M.Tech.

IN

INDUSTRIAL ENGINEERING AND MANAGEMENT

CURRICULUM AND SYLLABI

(Applicable from 2023 admission onwards)

Department of Mechanical Engineering
NATIONAL INSTITUTE OF TECHNOLOGY CALICUT
Kozhikode - 673601, KERALA, INDIA

The Program Educational Objectives (PEOs) of M.Tech.in Industrial Engineering and Management

PEO1	Graduates apply their in-depth and advanced knowledge for fostering skills of analysing, formulating, defining and solving complex industrial engineering and management problems for productive and successful careers.
PEO2	Graduates demonstrate innovative and independent research work in academia/industry/R&D to enhance the knowledge base in industrial engineering and management and to disseminate the knowledge
PEO3	Graduates exhibit a high level of professionalism, integrity, social responsibility and life-long independent learning ability.

Programme Outcomes (POs)) of M.Tech .in Industrial Engineering and Management

PO1	Independently carry out research/investigation and development work to solve practical problems
PO2	Write and present a substantial technical report/document
PO3	Demonstrate mastery in industrial engineering and management at a level higher than the requirements in the appropriate bachelor program.
PO4	Acquire and share in-depth knowledge in the area of industrial engineering and management.
PO5	Analyse complex problems in the field of industrial engineering and management critically and arrive at optimal solutions.
PO6	Use modern computer/software tools to model and analyse problems related to industrial engineering and management.

CURRICULUM

Total credits for completing M.Tech. in Industrial Engineering and Management is 75.

COURSE CATEGORIES AND CREDIT REQUIREMENTS:

The structure of M.Tech. programme shall have the following Course Categories:

Sl. No.	Course Category	Minimum Credits
1.	Program Core (PC)	26
2.	Program Electives (PE)	12
3.	Institute Elective (IE)	2
4.	Projects	35

The effort to be put in by the student is indicated in the tables below as follows:
L: Lecture (One unit is of 50 minute duration)
T: Tutorial (One unit is of 50 minute duration)
P: Practical (One unit is of one hour duration)
O: Outside the class effort / self-study (One unit is of one hour duration)

PROGRAMME STRUCTURE

Semester I

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	ME6101E	Decision Modelling	3	1	0	8	4	PC
2.	ME6102E	Statistics for Management	3	1	0	5	3	PC
3.	ME6103E	Inventory and Supply Chain Management	3	1	0	5	3	PC
4.		Elective 1	3	0	0	6	3	E
5.		Elective 2	3	0	0	6	3	E
6.	ME6191E	Industrial Engineering Lab	0	0	3	3	2	PC
7.		Institute Elective basket	2	0	0	4	2	EB
		Total	17	3	3	37	20	--

Semester II

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	ME6111E	Machine Learning and Artificial Intelligence	3	0	1	5	3	PC
2.	ME6112E	Operations Planning and Control	3	0	0	6	3	PC
3.	ME6113E	Accounting and Finance for Management	3	0	0	6	3	PC
4.	ME6114E	Ergonomics and Work System Design	3	1	0	5	3	PC
5.		Elective 3	3	0	0	6	3	E
6.		Elective 4	3	0	0	6	3	E
7.	ME6192E	Modelling and Data Analytics Laboratory	0	0	3	3	2	PC
8.	ME6193E	Project Phase I	0	0	0	6	2	PC
		Total	18	0	3	44	22	--

Semester III

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	ME7194E	Project Phase II	0	0	0	9*	3	PC
2.	ME7195E	Project Phase III	0	0	0	45	15	PC
		Total	0	0	0	54	18	--

* To be completed during semester break. The number of hours is indicative only, and corresponds to a regular semester. Since the duration of the semester break is shorter, students are expected to devote more time per week. Furthermore, if Project Phase II is done as an internship, the working hours will be governed by the organization in which the internship is done.

Semester IV

Sl. No.	Course Code	Course Title	L	T	P	O	Credits	Category
1.	ME7196E	Project Phase IV	0	0	0	45	15	PC
		Total	0	0	0	45	15	--

List of Electives

Sl. No.	Course Code	Course Title	L	T	P	O	Credits
1.	ME6121E	Marketing Management	3	0	0	6	3
2.	ME6122E	Consumer Behaviour	3	0	0	6	3
3.	ME6123E	Product Management	3	0	0	6	3
4.	ME6124E	Human Resource Management	3	0	0	6	3
5.	ME6125E	Organizational Behaviour	3	0	0	6	3
6.	ME6126E	Forecasting Techniques and Predictive Analytics	3	0	0	6	3
7.	ME6127E	Facilities Layout Planning	3	1	0	5	3
8.	ME6128E	Cellular Manufacturing Systems	3	0	0	6	3
9.	ME6129E	Industrial Scheduling	3	0	0	6	3
10.	ME6130E	Lean Production Management	3	0	0	6	3
11.	ME6131E	Sustainability Management	3	0	0	6	3
12.	ME6132E	System Modelling and Simulation	3	0	0	6	3
13.	ME6133E	Reliability Engineering and Management	3	0	0	6	3
14.	ME6134E	Product Life Cycle Management	3	0	0	6	3
15.	ME6135E	Soft Computing Techniques	3	0	0	6	3
16.	ME6136E	Advanced Decision Modelling	3	0	0	6	3
17.	ME6137E	Ethics and Human Values	3	0	0	6	3
18.	ME6138E	Introduction to Data Science	3	1	0	5	3

19.	ME6139E	Database Management	3	0	0	6	3
20.	ME6140E	Enterprise Resource Planning	3	0	0	6	3
21.	ME6141E	Decision Support and Expert System	3	0	0	6	3
22.	ME6142E	Information Sharing and Inventory in Supply Chain Management	3	0	0	6	3
23.	ME6143E	Project Management	3	0	0	6	3
24.	ME6144E	Management of Technology and Innovation	3	0	0	6	3
25.	ME6145E	Financial Management	3	0	0	6	3
26.	ME6146E	Investment Management	3	0	0	6	3
27.	ME6147E	Disaster Management	3	0	0	6	3

List of Institute Electives

Sl. No.	Code	Course Name	L	T	P	O	C
1	IE6001E	Entrepreneurship Development	2	0	0	4	2
2	ZZ6002E	Research Methodology	2	0	0	4	2
3	MS6174E	Technical Communication and Writing	2	1	0	3	2

ME6101E DECISION MODELLING

Pre-requisites: NIL

L	T	P	O	C
3	1	0	8	4

Total Sessions: 39L + 13T

Course outcomes:

CO1: Formulate decision problems as mathematical optimization problems
CO2: Explain the solution of linear programming problems using Simplex method, dual Simplex method and Karmarker's linear programming algorithm and illustrate sensitivity analysis
CO3: Formulate and solve integer programming problems
CO4: Solve network flow optimisation algorithms
CO5: Explain the principles and algorithms of optimisation of non-linear programming problems
CO6: Solve optimisation problems using software

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. Karmarker's linear programming algorithm.

Integer programming: Modelling optimization problems using binary variables; Solution of integer programming problems: Branch-and-bound method, Column generation method.
Network models and solutions: Shortest route problems, Minimal spanning tree problems, Maximal flow problems, Travelling salesman 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.

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] Rao, S. S., 2019, *Engineering Optimization: Theory and Practice*, John Wiley & Sons, New York.

[2] Ravindran, A., Philips, D. T., and Solberg, J. J., 1987, *Operations Research: Principles and Practice*, John Wiley & Sons, New York.

[3] Sarker, R. A., and Newton, C. S., 2008, *Optimization Modelling: A Practical Approach*, CRC Press, London.

[4] Srinivasan, G., 2017, *Operations Research: Principles and Applications*, PHI Learning Private Limited, New Delhi.

[5] Taha, H. A., 2019, *Operations Research: An Introduction*, Pearson Education, London.

[6] Winston, W. L., 2003, *Operations Research: Applications and Algorithms*, Cengage Learning, US.

[7] Hillier, F. S., Lieberman, G. J., Nag, B., and Basu, P., 2021, *Introduction to Operations Research*, McGraw Hill, New York.

[8] Arora, J. S., 2012, *Introduction to Optimum Design*, Elsevier Inc., USA.

[9] Hu, T. C., and Kahng, A. B., 2018, *Linear and Integer Programming Made Easy*, Springer, Switzerland.

ME6102E STATISTICS FOR MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	1	0	5	3

Total Lecture Sessions: 39

Course outcomes:

CO1: Execute the principles of data collection, organising and description

CO2: Illustrate business problems with appropriate probability distributions and statistical terms to make better decisions

CO3: Differentiate between various statistical tests and apply an appropriate test in the context of the problem

CO4: Develop critical and integrative thinking in order to communicate the results of the analysis clearly in the context of the problem

Exploratory data analysis and Probability distribution

Descriptive Statistics: Measures and application of central tendency and variation, Numerical description of data, Scales of measurement, Exploratory data analysis. Covariance, coefficient of variation. 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.

Statistical Hypothesis development and 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.

ANOVA

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, Multiple comparison test – Tukey‟s Honestly Significant Difference Test and Tukey-Kramer Procedure.

Regression and Non Parametric tests

Simple Linear Regression – Multiple Linear Regression – Non-Parametric Statistics: Mann-Whitney U Test, Wilcoxson, Matched-pairs signed rank test, Kruskal Wallis test, Friedman test, Spearman‟s Rank Correlation

References:

[1] Levin, R. I., Rubin, D. S., Siddiqui, M. H., and S. Rastogi, 2017, *Statistics for Management*, Pearson India Education, New Delhi.

[2] Levine, D. M., Stephan, D. F., and Szabat, K. A., 2017, *Statistics for Managers Using Microsoft Excel*. Pearson India Education, New Delhi.

[3] Black, K., 2012, *Business Statistics*, John Wiley & Sons, New York.

[4] Montgomery, D.C., and Runger, G.C., 2016, *Applied Statistics and Probability for Engineers*, John Wiley & Sons, New York.

ME6103E INVENTORY AND SUPPLY CHAIN MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	1	0	5	3

Total Lecture Sessions: 39

Course outcomes:

CO1: Understand and assess strategic and operational frameworks used to analyse supply chains.
CO2: Demonstrate an understanding of different design concepts for supply chain networks.
CO3: Explain and illustrate the use of inventory control models in deterministic scenarios.
CO4: Analyse and evaluate appropriate inventory control systems capable of managing multiple items under various constraints.
CO5: Analyse and evaluate different methods for developing inventory control systems under probabilistic scenarios.

Building a strategic framework to analyse supply chains

Understanding the supply chains – Supply chain flows, Decision phases, Process view, Competitiveness and supply chain strategies – Strategic fit, Financial measures of performance, Drivers of supply chain performance.
Supply chain operation simulation using role play game: Managing inventory in supply chain, Inventory costs, Supply chain performance evaluation under different scenarios, Bullwhip effect, Information and supply chain trade-offs.

Designing the supply chain network

Role of distribution, Factors influencing distribution network design, Design options, Online sales and distribution network, Designing the network, Models for facility location and capacity allocation

Independent demand inventory 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.

Inventory system with constraints

Inventory control systems under multiple items, Inventory problems with constraints, Exchange curve (Optimal policy curve).

Independent demand inventory systems (Probabilistic models)

Single order quantities – Payoff matrix – Order quantity modelling considering benefit and cost analyses; Dynamic order quantity systems (probabilistic models) - Fixed order size system – Periodic order interval systems, Safety stock modelling under known stock out costs and service levels.

References:

[1] Chopra, S., Meindl, P., and Kalra, D. V., 2018, *Supply Chain Management: Strategy, Planning and Operations*, Pearson Education Ltd, New Delhi.
[2] Simchi-Levi, D., Kaminsky, P., Simchi-Levi, E., and Shankar, R., 2022, *Designing & Managing the Supply Chain: Concepts, Strategies & Case studies*, McGraw-Hill Education, USA.
[3] Coyle, J. J., Langley, Jr. C. J., Novack, R.A., and Gibson, B.J., 2019, *Supply Chain Management: A Logistics Perspective*, CENGAGE Learning, USA.
[4] Tersine, R. J., 1994, *Principles of Inventory and Materials Management*, Prentice-Hall Inc., New Jersey.
[5] Starr, M. K., and Miller, D. W., 1986, *Inventory Control: Theory and Practice*, Prentice-Hall India, New Delhi.
[6] Department of Mechanical Engineering, NITC, 2017, *Supply Chain Role Play Game: Instructor's Manual*.
[7] Muller, M., 2019, *Essentials of Inventory Management*, Harper Collins Leadership, New York.

ME6191E INDUSTRIAL ENGINEERING LABORATORY

Pre-requisites: NIL

L	T	P	O	C
0	0	3	3	2

Total Practical Sessions: 39

Course outcomes:

CO1: Develop awareness about the application of scientific methods in the practical problems related to industrial engineering

CO2: Utilize methods/techniques for solving problems related to method study, work measurement, work systems design, production planning and quality control in a practical scenario and gain hand-on experience.

CO3: Apply the principles of human factors and ergonomics engineering to aid people by improving products, systems and system interface

List of Experiments

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 to identify and distinguish elements
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 assessment of Light and Noise Exposure on performance
10. Measurement of maximal heart rate and maximum oxygen intake level
11. Measurement of Anthropometric Data
12. Posture Analysis using OWAS, RULA and REBA
13. Demonstration of IDEEA Minisun Gait Analysis System

References

[1] Freivalds, A., and Niebel, B. W., 2013, Niebel's *Methods, Standards and Work Design*, McGraw Hill, USA.

[2] Barnes, R. M.,2013, *Motion and Time Study Design and Measurement of Work*, John Wiley & Sons, NY.

[3] Sandersand, M.S., and McCormick, E. J., 2013, *Human Factors in Engineering and Design*, McGraw-Hill, India

[4] I. L. O., 2011, *Introduction to Work Study: Indian Adaptation*, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

[5] Karwowski, W., and Marras W. S., 2019, *Occupational Ergonomics: Principles of Work Design (Principles and Applications in Engineering)*, CRC Press, London.

[6] Grant, E., and Leavenworth, R. S., 2017, *Statistical quality Control*, McGraw-Hill Education, India.

ME6111E MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Pre-requisites: Basic understanding of statistics

L	T	P	O	C
3	0	1	5	3

Total Lecture Sessions: 39

Course outcomes:

CO1: Demonstrate and compare supervised machine learning algorithms for solving real-life problems using Python Language

CO2: Apply unsupervised machine learning algorithms to solve real-life problems and evaluate their performances

CO3: Apply the concept of reinforcement learning, neural network and deep learning algorithms for developing and solving engineering and management problems

Supervised machine learning

Introduction to Algorithms in Machine Learning – Supervised machine learning; Regression: linear regression, Multiple linear regression, Non-Linear Regression, Bayesian Linear Regression; Classification: Random Forest, Decision Trees, Logistic Regression, Support Vector Machines, Naïve Bayes algorithm, K-nearest neighbors algorithm, Ensemble Learning: AdaBoost, Gradient Boosting, XG Boost

Unsupervised machine learning

Unsupervised machine learning: clustering, association, and dimensionality reduction. Clustering – K-Means algorithm, DBSCAN, Agglomerative Hierarchy clustering algorithm, Gaussian Mixture Model algorithm – association: Apriori algorithm, Eclat algorithm – dimensionality reduction: Principal Component Analysis, Manifold Learning, Autoencoders – algorithms for Anomaly Detection

Artificial Intelligence

Artificial Neural Network, logical computations with Neurons, the multilayer perceptron and back propagation – Deep learning, training deep neural networks, Regularization, Convolutional neural networks – Reinforcement learning - Markov decision processes, Q-learning- Approximate Q Learning and Deep Q-learning, Long Short-Term Memory (LSTM) – Natural language processing.

References:

[1] Hastie, T., Tibshirani, R., and Friedman, J., 2008. *The Elements of Statistical Learning: Data Mining, Inference and Prediction ("ESL")*, Springer, USA.

[2] Géron, A., 2019, *Hands-On Machine Learning with Scikit-Learn*, Oreilly, USA.

[3] Kumar, U. D., 2021, *Business Analytics*, Wiley, India.

[4] Pradhan, M., and Kumar, U. D., 2019, Machine *Learning using Python*, Wiley, India.

[5] Muller, A., 2016, *Introduction to Machine Learning with Python: A Guide for Data Scientists (Greyscale Indian Edition)*, Oreilly, USA.

ME6112E OPERATIONS PLANNING AND CONTROL

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course outcomes:
CO1: Explain the operations planning and control and functional units of enterprise resource planning
CO2: Analyse forecasting models and evaluate the models
CO3: Evaluate aggregate planning and master production scheduling techniques
CO4: Apply material requirements planning and capacity requirements planning techniques
CO5: Explain operations scheduling techniques

Introduction to operations management: Operations management functions – Operations strategy formulation.
Manufacturing Planning and Control (MPC): MPC systems, MPC system payoff, MPC system framework, Types of configurations of manufacturing system, Matching the MPC system with the needs of the firm.
Enterprise Information Systems: Enterprise Resource Planning (ERP), Functional units of ERP, ERP II, ERP III, Performance measures to evaluate integrated system 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, Economic indicators, Forecast errors, Interval estimate.

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.

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.
Operations scheduling - Production Activity Control: Shop floor control concepts and Techniques, Performance measures, Finite loading systems, Horizontal loading, vertical loading, Scheduling of flow shops, Scheduling of job shops, scheduling of service systems.

References

[1] Jacobs, F. R., Berry, W. L., Whybark, D. C., and Vollmann, T. E., 2014, *Manufacturing Planning and Control for Supply Chain Management*, McGraw Hill Education (India) Private Limited, Chennai.
[2] Silver, E. A., Pyke, D. F., and Thomas, D. J., 2017, *Inventory and Production Management in Supply Chains*, CRC Press, London.
[3] Narasimhan, S. L., McLeavy, D. W., and Billington, P. J., 2000, *Production Planning and Inventory Control*, Prentice-Hall of India Pvt. Ltd., New Delhi.
[4] Tersine, R. J., 1985, *Production/Operations Management*, North Holland.
[5] Mahadevan, B., 2015, *Operations Management: Theory and Practice*, Pearson, New Delhi.
[6] Chapman, S. N., Arnold, J. R. T., Gatewood, A. K., and Clive, L. M., 2017, *Introduction to Materials Management*, Pearson Education, Inc.
[7] Heizer, J., Render, B., Munson, C., and Sachan, A., 2017, *Operations Management: Sustainability and Supply Chain Management*, Pearson India Education Services Pvt. Ltd.
[8] Srinivasan, G., 2018, *Quantitative Models in Operations and Supply Chain Management*, PHI Learning.

ME6113E ACCOUNTING AND FINANCE FOR MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course outcomes:
CO1: Constructing, analysing and evaluating the financial statements
CO2: Understanding, applying and estimating the product and process costs for evaluating the decisions
CO3: Analyse and evaluate the time value of money and thereby the capital investments
CO4: Analyse and evaluate the tradeoffs involved in capital investment theories

Financial Accounting
Introduction to Accounting: Forms of ownership, Conceptual basis of accounting – Financial statements: Components, Construction of profit and loss and balance sheet – Working with financial statements, ratio analysis, DuPont analysis.

Management accounting
Cost Management Concepts: Concepts of cost, cost behavior and cost-volume-profit (CVP) relationships, cost functions, semi-variable cost measurement, applications - Activity based costing – Variable and absorption costing – Process costing – Cost variances analysis.

Financial Planning
Time value of money: stock valuation, bond valuation. Capital budgeting: traditional techniques, identifying relevant cash flows (effect of depreciation, working capital effect, single proposal), discounted cash flow techniques. Measurement of Cost of capital: cost of debt, cost of preference shares, cost of equity capital, computation of overall cost of capital. Short-term financial planning: computation of working capital requirement.

Financing Decision
Financial and operating and combined leverage - Capital structure theories: Net Income approach, Net operating income approach Modigliani-Miller approach.

References:
[1] Ramachandran, N., and Kakani, R. K., 2013, *Financial Accounting for Management,* McGraw Hill Education.

[2] D'Souza, D., 2023, *Indian Accounting Standards*. Snow White Publication.

[3] Khan, M. Y., and Jain, P. K., 2019, *Financial Management*, Tata McGraw Hill.

[4] Khan, M. Y., and Jain, P, K.,2008, *Management Accounting*" Tata McGraw Hill Delhi.

[5] Chandra, P., 2022, *Financial Management: Theory and Practice*, Tata McGraw Hill**.**

[6] Horngren, C. T., Sundem, G. L., Elliott, J. A., and Philbrick, D. R., 2018, *Introduction to Financial Accounting*, Pearson Education.

[7] Horne, V., 2015, *Fundamentals of Financial Management*, Pearson Education.

ME6114E ERGONOMICS AND WORK SYSTEM DESIGN

Pre-requisites: NIL

L	T	P	O	C
3	1	0	5	3

Total Lecture Sessions: 39

Course outcomes:
CO1: Appraise the principles and applications of ergonomics/human factors in system design.
CO2: Perform the biomechanical analysis in a system design
CO3: Explain the concept of productivity and conduct work study techniques to improve productivity
CO4: Apply the various methods of method study and work measurement in a work space

Introduction to Human factors and Ergonomics – ergonomics, work and health, Ergonomics and productivity – productivity measurement models. Design of cognitive work - information theory – human information processing model. Engineering anthropometry, Biomechanical bases of ergonomics – static biomechanical analysis and models, Physiological responses - physical work capacity – Assessment of aerobic capacity.
Work-space design – Principles of work design – workplace, machines, tools and equipment, design for standing and seated workers. Posture and movement - postural analysis in workspace design - Evaluation of required body posture for a practical case. Lifting and handling – mechanics of lifting, NIOSH lifting guidelines.

Work design decisions – behavioral considerations, sociotechnical systems approach, physical considerations. Principles of good work design. Work Study - concept of work content. Methods study - procedure for methods study, process analysis – exploratory tools, operation analysis. Manual Work design - principles of motion economy. Work measurement - estimation of time standards, allowances, 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.

Work environment design – working conditions - illumination, noise, temperature, vibration, radiation. Stress, fatigue and work environment – work stress and mental workload, shift work – Work rest scheduling. Workplace and systems safety, Occupational Safety and Health Administration, Job Hazard Analysis – analysis for a practical case, General Housekeeping, 5S.

References

[1] Sanders, M. S., and McCormick, E. J., 1993, *Human Factors in Engineering and design*, McGraw-Hill International.

[2] Freidvalds, A., 2013, *Niebel's Methods, Standards, and Work Design*, Mc-Graw Hill Education.

[3] Tayyari, F., and Smith J. L., 1997, *Occupational Ergonomics: Principles and applications*, Kluwer Academic Publishers.

[4] I.L.O., 2003, *Introduction to Work Study: Indian Adaptation*, Oxford & IBH Publishing.

[5] Barnes, R. M., 2009, *Motion and Time Study: Design and Measurement of Work*, John Wiley & Sons.

[6] Mital, A., Desai, A., and Mital, A., 2017, *Fundamental of Work Measurements: What every engineer should know*, CRC Press, London.

[7] Groover, M. P., 2014, *Work Systems: The Methods, Measurement and Management of Work*, Pearson Education Limited.

ME6192E MODELLING AND DATA ANALYTICS LABORATORY

Pre-requisites: NIL

L	T	P	O	C
0	0	3	3	2

Total Practical Sessions: 39

Course outcomes:

CO1: Analyse and assess production/operations management problems.
CO2: Demonstrate an understanding of simulation techniques for modelling manufacturing systems.
CO3: Evaluate and recommend strategies for improving coordination and collaboration in supply chain systems.
CO4: Evaluate and propose strategies for optimizing human performance in work systems.
CO5: Apply programming languages/software packages to solve problems in Industrial Engineering.

List of Experiments:

1. Mathematical Programming Models: Problem formulation, Solution Interpretation and Sensitivity analysis using the following packages:
   (a) LINGO
   (b) AMPL
   (c) GAMS
2. Programming exercises in the industrial engineering problem areas using the following programming languages/packages:
   (a) MATLAB
   (b) Scilab
   (c) Microsoft Excel
   (d) R
   (e) Python
   (f) Rust
3. Simulation modelling and analysis
   (I) Manual simulation of a small production system
   (II) Simulation exercise using the following packages:
      (a) ARENA
      (b) WITNESS
      (c) TECNOMATIX
4. Supply chain analytics
   (I) Supply chain operation simulations based on:
      (a) Supply Chain Role Play Game (SCRPG) software package - a serial supply chain performance analysis under different scenarios
      (b) Serial supply chain performance analysis using Excel
      (c) Divergent supply chains performance analysis using SCIPA software package
      (d) Blockchain Enabled Beer Game (BEBG) – a serial supply chain performance analysis
      (e) VMI-based supply chain role play – VMI collaboration in a serial supply chain
   (II) Supply chain modelling and analysis using AnyLogistix software package
5. Operations System modelling and analysis
   (a) Optimised process layout design
   (b) Rolling horizon based MRP analysis
6. Digital Human Modelling for Biomechanical Analysis using JACK software

References:

[1] Hillier, F. S., Lieberman, G. J., Nag, B., and Basu, P., 2021, *Introduction to Operations Research*, Tata McGraw Hill.
[2] Jacobs, F. R., Berry, W. L., Whybark, D. C., and Vollmann, T.E., 2015, *Manufacturing Planning and Control for Supply Chain Management*, McGraw Hill Education (India) Pvt. Ltd., New Delhi.
[3] Tomkins, J. A., White, J. A., Bozer, Y. A., Frazelle, E. H., Tanchoco, J. M. A., and Trevino, J., 2013, *Facility Planning*, John Wiley & Sons.
[4] Banks, J., Carson, J. S., Nelson, B. L., and Nicol, D.M., 2009, *Discrete-Event System Simulation*, Pearson Education, Inc.
[5] Winston,W. L.,2022, *Microsoft Excel Data Analysis and Business Modeling*, Prentice-Hall Inc.
[6] Ivanov D., 2021, *Supply chain simulation and optimization with anyLogistix*, Berlin School of Economics and Law.

ME6193E PROJECT PHASE I

Pre-requisites: NIL

L	T	P	O	C
0	0	0	6	2

Course outcomes:

CO1: Understand the process of reviewing and recording the literature
CO2: Understand the process of identification of the project problem
CO3: Apply the learning to define the problem and problem environment/boundary conditions
CO4: Develop a focused research learning, presentation and communication

Project Phase I is normally an initiation into the project.

Each student shall identify a topic of interest related to the core/elective courses undergone in the first semester of the M. Tech. programme. He/she shall get the topic approved by the project guide in the concerned area of specialization. The student is expected to conduct a literature survey. A mid semester evaluation shall be done by the guide. At the end of the semester the student shall present the project problem and the related literature in the presence of the duly constituted evaluation committee. Grade will be awarded on the basis of the student's work and presentation.

ME7194E PROJECT PHASE II

L	T	P	O	C
0	0	0	9	3

Course Outcomes for ME7194E, ME7195E and ME7196E Project Phase II, III and IV

CO1: Develop a systematic procedure to solve the identified research/industrial problem (This primarily pertains to the objective of Phase 2)
CO2: Analyse and Identify a suitable research methodology for solving the problem identified.
CO3: Apply the methods/tools learned to develop algorithms and solve the problem.
CO4: Analyze and interpret the results using tables and figures for visualization
CO5: Compile and construct a report by employing the techniques of academic writing critical analysis, and defend the thesis
CO6: Publish the findings in reputed journals, conferences or apply for patents

Project Phase II can be an extension of Phase I or internship outside during the summer semester break.
Students shall continue to work on the problem identified in the project phase I or undergo internship outside. Students shall identify the methodology, apply for a preliminary work. The work should be suitable for communicating to a conference. The student shall submit a report. All the projects will be evaluated by a duly constituted committee.

ME7195E PROJECT PHASE III

L	T	P	O	C
0	0	0	45	15

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 fulfil the requirements as specified in the "Ordinances and Regulations for M. Tech." The student is expected to complete the pilot study, redefine the project based on pilot study, decide on the appropriate research design, generate data/collect data, develop the algorithm and code, and obtain preliminary results 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.

ME7196E PROJECT PHASE IV

L	T	P	O	C
0	0	0	45	15

The project work 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.

The project work/thesis will be considered for awarding Grade 'S' only if a paper, based on the project work is published/accepted for presentation at least in a Scopus indexed conference or a software copyright is granted. However, in exceptional cases, where the student and the guide want to submit a journal/conference publication at a later stage and if the student is able to submit the draft version of the journal/conference paper to the evaluation committee at the time of final presentation of the project work, the student may be considered for awarding 'S' grade if the committee finds the work to be excellent and guide ensures the submission of the work for journal/conference publication"

Programme Specific Electives

ME6121E MARKETING MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course outcomes:

CO1: Outline the fundamental concepts of marketing, marketing environment, marketing planning.
CO2: Comprehend segmentation and target a market with proper positioning of products and new product development
CO3: Conduct market research and consumer research and also to price the products.
CO4: Understand the concepts of consumer behaviour, advertising and sales promotion.

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.

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

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, latest trends in marketing.

References:

[1] Kotler, P., Keller, K. L., Koshy, A., and Jha, M., 2018, *Marketing Management*, Pearson.

[2] Ramaswamy, V. S., and Namkumari, S., 2018, *Marketing Management*, Sage Publications.

[3] Majumdar, R., 2007, *Marketing Research - Text, Applications and Case Studies*, New Age International.

[4] Stanton, W. J., Etzel, M. J. and Walker, B. J., 1994, *Fundamentals of Marketing*, McGraw Hill International Edition.

ME6122E CONSUMER BEHAVIOUR

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course outcomes:

CO1: Demonstrate how knowledge of consumer behaviour can be applied to marketing,
CO2: Comprehend segmentation and target a market with proper positioning of products and understand the latest trends in consumer behaviour
CO3: Identify and explain the factors which influence consumer behaviour.
CO4: Relate internal dynamics such as personality, perception, learning motivation and attitude to the choices consumers make.
CO5: To analyse personal, socio-cultural, and environmental dimensions that influence consumer decisions making.

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, influencer marketing, phygital marketing, eco-responsible behaviour.

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.

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, L. G., and Kanuk, L. L., 2018, *Consumer Behaviour*, Pearson Education.

[2] Solomon, M. R., 2016, *Consumer Behaviour*, Pearson Education.

[3] Peter, J. P., and Olson,J. C., 2020, *Consumer Behaviour and Marketing Strategy*, Tata McGraw Hill/ Irwin.

[4] Arnould, E. J., Linda, P., and Zinkhan, G., 2004, *Consumers*, Tata McGraw Hill/ Irwin.

ME6123E PRODUCT MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course outcomes:
CO1: Outline the fundamental concepts of product management, product life cycle
CO2: Comprehend Segmentation and target a market with proper positioning of products and errors in positioning.
CO3: Illustrate the concepts of product innovation, adoption and diffusion
CO4: Understand the concepts of brand management, brand equity and brand positioning

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.

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

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, S. A., 2017, *Product Management*, Himalaya Publishing House.

[2] Majumdar, R., 2008, *Product Management*, Prentice-Hall of India.

[3] Lehmann, D., and Winer, R., 2005, *Product Management*, Tata McGraw Hill.

[4] Crawford, C., 2014, New Product Management, Tata McGraw Hill.

ME6124E HUMAN RESOURCES MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course outcomes:

CO1: Explain the key terms, theories/concepts and practices within the field of Human Resource Management

CO2: Explain human resource management functions and practices including man power planning, recruitment, selection methods, training, and performance appraisal. .

CO3: Determine compensation policies based on job analysis and job evaluation.

Human Resources Management: Concepts - Trends shaping Human Resources Management (HRM) - Workforce demographics, diversity trends, trends in jobs, globalisation, economic and technology trends; Strategic HRM - HR metrics, benchmarking, data analytics - High-performance work systems - Employee engagement and performance - Important Labour Laws - HRM and Industry 4.0 - Impact of AI in HR.

Personnel Management: Workforce planning and forecasting - Recruiting - Sources of candidates, Recruiting a more workforce- Employee testing and selection - Types of tests, Work samples and simulations, Types of interviews - Training and developing employees - Orienting and onboarding, Implementing the training program, Implementing management development programs, Evaluating the training effort. Performance Management and Appraisal- Traditional tools, Rater error appraisal problems, Managing the appraisal interview, performance management.

Compensation: Factors in determining pay rates - Job evaluation methods - Creating a market competitive pay-plan - Pricing managerial and professional jobs - Competency-Based Pay, Broadbanding, Comparable Worth - Pay for Performance and Financial Incentives: Individual employee incentive and recognition programs - Team and organization-wide incentive plans; Managing Global Human Resources, Managing Human Resources in Small and Entrepreneurial Firms

References

[1] Dessler, G., 2020, *Human Resource Management*, Person Education.

[2] Tarique, I., Briscoe, D. R., and Schuler, R. S., 2022, *International Human Resource Management: Policies and Practices for Multinational Enterprises*,, Routledge (T&F), Newyork.

[3] Zeuch, M. (editor), 2016, *Handbook of Human Resources Management*, Springer-Verlag, Heidelberg.

[4] Brewster, C., Houldsworth, E., Sparrow, P., and Vernon, G., 2023, *International Human Resource Management*, Kogan Page.

ME6125E ORGANIZATIONAL BEHAVIOUR

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course outcomes:

CO1: Describe different models used to explain individual behaviour.

CO2: Analyse the behaviour of groups in organisations in terms of the key factors that influence organisational behaviour.

CO3: Recognize how a changing business environment requires organisations to adapt.

Introduction to Organisational Behaviour (OB): Management and Organizational Behavior - Systematic study in OB - Contributing disciplines in OB - Developing an OB model. The individual: Understanding Diversity - Prejudice and Discrimination in Organizations - Cross-Cultural OB - Implementing Diversity Management, Attitudes and Behavior - Emotions and moods - Personality Attributes Relevant to OB - Perception and Individual Decision Making, Motivation: Classic theories - Contemporary Theories.

Group Process: Foundations of Group Behavior - Defining and Classifying Groups - Stages of Group Development - Group Decision Making - Differences Between Groups and Teams - Types of Teams - Creating Effective Teams - Interpersonal Communication - Cross-Cultural Communication - Leadership - leadership types - power- conflict and negotiation- negotiation methods- Sources of Conflict- Types of Conflict- Conflict Management Approaches

Organisational Process: Foundations of Organisational structure - Centralization and decentralization - Common Organisational designs - New design options, Organizational Culture - Creating and Sustaining Culture - Influencing Organizational Cultures - Organizational Change - Change and employee behaviour, Resistance to change - Approaches to Managing Organizational Change.

References

[1] Robbins, S. P., and Judge, T. A., 2023, *Organisational Behavior*, Pearson Education.

[2] Luthans, F., Luthans, B. C., and Luthans, K. W., 2021, *Organizational Behavior: An Evidence-Based Approach*, Information Age Publishing.

[3] McShane, S., and Von Glinow, M. A., 2022, *Organisational Behavior*, McGraw-Hill.

[4] Hersey, P., Balaschard, K. H., and Johnson, D. E., 2013, *Management of Organisational Behavior*, Pearson Education.

ME6126E FORECASTING TECHNIQUES AND PREDICTIVE ANALYTICS

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course outcomes:

CO1: Develop regression models for demand forecasting through the application of relevant variables and statistical techniques

CO2: Apply ARIMA model to forecast demand patterns from time series data.

CO3: Analyze and Evaluate predictive models to data from different environments.

Introduction to forecasting: Basic forecasting Tools- Forecast accuracy and error- Time series methods- Time series decomposition: Components of time series- trend- seasonal- cycle; Classical decomposition: additive and multiplicative decomposition. Regression methods: Simple linear regression- least square estimation- correlation coefficient- statistical testing of regression coefficient (f-test, t-test)- Multiple linear regression.

ARIMA models: Box-Jenkins methodology to the 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.

Introduction to Predictive Analytics: Naive Bayesian Classifier- Neural Network- Segmentation and Tree Models- Sweeping to Find the Best Cutpoint Impurity Measure of a Population: Entropy and Gini
Index, Chi-Square Splitting Rule; Additive Models - Boosted Tree, Least Squares Regression Boosting Tree, Binary Logistic Regression Boosting Tree; Support Vector Machine (SVM)- Wolfe Dual, Linearly Separable Problem, Linearly Inseparable Problem, Constructing Higher-Dimensional Space and Kernel; Clustering - K Means, Fuzzy C Means, Nearest Neighbor, K Nearest Neighbor (KNN).

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References

[1] Makridakis, S., Wheelwright, S. C., and McGee, V. E., 2008, *Forecasting, Methods and Applications*, Wiley India.

[2] Montgomery, D. C., Jennings, C. L., and Kulahci, M., 2015, *Introduction to Time Series Analysis and Forecasting*, John Wiley & Sons, Inc.

[3] Enders, W., 2014, *Applied Econometric Time Series*, John Wiley & Sons, Inc.

[4] Wooldridge, J. M., 2010, *Econometric Analysis of Cross Section and Panel Data*, The MIT Press.

[5] Wu, J., and Coggeshall, S., 2019, *Foundations of Predictive Analytics*, CRC Press, London.

[6] McCarthy, R. V., McCarthy, M. M., Ceccucci, W., and Halawi, L., 2022, *Applying Predictive Analytics: Finding Value in Data*, Springer.

ME6127E FACILITIES LAYOUT PLANNING

Prerequisite: NIL

L	T	P	O	C
3	1	0	5	3

Total Lecture Sessions: 39

Course outcomes:
CO1: Develop understanding of plant layout, facility planning and development process of layout
CO2: Examine and analyse the computerized layout planning, their features and algorithms
CO3: Analyse and assess Facility Location-allocation Problems
CO4: Develop understanding of warehouse management system and material handling equipment

Introduction to Facility Layout and Requirement
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, Types of Layout, Layout Design Process, Layout Design Cycle, Data Collection, Equipment Requirement, Activity Analysis, REL Diagram, Employee Requirement; Development of Layout - Block Plan, Evaluating and Selecting the Facilities Plan, Preparing, Presenting, Implementing, and Maintaining the Facilities

Layout Planning and Research Problems
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.

Facility Location Problems and Warehouse Management Systems
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, warehouse management system, Material handling equipment, factors affecting material handling.

References
[1] Tompkins, J. A., White, J. A., Bozer, Y. A., and Tanchoco, J.M.A., 2010, *Facility Planning*, Wiley.

[2] Francis, R. L., McGinnis, L. F. and White, J.A.., 2015, *Facility Layout and Location: An Analytical Approach*, Pearson Education India.

[3] Stephens, M.P., 2019, *Manufacturing Facilities Design and Material Handling*, Pearson, USA.

[4] Young, P. J., 2009, *Selecting, Buying, Installing and Using a Modern Warehouse Management System*, Lulu, India.

[5] Groover, M. P., 2016, *Automation, Production Systems, and Computer-Integrated Manufacturing*, Pearson Education, India.

ME6128E CELLULAR MANUFACTURING SYSTEMS

Pre-requisite: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course outcomes:

CO1: Understand the characteristics of cellular manufacturing system and the role of GT in production system configuration
CO2: Develop an understanding and assess various models for group formation.
CO3: Formulate and solve mathematical models for CMS design using analytical and heuristic methods
CO4: Assess development method for the creation of CMS and understand the automatic control of CMS

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 – Role of similarity in GT – Composite part; Coding and classification, Similarity coefficient-based clustering, Key machine approach, Binary ordering algorithm, Production flow analysis; Cell formation problem – a case study.

Models for Cellular Manufacturing System (CMS) Design: CMS design factors, Mathematical programming approaches, Model for dynamic part population, Solution procedure using genetic algorithm.
Workcell: Building blocks of workcell – Linked cell, Different types of cells, Cycle time, Workcell design; Worker assignment; Incentive plans; Issues in implementing cellular manufacturing.

Performance evaluation of CMS: Economic aspect of CM – Modelling CM performance – Experimental design for CM performance – Analysing CM performance.
Cellular manufacturing (CM) and Jidoka (autonomation): Overall equipment effectiveness for cellular manufacturing – Jidoka for ensuring OEE, Supervisory control and data acquisition (SCADA) for implementing jidoka – Case study: time-based cellular manufacturing.
Robust design of CMS: Robust design versus adaptive design – Robust design modelling – Analysing a robust design.
Networked CMS: Open systems interconnection (OSI) – layers of OSI – messages in a networked CMS – Error detection and corrections – Cycle redundancy check.

References

[1] Wang, J.X., 2021, *Cellular Manufacturing: Mitigating Risk and Uncertainty*, CRC Press, London.

[2] Nicholas, J., 2001, *Competitive Manufacturing Management - Continuous Improvement, Lean Production, and Customer-Focused Qualities*, Tata McGraw-Hill Edition.

[3] Sing, N., and Rajamani, D., 2011, *Cellular Manufacturing Systems: Design, Planning & Control*, Chapman & Hall.

[4] Askin, R. G., and Standridge, C. R., 1993, *Modelling and Analysis of Manufacturing Systems*, John Wiley & sons. Inc.

[5] Groover, M.P., 2016, *Automation, Production Systems, and Computer-Integrated Manufacturing*, Pearson.

ME6129E INDUSTRIAL SCHEDULING

Pre-requisites: NIL

L	T	P	C
3	0	0	3

Total Lecture Sessions: 39

Course outcomes:
CO1: Understand and classify scheduling problems based on characteristics and computational complexity
CO2: Formulate and solve scheduling models for single-machine shops, flow shops and job shops
CO3: Explain the scheduling of assembly lines
CO4: Illustrate scheduling of service systems

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, Neighbourhood search techniques, Random sampling, Parallel machine models.

Flow shop scheduling: Permutation schedules, Johnson's problem, Ignall and Schrage algorithm, Dominance properties for makespan 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.

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] Pinedo, M., 2016, *Scheduling: Theory, Algorithms and Systems*, Springer.

[2] Baker, K.R., and Trietsch, D., 2018, *Principles of Sequencing and scheduling*, Wiley.

[3] French, S., 1982, *Sequencing and Scheduling*, Elis Horwood Ltd., Chichester, U.K..

[4] Bazargan, M., 2010, *Airline Operations and Scheduling*, Routledge

ME6130E LEAN PRODUCTION MANAGEMENT

Pre-requisite: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course outcomes:

CO1: Describe and assess the impact of small lot production on the performance of a production system.
CO2: Apply and evaluate pull production control principles and techniques.
CO3: Analyse and evaluate different methods and techniques for achieving production levelling.
CO4: Analyse and assess different approaches and methodologies for achieving synchronization and balance in a production system.

Small-lot production and Setup time reduction

Small-Lot Production: Wastes due to large lot production – Lot splitting and lot streaming – Transfer batches and performance – Lot-size reduction and competitiveness – Minimal lot-size – Facilitating small lot-size.
Setup-time reduction: Benefits of simplified setup – Setup Reduction Methodology – Techniques for Setup-Reduction – setup Reduction Projects.

Pull Production Systems

Group technology: General features of group technology – Types of group layouts – Cellular manufacturing – Production flow analysis – Algorithms for cell and part family formations.
Pull Production Systems: Pull production – Determination of buffer size – Conveyance and production kanbans – Pull and Push Systems – Conditions for Pull Production Systems – How to achieve Pull Production – Signal kanbans – CONWIP system.
Workcells and Cellular Manufacturing: Linked workcells and subcells – Workcell design: cycle time, Assembly cells and machining cells.

Production planning for lean production

Scheduling for Smooth Flow: Production Levelling – Levelling production with uniform schedules – Levelling the master production schedule.
Level Scheduling in Pull Production: Mixed model production (Heijunka) – Uniform load production scheduling for MTS – Modularisation and planning bills for ATO – Level scheduling for MTO.
Synchronising and Balancing Process: Synchronisation – Synchronised cycle time; Bottleneck Scheduling – Drum-buffer-rope system; Balancing – Balancing for mixed-model production – Balancing for synchronous flow.
Planning and Control in Pull Production: Centralised and decentralised planning and control systems; Adapting MRP-based production planning and control system to pull production – Flattening of BOMs – Post deduct/backflushing.

References

[1] Nicholas, J., 2018, *Lean Production for Competitive Advantage: A comprehensive Guide to Lean Methodologies and Management Practices*, CRC Press, London.

[2] Nicholas, J., 2001, *Competitive Manufacturing Management – Continuous Improvement, Lean Production, and Customer-Focused Qualities*, Tata McGraw-Hill Edition.

[3] Askin, R. G., and Goldberg, J. B., 2007, *Design and Analysis of Lean Production Systems*. Wiley Student Edition.

[4] Korgaonker, M. G., 2012, *Just In Time Manufacturing*, Macmillan Publishers India Limited.

ME 6131E SUSTAINABILITY MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Sensitize the business professionals on their affirmative role in sustainable development
CO2: Apply green management tools for achieving sustainability
CO3: Analyse and evaluate the sustainable supply chains
CO4: Analyse and evaluate sustainability with innovation and waste management

Management of sustainability: rationale and political trends - An introduction to sustainability management - International and Indian policies on sustainable development – Sustainable development goals (SDG/SCG) and performance measures - Corporate sustainability and shared 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.

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.

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., 2015, *Sustainability Engineering: Concepts, Design and Case Studies*, Pearson Education India.

[2] Bradley, A. S., Adebayo, A.O., and Maria, P., 2016, *Engineering Applications in Sustainable Design and Development*, Cengage learning , 2016.

[3] Cetinkaya, B.,Cuthbertson, R., Ewer, G., Klaas-Wissing, T., Piotrowicz, W., and Tyssen, C., 2011, *Sustainable Supply Chain Management: Practical Ideas for Moving Towards Best Practice*, Springer-Verlag Berlin Heidelberg.

[4] Daddi, T., Iraldo, F., and Testa, F., 2015, *Environmental Certification for Organizations and Products: Management Approaches and Operational Tools*, Routledge.

[5] Gerwig, K., 2015, *Greening Health Care*, Oxford University Press.

[6] Morana, J., 2013, *Sustainable Supply Chain Management*, John Wiley & Sons, Inc.

ME6132E SYSTEM MODELLING AND SIMULATION

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Explain the role of important elements of system modelling and discrete event simulation
CO2: Develop simulation models using various techniques
CO3: Illustrate input data modelling for simulation
CO4: Apply tests for verification and validation of simulation models
CO5: Apply simulation modelling and analysis to various realistic situations

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

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. Estimation of Absolute Performance: Types of Simulations with respect to output Analysis, Measures of performance and their estimation, Output analysis for terminating simulations, Confidence intervals with specified precision.

Output analysis for steady state simulations: Initialisation bias, Sample size determination, Estimation of relative performance - Metamodelling: Regression models, simulation-optimization.
Simulation modelling and analysis of typical manufacturing systems, Supply chains, Healthcare systems, PERT networks.

References:
[1] Altiok, T. and Melamed, B., 2014, *Simulation modeling and analysis with Arena*, Elsevier.

[2] Banks, J., Carson, J.S., Nelson, B. L., and Nicol, D. M., 2014, *Discrete-Event System Simulation*, Pearson Education.

[3] Choi B K., 2013, *Modeling and Simulation of Discrete-Event Systems*, John Wiley & Sons Inc.

[4] Deo, N., 1997, *System Simulation with Digital Computer*, Prentice Hall of India.

[5] Law, A. M., 2017, *Simulation Modelling and Analysis*, McGraw-Hill Education.

[6] Rossetti, M. D., 2015, *Simulation Modelling and ARENA*, Wiley-Blackwell.

[7] Robinson, S., 2014, *Simulation: The Practice of Model Development and Use*, Palgrave Macmillan.

[8] Oakshott, L., 1997, *Business Modelling and Simulation*, Pitman Publishing.

ME6133E RELIABILITY ENGINEERING AND MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Understand the basic concepts of system reliability models
CO2: Analyze failure data
CO3: Compute measures of reliability of products and systems
CO4: Explain the techniques of reliability improvement

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

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

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] Balagurusamy, E., 2017, *Reliability Engineering*, McGraw Hill Education India P Ltd.

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ME6134E PRODUCT LIFE CYCLE MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Define and describe the needs and importance of Product Life Cycle Management (PLM).
CO2: Analyse and evaluate different methods and approaches for implementing PLM.
CO3: Describe and explain the stages and activities involved in the product launch process.
CO4: Classify and categorize the different stages and characteristics of a product life cycle.

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.

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

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] John, S., 2019, *Product Lifecycle Management: Paradigm for 21st Century Product Realisation*, Springer.

[2] Giudice, F., La Rosa, G., and Risitano, A., 2019, *Product Design for the environment-A life cycle approach*, Taylor & Francis.

[3] Antti, S., and Anselmi, I., 2005, *Product Life Cycle Management*, Springer.

[4] Grieves, M., 2005, *Product Lifecycle Management: Driving the Next Generation of Lean Thinking*, McGraw Hill.

ME6135E SOFT COMPUTING TECHNIQUES

Pre-requisites: NIL

L	T	P	O	C
3	1	0	5	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Apply metaheuristic algorithms for solving optimization problems
CO2: Apply fuzzy logic in decision-making systems
CO3: Develop prediction models using Artificial Neural Networks

Metaheuristic Algorithms: 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. Multi-objective GA - Simulated Annealing: Introduction - Algorithm - Applications. 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.

Artificial Neural Networks: Fundamental concepts and models of artificial neural systems – Biological and artificial neurons, Models of Artificial Neural Networks (ANN)- Feedforward and feedback network- Neural Network learning rules- Single layer perceptron classifiers- Multilayer feedforward networks - Applications of ANN in optimization. Modelling using software packages.

References

[1] Goldberg, D. E., 2008, *Genetic Algorithms in Search, Optimization, and Machine Learning*, Pearson India.

[2] Bozorg-Haddad, O., Solgi, M., and Loáiciga, H. A., 2017, *Meta-Heuristic and Evolutionary Algorithms for Engineering Optimization*, John Wiley & Sons, Inc.

[3] Deb, K., 2012, *Optimization for Engineering Design*, Prentice Hall of India.

[4] Ross, T.J., 2011, *Fuzzy Logic with Engineering Applications*, Wiley India.

[5] Sundareswaran, K., 2019, *A Learner's Guide to Fuzzy Logic Systems*, Jaico Publishing House.

[6] Zurada, J.M., 2006, *Introduction to Artificial Neural Systems*, Jaico Publishing House.

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[8] Schalkoff, R. J., 2011, *Artificial Neural Networks*, Tata McGraw Hill.

ME6136E ADVANCED DECISION MODELLING

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Solve decision problems under risk and uncertainty
CO2: Explain the basic concepts and methods of multi-objective decision making
CO3: Model and analyse deterministic and stochastic dynamic programming problems
CO4: Model and analyse waiting line system

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.

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

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, A., Phillips, D. T., and Solberg, J. J., 1987, *Operations Research: Principles and Practice*, John Wiley & Sons.

[2] Budnick, F. S., McLeavey, D., and Mojena, R., 1991, *Principles of Operations Research for Management*, Richard D. Irwin Inc., Homewood, Illinois.

[3] Hillier, F. S., and Liberman, G. J., 2021, *Introduction to Operations Research*, McGraw-Hill Education.

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[5] Ramanathan, R., 2003, *An Introduction to Data Envelopment Analysis: A Tool for Performance Measurement*, SAGE Publications Pvt. Ltd.

[6] Rao, S. S., 2021, *Engineering Optimization: Theory and Practice*, Wiley eastern.

ME6137E ETHICS AND HUMAN VALUES

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Comprehend the importance of business ethics and its impact on individuals, organizations, and society
CO2: Articulate and communicate the importance of human values and virtues in various spheres of life
CO3: Analyse the social and ethical implications of AI technologies and contribute to the discourse on responsible AI development and use

Business Ethics: Personal ethics and professional ethics - Significance of business ethics - Values and ethics in business - Concepts and Theories of Business Ethics - Morality and law - Normative theories - Ethical theories in relation to business - Indian ethical traditions; Ethical dilemmas, Sources and their resolutions: Corporate dilemma over ethical behaviour - Sources of ethical problems - Code of personal ethics for employees - Creating ethical working environment - Resolving ethical problems and dilemmas; Ethical Decision-making in Business.

Human Values: Foundations of human values - Human values and sub-values - Morals, values and ethics - Virtues - McIntyre's list of virtues: Unity, Integrity, Honesty, Self-respect, Responsibility, Accountability; Civic Virtues, Respect for others, Living peacefully, Caring, Sharing, Courage, Valuing Time, Co-operation, Commitment, Empathy, Self-Confidence, Modesty, Generosity, Character, Spirituality.

AI Ethics: Introduction to AI - History of AI ethics - Ethical questions in AI - Comparing AI to Humans - Moral Agency, moral patiency - Privacy and data protection, Safety and security, Transparency and Explainability, Bias - Applied Ethics: Methods in applied ethics - AI in applied ethics - Normative Ethical Theory and AI Ethics - Philosophy for AI Ethics - AI in the workplace - Superintelligence, Existential Risk, and the Control Problem.

References

[1] Fernando, A.C.,2019, *Business Ethics: Indian Perspective*, Pearson Education India.

[2] Gupta, A. D., 2014, *Business Ethics: Texts and Cases from the Indian Perspective*, Springer India.

[3] Oderberg, D. S., and Chappell, T., 2004, *Human Values: New Essays on Ethics and Natural Law*, Palgrave Macmillan.

[4] Kiran, D. R., 2014, *Professional Ethics and Human Values*, McGraw Hill Education (India) Private Limited, New Delhi.

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[6] Coeckelbergh, M., 2020, *AI Ethics*, The MIT Press, London.

ME6138E INTRODUCTION TO DATA SCIENCE

Prerequisite: NIL

L	T	P	O	C
3	0	1	5	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Explain the basics of Python functions, parameters and collections
CO2: Apply the python libraries for data manipulation, visualization, statistics, and scientific calculations
CO3: Apply fundamentals of statistics for analyzing real life cases using python

Fundamentals of Python Programming
Introduction of data science, Programming in Python: Basics-variables, data types, expressions, arithmetic operations – Control statements: conditions and looping statements – Functions-mathematical functions, user defined functions –parameters and arguments–Python collection: list, dictionary, tuple, set, namedtuple, deque, ChainMap, Counter, OrderedDict, defaultdict – errors and exceptions – classes –modules –files, strings – lambda function

Data Science Packages
Data Science packages - Data Manipulation and Analysis with NumPy and Pandas, scientific and linear algebra calculation using NumPy, SciPy and SymPy, Data Visualization with Matplotlib and Seaborn, statistics analysis using statsmodels

Applied Statistics for Data Science
Applied Statistics for Data Science using Python: Exploratory data analysis (EDA)**,** EDA steps**,** EDA Univariate, Bivariate, and multivariate analysis –Probability distributions – sampling, sampling techniques – Correlation – Covariance and Interquartile Ranges – hypothesis testing – linear and non-linear regression, text analysis, social network analysis - time series analysis, introduction to machine learning classification, regression, and clustering algorithms, case studies on real life problems

References:
[1] McKinney, W., 2022, *Python for Data Analysis*, O'Reilly, USA.

[2] Molin, S., 2019, *Hands-On Data Analysis with Pandas*, O'Reilly, USA.

[3] Deitel, P., and Deitel, H., 2020, *Python for Programmers*, Pearson USA.

[4] Montgomery, D. C., and Runger, G. C., 2016, *Applied Statistics and Probability for Engineers*, Wiley.

[5] Gujarati, D., Porter, D., and Gunasekar, S., 2017, *Basic Econometrics*, McGraw Hill Education, India.

ME6139E DATABASE MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Explain database management, structure and system requirements.
CO2: Apply relationship model and normalization approach for database design
CO3: Illustrate the concept of data storage, indexing, hashing, and their applications
CO4: Design, analyse and validate database using SQL

Introduction to Database
Database systems, purpose, Abstraction – Data models, Instances and Schemes - Data independence - Data Definition Language - Data Manipulation Language - Entity Sets, Relationship Sets, attributes - Mapping Constraints, keys - Structure of Relational Databases - Relational algebra - Domain relational calculus - modifying the database - SQL fundamentals, Advanced SQL features, Embedded SQL, Dynamic SQL

Database Design
Entity-Relationship (ER) model, ER Diagrams, Enhanced-ER Model - Integrity Constraints - Domain Constraints, Referential integrity - functional dependencies - assertions – triggers and active databases - Relational Database design - pitfalls - Normalisation using functional, Multi-valued and join dependencies, domain key normal form - alternative approaches, 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.

Database Management
Data definition language, Query Processing - Interpretations - equivalence of expressions - Estimating cost of Query processing and access using Index – Transaction Processing – Design Coding and Testing of databases, Security and Integrity, Violations, Authorisation and views - encryption - Data validation, Multiple user access- Data mining – Data Warehousing

References
[1] Connolly, T., and Begg, T, 2010, *Database Systems: A Practical Approach to Design, Implementation and Management*, Addison-Wesley.

[2] Jukic, N., Vrbsky, S., and Nestorov, S., 2016, *Introduction to Databases and Data Warehouses,* Prospect Press.

[3] Silberschatz, A., Korth, H. F., and Sudarshan, S., 2013, Database system concepts, McGraw Hill Education, India.

[4] Ramez, E., and Navathe, S., 2017, Fundamentals of Database System, Pearson Education, India.

ME6140E ENTERPRISE RESOURCE PLANNING

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Explain the features of Enterprise Resource Planning systems
CO2: Describe the benefits of ERP implementation in an organization
CO3: Analyze various success and failure factors of ERP implementation
CO4: Select and implement the appropriate ERP systems in an organization

Introduction to Enterprise Resource Planning: Business functions and Business processes, Evolution of information systems, Enterprise information systems: Enterprise Resource Planning (ERP), Supply Chain Management (SCM), Manufacturing Execution Systems (MES), Customer Relationship Management (CRM), Product Lifecycle Management (PLM) and Business Intelligence (BI). ERP data input – ERP output capabilities, Productivity improvement through ERP.

Introduction to ERP packages – Comparison of ERP packages – Open Source ERP - Successes and failure factors of ERP, ERP strategy and implementation methodology, Implementation challenges, Roles and responsibilities of ERP consultant, ERP life cycle phases – production and materials management systems within ERP – E-commerce: e-procurement, e-auction, e-supply chain, e-market place. Introduction to Open Network for Digital Commerce.

Post implementation issues – Nature of ERP maintenance and support, client-vendor partnership, ERP vendors' policies, services, and impacts on ERP adoption, Impact of RFID, Business intelligence, mobile computing, cloud computing on ERP – Latest trends: ERP II, ERP III

References:
[1] Law, C.C., 2019. *Managing enterprise resource planning adoption and business processes: A holistic approach*, Cambridge Scholars Publishing.

[2] Monk, E. and Wagner, B., 2014. *Concepts in enterprise resource planning*, Cengage Learning.

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[4] Sumner, M., 2007, *Enterprise resource planning*, Pearson Education.

[5] Leon, A., 2019, *Enterprise Resource Planning*, Mc-Graw Hill Education India.

[6] Chan, H., Lee, R., Dillon, T. and Chang, E., 2007, *E-commerce, fundamentals and applications*, John Wiley & Sons.

[7] Joseph, P.T., 2023, *E-commerce: An Indian perspective*, PHI Learning Pvt. Ltd.

ME6141E DECISION SUPPORT AND EXPERT SYSTEM

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Explain the fundamental concept and classification of decision support system
CO2: Demonstrate the applications of Knowledge-Based Expert System and Search Techniques with industry problems
CO3: Evaluate Knowledge-Based Expert System methods and models

Fundamentals of Decision Support System
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).

Knowledge-Based Expert System and Search Techniques
Knowledge-Based Expert System (KBES): Introduction, 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.

Evaluation of Knowledge-Based Expert System
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.

References

[1] Krishnamoorthy, C. S. and Rajeev, S., 1996, *Artificial Intelligence and Expert Systems for Engineers*, CRC Press Inc., New York.

[2] Pascual, D. G., 2020, *Artificial Intelligence Tools: Decision Support Systems in Condition Monitoring and Diagnosis*, CRC Press, India

[3] Sharda, R., Turban, E., and Delen, D., 2015, *Decision Support and Business Intelligence Systems*, Pearson Education, India

[4] Hopgood, A. A., 2021, Intelligent *Systems for Engineers and Scientists: A Practical Guide to Artificial Intelligence*, Taylor & Francis Ltd, India.

ME 6142E INFORMATION SHARING AND INVENTORY IN SUPPLY CHAIN MANAGEMENT

Pre-requisite: Basic understanding of inventory control and supply chain management

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Describe and explain the key concepts and principles of supply chain operation through role play and inventory policy-based simulations.
CO2: Define and identify the fundamental principles, techniques and methods for informed decision making of inventory management in supply chains.
CO3: Compare and contrast different collaboration methods used to enhance supply chain performance.
CO4: Analyse and interpret the causes and consequences of the bullwhip effect in supply chains.

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.

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, Blockchain-based secure information sharing platform for supply chain management, Demonstration of blockchain based operation simulation.
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, supply chain as a multi-agent system, AI/ML application in supply chain order management and coordination.

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] Pillai, V. M., 2017, *Supply Chain Role Play Game (SCRPG) exercise handout and user manuals of SCRPG and VMI-SCRPG*, Department of Mechanical Engineering.
[2] Pillai, V. M., 2022, *Supply chain management game: revealing implied demand uncertainty*, white paper, Department of Mechanical Engineering.
[3] Pillai, V. M., 2016, *Performance analysis of a four-echelon supply chain under order up-to policy using SCIPA software package*, Department of Mechanical Engineering.
[4] Tersine, R. J., 1994, *Principles of Inventory and Materials Management*, Prentice-Hall Inc., New Jersey.
[5] Shah, K., Lakshmi Gorty, V. R., and Phirke, A., (Editors), 2011, *Technology Systems and Management, Communications in Computer and Information Science*, 145(3), Springer-Verlag Berlin Heidelberg, pp. 327-332.
[6] Soliman, F., (Editor), 2015, *Cloud Systems in Supply Chains*, Palgrave Macmillan.
[7] Kurian, D. S., Pillai, V. M., and Gautham, J., 2023, "Data-driven imitation learning-based approach for order size determination in supply chains", *European Journal Industrial Engineering*, 17(3), pp. 379 – 407.
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[9] Chopra, S., Meindl, P., and Kalra, D. V., 2018, *Supply Chain Management: Strategy, Planning and Operations*, Pearson Education Ltd.

ME6143E PROJECT MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Understand the importance of the evaluation of social cost benefit analysis
CO2: Develop project network and estimate the cost and time for project completion
CO3: Applying tools and techniques for scheduling the project under resources constraints
CO4: Develop tools to monitor, control and close the project

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.

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.

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, Project risk analysis, Performance evaluation, Abandonment analysis, Project organization, Matrix organization, Project control, Variance analysis approach, Performance analysis.

References

[1] Pinto, J. K., 2015, *Project Management: Achieving Competitive Advantage*, Pearson.

[2] Weist, J. D., and Levy, F. K., 1994, *A Management Guide to PERT/CPM*, Prentice Hall of India, New Delhi .

[3] Larson, E W., Gary, C. F., and Joshi, R., 2021, *Project Management: The Managerial Process*, 8th ed., McGraw Hill.

[4] Chandra, P., 2019, *Projects: Planning, Analysis, Selection, Financing, Implementation, and Review*, McGraw Hill Education (India).

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[7] *A guide to the Project Management Body of Knowledge*, 2017, Project Management Institute.

ME6144E MANAGEMENT OF TECHNOLOGY AND INNOVATION

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Develop an understanding of the "state of the art" of the strategic management of technology and innovation in both large and small firms.

CO2: Develop a conceptual framework for assessing and auditing the innovative capabilities of a business organization.

CO3: Consider all three aspects of innovation: creativity, implementation and marketing and to have an understanding of Design Thinking

CO4: Understand the directions of Intellectual Property Rights and how to take advantage of opportunities for IP-based innovation

Technology Management: An overview

Understanding Management of Technology, key concepts, critical factors in managing technology – creativity factor, timing factor, technology-price relationship, managing change – Process of technological change: Technology life cycles (supply side) - Diffusion (market side), methods of diffusion – technology and competition

Business Strategy and Technology Strategy

Formulation of strategy – Methods used in strategic analysis: Product evaluation matrix, BCG matrix, X-Y coordinate positioning, M-by-N matrix, technology evaluation for adoption decision, SWOT matrix – Formulation of technology strategy: Technology and core competence, linking technology and business strategies, creating the product-technology-business connection. Technology planning: Technology forecasting, technology audit models, technology roadmap matrix, planning based on technology life cycles, B-Tech approach to planning – case discussion.

Deployment of Technology in New Product

Design thinking process - New product development process: strategic and operational phase – Approaches to speeding product development: Internal organizational mechanisms, intra-organizational mechanisms, external organizational mechanisms: acquisition and deployment of technology, methods of acquiring technology, exploitation of technology – Case discussion.

Intellectual Property Strategy

Deployment of technology in value chain – Intellectual property strategy: Mechanisms for Intellectual property protection- Technology evaluation and financing – changing role of R & D,

References:

[1] Burgelman, R. A., Christensen, C. M., and Wheelwright, S. C., 2009, *Strategic Management of Technology and Innovation*, McGraw-Hill/Irwin.

[2] Khalil, T., and Shankar, R., 2017, *Management of Technology: The key to competitiveness and wealth creation*, McGraw Hill Education.

[3] Narayanan, U .K., 2001, *Managing Technology and Innovation for competitive Advantage*, Pearson Education, Asia.

[4] White, M. A., and Burton, G. D., 2011, *The Management of Technology and Innovation: A strategic approach*, Cengage Learning.

ME6145E FINANCIAL MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Evaluate the cost of investments in a real-time environment
CO2: Evaluate the capital budgeting risks for decision making
CO3: Compute the cost of capital and understand the optimum capital structure
CO4: Understand the implications of the dividend on the valuation of the firm

Financial Management: An overview
Finance and Related Disciplines; Scope of Financial Management; Objectives of Financial Management; Primary Objective of Corporate Management; Agency Problem; Organization of Finance Function; and Emerging role of Finance Managers in India.

Time value of money
Time value of money: practical application of compounding and discounting, Stock valuation, Bond valuation. Conceptual Framework of Risk and Return: Type of Risks; Risk and Return of a Single Asset; Risk and Return of Portfolio; Portfolio Selection – Capital Asset Pricing Model (CAPM)

Capital Budgeting and Cost of Capital
Budgeting and Profit planning - Investment in long term assets: Capital budgeting decision criteria, traditional techniques, discounted cash flow techniques, determination of relevant cash flows (single proposal, salvage value is nil, replacement situation, mutually exclusive situation), NPV – IRR comparisons, project selection under capital rationing, inflation and capital budgeting – Capital budgeting measurement of risk and risk evaluation – Computation of cost of capital, bonds, shares and overall cost of capital – Operating leverage, financial leverage.

Designing Capital Structure
Profitability Aspect - Liquidity Aspect; Control - Leverage Ratios for other Firms in the Industry - Nature of Industry - Consultation and Investment Bankers and Lenders – Maintaining maneuverability for Commercial Strategy; Timing of Issue; Characteristics of Company; Tax Planning; and Capital Structure Practices in India – Dividend theories - Relevance and Irrelevance of dividends.

References:
[1] Khan M. Y., and Jain P. K., 2019, *Financial Management*, Tata McGraw Hill.

[2] Chandra, P., 2022, *Financial Management: Theory and Practice*, Tata McGraw Hill**.**

[3] Pandey, I. M., 2005, *Financial Management*; Vikas Publishing House, New Delhi.

[4] Brealey, R., and Myers, S., 2008, *Principles of Corporate Finance*, Tata McGraw Hill, New Delhi.

[5] Vanhorne, J. C., 2002, *Financial Management and Policy*, Prentice Hall of India, New Delhi.

ME6146E INVESTMENT MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:
CO1: Understand the roles and functions of the stock market
CO2: Conduct Macro economic analysis and Estimate the risks of investments
CO3: Evaluate the investment instruments to optimize the portfolio
CO4**:** Understand and evaluate the derivatives as an investment instrument

Investment Management: An overview
Investment environment: - securities and market, investment process – Financial instruments: Money market instruments, capital market instruments.
Primary Market: Role and functions, Modes of raising funds - Secondary Market: Role and functions - Trading and Settlement Procedures, Leading Stock Exchanges in India. Stock Market Indicators- Types of stock market Indices, Indices of Indian Stock Exchanges.

Macro Economic analysis
Fundamental analysis – Company Analysis - Technical Analysis: Concept, Theories: Dow Theory, Eliot wave theory - Charts-Types, Trend and Trend Reversal Patterns. Mathematical Indicators – Moving averages, ROC, RSI, and Market Indicators

Modern Portfolio theory
Types of Risk: Systematic risk, Unsystematic risk, Calculation of Risk and returns of individual security,
Portfolio analysis: Markowitz Model, Portfolio Selection, Opportunity set, Efficient Frontier - Capital Asset pricing model: CAPM Equation, Security Market line, Capital market line, SML VS CML.- Arbitrage pricing theory: Arbitrage, Equation, Assumption, Equilibrium, APT AND CAPM
Portfolio Management: Diversification, Investment objectives, Risk Assessment, Selection of asset mix, Risk, Return and benefits from diversification. Portfolio Management Strategies: Active and Passive Portfolio Management strategy. Portfolio Revision: Portfolio Revision Strategies – Objectives, Performance plans. Portfolio Evaluation: Holding period's returns, Measures of portfolio performance. Sharpe's, Treynor's and Jenson's.

Investment evaluation and Derivatives
Fixed income securities: - Types, Bond valuations, Bond analysis and portfolio management, Mutual
Funds – Call and Put options (American and European), Black-Scholes option pricing model – Derivatives: Forward contracts, Future contracts, Payoff for futures - International investing.

References:
[1] Khan M.Y., and Jain P. K., 2019, *Financial Management*, Tata McGraw Hill.

[2] Chandra, P., 2008, *Financial Management*; Tata McGraw Hill, New Delhi.

[3] Reilly, F. K., and Brown, K. C., 2011, *Investment Analysis and Portfolio Management*, Cengage Learning.

[4] Sharpe, W. F., Alexander, G. J., and Bailey, J. V., 2019, *Investments*, Prentice Hall.

[5] Fabozzi, F. J., and Peterson, P. P., 2003, *Financial Management and Analysis*, Wiley.

ME6147E DISASTER MANAGEMENT

Pre-requisites: NIL

L	T	P	O	C
3	0	0	6	3

Total Lecture Sessions: 39

Course Outcomes:

CO1: Develop understanding on science of natural and man-made disasters
CO2: Demonstrate hazard mapping, vulnerability and risk assessment using GIS
CO3: Identify the role and relationships of community, government and non-government organizations in managing phases of disasters
CO4: Apply the concepts of supply chain, and business statistics to develop the decision-making models in managing disasters

Basics of Disasters

Understanding of Natural Hazards, Disasters, vulnerability, resilience, Pressure and Release Model – Natural Disasters types, impact and science, Climate Change, and Global Warming – Manmade Disasters, types, and impact, Accidents, and E-Waste

Hazard, Risk and Vulnerability Mapping and Assessment

Hazard, Risk and Vulnerability – Hazard Mapping and Vulnerability Assessment, Introduction of Geographical Information System (GIS) – Understanding Risk Concept and Elements, Risk Analysis and Risk Assessment using GIS, Risk Reduction Measures, Risk sharing – Socioeconomic Vulnerability assessment using secondary data and GIS - Community Participation in Disaster Risk Reduction - Prediction and early warning systems

Disaster Management Cycle and its Management

Disaster Management: Disaster Management Cycle, Disaster Prevention and Mitigation, Disaster Preparedness, Disaster Response, Disaster Recovery and Rehabilitation; Disaster Management Institutions and their Role in Disaster Mitigation – Role of Government and Non-Government Organizations in Managing Disasters, damage and need assessment, scenario building, disaster resilient communities - Last mile connectivity, route optimization problems for response and recovery under chaotic environment

Social and Business Concepts in Managing Disasters

Humanitarian Logistics – Role of Information and Communication Technology in Disaster Prevention and Management – Education and Awareness on Disaster Management – Practical Ethics and Legal Framework in Disaster Management –National disaster management policy of India and Indian states – facility location and capacity problems- forecasting of human and relief resources

References:

[1] Tatham, P. and Christopher, M., 2018, *Humanitarian Logistics: Meeting the Challenge of Preparing for and Responding to Disasters*, Kogan Page, London, UK.

[2] Gupta, H. K., 2003, *Disaster Management*, Universities Press.

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[5] Valcik, N. A., and Tracy P. E., 2017, *Case Studies in Disaster Response and Emergency Management*, Routledge, USA.

[6] Diwan, P., 2010, *A Manual on Disaster Management*, Pentagon Press.

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INSTITUTE ELECTIVES

IE6001E ENTREPRENEURSHIP DEVELOPMENT

Pre-requisites: NIL

L	T	P	O	C
2	0	0	4	2

Total Lecture Sessions: 26

Course Outcomes:

CO1: Describe the various strategies and techniques used in business planning and scaling ventures.
CO2: Apply critical thinking and analytical skills to assess the feasibility and viability of business ideas.
CO3: Evaluate and select appropriate business models, financial strategies, marketing approaches, and operational plans for startup ventures.
CO4: Assess the performance and effectiveness of entrepreneurial strategies and actions through the use of relevant metrics and indicators.

Entrepreneurial Mindset and Opportunity Identification
Introduction to Entrepreneurship Development - Evolution of entrepreneurship, Entrepreneurial mindset, Economic development, Opportunity Recognition and Evaluation - Market gaps - Market potential, Feasibility analysis - Innovation and Creativity in Entrepreneurship - Innovation and entrepreneurship, Creativity techniques, Intellectual property management. .

Business Planning and Execution
Business Model Development and Validation - Effective business models, Value proposition testing, Lean startup methodologies - Financial Management and Funding Strategies - Marketing and Sales Strategies - Market analysis, Marketing strategies, Sales techniques - Operations and Resource Management - Operational planning and management, Supply chain and logistics, Stream wise Case studies.

Growth and Scaling Strategies
Growth Strategies and Expansion - Sustainable growth strategies, Market expansion, Franchising and partnerships - Managing Entrepreneurial Risks and Challenges - Risk identification and mitigation, Crisis management, Ethical considerations - Leadership and Team Development - Stream wise Case studies.

References:

[1] Kaplan, J. M., Warren, A. C., & Murthy V. (Indian Adoption), 2022, *Patterns of entrepreneurship management.* John Wiley & Sons.

[2] Kuratko, D. F., 2016, *Entrepreneurship: Theory, process, and practic*e. Cengage learning.

[3] Barringer, B. R. 2015, *Entrepreneurship: Successfully launching new ventures*. Pearson Education India.

[4] Shah Rajiv, Zhijie Gao, Harini Mittal, 2014, *Innovation, Entrepreneurship, and the Economy in the US, China, and India,* Academic Press.

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[6] Gordon, E., Natarajan, K., *Entrepreneurship Development*, Himalya Publishers, Delhi.

[7] Biswas Debasish, Dey Chanchal, 2021, *Enterpreneurship Development in India*, Taylor & Francis.

ZZ6002E RESEARCH METHODOLOGY

Pre-requisites: NIL

L	T	P	O	C
2	0	0	4	2

Total Lecture sessions: 26

Course Outcomes
CO1: Explain the basic concepts and types of research.
CO2: Develop research design and techniques of data analysis
CO3: Present research to the scientific community

Exploring Research Inquisitiveness
Philosophy of Scientific Research, Role of Research Guide, Planning the Research Project, Research Process, Research Problem Identification and Formulation, Variables, Framework development, Research Design, Types of Research, Sampling, Measurement, Validity and Reliability, Survey, Designing Experiments, Research Proposal, Research Communication, Research Publication, Structuring a research paper, structuring thesis/ dissertation.

Data Analysis
Literature review :Tools and Techniques - Collection and presentation of data, processing and analysis of data - Descriptive statistics and inferential statistics- Measures of central tendency, dispersion, skewness, asymmetry- Probability distributions – Single population and two population hypothesis Testing - Parametric and non-parametric tests - Design and analysis of experiments: Analysis of Variance (ANOVA),completely randomized design – Measures of relationship: Correlation and regression, simple regression analysis, multiple regression – interpretation of results - Heuristics and simulation

Research writing and Ethics
Reporting and presenting research, Paper title and keywords, writing an abstract, writing the different sections of a paper, revising a paper, responding to peer reviews.
The codes of ethics, copyright, patents, intellectual property rights, plagiarism, citation, acknowledgement, avoiding the problems of biased survey

References:

[1] Krishnaswamy, K.N., Sivakumar, A.I., and Mathirajan, M., 2006, *Management Research Methodology, Pearson* Education.
[2] Leedy, P, D., 2018, *Practical Research: Planning and Design*, Pearson.
[3] Kothari, C.R., 2004, *Research Methodology – Methods and Techniques*, New Age International Publishers.
[4] Martin Mike, Schinzinger Roland, 2004, *Ethics in Engineering*, Mc Graw Hill Education.
[5] Sople, Vinod V., 2014, *Managing Intellectual Property-The Strategic Imperative*, EDA Prentice of Hall Pvt. Ltd.

MS6174E TECHNICAL COMMUNICATION AND WRITING

Pre-requisites: NIL

L	T	P	O	C
2	1	0	3	2

Total Lecture Sessions: 26

Course Outcomes:

CO1: Apply effective communication strategies for different professional and industry needs.
CO2: Collaborate on various writing projects for academic and technical purposes.
CO3: Combine attributes of critical thinking for improving technical documentation.
CO4: Adapt technical writing styles to different platforms.

Technical Communication
Process(es) and Types of Speaking and Writing for Professional Purposes - Technical Writing: Introduction, Definition, Scope and Characteristics - Audience Analysis - Conciseness and Coherences - Critical Thinking - Accuracy and Reliability - Ethical Consideration in Writing - Presentation Skills - Professional Grooming - Poster Presentations

Grammar, Punctuation and Stylistics
Constituent Structure of Sentences - Functional Roles of Elements in a Sentence - Thematic Structures and Interpretations - Clarity - Verb Tense and Mood - Active and Passive Structures - Reporting Verbs and Reported Tense - Formatting of Technical Documents - Incorporating Visuals Elements - Proofreading

Technical Documentation
Types of Technical Documents: Reports, Proposals, Cover Letters - Manuals and Instructions - Online Documentation - Product Documentation - Collaborative Writing: Tools and Software - Version Control Document Management - Self Editing, Peer Review and Feedback Processes

References:

[1] Foley, M., and Hall, D., 2018, *Longman advanced learner's grammar, a self-study reference & practice book with answers*, Pearson Education Limited.

[2] Gerson, S. J., and Gerson, S. M., 2009, *Technical writing: Process and product*, Pearson.

[3] Kirkwood, H. M. A., and M., M. C. M. I., 2013, *Hallidays introduction to functional grammar*, Hodder Education.

[4] Markel, M., 2012, *Technical Communication*, Palgrave Macmillan.

[5] Tuhovsky, I., 2019, *Communication skills training: A practical guide to improving your social intelligence, presentation, Persuasion and public speaking skills*, Rupa Publications India.

[6] Williams, R., 2014, *The Non-designer's Design Boo*k, Peachpit Press.