CURRICULUM

M. TECH. IN INDUSTRIAL ENGINEERING AND DATA ANALYTICS

(July 2023 admissions onwards)

APPROVED BY

BOARD OF STUDIES (BOS)

During meeting on May 16, 2023

Teaching Scheme

DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING

Dr B R AMBEDKAR NATIONAL INSTITUTE OF TECHNOLOGY, Jalandhar

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Programme Educational Objectives (PEOs):

- The graduates will have capability to focus on the processes and find ways for improvement.
- The graduates will be able to make optimal and sustainable business decisions using the complex chunks of data**.**
- The graduates will be capable of taking on supply chain management, marketing and finance along with the grasp on the technical aspects.

Programme Outcomes (POs):

- **Problem analysis:** Identify, formulate, review and analyze engineering problems reaching optimal solutions using principles of mathematics and engineering sciences.
- **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
- **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
- **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Course Structure and Scheme for M. Tech (Full Time) Programme in Industrial Engineering and Data Analytics

SEMESTER - I

S No	Course Code	Course Title	Hrs/week			Credits
			L	T	P	
1	IEA-501	Advanced Statistics	3	0	0	3
2	IEA-503	Management Information Systems	3	0	0	3
3	IEA-505	Modelling & Simulation	3	0	0	3
4	IEA-507	Work Systems Design	3	0	0	3
5	IEA-509	Advanced Operations Research	3	0	0	3
6	IEA-511	Quality Management	3	0	0	3
7	IEA-513	Operations & Simulation Laboratory	0	0	3	2
8	IEA-515	Work Systems Design Laboratory	0	0	3	2
Total			18	0	6	22

SEMESTER – II

S.No	Course Code	Course Title	Hrs/week			Credits
			L	T	P	
1	IEA-502	Data Analytics	3	0	0	3
2	IEA-504	Deep Learning	3	0	0	3
3	IEA-506	Logistics & Supply Chain Management	3	0	0	3
4	IEA-508	Operations Management	3	0	0	3
5	IEA-	Program Elective–I*	3	0	0	3
6	IEA-	Program Elective–II*	3	0	0	3
7	IEA-510	Data Analytics Laboratory	0	0	3	2
8	IEA-512	Deep Learning Laboratory	0	0	3	2
Total			18	0	6	22

TEACHING SCHEME FOR M.TECH "INDUSTRIAL ENGINEERING AND DATA ANALYTICS" APPROVED FROM BOARD OF STUDIES OF DEPARTMENT OF INDUSTRIAL AND PRODUCTION ENGINEERING Applicable w.e.f. July 2023 Onwards

SEMESTER - III

Sr. No	Course Code	Course Title	Hrs/week			Credits
			L	T	P	
1	IEA-601	Seminar	0	0	6	3
2	IEA-600	Dissertation(Phase-I) **	0	0	12	6
Total			0	0	18	9

SEMESTER – IV

Sr. No	Course Code	Course Title	Hrs/week			Credits
			L	T	P	
1	IEA-600	Dissertation(Phase-II) **	0	0	24	12
Total			0	0	24	12

***In 2nd semester, students will be offered one elective from Industrial Engineering stream and other from Data Analytics stream.**

List of Electives (Industrial Engineering Stream)			L	T	P	C
Sr.No.	Code	Course Name	3	0	0	3
1	IEA-521	Project Management	3	0	0	3
2	IEA-522	Reliability and Maintenance Engineering	3	0	0	3
3	IEA-523	Product Design and Development	3	0	0	3
4	IEA-524	Facilities Design	3	0	0	3
5	IEA-525	Design and Analysis of Experiments	3	0	0	3
6	IEA-526	Occupational Health and Safety Management	3	0	0	3
7	IEA-527	Human Factors Engineering	3	0	0	3
8	IP-565	Finite Element Methods	3	0	0	3
9	IP-562	Computer Integrated Manufacturing	3	0	0	3
LIST OF ELECTIVES (Data Analytics Stream)						
Sr.No.	Code	Course Name	L	T	P	C
1	IEA-541	Visualization and Big Data Analytics	3	0	0	3
2	IEA-542	Data Structures and Programming Methodology	3	0	0	3
3	IEA-543	Linear Algebra	3	0	0	3
4	IP-556	Industrial Internet of Things	3	0	0	3

SEMESTER 1

IEA-501 Advanced Statistics [3-0-0-3]

Course Objective

To train the students about various tools and techniques of statistics so that they can apply the same for analysis of real life data encountered in their jobs.

Course Outcomes

After completing the course students will be able to

CO1. Student shall be able to calculate central tendency and dispersion from the data.

CO2. Student shall be able to understand various theoretical probability distributions and apply the same in real life situations.

CO3. Student shall be able to perform correlation and regression analysis, to establish the relation between dependent and independent variables.\

CO4. Student shall be able to understand the method to apply advance statistical tests like chi-square test, F- test, T-test etc. and use them to find the significance of variance.

CO5 Student shall be able to estimate the values of population parameters from sample statistics.

DETAILED SYLLABUS

Section A

Concept of statistics, measure of central tendency and dispersion, coefficient of dispersion, moments, factorial moments, skewness and kurtosis.

Different approaches to probability, addition and multiplication theorem of probability, Conditional probability, Bayes theorem and applications. Random variables – discrete and continuous, distribution function, probability mass function, probability density function, two dimensional random variables, mathematical expectation, expectation of discrete and continuous random variables, properties of expectation, conditional expectation. Discrete and Continuous Probability Distributions: Hyper-geometric, Binomial, negative Bi-nomial, Poisson, Normal, Exponential, log-normal distribution

Section B

Correlation analysis, Regression analysis (simple, multiple and polynomial), Curve fitting using least square method.

Estimation Theory: Sampling and sampling distribution, Point and interval; estimation, Tests of significance, One tail and two tails test, standard error, sampling of attributes, test of number and proportion of success, difference of two proportions, sampling of variables, Large sample test for single mean, difference between two means and standard deviation, small sample tests:- students t-test for single mean, difference between two means, F-test. equality of variance.

Non Parametric Tests: The sign test, rank sum tests, test of randomness, the Kolmogorov-Smirnov and Anderson- Darling tests

Section C

Chi-square Test : use of chi-square test for determining Goodness of Fit and independence of attributes

Analysis of time series:- introduction, stationarity of data, Components of time series, Measurement of trend and seasonal variation. Dickey Fuller test, augmented Dickey Fuller test, Auto regressive models, moving average models, ARIMA model, vector auto-regression.

Interpolation and Extrapolation: - Introduction, graphic method, Algebraic methods-bi-nomial expansion, Newton's and Lagrange's methods.

TEXT BOOKS

1. Levin & Rubin, "Statistics for Management" 7th Edition, Pearson Education Singapore.
2. Sukhminder Singh, M.L. Bansal" Statistical methods for research workers" Kalyani Publishers
3. Bhattacharya G.K. and Johnson R.A.: Statistical Concepts and Methods, John Wiley, New Delhi,2002.
4. Hogg R. V. And Elliot A.T," Probability and Statistical Inference", Pearson Education, 6th Edition.
5. Hogg R V, Craig A T ,"Introduction to Mathematical Statistics", Sixth Edition, Pearson Education, Delhi

REFERENCE BOOKS

1. Walpole & Mayers, "Probability & Statistics" 8th Ed. Pearson Education, New Delhi.

ONLINE RESOURSES

NOC: Probability and Statistics, Prof. Somesh Kumar, Department of Mathematics, IIT Kharagpur https://nptel.ac.in/courses/111105090, https://nptel.ac.in/courses/112107209/

IEA -503 Management Information Systems [3-0-0-3]

COURSE OBJECTIVE

The course aims at making a student understand the importance of computer based information system, components of such a system and peculiarities of different stages in development of an information system.

COURSE OUTCOMES

After completing the course

CO1. Students will be able to understand and apply the concepts like data, information, normalization etc. in real life.

CO2. Students will be able to help in designing suitable information system for the specific needs of a functional area/organization as a whole

CO3. Students will be able to analyse the errors in the flow of information in an organization and suggest suitable system to rectify this problem.

CO4. Students will have sufficient knowledge of advanced tools like simulation and artificial intelligence and their role in decision making process.

CO5. Students will be able to work as team leaders/co-ordinators in the team created to develop and implement Computer based information system in an organization.

DETAILED SYLLABUS

Section A

Managing the digital firm: Concepts, need and scope of Information system in business organization, the competitive business environment and the emerging digital firm, transformation of business enterprise, major business functions, approaches to the development of an organization's information system; technical approach, behavioral approach, socio – technical approach, new options for organization design, the Network revolution, Internet and its functions, World Wide Web, LAN etc., positive & negative impacts of information systems.

Information systems in the enterprise: Organizational levels, subsystems of information system; operational level, knowledge level, management level and strategic level information systems, transaction processing systems, office automation systems, knowledge work systems, MIS, DSS, ESS, relationship of various information systems to one another, systems from a functional perspective, System development life cycle, Nolan's model of growth of MIS in an organization, introduction to ERP, information interpretation.

Managing data resources: Components of computer based information system (CBIS), file organization terms & concepts, problems with traditional file environment, Database Management System (DBMS), types of Databases, Relational DBMS, hierarchical & network DBMS, Object oriented databases. Data mining, Knowledge management.

Decision making: Steps in decision making, Simons model of decision making, Types of decisions i.e. structured and unstructured decisions, Departmental, inter departmental and organizational decisions, role of MIS in decision making

Section B

Logical database design: Entity relationship diagram, properties of tables, Data flow, Data flow diagram, update anomaly, insertion anomaly, deletion anomaly, inconsistency anomaly, repeating groups, primary key and concatenated key, Normalization, 1NF to 2NF to 3 NF steps, Object oriented analysis and design.

Expert System: Expert system, features of an expert system, heuristic and algorithm, human expertise vs. artificial expertise, knowledge representation: rule-based methods &

frame-based methods, tasks and stages of expert system development and difficulties in developing an expert system.

Section C

Introduction to SQL: - Practice of basic commands of SQL, development of MIS for simple business situations

Recommended Books

1. Laudon Kenneth C and Laudon Jane P, *Management Information Systems*, Pearson Education Asia, Eighth Edition (2004)
2. Donald A Waterman, *A Guide to Expert Systems*, Pearson Education Asia, Third Indian Reprint (2002)
3. Banks Jerry…[et al.], *Discrete Event System Simulation*, Pearson Education Asia, Third Edition (2001)
4. Davis & Olson, *Management Information Systems*, McGraw Hill International Editions.

REFERENCE BOOKS

1. Parker & Case, "*Management Information Systems*", McGraw Hill International Editions.

ONLINE RESOURSES

Prof. Biswajit Mohanty, IIT Kharagpur, https://nptel.ac.in/courses/122105022/

IEA- 505 Modeling & Simulation [3-0-0-3]

COURSE OUTCOMES:

CO1: Describe the role of important elements of discrete event simulation and modeling paradigm.

CO2: Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.

CO3: Develop skills to apply simulation software to construct and execute goal-driven system models.

CO4: Interpret the model and apply the results to resolve critical issues in a real world environment.

Definitions of manufacturing with input-output model, Introduction to systems and modeling, System Modeling Issues, System Modeling Tools and Techniques: Introduction to mathematical modeling, optimization, and simulation; Issues related with deterministic and stochastic models; Continuous and discrete mathematical modeling methods

Random Numbers: Random number generation, Properties of Random Numbers, Generation of Pseudo Random Numbers, Techniques –Tests for Random Numbers

Random variates generation, Inverse Transform Technique, Direct Transform Techniques Convolution Method, Acceptance Rejection Technique, Routines for Random Variate Generation

Discrete Event Simulation: Simulation of Single Server Queuing System. Simulation of manufacturing shop floor system, Simulation of Inventory System, Modeling of absorbing states and deadlocks; Conflicts; Concurrency, and synchronization etc., Basic concepts of Markov chains and processes; Models of manufacturing systems, introduction to Petri nets.

Data Input Modelling: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis.
Verification and Validation of Model – Model Building, Verification, Calibration and Validation of Models.

Output Analysis: Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations.
Simulation languages and packages-Case studies in FLEXSIM, ARENA, Modeling and Simulation with Petrinets, case studies in manufacturing systems

References

1. Jerry Banks & John S.Carson, Barry L Nelson, "Discrete event system simulation" ,Prentice Hall (5th Edition)
2. Law A.M, "Simulation Modeling and Analysis", Tata Mc Graw Hill (5th Edition)
3. Narsingh Deo, " System Simulation with Digital Computer", PHI Learning
4. Pidd, M, "Computer Simulation in Management Science", John Wiley & Sons, Inc. (5th Edition)
5. Geoffrey Gordon, System Simulation, Prentice Hall publication, (2nd Edition)

IEA-507 Work System Design [3-0-0-3]

COURSE OBJECTIVES

1. To provide basic understanding and impart thorough knowledge to the students about application of work-study and Ergonomics tools for improving the productivity of an organization.
2. To inculcate the skill among the students for analyzing and improving existing methods of working and allowances, rating, calculation of basic and standard time for manual operations on the shop floor of an organization.
3. To inculcate analyzing skills among the students and apply Human Factors Engineering and Ergonomics with respect to design work place and working with safety, comfort and efficiency.

COURSE OUTCOMES

CO 1: Students will be able to calculate the basic work content of a specific job for employees of an organization. Thereby they will be able to calculate the production capacity of man power of an organization.

CO 2: Students will be able to analyze and calculate the level of risk in a job causing stress, fatigue and musculoskeletal disorders and design appropriate work systems.

CO 3: Students will be able to rate a worker engaged on a live job and calculate basic, allowed and standard time for the same.

CO 4: Students will be able to analyze the existing methods of working for a particular job and develop an improved method through questioning technique.

CO 5: Students will be able to provide appropriate allowances for the jobs under analysis.

DETAILED SYLLABUS

Introduction: Productivity, definition and scope of motion and time study, history of motion and time study, work method design, human factor in the application of work study, man-machine interface.

Motion study: concept, operation process chart, flow chart, multiple activity charts, travels chart, flow diagram, and operation analysis. Micro motion study, memo motion study, cycle graphic and chronocyclegraph analysis, fundamental hand motions, therbligs, micro motion study equipment, film analysis- SIMO charts, principles of motion economy.

Time study: concept, uses of time study, time study equipment, making the time study, work sampling, determination of sample size, procedure for selecting random observations, errors in work sampling. Rating factors and allowances: the concept of qualified worker, the average worker, standard rating and standard performance, definition of rating, systems of rating, rating of efforts, scales of rating, introduction to allowances, classification of allowances, applying the allowances, determining the time standards, predetermining time standards (PTS), standard data, the uses of time standards, MTM-I, MTM-II.

Principles of workplace design, physical requirements in the workplace anthropometrics and communication considerations, social requirements of the workplace- personal and territoriality considerations. Workspace design; general principles, deciding position of control with respect to other controls, position of displays with respect to other displays, positioning of displays and controls, control display compatibility.

Ergonomics: Introduction, definition, objectives and scope, man-machine system and its components. Introduction to musculoskeletal system, respiratory and circulatory system, metabolism, measure of physiological functions- workload and energy consumption, Introduction to biomechanics, types of movements of body members, Design of lifting tasks using NIOSH lifting equation, Distal upper extremities risk factors, risk assessment tools; Strain Index, RULA, REBA. Introduction to anthropometry; work table and seat designing. Design of Visual displays and controls. Occupational exposure to; noise, whole body Vibrations, heat stress and dust. Effect of vibration/ noise, temperature, illumination and dust on human health and performance. Occupational Health and safety, Relationship between safety, health and productivity

TEXT BOOKS

1. Barnes Ralph M., "Motion & Time study: Design and Measurement of Work", Wiley Text Books, 2001.
2. Marvin E, Mundel & David L, "Motion & Time Study: Improving Productivity", Pearson Education, 2000.
3. Benjamin E Niebel and Freivalds Andris, "Methods Standards & Work Design", Mc Graw Hill, 1997.
4. Lakhwinder P S, "Work Study and Ergonomics", Cambridge University Press, 2016

REFERENCE BOOKS

1. International Labour organization, "Work-study", Oxford and IBH publishing company Pvt. Ltd., N.Delhi, 2001.
2. Sanders Mark S and McCormick Ernert J, "Human Factors in Engineering and Design", McGraw- Hill Inc., 1993.
3. KjellZandin, Maynard's Industrial Engineering Handbook, Fifth Edition, McGraw Hill, 2001.

IEA-509 Advanced Operations Research [3-0-0-3]

COURSE OBJECTIVES

The objective of this course is to develop an ability in the students to understand and analyze managerial problems in industry so that they are able to use resources (capitals, materials, staffing, and machines) more effectively, develop skills for formulating mathematical models and solving these problems.

COURSE OUTCOMES

CO1. Students shall be able to use variables for formulating complex mathematical models in management science, industrial engineering and transportation science.

CO2. Students will be able to use various software packages such as Lingo, Solver, and TORA for solving linear programming and integer programming models.

CO3. Students will be able to solve problems related with transportation and assignment problems, queuing theory etc. by traditional algorithms and also by using linear programming approach.

CO4. Understand and apply different algorithms for solving goal or integer programming, nonlinear programming problems.

CO5. Understand genetic algorithms, Binary/Real coded GAs for constrained optimization, and simulated annealing, ant colonies, particle swarm optimization.

DETAILED SYLLABUS

The simplex algorithm, duality, sensitivity analysis-changes in right- hand side constants of constraints-changes in objective function co-efficient-adding a new constraints-adding a new variable. Transportation algorithm and optimality, assignment model, Hungarian method. Model development for using LPP approach for solving Transportation and Assignment Problems using Excel Solver. Decision making under risk and uncertainty, game theory, two-person zero sum game, mixed strategy. Dynamic programming, Integer programming algorithm – Cutting plane algorithm- Zero-one implicit enumeration algorithm. One dimensional cutting stock problem. Goal programming formulations. Nonlinear programming problems. Network models, shortest path problems, Maximum flow problem, Branch and Bound algorithm and heuristics for travelling salesman problem, Vehicle routing problems, Chinese postman problem. Single and multiple server queuing models, Genetic algorithm.

Recommended Books

1. Taha, H.A., Operations Research - An Introduction, Sixth Edition, Prentice Hall of India Private Limited, N. Delhi, 1997.

2. Hillier, F.S., Operations Research, First Indian Edition, CBS Publishers and Distributors, Delhi, 1994.

3. Wagner H.M., Principles of Operations Research, Second Edition, Prentice Hall of India Private Limited, New Delhi, 1996.

4. G.Srinivasan , "Operations Research Principles and Applications" ,PHI 2008.

5. Panneerselvam ,R, "Operations Research", Prentice – Hall of India, New Delhi,2002.

IEA- 511 Quality Management [3-0-0-3]

COURSE OUTCOMES

CO1: To develop an ability to apply the basic concepts of quality monitoring.

CO2: Formulate an adequate statistical control problem for a production or similar process & use alternative statistical methods for solving the process control problem.

CO3: Student shall be able to demonstrate reduction in formation of defectives by comparing alternative process control methods concretely (numerically) & in general.

CO4: Use attribute sampling methods & assess economics of inspection for choosing an inspection strategy (No Inspection, Sampling Inspection & 100% Inspection).

CO5: The students will be able to use statistical tools to characterize the reliability of an item and determine the reliability of a system.

DETAILED SYLLABUS

Introduction: Importance of quality- evolution of quality- definitions of quality- dimensions of quality- quality control- quality assurance.

Statistical Process Control: Control charts and application, Type-1 and Type II errors, effect of control limits on errors, effect of sample size on control limits, sample size, Type of control charts- control chart for variable and attribute, different adaptations of control charts, manufacturing process variability, Process capability- process capability study using control charts and capability evaluation- Cp, Cpk and Cpm.

Acceptance Sampling: Operating Characteristic Curve (O-C curve); Effect of sample size and acceptance number, Single, Double and Multiple Sampling Plans, Acceptance/ rejection and acceptance/ rectification plans. Producer's risk and consumer's risk. Indifference quality level, Average Outgoing Quality (AOQ) curve, AOQL. Quality protection offered by a sampling plan. Average Sample Number (ASN) curve, Average Total Inspection (ATI) curve. Design of single sampling plans.

TQM Tools & Techniques: The seven traditional tools of quality – Six-sigma: (6σ): introduction, comparison of 3σ / 6σ yield levels, CTQ: Critical to Quality, theme selection (activity focusing). 6σ methodology: DMAIC -Various formulae to measure different metrics related to Six Sigma defects, yield calculations, Case Study & Numericals, Quality function deployment, quality circles, Kano's Model: Categorizing & Prioritizing the Requirements, Product Assessment, Setting up targets, Case Study & Numericals. Quality Audit: process audit & product audit, internal audit, second party, third party audit, pre-assessment, compliance audit. Procedure of auditing: Audit planning, audit execution, audit reporting, close out of corrective action. Minor & major non-conformities.

Reliability: Quality vs Reliability, Reliability Indices: Failure Rate, MTBF and MTTF. Reliability at different MTBFs. Life Cycle Curve, Exponential, Weibull, and normal distributions models. OC Curve based on maximum number of tests at constant failure rate, System reliability for components in Series, parallel and mixed mode. Concept of availability and maintainability.

TEXT BOOKS

1. Grant E L and Leavenworth R S, "Statistical Quality Control", McGraw Hill, Sixth Edition (2000)
2. Amitava Mitra, "Fundamentals of Quality Control and Improvement", Pearson Education Asia, Third Edition (2014)
3. James R. Evans and William M. Lindsay, "The Management and Control of Quality", (6th Edition), South-Western (Thomson Learning), 2005.
4. Srinath L S "Reliability Engineering", Affiliated East-West Press Limited, New Delhi, 2002.

REFERENCE BOOKS

1. Hansen Bertrand L and Ghare Prabhakar M, "Quality Control and Applications" Prentice Hall of India Pvt. Ltd., First Edition (1993)
2. Zaidi A., "SPC: Concepts, Methodologies and Tools", Prentice Hall of India, First Edition, (2003).

3. Ebling CE, "An introduction to Reliability And. Maintainability Engineering" Tata Mc Graw Hill, Delhi, 2004.

IEA-513 Operations and Simulation Laboratory [0-0-3-2]

COURSE OBJECTIVE

To provide students with an opportunity to learn to use the methods of modelling and simulation as a tool to improve the effectiveness of production systems.

COURSE OUTCOMES

After completing the course, students will be able to

CO1: Appreciate the power of Modelling and Simulation as a tool for the planning and design of Production Systems

CO2: Use MS Excel for simulation of simple problems of Production Systems

CO3: Use advanced software for discrete event system simulation

Packages: Microsoft EXCEL, Flexsim and other emerging packages, Programming in C and MATLAB)

LIST OF EXERCISES

1. Random Number Generation approaches.
2. Random Variate Generation
3. Simulation of Manufacturing Shop
4. Simulation of Multiple Servers Queuing System
5. Simulation of Supply Chain Inventory System
6. Simulation of Inventory problem in Microsoft Excel.
7. Analysis of Linear Programming Problems using Excel Solver.
8. Analysis of Transportation Problems using Excel Solver.
9. Analysis of Complex Integer programming using Excel Solver.
10. Simulation of Batch Production System.
11. Simulation of Multi-Machine Assignment System.
12. Simulation of Manufacturing and Material Handling Systems.
13. Simulation of a Shop Floor.
14. Simulation of Material Handling Systems.

TEXTBOOKS

1. User manuals of respective software's

IEA-515 Work Systems Design Laboratory [0-0-3-2]

COURSE OBJECTIVES

To inculcate the skill among the students for analysing and improving existing methods of working on the shop floor of an organisation.

To develop analysing skills among the students w.r.t. work place design, working postures and lifting tasks.

To provide thorough knowledge about assessment about exposure to occupational hazards and design the work systems for safety and efficiency.

COURSE OUTCOMES

CO1. Students will be able to calculate the basic work content of a specific job for employees of an organisation. Thereby they will be able to calculate the production capacity of man power of an organisation.
CO2. Students shall be able to analyse the existing methods of working for a particular job and develop an improved method.
CO3. Students shall be able to rate a worker engaged on a live job and calculate basic, allowed and standard time for the same.
CO4. Students shall be able to provide appropriate allowances for the jobs under analysis.
CO5. Students shall be able to analyze and calculate the level of risk of the job causing stress, fatigue and musculoskeletal disorders among the employees of an organization.
CO6. Students shall be able to assess the occupational environmental factors like heat stress, noise, vibration and RSPM level in the industry.

DETAILED SYLLABUS

1. To analysis and improve the assembly and dis-assembly of a Bolt, a nut and three washers
2. Rating Practice –Walking on level grounds and dividing a pack of cards into four equal piles.
3. Therbligs and Micro motion analysis using videography.
4. Standard Time Calculation Using, Work sampling and Stop watch time study on different processes.
5. Calibration of an individual using Tread Mill as a loading-device.
6. To analyze the work posture of an individual using Ergo master/CAPA Software.
7. To analyze and Design a lifting task using NIOSH Lifting Equation.
8. Measurement of anthropometrics data and analysis of data.
9. Audiometric examination a through pure tone audiogram of a subject using portable audiometer in a audiometric testing cabin.
10. To measure the respiratory parameter of an individual.

SEMESTER 2

IEA– 502 DATA ANALYTICS [3-0-0-3]

Course Objective

This course intends to train the students in various concepts and methods of Data analysis like Regression, classification, clustering, dimensionality reduction and to make them industry ready to take up Data analyst jobs.

Course Outcomes

CO 1: The students will learn, understand and will be able to apply the basic commands of python for data analytics

CO 2: The students will learn, understand and will be able to apply data extraction, visualization and normalization techniques using various libraries of python.

CO 3: The students will be able to define and differentiate among various concepts and techniques of data analytics

CO 4: The students will be able to list, understand, differentiate and apply various regression and classification algorithms of Supervised Learning,

CO 5: The students will be able to list, understand, differentiate and apply various clustering algorithms of Un-Supervised Learning

CO 6: The students will be able to analyze a complex real life case situation, choose or design the appropriate algorithm to solve it, construct the model using appropriate programming technique, solve the same and interpret the results.

CO 7: The students will be able to apply multiple models in a given situation, evaluate and compare their prediction accuracies and choose the best model.

DETAILED SYLLABUS

Section A

Machine Learning

Types of Learning: Supervised Learning, Classification vs. Regression, Un- Supervised Learning, Derivative and Gradient, Bias- Variance dichotomy, Hyper parameter Tuning, Cross-Validation, Handling Imbalanced Datasets

Data pre-processing: Normalization, one hot encoding, handling missing values, dimensionality reduction, PCA, LDA, Outlier Detection

Basic Python commands

Print command, input commands, looping statements, conditional statements, important functions in python: string functions, time functions, random functions, user defined functions, local and global variables, threading, data structures in python: List, Tuples, Dictionary, features and usage of various libraries like matplotlib, numpy, pandas, sklearn, data transfer between excel files and numpy/pandas arrays, plotting line graphs, bar charts, scatter diagrams and pie charts using matplotlib, data manipulation operations on arrays, various types of join operations, linking python with SQL for data sharing.

Section B

Supervised Learning

Regression

Regression: simple and multiple linear regression, polynomial regression Ordinary Least Squares method, Gradient descent method, Regularization: Ridge Regression, Lasso Regression, role of scatter plots in parameters selection, Nearest Neighbours Regression, Bias-Variance Dichotomy, Model Validation Approaches, Decision Trees Regression, Random Forest Regression, Support Vector Regression,

Section C

Classification

Classification: maximum likelihood approach, Sigmoid Function, Logistic Regression, Train-Test- Validate data, Decision tree classification, entropy minimization approach, Ginni's imperfection, Support Vector Machines, Kernel functions, KNN classification, cosine similarity, Naive Bayes Classification, Ensemble Methods: Random Forest, Model Performance Assessment: Confusion matrix, Accuracy, Cost-sensitive accuracy, Precision/recall, Mathew's correlation co-efficient, Area under the ROC curve,, visualizing the decision boundaries using Meshgrids and contour plots

Unsupervised Learning

Clustering

Difference between agglomerative and divisive clustering techniques, K-Means Clustering, WCSS, elbow and Dendrograms methods to find optimal number of clusters, visualizing clusters using scatter plots.

TEXT BOOKS

1. Andriy Burkov, "The Hundred-Page Machine Learning Book"
2. Ethem Alpaydin, Introduction to Machine Learning, 4th edition, MIT Press 2020
3. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

REFERENCE BOOKS

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press, 2014.
2. Zhi-Hua Zhou, Ensemble Methods: Foundations and Algorithms, CRC Press, 2012

ONLINE RESOURSES

Introduction to Data Analytics, NPTEL course, Prof. Nandan Sudarsanam and Prof. Balaraman Ravindran Deptt.of Management Studies , IIT Madras, http://nptel.ac.in/courses/110106064
StatQuest; https://www.youtube.com/@statquest

IEA-504 Deep Learning **[3-0-0-3]**

Course Objective

This course intends to train the students in various concepts of deep learning like artificial neural networks, convolutional neural networks and recurrent neural networks and to make them industry ready to take up AI jobs.

Course Outcomes

CO 1: The students will learn about history of development of deep learning and its present state of art.

CO 2: The students will learn, understand and will be able to apply various state of art architectures like AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet

CO 3: The students will be able to learn, understand and will be able to apply various parameter learning approaches, their advantages and shortcomings

CO 4: The students will be able to learn and understand various techniques for faster convergence of deep learning models.

CO 5: The students will be able to list, understand, differentiate and apply various time series models

DETAILED SYLLABUS

Section A

History:

History of Deep Learning, Deep Learning Success Stories, McCulloch Pitts Neuron, Thresholding Logic, Perceptrons, Perceptron Learning Algorithm and Convergence, Multilayer Perceptrons (MLPs), Representation Power of MLPs

Understanding current scenario:

Sigmoid Neurons, Gradient Descent, Feedforward Neural Networks, Representation Power of Feedforward Neural Networks, and Feedforward Neural Networks

Techniques for Parameter Training:

Backpropagation, and Computation Graphs, Gradient Descent (GD), Momentum Based GD, Nesterov Accelerated GD, Stochastic GD, AdaGrad, RMSProp, Adam

Auto Encoders:

Eigenvalues and eigenvectors, Eigenvalue Decomposition, Basis, Principal Component Analysis and its interpretations, Singular Value Decomposition, Autoencoders and relation to PCA, Regularization in autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive autoencoders

Section B

Regularization:

Bias Variance Tradeoff, L2 regularization, Early stopping, Dataset augmentation, Parameter sharing and tying, Injecting noise at input, Ensemble methods, Dropout

Techniques for Faster Convergence:

Greedy Layerwise Pre-training, Better activation functions, Better weight initialization methods, Batch Normalization

Section C

CNN:

Convolutional Neural Networks, LeNet, AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet

RNN:

Learning Vectorial Representations Of Words, Recurrent Neural Networks, Backpropagation Through Time (BPTT), Vanishing and Exploding Gradients, Truncated BPTT, Gated Recurrent Units (GRUs), Long Short Term Memory (LSTM) Cells, Solving the vanishing gradient problem with LSTMs

Text Books:

1. Ian Goodfellow and Yoshua Bengio and Aaron Courville. "Deep Learning. An MIT Press book". 2016.
2. Charu C. Aggarwal. "Neural Networks and Deep Learning: A Textbook". Springer. 2019.

3. Aston Zhang, Mu Li "Dive into Deep Learning", open source link: https://arxiv.org/ftp/arxiv/papers/2106/2106.11342.pdf

REFERENCE BOOKS

1. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press, 2014.
2. Zhi-Hua Zhou, Ensemble Methods: Foundations and Algorithms, CRC Press, 2012
3. Ethem Alpaydin, Introduction to Machine Learning, 4th edition, MIT Press 2020
4. Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.

ONLINE RESOURSES

Deep Learning, Dr.Mitesh Khapra, IIT Madras, NPTEL Course
https://www.youtube.com/watch?v=aPfkYu_qiF4&list=PLEAYkSg4uSQ1r-2XrJ_GBzzS6I-f8yfRU

IEA- 506 Logistics and Supply Chain Management [3-0-0-3]

COURSE OBJECTIVES

The objective of the course is to provide student with the knowledge of supply chain design, planning, and operation under competitive environment. The role of e-businesses in supply chain management. Various key Drivers of supply chain performance and how these drivers can be used in practical level. Knowledge of various distribution and transportation networks and their applications.

COURSE OUTCOMES

CO1. Students will be able to Interpret and apply the concepts of logistics and supply chain management in improving other functional areas of business organizations.

CO2. Students will be able to understand different distribution networks and design a network for meeting a particular strategy of an organization

CO3. Students will be able to improve the performance of existing Supply Chains by developing a better decision support system

CO4. Students will be able to apply the knowledge of Linear Programming to find optimal solutions of Supply Chain & Logistics related problems.

CO5. Students will have sufficient knowledge to develop models and solve problems by using tools such as Solver, Lingo Etc. and develop interest for research & higher education.

CO6. Students will be able to save resources for the organizations & make Supply Chains environmental friendly

Detailed Syllabus

Section A

Introduction to Supply Chain: Objectives of supply chain, stages of supply chain, supply chain process cycles, customer order cycle, replenishment cycle, manufacturing cycle, procurement cycle, push/pull view of supply chain processes, importance of supply chain flows, and examples of supply chain. Supply Chain Performance: supply chain strategies, achieving strategic fit, product life cycle, the minimize local cost view, the minimize functional cost view, the maximize company profit view, the maximize supply chain surplus view. Supply Chain Drivers and Obstacles: Four drivers of supply chain – inventory, transportation, facilities, and information, a framework for structuring drivers, role of each driver in supply chain, obstacles to achieve strategic fit. Information Technology in Supply chain: Enabling supply chain through IT, ERP vendor platform, service oriented architecture (SOA), RFID. Decision making for facility location, centralization versus decentralization, cross docking, Customer relationship management(CRM), supplier relationship management(SRM), Discussion of case studies with analytics.

Section B

Network Design: Factors influencing distribution in network design, distribution networks in practice, framework for network design decisions, models for facility location and capacity allocation, making network design decisions in practice. Global supply chain networks. Aggregate planning in supply chains: Role of aggregate planning in a supply chain, aggregate planning strategies, aggregate planning using linear programming and problem solving using solver, practical problems concerning aggregate planning. Analytics for network design options using case studies.

Section C

Transportation in a Supply Chain: Facilities affecting transportation decisions, modes of transportation and their performance characteristics, design options for a transport network, tradeoffs in transportation decision, tailored transportation, routing and scheduling in transportation, making transportation decisions in practice. Sourcing decisions in supply chains: Role of sourcing in supply chains, supplier assessment, design collaboration, sourcing planning and analysis, market sourcing decisions in practice. Coordination in a supply chain: Lack of supply chain coordination and the bullwhip effect, effect of lack of coordination on performance, obstacles to coordination, managerial levers to achieve coordination, achieving coordination in practice. Transportation and sourcing decisions analytics with case studies.

Recommended Books

1. Martin Christopher, Logistics and Supply Chain Management, Pearson Education Asia (2002).

2. Peter Meindl , Supply Chain Management – Strategy, planning and operation's, Pearson Education ,Asia (2002).

3. Kapoor K K, Kansal Purva, Marketing logistics: A Supply Chain Approach, Pearson Education Asia (2002). 4. Buffa, Modern production/operations Management, Wiley Eastern Ltd. (2000)

5. Alan Muhlemann, John Oakland and Keith Lockyer, Production and operation Management, Macmillan India Publications (2000)

6. K.Aswathappa,K.S.Bhat, Production and Operations Management, Himalaya Publishing House, Mumbai (2000).

7. R.Panneerselvan, Production and operations Management, Prentice Hall of India, Delhi (2000).

IEA – 508 Operations Management [3 0 0 3]

COURSE OUTCOMES

CO1: Understand the input–process–output framework, the extensions of it, and apply them to a wide range of operations.

CO2: The ability to forecast and stay ahead of digital and customer trends.

CO3: Shall be able to analyze the inventory situation of a company and carry out improvements.

CO4: Shall be able to improve due date performance through use of MRP techniques keeping in view capacity considerations.

CO5: Solve industrial problems related to inventory and scheduling.

DETAILED SYLLABUS

Introduction: The scope of operations function in the organization, the transformation process, goods-service continuum, manufacturing vs. service, system's view of operations, managing sub-systems of operations, strategic role of operations, historical evolution, trends in operations management.

Forecasting: Forecasting time horizons, the influence of product life cycle, types of forecasts, the strategic importance of forecasting, steps in the forecasting system. Qualitative methods & quantitative methods: Delphi method, decomposition of time series, naïve approach, moving averages, exponential smoothing, exponential smoothing with trend adjustment, seasonal variations in data, cyclic variations in data. Forecast accuracy and control, forecast accuracy metrics, forecast error calculation, guidelines for selecting forecasting model.

Capacity Planning: design capacity, effective capacity, actual output, efficiency and utilization, capacity cushion, steps in capacity planning, developing capacity alternatives, capacity strategies, economies of scale, and evaluating capacity alternatives, cost-volume analysis.

Inventory management: Inventory concepts, reasons for holding inventory, types of inventory, inventory reduction tactics. Inventory turnover ratio. Selective Inventory management: ABC, VED, and FSN analysis etc., identifying critical items.

Optimizing Inventory: Assumptions for Wilson's lot size model, inventory costs, hidden costs, composition of costs, estimation of inventory related costs, lead time, stock out point, number of time periods, calculating Economic Order Quantity (EOQ), sensitivity analysis of EOQ model.

Special inventory models: Finite replenishment rate model, lot size models with planned backlogging, generalized model with uniform replenishment rate, inventory model with lost sales, quantity discount model, one period decisions. Determination of safety stock, service level and uncertainty in demand. Information systems for inventory management.

Materials Requirement Planning: Independent vs Dependent demand, Ordering & Manufacturing lead times, inputs to MRP, MRP processing, basic MRP logic. Lot sizing rules, Lot for lot ordering policy, MRP output reports, safety stock in MRP, evolution of MRP. JIT & lean manufacturing.

Scheduling: basic concepts – various types of scheduling – Methods and tools to solve scheduling problems – scheduling techniques for job shop, stages in scheduling.

Sequencing: Sequencing process, priority sequencing rules: FCFS, SPT, LPT, EDD, CR - critical ratio, S/O - slack per operation, Rush - emergency, dynamic sequencing rules, Johnson's Rule, numericals.

TEXT BOOKS

1. Krejwski L J , Ritzman L P , Operation Management, Pearson Education Asia, 6th edition

2. Panneerselvam R. Production and Operations Management, PHI, 2005.

3. Mukhopadhyaya, S.K., "Production Planning and Control – Text and Cases", Prentice-Hall of India,2004

REFERENCE BOOKS

1. Evert E. Adam, Ronald J Ebert, Production and Operations Management, Prentice Hall of India, 5th edition.

2. J R Tony Arnold, Chapman Stephen N., Introduction to Materials Management, Pearson Education Asia, 4th edition.

3. Ray Wild, Operation Management, Thomson press, 6th edition.

ONLINE RESOURSES

1. Coursera Course, Operations Management: Analysis and Improvement Methods, https://www.coursera.org/learn/process-improvement

2. Coursera Course, Operations Management and Strategy Toolkit for Managers, https://www.coursera.org/learn/strategy-and-operations

3. Project and Production Management, NPTEL course by Prof. Arun Kanda, Department of Mechanical Engineering, Indian Institute of Technology, Delhi , https://nptel.ac.in/courses/112102106/

IEA - 510 Data Analytics Laboratory [0-0-3-2]

Course Objective

To develop the skills in applying appropriate supervised, semi-supervised or unsupervised learning algorithms for solving practical problems.

Course Outcomes

CO 1: The students will learn, understand and will be able to apply the basic commands of python for data analytics

CO 2: The students will learn and develop an expertise in using important libraries of python like matplotlib, pandas and numpy

CO 3: The students will learn and develop an expertise in using different supervised and un-supervised learning techniques

CO 4: The students will be able to select and apply appropriate algorithms for solving real-world problems.

List of experimental exercises:

Basic python programming exercises

1 Write programs in Jupyter notebooks to do the following.

1. Print first 10 whole numbers
2. Print first 10 natural numbers
3. Take an input from the user and print natural numbers upto that value
4. Print first 10 natural numbers except multiples of 4 in the range
5. Take a number from the user and find its

a) Factorial
b) Sum of digits of the number entered
c) Reverse of Digit
d) Palindrome No
e) Fibonacci Series upto that number

2 Write programs using conditional statements in Jupyter notebooks to produce required outputs.

3 Write programs in Jupyter notebooks to print the five given patterns.

Numpy/ pandas exercises

4 You are given an excel file containing data about a number of movies. Write program to import data in pandas dataframe, perform data cleaning, add new columns and plot the graphs as instructed.

5 You are given a csv file named 'ball_by_ball.csv'. Write program to import data in pandas dataframe, identify the maximum run scorer, maximum wickets taker, player who hit maximum sixes, took maximum catches etc.

Regression exercises

6 You are given with excel file named "Melbourne.csv". The file contains data of a large number of houses sold in Melbourne. Import data to pandas dataframe, do data cleaning, identify the price range, size range, range of number of rooms in the houses sold. Identify five most important parameters that effect the price, fit multiple regression model and determine the amount of variance explained.

7 You are given with excel file named "50_startups.csv". Taking R & D expenditure, A dministrative expenditure, Marketing expenditure and City as independent variables and profit as dependent variable, fit a multiple regression model in the data and determine th e amount of variance explained. Take the inputs from the user regarding R & D expendi ture, Administrative expenditure, Marketing expenditure and City of origin of some hyp othetical startup and use the model developed to predict the likely profit of that startup.

Classification exercises

8 From the various datasets available on sklearn, import load_iris dataset. It contains in formation on sepal and petal lengths and widths of a number of iris plants and their cate gories. Standardize this data, divide it into training and test datasets, fit various classific ation models on trainig datasets, check the prediction accuracies of models using confus ion – matrix and identify the best performing model.

9 Samples of the wine prepared at three different wineries were taken and were analysed to determine the values of 12 quality parameters and is given in an excel file. Last column mentions the winery. Store the quality parameters and wine class in different dataframes, use LDA to reduce the quality parameters to two new parameters. Fit different classification models on the data and compare their accuracies.

Clustering exercises

10 You are given with excel file named "Wholesale.csv". it contains data on eight important customer attributes. Use elbow method to determine optimal number of clusters. Fit K-means clustering model to the data, add a column and fill cluster value of each customer in it. Using the attributes information, give suitable name to each cluster.

IEA - 512 Deep Learning Laboratory [0-0-3-2]

Course Objective

This course intends to provide hands on training to the students in various concepts of deep learning like artificial neural networks, convolutional neural networks and recurrent neural networks and to make them industry ready to take up AI jobs.

Course Outcomes

CO 1: The students will learn about various Python libraries like Tensorflow, Keras and Pytorch.

CO 2: The students will learn, understand and will be able to apply various state of art architectures like AlexNet, ZF-Net, VGGNet, GoogLeNet, ResNet

CO 3: The students will be able to learn, understand and will be able to apply various parameter learning approaches, their advantages and shortcomings

CO 4: The students will be able to learn and understand various techniques for faster convergence of deep learning models.

CO 5: The students will be able to list, understand, differentiate and apply various time series models

List of experimental exercises:

1. Practice exercises on numpy and Pandas
2. Practice exercises on basics of Tensor flow
3. Practice exercises on contours and 3D plots
4. Practice exercises on PCA and LDA
5. Practice exercises on Gradient Descent
6. Practice exercises on momentum based Gradient Descent, Nestrov based Gradient Descent, ADAM
7. Practice exercises on training single neuron
8. Practice exercises on CNN
9. Practice exercises on LSTM
10. Practice exercises on GRU

PROGRAM ELECTIVES (Industrial Engineering stream)

IEA-521 Project Management [3-0-0-3]

COURSE OBJECTIVE

1. To provide basic and some advanced exposure to enable the students to successfully complete sophisticated projects within the constraints of capital, time, and other resources.

2. To enable the students to prepare networks based time schedules and analyse the project activities.

3. To enable the student to practice project management with ethics.

COURSE OUTCOMES

CO1: To understand the concepts of project definition, life cycle, and systems approach;

CO2: To develop competency in project scoping, work definition, and work breakdown structure (WBS);

CO3: To handle the complex tasks of time estimation and project scheduling, including PERT and CPM

CO4: To develop competencies in project costing, budgeting, and financial appraisal;

CO5: To gain exposure to project control and management, using standard tools of cost and schedule variance analysis;

CO6: To appreciate and understand the use of computers in project management, especially a software like MS Project.

DETAILED SYLLABUS

Introduction: concept and definition of a project, categories of projects, project life cycle phases, project visibility, roles and responsibility of project manager.

Project planning and analysis: Generation of ideas, monitoring the environment, corporate appraisal, scouting for project ideas, preliminary screening, project rating index, sources of positive net present value. Market and demand analysis, technical analysis, project cash flows, social cost benefit analysis, project viability. The statement of work, project specifications, work breakdown structure. Contracting in projects, types of contracts. Organization planning, project versus non-project organization, matrix form of organization.

Project scheduling: Gantt chart, milestone chart, limitations of Gantt and milestone charts. Development of the network, activity on node and activity on arc network precedence diagrams, Fulkerson's flow algorithm, topological ordering, redundancy removal, tackling cycles in the network. Isolating critical path, multiple critical paths.

Determination of the floats: total float, safety float, free float and independent float. Decision CPM, Generalized activity networks, GERT.

The PERT model: event orientation, uncertainty, the PERT assumptions, variability of the activity times, expected times for activities, expected length of the critical path, invoking central limit theorem, due date probability, limitations of network models, method of precedence (MOP).

Time-cost trade off: cost versus time, straight-line approximation of variation of cost with reduction in time for activities, direct and indirect costs. Contracting the network: fixed project duration and corresponding total cost, optimum project duration and minimum project cost, project cost curve.

Network cost accounting: cumulative costs for early and late start schedules, range of feasible budgets, graphic display of cost and time data, time and cost overrun or underrun in projects.

Scheduling with limited resources: the complexity of the project scheduling with limited resources, heuristic programs, resource leveling and resource allocation in project scheduling. Information requirements for projects, project management software based application using Microsoft Project, Primavera.

TEXT BOOKS

1. Kerzner Harold, "Project Management - A Systems Approach to Planning, Scheduling and Controlling", CBS Publishers Delhi, Second edition (2002).
2. Weist Jerome D and Ferdinand K. Levy, "A Management Guide to PERT/CPM with GERT/PDM/DCPM and other networks", Prentice-Hall of India New Delhi, Second edition (2003)
3. Parsanna Chandra, "Project Planning, Analysis, Selection, Implementation and Review", Tata McGraw Hill, Fourth Edition (2002)

REFERENCE BOOKS

1. Srinath L.S., "PERT & CPM Principles and Applications", Affiliated East- West Press Pvt. Ltd., New Delhi, Third Edition (1993)
2. Ghattas R G and Sandra L Mckee, "Practical Project Management" Pearson Education Asia, First edition (2004).
3. PMI, A guide to Project Management body of knowledge, 2000.

ONLINE RESOURSES

1. Coursera Course, "Introduction to Project Management Principles and Practices Specialization",
2. https://www.coursera.org/specializations/project-management
3. Coursera Course "Professional Certificate in Applied Project Management",
4. https://www.coursera.org/professional-certificate/applied-project-management
5. Project management Institute, https://www.pmi.org/

6. Project and Production Management, NPTEL course by Prof. Arun Kanda, Department of Mechanical Engineering, Indian Institute of Technology, Delhi , https://nptel.ac.in/courses/112102106/

IP-522 Reliability and Maintenance Engineering [3-0-0-3]

COURSE OBJECTIVES

This course is designed to introduce basic concepts of maintenance and reliability to the students, to introduce various methods of reliability analysis with real time problems with constraints and to make understanding the applications of Reliability and Maintenance analysis in different types of systems.

COURSE OUTCOMES

CO1.The students will be able to calculate the reliability of a system, and will also understand the application of maintenance strategies in a manufacturing environment;

CO2. The students will be able to establish maintenance strategies according to system characteristics and design transition programs to implement these strategies.

CO3. The students will develop ability in formulating suitable maintenance strategies to enhance system reliability of a manufacturing system

CO4. Student will be able to apply concepts of TPM, RCM, & FMECA in managing the manufacturing organisation with highest possible levels of reliability/ availability.

Maintenance Engineering

Introduction: Role of maintenance in the organization, system approach, objectives of maintenance, types of maintenance systems, Principles of maintenance

Planned Preventive Maintenance, Corrective maintenance, Predictive maintenance, Total Productive maintenance, Reliability Centred maintenance: Concept, importance, planning and relevance in industry

Maintenance planning: Long range planning, short range planning, planning techniques, planning procedure, estimation of maintenance work

Maintenance evaluation: Need of evaluation, types of evaluation, life cycle costing

Maintainability: Concept, maintainability measures, FMEA analysis, FTA analysis, availability, system downtime

Failure concepts and Characteristics: Failure analysis, Machine vibration, Data acquisition, Fault detection and vibration monitoring.

Reliability Engineering

Introduction: Concept, certain and impossible events, complementary events, Kolmogorov Axioms, definition of reliability

Failure data analysis: Failure data, mean failure rate, MTTF, MTBF, calculation from filed data

Hazard models: Introduction, constant hazard, linearly increasing hazard, The Weibull Model, distributions functions and reliability analysis

System Reliability: Conditional probability, multiplication rule, Venn diagram, Bayes' theorem, calculation of system reliability for series, parallel and mixed configuration, logic diagram, Markov models- Load –sharing system, Standby system, standby system with switching failure and degrade system.

Reliability improvement: Element and unit Redundancy, standby redundancy, fault tree construction, tie set and cut set methods

Recommended Books

1. Clifton R H, Principles of Planned Maintenance, McGraw Hill, New York, 2001.

2. Higgins, Handbook of Maintenance Management, Prentice Hall, New York, 1999.

3. Srinath L S, Reliability Engineering, Affiliated East-West Press Limited, New Delhi, 2002.

4. Dhillon B S, Engineering Maintainability, Prentice Hall of India, New Delhi, 2000.

5. Wireman Terry, Preventive Maintenance, Reston Publishing Company, Reston Virginia, 1998.

IEA-523 Product Design and Development [3-0-0-3]

COURSE OUTCOMES

CO1: understand manufacturing attributes of an industry and classify various plant layouts

CO2: analyse various location choices to select an appropriate location for manufacturing and services

CO3: design a process layout through various strategies

CO4: design a product layout through various strategies

CO5: design a group technology based layout through various strategies

CO6: identify and analyse the problems in the existing layout/material handling system and suggest appropriate material handling strategies

DETAILED SYLLABUS

Need for Developing Products: The importance of engineering design-types of design-the design process-generic product development process-various phases of product development-planning for products- Adapting the Generic Product Development Process

Opportunity Identification: What is an Opportunity, Types of Opportunities, Tournament Structure of Opportunity, Identification, Opportunity Identification Process

Product Planning and Identifying Customer Needs: The Product Planning Process, The Importance of Latent Needs, The Process of Identifying Customer Needs-gather raw data – Interpret raw data- organize the needs into a hierarchy – Relative importance of the needs.

Product Specifications and Concept Generation, Selection & Testing: Specifications-Specifications Establishment, Refining specifications, Target Specifications. A Five-Step Method: Clarify the Problem, Search internally – Search externally – Explore systematically. Concept Screening – Concept Scoring – Concept Testing.

Product Architecture: Types of Modularity, Implication of architecture – Establishing the architecture, Delayed Differentiation, Platform Planning

Industrial Design: Need for industrial design – Impact of industrial design – Industrial design process – Management of industrial design process – Assessing the quality of industrial design.

Prototyping: Principles of Prototyping – Types of Prototypes – Planning for Prototypes, Prototyping Technologies: 3D CAD Modeling and Analysis, 3D Printing: Advantages and Drawbacks

Design for Manufacturing and Assembly: Overview of the DFMA Process, Materials selection, process considerations, and design guidelines for manufacturing.

Patents and Intellectual Property: Intellectual Property, Overview of Patents-Utility Patents Preparing a Disclosure-Formulate a Strategy and Plan - Timing of Patent Applications- Type of Applications- Scope of Application- Study Prior Inventions- Outline Claims-Write the Description of the Invention-Defensive Disclosure, Refine Claims, Writing the Claims, Guidelines for Crafting Claims

Economics of Product Development: Elements of Economic Analysis, Economic Analysis Process

Value Engineering: Origin of Value Engineering, Meaning of Value, Definition of Value Engineering, Types of Value, Function - Basic and Secondary functions, Seven Phases of Job Plan, FAST Diagram as Value Engineering Tool, Benefits of Value Engineering, value stream mapping (VSM).

TEXT BOOKS

1. Karl, T. Ulrich Steven D. Eppinger, "Product Design and Development", McGraw Hill, International Editions, 2003.
2. Mudge, Arthur E. "Value Engineering"- A systematic approach, McGraw Hill, New York, 2000.
3. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7
4. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9

5. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education,ISBN 9788177588217
6. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141

REFERENCE BOOKS

1. S.Rosenthal, "Effective Product Design and Development", Irwin, 1992.
2. Charles Gevirtz, "Developing New products with TQM", McGraw Hill, International Editions, 1994.

ONLINE RESOURSES

Product design and Development, NPTEL course, Prof. Inderdeep Singh, Department of Mechanical and Industrial Engineering Indian Institute of Technology (IIT), Roorkee. https://onlinecourses.nptel.ac.in/noc17_me16/preview

IEA-524	Facilities Design	[3-0-0-3]

COURSE OUTCOMES

CO1: understand manufacturing attributes of an industry and classify various plant layouts

CO2: analyse various location choices to select an appropriate location for manufacturing and services

CO3: design a process layout through various strategies

CO4: design a product layout through various strategies

CO5: design a group technology based layout through various strategies

CO6: identify and analyse the problems in the existing layout/material handling system and suggest appropriate material handling strategies

DETAILED SYLLABUS

Introduction: Concept of facilities, layout problem, classification of layouts with relative advantages and limitations, Plant services and Auxiliary departments: Considerations about receiving area, storage, warehousing, shipping, tool room and tool crib, plant services and employee services.

Plant location: Hierarchy of location problems, factors affecting site location for heavy manufacturing industry, light industry and warehouse. Various theories/models of site location like bid rent curves, Weber's isodapanes, Weber's classification of industries, Hoover's tapered transport rates, agglomeration, factor rating method, single facility location, load-distance model, break-even analysis, transportation method.

Process Layout: Factors affecting plant layout, Types of flow patterns, flow analysis approaches, activity relationship analysis, relationship diagram, layout procedures by Nadler, Immer, Apple and Reed. systematic layout planning, relationship (REL) chart, traditional layout configuration, production space requirements, manual CORELAP algorithm and examples, computerized layout evaluation based on adjacency based scoring, distance based scoring, distance weighted adjacency-based scoring and more complex scoring models, construction and improvement algorithms, ALDEP, CORELAP, CRAFT algorithms.

Product Layouts: basic features of mass manufacturing, advantages & disadvantages of flow-line production, product-oriented layout – assumptions & types, assembly line layout, assembly line balancing. Design of an assembly line, layout heuristics for assigning tasks in assembly line balancing, assembly line balancing equations.

Group Technology Based Layouts: Group Technology, Cluster Analysis, Planning and design of Cellular Manufacturing System, Flexible Manufacturing Systems. Layout issues in Agile Manufacturing, JIT maufacturing paradigms

Material handling: Relationship of material handling with plant layout, material handling equation, classification of material handling equipment, various types of conveyors, hoists, craves, and mobile equipment, Material handling Strategies, Automation of material handling in various layout types

TEXT BOOKS

1. Francis, McGinnis and White, "Facilities Layout & Location –an analytical approach" Prentice Hall of India Pvt Ltd. 2001
2. James Apple, "Plant Layout & Material Handling", The Ronalt Press Co., New Delhi, 1998.
3. Richards Muther, "Practical Plant Layout", McGraw Hill Book Co., New York, 1982.
4. Ronald H Ballou, "Business Logistics", Pearson Education, Inc. New Delhi, 2004.
5. Tompkins J A & J A White, "Facilities Planning", John Wiley & Sons, Inc. New York, 1984
6. G.K.Aggarwal, "Plant Layout and Material Handling", Jain Brothers New Delhi (2000)

ONLINE RESOURSES

1. Industrial Engineering, NPTEL course by Prof. Pradip Kumar et al., Department of Mechanical & Industrial Engineering, Indian Institute of Technology (IIT), Roorkee, https://nptel.ac.in/courses/112107143/36
2. Project and Production Management, NPTEL course by Prof. Arun Kanda, Department of Mechanical Engineering, Indian Institute of Technology, Delhi, https://nptel.ac.in/courses/112102106/

IEA-525 Design and Analysis of Experiments [3-0-0-3]

Course Objectives: The objective of this course is to impart the knowledge of the fundamentals of experimental designs, analysis tools and techniques, interpretation, and real time applications.

Course Outcomes:

CO1: Apply basic statistics techniques including ANOVA and regression,

CO2: Create the experimental designs such as RCBD, BIBD, Latin Square, factorial and fractional factorial designs,

CO3: Use application of statistical models in analysing experimental data,

CO4: Apply RSM and Taguchi to optimize response of interest from an experiment, and

CO5: Apply Robust design of process and product for the real time applications**.**

Detailed Syllabus

Section A

Experimental design fundamentals: Importance of experiments, experimental strategies, basic principles of design, terminology, steps in experimentation, sample size, Basic statistics, Regression, ANOVA.

Experimental designs: Completely randomized design, RCBD, Latin square, Balanced Incomplete block design (BIBD), Estimation of model parameters, Model adequacy checking, Pair wise comparison tests.
(15 Hours)

Section B

Factorial designs: Full factorial designs, 2 k factorial designs, Blocking and confounding in 2 k factorial designs, 2 k - p factorial designs, Fractional factorial design, nested designs, Split plot design.

Response surface methodology: Introduction to Response Surface Methodology, Experiments with random factors, rules for expected mean squares, approximate F-tests, method of steepest ascent, Analysis of second order responses, Multiple responses. (15 Hours)

Section C

Taguchi Methods: Steps in experimentation, design using orthogonal arrays, data analysis, robust design/ control and noise factors, S/N ratios, parameter design, case studies.

Robust Design: Crossed array design, Combined array design. (10 Hours)

TEXT BOOKS

1. Design and Analysis of Experiments by D C Montgomery, Wiley
2. Applied Statistics and Probability for Engineers by D C Montgomery and G C Runger, Wiley
3. Design of Experiments-An Introduction Based on Linear Models by M D Morris, CRC Press.

IEA-526 Occupational Health and Safety Management [3 0 0 3]

COURSE OBJECTIVES

The main objective of this course is to make the students aware of occupational health and safety issues in the industries, environmental laws, safety management laws and their applications.

To provide knowledge and skill about conventional and advanced strategies for occupational protection, and occupational health assessment methods.

COURSE OUTCOMES

CO1. Students will understand the basic laws related to environmental and safety management in the industries.

CO2. Students will be able to formulate and implement new strategies for assuring health and safety issues in the industries.

CO3. Students will learn the compliance requirements for the industries as per the existing regulations such as Factory Act.

CO4. Students will be able to make appropriate decisions for w.r.t. factors affecting occupational health.

CO5. Students will be able to create awareness the humans during assessment of health hazards in their working environment

CO6. Students will be able to contribute towards making efficient and more comfortable occupational Environment.

DETAILED SYLLABUS

Introduction: Concept of Occupational safety & Health, Importance of Occupational Safety & Health, Relationship between safety, health and productivity, Safety Triangle.

Safety: Influence of Plant layout & Design, Equipment Design, Workplace design on Safety, Industrial Accidents- types and causes, Cost of Accidents – Cost Analysis, Systems Safety Analysis- methods and Techniques.

Noise & vibrations: Physics of Sound, Physiology of Hearing, Acceptability Criterion, Noise Measurements, Control of Noise Exposure, Hearing Conservation Programs, Vibration in workplace- measurement & Control.

Hot & Cold Environments: Introduction, Physiology of Thermoregulation, Mechanisms of Thermal Exchange, Measuring Thermal Environment, Heat Stress Indices, Heat Exposure Limits, Assessing Environmental Strain, Controlling Thermal Exposure.

Design of Local Exhaust system and general ventilation system.

Industrial Illumination: Need for lighting, relationship between illumination- safety, performance & Health. Natural & Artificial lighting sources, Characteristics of artificial lighting sources, quantity and quality of illumination, IES procedure for calculating optimum lighting requirement, recommended illumination standards for various industrial tasks.

Books Recommended:

1. Grimaldi J V, "Safety Management- 5th Edition", AITBS Publishers, Delhi, (2006).
2. McCormick J, "Human Factors in Engineering & Design- 7th Edition", McGraw Hill Publishing Company limited (1992).
3. Salvator R Dinardi- Editor, "The Occupational Environment- Its Evaluation, Control and Management", AIHA Press, Fairfax, Virginia, (2003).
4. David Goetch, "The Safety and Health Handbook", Pearson Education, (1999).

IEA-527 Human Factors Engineering [3-0-0-3]

COURSE OBJECTIVES

1. To Educate the students about latest and established research and practice methodologies in ergonomics and safety;
2. Provide participants with the emerging trends and tools in Human factors Engineering ergonomics to accomplish their job responsibilities in industry sectors such as Manufacturing, Automotive, Distribution, Construction, Mining, and Healthcare.
3. To Enhance student's ability to find solutions for their workplace ergonomics- and safety-related problems, and implement a successful ergonomics and safety program at their workplace.

Course Outcomes

CO1. Students will be able to apply the basic knowledge of effect of factors like visual, auditory and cognitive on performance to design suitable work systems.

CO2. The students will be able to analyze the factors affecting injury and MSDs and apply various Tools for effective and job design.

CO3. Students shall be able to analyses and assure reliable and safe work and work systems and environments.

CO4. Students shall be awarded about the latest Emerging Trends in Ergonomics and Safety.

DETAILED SYLLABUS

Introduction: Introduction to Human Factors Engineering, Historical evolution of ergonomics, ergonomics and human factors engineering, overview of research methods, experimental research methods Experimental design.

Work Physiology: Work Physiology, Energy Expenditure Models, Heart Rate and Heart Rate Variability, Circulatory and Pulmonary Systems, Neuroergonomics, Fundamentals of Near-infrared spectroscopy (NIRS), NIRS Applications in Ergonomics.

Cognition: Information processing models, selective attention, Reception, Human Factor Guidelines in perception, Human factors Implications of working memory Limits, Long term memory, Organization of information in; long term memory, episodic memory, Situation Awareness (SA), problem solving and troubleshooting, Metacognition and effort, Attention and Time sharing, mental effort and resource demand, task management and interruptions, addressing time sharing overload.

Injury Prevention – Theory of MSDs, Injury Prevention – Fatigue Failure Model of MSDs, Evaluation Methods; RULA, REBA, OCERA etc…, and NIOSH), Evaluating work using RULA, REBA and NIOSH, Upper Extremity disorders and Exposure Analysis, Strain Index for Upper Extremity,

Displays & Controls: Basics of Human Anthropometry, Anthropometry in work place and product Design. classifications of displays, principles of display design, altering displays, labels, monitoring, multiple displays; display layouts, head up displays, configurable displays, navigation displays and maps, Quantitative information displays. Controls; Principles of response selection, Discrete control activation, Positioning Control Devices, Verbal and symbolic inputs, Voice input, Continuous Control tracking, Control Order.

High-Reliability Organizations and Safety Culture; Healthcare Industry as a High-Reliability Organization. Hazard Recognition and Mitigation strategies in Healthcare, Healthcare Ergonomics, Total Worker Health. Environmental Ergonomics - Light; Noise, Heat and Cold Stress Whole-body vibration,

Emerging Ergonomics Assessment Tools: Emerging Trends in Ergonomics and Safety – Introduction to Exoskeletons and Augmented/Virtual Reality. Exoskeletons – History, Safety, and Ergonomics. Virtual/Augmented Reality – Ergonomics and Human Factors.

TEXT BOOKS

1. Christopher D W, John D Lee. Gordon Becker, "Human Factors Engineering", PHI, 2011.
2. MI Khan, "Industrial Ergonomics", PHI, 2011.
3. Sanders Mark S and McCormick Ernert J, "Human Factors in Engineering and Design", McGraw- Hill Inc., 1993.
4. John B West, "Respiratory Physiology" Wolter Kulwer Lippincott Williams & Wilkins.
5. David J. Oborne," Ergonomics at Work", John Willey & Sons.

IP-565 Finite Element Methods [3-0-0-3]

COURSE OUTCOMES

At the end of the course, students will be able to:

CO1. Understanding of finite element method for 1-D problems

CO2. Apply numerical methods to solve mechanics of solids problems

CO3. Analyze two-dimensional problems using triangle and quadrilateral elements.

CO4. Evaluate axisymmetric and heat transfer problems.

DETAILED SYLLABUS

Basic concepts: Variational and Residual methods-Introduction - Different approaches in Finite Element Method - Direct Stiffness approach, simple examples Variational approach, Elements of variational calculus – Euler's-Lagrange equation, Rayliegh Ritz method , Weighted Residual methods, Point Collation method, Sub domain Collation method, Galerkins method - Steps involved in FEM.

Elements and Interpolation Functions: Elements and coordinate system -Interpolation Polynomials - Linear elements Shape function - Analysis of simply supported beam - Element and Global matrices - Two dimensional elements, triangular and rectangular elements - Local and Natural Co-ordinate systems.

Finite Element Solution of Field Problems: Field problems – Finite element formation of field problems - Classification of partial differential equations – Quasi-harmonic equation - Steady state problems - Eigen value problems - Propagation problems - Examples, Torsional problem - Fluid flow and Heat transfer problems - Acoustic vibrations – Application in manufacturing problems – metal cutting and metal forming.

Finite Element Solution of Structural Problems: Solid mechanic problems – Finite element formulation of solid mechanic problems - Axial force member - element matrices for axial force members - Truss element analysis of pinned truss - Two dimensional elasticity problems.

Higher Order Elements and Numerical Methods: Numerical method and computer implementation –Numerical method in FEM and Computer implementation. Evaluation of shape functions - One dimensional & triangular elements, Quadrilateral elements, Iso-parametric elements - Numerical Integration, Gauss Legendre quadrature - Solution of finite element equations - Cholesky decomposition - Computer implementation- Use of FEM software.

TEXT BOOKS

1. Larry J Segerlind, "Applied Finite Element Analysis‖", John Wiley, 1984
2. Bathe, K J, "Finite Element Procedures‖", Prentice Hall, 1994.
3. Huebner, K H and Thornton, E.A., "The Finite Element Method for Engineers", John Wiley, 1982.
4. Reddy,J N., ―Introduction to Finite Element Method‖, McGraw Hill, 1993
5. Zienkiewich . O.C., and Taylor. R L "The Finite Element Method‖", McGraw-Hill,1991.
6. Rao S S, "Finite element method", 1995.

ONLINE RESOURCES

1. Finite Element Method, NPTEL course, Professor R. Krishna kumar, IIT Madras: https://archive.nptel.ac.in/courses/112/106/112106135/

IP-562 Computer Integrated Manufacturing [3-0-0-3]

COURSE OUTCOMES:

CO1: Gain a comprehensive understanding of the principles, concepts, and components of Computer Integrated Manufacturing systems.

CO2: Create and modify 3D models and generate machining instructions.

CO3: Understand about industrial robotics and automation systems

CO4: Develop problem-solving and troubleshooting skills to identify and address issues related to CIM systems

CO5: Create awareness of industry trends and emerging technologies in the field of CIM

DETAILED SYLLABUS:

- Introduction to computer integrated manufacturing, overview of CIM and its significance in modern manufacturing, role of computers, automation, and information systems in CIM.
- Computer-Aided Design (CAD): Introduction to CAD software and its capabilities, 2D and 3D modeling techniques, CAD file formats, data exchange
- Computer-Aided Manufacturing (CAM): CAM systems and their integration with CAD, Toolpath generation and optimization, Post-processing and machine simulation.
- Computer Numerical Control (CNC) Machining: Principles of CNC machining and programming, CNC machine components and their functions, G-code programming and CNC machine operation.

- Robotics and Automation: Introduction to industrial robots and their applications, Robot programming and control, Integration of robots with manufacturing processes.
- Manufacturing Resource Planning (MRP II): Overview of MRP II systems and their functionalities, Material planning, inventory management, and procurement in MRP II, Integration of MRP II with other CIM components.
- Enterprise Resource Planning (ERP): Introduction to ERP systems and their benefits, Integration of manufacturing, finance, and other business functions in ERP, ERP implementation and challenges.
- Manufacturing Data Management: Data modeling and database systems in CIM, Product data management (PDM) and product lifecycle management (PLM), Data security, integrity, and access control in CIM.
- Integration of Manufacturing Systems: Interfacing and communication standards in CIM, Integration of CAD, CAM, CNC, MES, and ERP systems
- Quality Control and Inspection in CIM: Statistical process control (SPC) techniques., Inspection technologies and equipment, Automated inspection and quality assurance in CIM.
- Emerging Technologies in CIM: Internet of Things (IoT) and its role in manufacturing, Additive manufacturing and its integration with CIM, Cloud computing, big data analytics, and artificial intelligence in CIM.

TEXT BOOKS:

1. "Computer Integrated Manufacturing" by James A. Rehg and Henry W. Kraebber
2. "Computer Integrated Manufacturing: From Fundamentals to Implementation" by Timothy L. Baines, Paul A. Ladley, and David J. Harrison
3. "Computer Integrated Manufacturing Systems" by N. Viswanadham and Y. Narahari
4. "Introduction to Computer-Integrated Manufacturing" by James A. Rehg and Henry W. Kraebber
5."Principles of Computer-Integrated Manufacturing" by S. Kant Vajpayee
6. "Computer Integrated Manufacturing: From Concepts to Realization" by Alojz Pecar and Milan Milanovic

PROGRAM ELECTIVES (DATA ANALYTICS STREAM)

IEA-541 Visualization and Big Data Analytics [3-0-0-3]

Course Objective

This course intends to train the students in various concepts of big data analytics like Big Data Platforms, Apache Hadoop Ecosystem, HDFS and Map Reduce and to make them industry ready to take up jobs in this field.

Course Outcomes:

CO1: The students will be able to Describe big data and use cases from selected business domains
CO2: The students will be able to List the components of Hadoop and Hadoop Eco-System
CO3: The students will be able to Access and Process Data on Distributed File System
CO4: The students will be able to Manage Job Execution in Hadoop Environment
CO5: The students will be able to Develop Big Data Solutions using Hadoop Eco System

DETAILED SYLLABUS

Section A

Introduction to Big Data and Hadoop: Types of Digital Data – Introduction to Big Data – Big Data Analytics – History of Hadoop – Analysing Data with Hadoop – Hadoop Streaming – Hadoop Eco System – Applications of Big Data: marketing – fraud detection – risk assessment – credit risk management – healthcare – medicine – advertising.

HDFS (Hadoop Distributed File System): Design of HDFS – HDFS Concepts – Command Line Interface – Hadoop file system interfaces – Data flow – Data Ingest with Flume and Sqoop – Hadoop I/O: Compression – Serialization – Avro and File-Based Data structures.

Section B

Map Reduce: Anatomy of a Map Reduce - Job Run – Failures – Job Scheduling – Shuffle and Sort – Task Execution – Map Reduce Types and Formats – Map Reduce Features - Composing map reduce calculations.

Hadoop Ecosystem: Introduction to PIG – Execution Modes of Pig – Comparison of Pig with Databases – Grunt – Pig Latin – User Defined Functions – Data Processing operators - Hbase – data model and implementations – Hbase clients – Hbase examples – Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.

Section C

Mining Data Streams: Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows.

Data visualization using Matplotlib and Tableau

REFERENCES:

1. Tom White "Hadoop: The Definitive Guide" Third Edition, O'reily Media, 2012.
2. Seema Acharya, Subhasini Chellappan, "Big Data and Analytics" Wiley Publication, 2015.
3. Raj Kamal, Preeti Saxena, "Big Data Analytics: Introduction to Hadoop, Spark, and Machine Learning", McGraw Hill, 2018.
4. Jay Liebowitz, "Big Data and Business Analytics" CRC press, 2013.
5. Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Archana Mire, Advanced Analytics", John Wiley & sons, 2012.
6. Jure Leskovec, Anand Rajaraman, Jeffrey Ullman. "Mining of Massive Datasets." Cambridge University Press. 2014.

IEA-542 Data Structures and Programming Methodology [3-0-0-3]

COURSE OUTCOMES

CO1: Understand the fundamental concepts of data structures and their applications.

CO2: Design and implement algorithms using various data structures.

CO3: Analyze the time and space complexity of algorithms.

CO4: Understand the properties and operations of abstract data types.

CO5: Develop programming skills in implementing data structures and algorithms.

Detailed Syllabus

Unit 1: Introduction to Data Structures

Overview of data structures and algorithms, Arrays, linked lists, stacks, and queues, Abstract data types and interfaces

Unit 2: Trees and Graph

Binary trees and binary search trees, AVL trees and balanced search trees, Graphs, DFS, BFS, and shortest path algorithms

Unit 3: Hash Tables and Heaps

Hash tables and collision resolution, Heaps and priority queues, Sorting algorithms and their analysis

Unit 4: Advanced Data Structures

Disjoint sets and union-find algorithms, B-trees and external memory algorithms, Trie and suffix tree data structures

Unit 5: Applications of Data Structures

Searching and sorting algorithms, Text processing and pattern matching, Network flow and graph algorithms, Data compression and encryption

REFERENCE BOOKS:

Cormen, T. H., Leiserson, C. E., Rivest, R. L., & Stein, C. (2009). Introduction to Algorithms (3rd ed.). MIT Press.

IEA-543 Linear Algebra [3-0-0-3]

COURSE OUTCOMES:

CO1: Demonstrate an understanding of the fundamental concepts of linear algebra and matrix algebra.

CO2: Ability to solve systems of linear equations using various methods,

CO3: Understand the properties of vector spaces and linear transformations, including linear independence, basis, and dimension.

CO4: Compute determinants, eigenvalues, and eigenvectors of matrices and understand their properties and applications.

CO5: Apply linear algebra to solve engineering problems, including linear regression, curve fitting, optimization, and control systems.

DTAILED SYLLABUS

Unit 1: Vectors and Matrices

Vector algebra, Dot product and cross product, Matrices and operations on matrices

Inverse and transpose of a matrix, Rank of a matrix

Unit 2: Systems of Linear Equations

Gaussian elimination, Matrix representation of systems of linear equations, Homogeneous and non-homogeneous systems, Solutions of systems of linear equations

Unit 3: Linear Transformations

Definition and examples of linear transformations, Properties of linear transformations

Kernel and image of a linear transformation, Eigenvalues and eigenvectors

Unit 4: Vector Spaces

Definition and examples of vector spaces, Subspaces and linear independence, Basis and dimension of a vector space, Change of basis

Unit 5: Applications of Linear Algebra

Linear regression, Computer graphics, optimization problems

Reference Books:

Elementary Linear Algebra by Howard Anton and Chris Rorres

Linear Algebra and Its Applications by Gilbert Strang

Linear Algebra: A Modern Introduction by David Poole

Lay, David C. Linear Algebra and Its Applications. Pearson, 2015

IP-556 Industrial Internet of things [3-0-0-3]

COURSE OUTCOMES:

CO1: Understand the fundamental concepts and principles of the Industrial Internet of Things (IIoT), including the integration of physical devices, sensors, and actuators with network connectivity.
CO2: Identify and analyze the various components and technologies involved in IIoT systems, such as embedded systems, wireless communication protocols, data analytics, and cybersecurity.
CO3: Apply knowledge of networking protocols, such as MQTT and CoAP, to enable seamless communication and data exchange between IIoT devices, gateways, and cloud platforms.
CO4: Evaluate and select appropriate sensors, actuators, and communication technologies based on specific industrial requirements, considering factors such as reliability, scalability, power consumption, and data transmission rates.
CO5: Design and develop IIoT applications and solutions for industrial automation, predictive maintenance, real-time monitoring, and optimization of industrial processes.

DETAILED SYLLABUS

Introduction to IIoT
Define IoT and its impact on society, embedded system is and its components, interaction between software and hardware in an IoT device, role of an operating system in supporting software in an IoT device. Introduce the Arduino and Raspberry Pi platforms and their use in IoT devices, sensors and actuators in IIoT.

Networking for IIoT
Basic Characteristics of Computer network, Elements of Network Communication Protocols, OSI Model, IPv4 and IPv6, network topologies, IEEE 802 standard, Mobile AdHoc Network (MANET), IoT Network quality of service, MQTT and CoAP communication protocols, Serial communication methods, I2C, SPI and UART. Describe the use of networking and basic networking hardware.

Arduino Platform and Programming
Composition of the Arduino development board, pinout diagram and datasheet of Arduino Uno. Installation of the Arduino IDE and compile/run sample sketches, Use embedded C programming language to write sketches for the Arduino, Simulate integration of various sensors and actuators with Arduino Uno on Tinkercad platform. Develop Arduino Uno based real world novel applications using Arduino-specific shields and software libraries.

Raspberry Pi Platform and Programming
Set up the Raspberry Pi environment and get a Linux operating system running, Use Python programming language to write code for the Raspberry Pi, Learn how to use Python-based IDEs for the Raspberry Pi and how to trace and debug Python code on the device. Interface the Raspberry Pi with more complicated sensors and actuators. Explore the use of the Raspberry Pi camera module and servos.

Design, build, and test a microcontroller-based embedded system on a low-cost budget for a real-world application.

TEXTBOOKS:
"Arduino for Dummies" by John Nussey
"Programming the Raspberry Pi: Getting Started with Python" by Simon Monk
"Learning Python with Raspberry Pi" by Alex Bradbury and Ben Everard

REFERENCE BOOKS:

1. "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry" by Maciej Kranz (2nd Edition, 2021)
2. "Designing Connected Products: UX for the Consumer Internet of Things" by Claire Rowland, Elizabeth Goodman, Martin Charlier, and Ann Light (2nd Edition, 2021)
3. "The Fourth Industrial Revolution" by Klaus Schwab (2017)
4. "Industry 4.0: The Industrial Internet of Things" by Alasdair Gilchrist (1st Edition, 2016)
5. "IoT Inc: How Your Company Can Use the Internet of Things to Win in the Outcome Economy" by Bruce Sinclair (1st Edition, 2017)

ONLINE RESOURCE:

"Introduction to the Internet of Things and Embedded Systems" by Professor Ian Harris, University of California, Irvine on Coursera.
https://www.coursera.org/learn/iot-foundations

"The Internet of Things" by Professor Greg Benson, University of San Francisco on Coursera: https://www.coursera.org/learn/iot/home/welcome

"Introduction to the Internet of Things (IoT)" by IBM on Coursera: https://www.coursera.org/learn/internet-of-things

"Getting Started with the Internet of Things (IoT)" by Intel on edX: https://www.edx.org/course/getting-started-with-the-internet-of-things-iot

"Embedded Systems - Shape The World: Microcontroller Input/Output" by Professor Jonathan Valvano, University of Texas at Austin on edX: https://www.edx.org/course/embedded-systems-shape-the-world-microcontroller-i

"Introduction to Cybersecurity for the Internet of Things" by IBM on edX: https://www.edx.org/course/introduction-to-cybersecurity-for-the-internet-of-t

NPTEL Courses

Industrial Internet of Things - Dr. S. V. Kasmir Raja: https://onlinecourses.nptel.ac.in/noc21_ee32

Introduction to Industrial Internet of Things - Dr. Samarjit Sengupta: https://onlinecourses.nptel.ac.in/noc21_ee13

Industrial IoT Fundamentals - Dr. R. Senthil Kumar: https://onlinecourses.nptel.ac.in/noc21_ee40

IoT for Smart Manufacturing - Dr. S. S. Pande: https://onlinecourses.nptel.ac.in/noc20_mm31

IoT and Sensor Based Industrial Automation - Dr. S. S. Pande: https://onlinecourses.nptel.ac.in/noc20_mm30