constraints, constraint surface, objective function surfaces, and multilevel optimization.

Karmarkar's method of solving L.P. problems, Quadratic programming, non-linear programming – unconstrained optimization techniques, Basics of constrained optimization.

Integer linear programming methods and applications, Introduction to integer non-linear programming,

Basics of geometric programming. Multi-objective optimization methods and applications, Formulation of problems – Separable programming and stochastic programming. Introduction to Genetic algorithms, Simulated Annealing, neural network-based optimization, and optimization of fuzzy systems.

Books

1. Kalyanmoy Deb, Optimization for Engineering design – algorithms and examples. PHI, New Delhi, 1995.
2. Singiresu S. Rao, “Engineering optimization – Theory and practices”, John Wiley and Sons, 1998.
3. Garfinkel, R.S. and Nemhauser, G.L., Integer programming, John Wiley & Sons, 1972

IEM-5091: Product Design & Development

Product definition, New product development concept, product development process, consumer behaviour, identifying customer needs. Establishing product specification, concept generation, concept selection, and product architecture. Industrial design, design for manufacturing prototyping, Economic analysis of new products. Test marketing and commercialization of new products.

Books:

1. Chitale A.K. and Gupta R.C., Product Design and Manufacturing, PHI
2. Saunders, M.S. and McCormick E.J., ‘Human Factors in Engineering & Design’, McGraw Hill.
3. Ulrich K.T. and Eppinger S.D., Product Design and Development, McGraw Hill. IEM-113: Enterprise Resource Planning

IEM-5092: Modelling & Simulation

Introduction to systems and modelling: discrete and continuous system, Limitations of simulation, areas of application, Monte Carlo Simulation. Discrete event simulation and their applications in queueing and inventory problems.

Random number generation and their techniques, tests for random numbers Random variable generation – Analysis of simulation data, Input modelling – verification and validation of simulation models – output analysis for a single model.

Simulation languages and packages - ARENA, QUEST, VMAP - Introduction to GPSS – case studies - Simulation of manufacturing and material handling system.

Books:

1. Jerry Banks and John, S. Carson II, ‘Discrete – Event System Simulation’, Prentice Hall Inc., New Jersey, 1984.
2. Geoffrey Gordon, ‘System simulation’, Prentice Hall, NJ, 1978.
3. Law, A.M. and W.D. Kelton, ‘Simulation modelling analysis’, McGraw Hill, 1982.

IEM-5093: AI/ML in Industrial Engineering and Management

Artificial Intelligence: Decoding Artificial Intelligence, Fundamentals of Machine Learning and Deep Learning, Machine Learning Workflow, Performance Metrics

Machine Learning Applications: Basics of Machine Learning, The Machine Learning Process, Into Machine Learning working cycle, Preparing Data, Running Experiments, Finding the Model, Training the Model, Deploying and using a Model, Machine Learning in practice (examples of existing or future applications in the field of manufacturing)

References: Refer Various Research Articles

IEM-5094: Decision Science Modelling

Decision-Making Models and Theories, Decisions Involving Multiple Objectives, Multiple Objective Decision Making Problems Through SMART and Alternative Models, Decision Making under Risk and Uncertainty, Decision Trees, Influence Diagrams and Bayesian Networks, System Dynamic Models, Group Decision-Making & Negotiations.

Application of fuzzy sets in optimization and decision-making problems,

Multi-criteria decision-making tools-AHP & ANP, Best-Worst Method, TOPSIS, ELECTRE, PROMETHEE, DEMATLE, VIKOR.

Data Envelopment Analysis: Return to scale, CCR, and BCC models.

Books:

1. Multiple Criteria Decision Making in Supply Chain Management by Ravindran, A. Ravi, CRC Press.
2. Decision Sciences: Theory and Practice: Dutta, Jaydeep, Gupta, Aparna, Sengupta, Raghunandan, Cengage Learning.

IEM-5095: Six-Sigma and Lean Manufacturing

Lean & Six Sigma – Introduction, Lean - Evolution & Steps, Introduction to Lean Manufacturing, Lean - Specify Value - Quality at Source.

Total Productive Maintenance: 5S Concepts, 5S Implementation Lean - Identify Value Stream - Process Mapping, Lean - Pull - Visual Controls, Lean - Pull - Push & Pull Systems, Lean - Pull – JIT Statistics - Data & Descriptive Statistics, Statistics - Distributions,

Process Variations & Sigma, Six Sigma: Overview, Six Sigma (basics and history of the approach, methodology, and focus), the

application of Six Sigma in production and service industries, Relationship of Six Sigma and Lean Management, linking Six Sigma project goals with organizational strategy; Basic description of the DMAIC methodology

Fundamental of Quality: Contribution of quality gurus, quality cost. statistical process control & process capability. Acceptance Sampling plans for attribute and variable. Taguchi quality loss function and concept of robust design. Concept of six sigma, FMEA, QFD, Poka Yoke. **ISO 9000 series of standard**, QS 9000, TQM, Quality circles. Benchmarking. Reliability.

Books:

1. Becoming Lean-Inside Stories of U.S. Manufacturers, Jeffrey K. Liker, Productivity Press, Portland, Oregon
2. The Six Sigma Handbook, Third Edition, Thomas Pyzdek & Paul Keller, McGraw-Hill

Semester II

IEM-502: Operations Research

Linear Programming Problem, Simplex technique, Big-M and Two-phase method, Duality and Post Optimal Sensitivity Analysis.

Integer Linear Programming- Gomory's Cutting plane and Branch & Bound methods.

Network Models- Shortest Path problem, Spanning tree problem, Maximum flow problem, Travelling salesman problem.

Goal Programming, Queuing Models.

Books:

1. Operations Research by Hamdy A. Taha, 6/e, PHI
2. S.S. Rao, Optimization Techniques, Wiley Eastern
3. Operations Research by J.K. Sharma, McMillan.

4. Operations Research by Panneerselvam, PHI

IEM-504: Supply Chain Management

Role of supply chain management in Economy and Organization- Introduction to SCM, Evolution, Key concepts, Decisions, and Importance of SCM. Supply chain strategy and Performance Measures- Competitive supply chain strategies, CRM strategy, Supplier relationship strategy- Performance Measures (Financial, Productivity, Quality and cycle time). Supply chain drives- Introduction, Facilities, Inventory, Transportation, and Information. Supply chain design- Network design and operation models.

Sourcing and Transportation- Role of sourcing, Supplier selection and contracts, Procurement process, Role of Transportation, Design options for the transportation network.

Planning and Managing Inventories- Introduction, cycle/safety/seasonal stock, Inventory for short life cycle products, Multi echelon inventory, Bullwhip Effect, Risk Pooling.

Information Technology in SCM- Role of IT, E-business and future trends. Supply chain innovations- Introduction, Supply chain integration, Restructuring, Agile supply chains, Case studies.

Books:

1. Designing and Managing the Supply Chain: David Simchi-Levi, Philip Kaminsky, Edith Simchi – Levi, Ravi Shankar, Mc Graw Hill Education, 2008
2. Supply chain management text and cases: Janat Shah, Pearson Education, 2009.
3. Supply chain management strategy, planning, and operation, Sunil Chopra, Peter Meindl, PHI.

Supply chain management: Chopra, Pearson Education, 2009. 5. Business logistics/Supply chain management, 5/e: Ballou, Pearson Education

IEM-5061: Total Quality Management

Concepts of TQM: Philosophy of TQM, Quality philosophies of Deming, Crosby. Juran Trilogy, Customer Focus, Organization, Top management commitment, Teamwork.

TQM process: QC tools, Problem-solving methodologies, New management tools, Work habits, Quality circles, Benchmarking, Strategic quality planning.

TQM systems: Quality function deployment, Standardization, Designing for quality, Manufacturing for quality, Failure Mode Effect Analysis.

Statistical Process Control; Advanced Analytical Tools Statistical Design of Experiments; Taguchi Approach; Cost of Quality; Reliability and failure analysis. FMECA, Quality Function Deployment, Benchmarking, Concurrent Engineering.

Quality system: Need for ISO 9000 system, Advantages, Clauses of ISO 9000, Implementation of ISO 9000, Quality costs, Quality auditing, Case studies.

Implementation of TQM: Steps, KAIZEN, 5S, JIT, POKA YOKE, Case studies.

Environment Management Systems: Need for proper Environment Management Systems and their economic implications. Environment Management Systems, Green Products and Strategies, Environment Assessment: Environment Protection Act, ISO 14000, Case Studies.

Text Books:

1. Total Quality Management by Besterfield et al., Pearson Education, India, 2009
2. The Essence of Total Quality Management by John Bank, PHI, 1993.
3. Total Quality Management by Rose, J.E., Kogan Page Ltd., 1993

IEM-5062: Industrial Waste Management

Introduction to waste and waste management. The concept of wastivity and its inter-relationship with Productivity Quality and Flexibility. Wastivity and productivity measurement. The categories of industrial systems waste. Stages and causes of waste generation in industrial systems. Waste reduction measures and systems in the industry. Collection and disposal system of scrap, surplus, and obsolete items. Recycling and processing of industrial waste. Industrial pollution and environment control.

Management of waste in industrial and service sectors. Management of manpower waste and unemployment. Management of energy waste in the national economy. Energy recycling, Waste management, and energy conservation. Total energy concept, overall energy wastivity. Interfaces of waste management: environment control, nature conservation, resource development, Quality and Productivity Management, Business Process Reengineering. Role of legislation and government. Waste management and national planning.

Books:

1. IndustrialWasteTreatmentHandbook,1stEdition,Butterworth-Heinemann
2. Principlesof Industrial WasteManagement,AlinaCovali,LAPLAMBERTAcademic Publishing, Mauritiu
3. Waste Management Practices: Municipal, Hazardous, and Industrial, Second Edition, by John Pichtel

IEM-5063: FinancialManagement

Financial Statement: balance sheet, P&L accounts, Financial analysis, liquidity ratios, leverage ratio, profitability ratios and activity ratios.

Profit planning: Break even analysis, marginal analysis, EPS, P/E ratio, Return- on- Investment leverage.

CapitalBudgeting:NatureofCapitalbudgetingDecisions,timevalueofmoney, Various approaches to evaluate investment proposals.

Risk and required return: Capital asset theory, weighted average required return, determinationofrequiredreturn,valuationofthefirmscommonstock. Short term and long term financial decisions: Sources of short-term finance, Sources of long termfinancing:convertiblesecurities,warrants,effectivecostoflongtermdebt. **Dividends policies and decisions:** Nature of dividend decision, factors affecting dividend decisions,alternativeformofdividends,developingdividendpolicies.

Books:

1. ChandraPrasanna,FinancialManagement,Theory&Practice,TataMcGrawHill.
2. Kuchal,S.C.FinancialManagement&AnalyticalandConceptualApproach,Chitanaya Publishing House, Bombay.
3. JohnJ.Humpton,FinancialDecision-Making,PrenticeHallIndia.
4. I.M.Pandey,FinancialManagement,VikasPublishingHouse.

IEM-5064: Enterprise Resource Planning

ERP: An Overview - Benefits of ERP - ERP and Related Technologies - Business Process Reengineering (BPR).

Data Warehousing - Data Mining - On-line Analytical Processing (OLAP) - Supply Chain Management.

ERP Implementation - ERP Implementation Lifecycle - Implementation Methodology Vendors, Consultants and Users - Contracts with

Vendors, Consultants and Employees Project Management and Monitoring.

Business Modules in an ERP Package - ERP Market - ERP-Present and Future – Turbo Charge the ERP System.

Enterprise Integration Applications (EIA) - ERP and E-Commerce - ERP and Internet Future Directions in ERP.

Books

1. Alexis Leon, ERP Demystified, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2002
2. Brady, Enterprise Resource Planning, Thomson Learning, 2001
3. S. Sadagopan, ERP: A Managerial Perspective, Tata McGraw-Hill Publishing Company Limited, New Delhi 1999

IEM-5065: Innovation and Entrepreneurship

Introduction to Entrepreneurship: Entrepreneurs; entrepreneurial personality and intentions - characteristics, traits and behavioural; entrepreneurial challenges.

Entrepreneurial Opportunities: Opportunities. discovery/ creation, Pattern identification and recognition for venture creation: prototype and exemplar model, reverse engineering

Entrepreneurial Process and Decision Making: Entrepreneurial ecosystem, Ideation, development and exploitation of opportunities; Negotiation, decision-making process and approaches, Effectuation and Causation.

Crafting business models and Lean Start-ups: Introduction to business models; Creating value propositions-conventional industry logic, value innovation logic; customer-focused innovation; building and analyzing business models; Business model canvas, Introduction to lean startups, Business Pitching.

Organizing Business and Entrepreneurial Finance: Forms of business organizations; organizational structures; Evolution of Organisation, sources, and selection of venture finance options and its managerial implications. Policy Initiatives and focus; the role of institutions in promoting entrepreneurship.

Books

1. Ries, Eric (2011), The Lean Start-up: How constant innovation creates radically successful businesses, Penguin Books Limited.
2. Blank, Steve (2013), The Startup Owner's Manual: The Step by Step Guide for Building a Great Company, K&S Ranch.
3. S. Carter and D. Jones-Evans, Enterprise and small business-Principal Practice and Policy, Pearson Education (2006)

4. T.H.Byers,R.C.Dorf,A.Nelson,TechnologyVentures:FromIdeatoEnterprise, McGraw Hill (2013)

IEM-5081: Value Engineering

An overview of value engineering (VE) - Definition, Concepts, and approaches of value analysis and engineering – evaluation of VE.

Evaluation of function, Problem setting system, problem-solving system, setting and solving management-decision – type and services problem, evaluation of value. Results accelerators, Basic steps in using the systems Value analysis - Understanding the decision environment, Effect of value analysis on other work in the business.

VE Team, Co-ordinate, designer, different services, definitions, construction management contracts, value engineering case studies, Effective organization for value work, function analysis system techniques-FAST diagram.

Books:

1. Parker,D.E.,”ValueEngineeringTheory”,SundaramPublishers,1990
2. Miles, L.D., “Techniques of Value Engineering and Analysis”, McGraw Hill Book Co.,2nd Edn., 1972.
3. TuftyHerald,G.CompendiumonValueEngineering,TheIndoAmericanSociety,1st Edn., 1983

IEM-5082: Live Industry Project

In this elective, the students will take a live project from the industry. The evaluation will be based on the submission of the project report and its presentation.

IEM-5083: Management Information Systems

Concepts of MIS: Global factors responsible for the growth of information systems, Types of Information Systems Evolution of information theory, Characteristics of management information System, Richard Nolan MIS Stages theory, Information Resource Management, Management information system organization functions MIS Long-range planning Meaning and role of MIS in an organization. Analysis and design of information systems;

Conceptual modelling of data and process in organizations: System development life cycle model, Methods of collection of data, tools for modelling and analysis of data: Concept of DataBase Database management systems and its functions Data flow diagram, Data dictionary, Data banks. Tools for modelling and analysis of processes: Flow charts, Decision tables, Decision trees. Transform analysis, Transaction analysis. Information systems audit. Impact of MIS on organizations. The usefulness of various industrial engineering

techniques in the design of MIS.

Books:

1. Management Information Systems, Laudon and Laudon, PHI (1999)
2. Management Information Systems by Jerome Kanter
3. Management Information Systems by Davis Gordon.

IEM-5084: Principles of Management

Management principles: Management functions, Roles & Skills, History of management thought - Various theories and approaches to management, Management by objectives

Formal and informal organizations: Organisation structure and design – Organization principles of line and staff authority and span of control.

Motivation Theory: Concept of Motivation, Maslow Need Hierarchy Theory, Herzberg's Motivation Hygiene Theory, McGregor's Theory X and Theory Y and Theory Z, Motivational applications.

Decision Making: Planning process, tools, and techniques: Fundamentals of Directing, Decision-making process, approaches, and aids.

Leadership: Concept of Leadership, Leadership theories, Leadership Styles, Concept of Power and Concept of Authority and Responsibility, Delegation, decentralization, and autonomy

Communication: Concept of Communication, types of communication, aids, and Barriers in communication, Conflict, and Coordination.

Managerial control-need and principles: Role of information in control - Control methods and techniques - Managerial ethics and social responsibility.

Text Books:

1. Principles and Practice of Management by L.M. Prasad.
2. Introduction to Management by Plankett, W.R. and Attner, R.F., Kent Publishing Company.

IEM-5085: Maintenance Management

Reliability: Hazard rate, mean time to failure. Hazards models. Constant hazard Weibull model.

System Reliability: Series, parallel, and mixed configurations. k-out-of-n-structure. Economics of introducing a stand-by or redundancy into a production system, optimum design configuration of a series/parallel system: maximizing reliability subject to budgetary constraint optimum level of active parallel redundancy for equipment with components subject to failure.

Maintainability: Maintainability increment Equipment and mission availability.

Replacement Decisions: Economic models block replacement policy, age replacement policy, replacement policies to minimize downtime, the economics of preventive maintenance.

Inspection Decisions: Optimal inspection frequency to profit-maximizing, minimization of downtime, and availability maximization.

Overhaul and Repair Decisions: Optimal overhaul/repair/replace maintenance policies for equipment subject to breakdown finite and infinite time horizon. Optimal repair effort of a maintenance workforce to meet fluctuating taking into subcontracting opportunities.

Spares Provisioning: Spares provisioning for single and multi-echelon systems under budgetary constraints. Maintenance Organisation: Computer application in maintenance management, MIS for maintenance.

Books:

1. Gopalakrishnan, P. and Banerji, A.K. (2009), Maintenance and Spare Parts Management, PHI Learning.
2. Srivastava, SK. (2012), Maintenance Engineering Principles, Practices and Management, S.Chand Publishers.

Semester III

IEM-601: Computer Integrated Manufacturing & Robotics

Information to automation & CIM, NC, CNC, DNC, PLC Manual & Computer-aided part programming Group Technology & Computer-aided process planning, Automated Guided Vehicles.

Automated material handling system, Automatic storage & retrieval system. Robotics in Manufacturing System.

Introduction to robots and robotic arms.

CAD/CAM: Solid modelling, a database for CAD/CAM, and data exchange standards. Flexible Manufacturing System.

Books:

1. Ranky P.G. Computer Integrated Manufacturing, Prentice-Hall.
2. Mikell P. Groover, Automation, Production Systems and Computer-Integrated Mfg, Prentice Hall
3. Rao, P N, CAD/CAM, TMH

IEM-6021: Supply Chain Analytics

Introduction to mathematical modelling as a tool to address challenges in production logistics and supply chains. Problem formulation and choice of modelling. Linear, dynamic, non-linear, and stochastic programming. Flow and network modelling. Queueing models and Markov chains. Some analytical results and use of discrete event simulation. Monte Carlo simulation. Stochastic inventory models. Forecasting. Reliability and maintenance of the production line. Synchronization of maintenance and production activities. Models and visualization of cyber-physical systems in real-time. Decision trees. Expected Utility theory.

Books

1. Márquez Adolfo Crespo (2010) “Dynamic Modelling for Supply Chain Management: Dealing with Front-end, Back-end and Integration Issues”, Springer
2. Simchi-Levi, David, Chen, Xin, Bramel, Julien (2014), “The Logic of Logistics Theory, Algorithms, and Applications for Logistics Management”, Third Edition, Springer, ISBN- 978-1- 4614-9149-1
3. Tang Christopher S, Teo Chung-Piaw and Wei Kwok-Kee (Eds) (2008), “Supply Chain Analysis: A Handbook on the Interaction of Information, System and Optimization”, Springer, ISBN-13: 978-0- 387-75239-6
- 4.

IEM-6022: International Logistics & Warehousing Management

Globalization and International Trade :

Growth in International Trade Measuring Logistics Performance, Globalisation, Outsourcing, Offshoring Failures in Outsourcing, Evaluating and Selecting Outsourcees, Outsourcer and Outsourcee Relationship Development, Supply Chain Integration, Supply Chain Collaboration

Transport in Supply Chains: Characteristics of the Different Transport Modes, Transport Operations, Distribution Centres and the Role of Factory Gate Pricing, Efficiency of Transport Services, Transport Security, Piracy, Global Transport Security Initiatives, Transport Security Technology, Fourth-Party Logistics, Selecting Logistics Service Providers and Services.

Warehousing and Materials Handling: Warehousing In Global Supply Chains, Warehouse Layout And Design, Warehouse Management Systems, Materials Handling And Storage, Work Organisation And Job Design.

Supply Chain Vulnerability, Risk, Robustness, and Resilience: Changing Times and an Uncertain World, The Shortcomings of Risk Management, The Need for Holistic Approaches. **Sustainable Logistics and Supply Chain Systems:** The 'Green Revolution' and Supply Chain Redesign, The Link Between Economic Growth and Transport Growth, The Role of 'Scale' in Logistics and SCM Efficiency Solutions.

Reverse Logistics: Definition, Motivations for Reverse Logistics, Recovery Options in Reverse Logistics, Characteristics of the Remanufacturing Environment in Reverse Logistics, Factors for Successful Reverse Logistics Implementation, Performance Measures in Reverse Logistics, Case Studies.

Books:

1. **Global Logistics and Supply Chain Management (2nd Edition)** Mangam, Lalwani, Butcher, & Javadpour, John Wiley & Sons, 2nd Edition, 2011
2. **Logistics and Supply Chain Management**, Martin Christopher, Pearson Education Limited

IEM-6023: Knowledge Management

Overview of Knowledge Management: Introducing Knowledge Management, need for Knowledge Management, Forces Driving Knowledge Management, Issues in Knowledge Management. Cognitive Psychology, Data, Information and Knowledge, Kinds of Knowledge, Expert Knowledge, Thinking and Learning in Humans, Knowledge vs Intelligence, dumb search, Heuristic search in Knowledge-Based Systems.

Knowledge Management Systems Life Cycle: Challenges in KM Systems Development, Conventional Vs KM Systems Life Cycle (KM SLC), Key Differences, Key Similarities, KM SLC Approaches. Knowledge Creation, Nonaka's Model of Knowledge Creation & Transformation, Knowledge Architecture, Acquiring the KM System.

Knowledge Capturing Techniques: On-Site Observation (Action Protocol), Brainstorming, Electronic Brainstorming, Protocol Analysis (Think-Aloud Method), Consensus Decision Making, Repertory Grid, Nominal Group Technique (NGT), Delphi Method, Concept Mapping, Blackboarding.

Knowledge Codification: Modes of Knowledge Conversion, Codifying Knowledge, Codification Tools/Procedures, Knowledge Maps, Decision Table, Decision Tree,

Frames, Production Rules, Case-Based Reasoning, Knowledge-Based Agents, Knowledge Developer's Skill Set, Knowledge Requirements, Skills Requirements.

Learning from Data: The Concept of Learning, Data Visualization, Neural Network (Artificial) as Learning Model, Supervised/Unsupervised Learning, Applications in Business, Relative Fit with KM, Association Rules, Classification Trees.

Preserving and Applying Human Expertise: Knowledge-Based Systems: Knowledge-Based System: User's View, Developer's View, Knowledge Representation: Rules, Inference chains, Knowledge Representation: Frames, Functional attributes, Frame-Based Reasoning, Rule-Based Reasoning, forward chaining: Rule Interpretation Process, Backward chaining: Rule Interpretation Process, Backward chaining: Closed World Assumption, Knowledge engineering, Tools. Case-Based Reasoning Systems: Weaknesses of rule-based systems, Case-Based Reasoning (CBR), Case-Based Reasoning (CBR): Adaptation, Case-Based Reasoning (CBR): Successful vs failed cases, Indexing the case library: Flat Library, Indexing the case library: Shared feature networks, Indexing the case library: Redundant shared feature networks, Advantages and Disadvantages of Case-based systems.

Knowledge Elicitation: Converting Tacit Knowledge to Explicit: Basic One-On-One Interviews: Specific Problem-Solving, Knowledge-Gathering Sessions, Basic One-On-One Interviews: Knowledge Elicitation Sequence, Observational Elicitation, Observational Elicitation: Quiet on-site observation, Exercising the expert, Problem description and analysis,; Role Reversal Techniques, Team Interviewing, Team Interviewing: One-on-many, Team Interviewing: Many-on-many, Many-on-one.

Books:

1. Dalkir, K. (2011). Knowledge Management in Theory and Practice (2nd edition). Cambridge, Massachusetts: The MIT Press.
2. Hislop, D., Bosua, R., & Helms, R. (2018). Knowledge management in organizations: A critical introduction. (4th edition) Oxford: Oxford University Press.
3. Mohapatra, S., Agrawal, A., & Satpathy, A. (2016). Designing Knowledge Management-Enabled Business Strategies. Switzerland: Springer.
4. Becerra-Fernandez, I., & Sabherwal, R. (2015). Knowledge Management Systems and Processes. (2nd edition). New York: M.E. Sharpe.
5. North, K., & Kumta, G. (2014). Knowledge management: Value creation through organizational learning. Switzerland: Springer.
6. Jashapara, A. (2011). Knowledge Management: An Integrated Approach (2nd edition). Harlow: Pearson Education Limited.

IEM-6024: Reliability Engineering

Introduction: Concepts of quality and reliability, a brief history, terms, definitions, reliability function, MTTF, Hazard rate function, bathtub curve, conditional reliability.

Constant failure rate models: Exponential reliability, failure modes, failure modes with exponential distribution, applications, two parameter exponential distribution, Poisson process.

Time-dependent failure models: Weibull distribution, burn-in screening for Weibull, three-parameter Weibull distribution, Normal and Lognormal distributions

Reliability of systems: Series, parallel configurations, combined systems, k-out-of-n systems, complex configurations, common failure modes, minimal cuts, and minimal paths. **State-dependent systems:** Markov analysis, load sharing, standby systems, degraded systems

Physical reliability models: Static models- random stress and random strength, dynamic models, periodic models, random loads.

Design for reliability: Reliability specification, Lifecycle costs, reliability allocation, design methods, failure analysis, FTA.

Reliability testing: Life testing, burn-in testing, acceptance testing- binomial acceptance testing. **Reliability growth testing:** Reliability growth process, idealized growth curve, Duane growth model.

Text Book:

1. Introduction to Reliability and Maintenance Engineering by Charles E. Ebeling, Tata McGraw-Hill, India.
2. Introduction to Reliability Engineering by E.E. Lewis, John Wiley & Sons, New York
- Reliability-based design by S.S. Rao, McGraw-Hill, New York

IEM-6025: Safety and Disaster Management

Safety: Heinrich's Axioms of Industrial Safety, Concepts of Safety, Organization for Safety, Organization, Definition, Need & Principles, Organizing for Health, And, Environmental, Activities, Organization Structure, Function & Responsibilities

Disaster: Different Types of Disaster- Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides, etc. Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism, etc. Causes, effects, and practical examples for all disasters.

Risk and Vulnerability Analysis: Risk- Its concept and analysis, Risk Reduction, Vulnerability- Its concept and analysis, Strategic Development for Vulnerability Reduction.

Disaster Preparedness: Disaster Preparedness: Concept and Nature, Disaster Preparedness Plan, Prediction, Early Warnings and Safety Measures of Disaster, Role of Information, Education, Communication, and Training, Role of Government, International and NGO Bodies. Role of IT in Disaster Preparedness, Role of Engineer on Disaster Management.

Disaster Response: Introduction, Disaster Response Plan, Communication, Participation, and Activation of Emergency Preparedness Plan, Search, Rescue, Evacuation and Logistic Management, Role of Government, International and NGO Bodies, Psychological Response and Management (Trauma, Stress, Rumor, and Panic), Relief and Recovery. 8. Medical Health Response to Different Disasters.

Rehabilitation, Reconstruction and Recovery: Reconstruction and Rehabilitation as a Means of Development. Damage Assessment, Post Disaster effects and Remedial Measures, Creation of Long-term Job Opportunities and Livelihood Options, Disaster Resistant House Construction, Sanitation and Hygiene, Education and Awareness, Dealing with Victims' Psychology, Long-term Counter Disaster Planning, Role of Educational Institute.

Books:

1. Disaster Management by Mrinalini Pandey, Wiley India Pvt. Ltd.
2. Disaster Science and Management by Tushar Bhattacharya, McGraw Hill Education (India) Pvt. Ltd.
3. Disaster Management: Future Challenges and Opportunities by Jagbir Singh, KW Publishers Pvt. Ltd.
4. Disaster Management by J.P. Singhal, Laxmi Publications.