Programme Structure and Syllabi
for
Master of Technology (M. Tech)
in
Industrial Engineering and Management
(2026 batch onwards)

Department of Production and Industrial Engineering

Punjab Engineering College

(Deemed to be University)

Chandigarh, India

Proposed PG Specialization (As per AICTE regulation 2024-2025)

1. **M. Tech: Industrial Engineering and Management**

Proposed Semester-wise PG Scheme to be implemented w.e.f 2025-26 session

Semester-I					Semester-II			
S.N.	Course Code	Courses	Credits		S.N.	Course Code	Courses	Credits
1.	EM1006	Statistics and Data Analytics	3		1.	IE1104	Optimization Techniques (DCC-IV)	3
2.	IE1101	Advanced Ergonomics and work Study (DCC-I)	3		2.	IE1105	Logistic and Supply Chain Management (DCC-V)	3
3.	IE1102	Advanced Operation Research (DCC-II)	3		3.	IE1106	Modelling and Simulation (DCC-VI)	3
4.	IE1103	Operation Planning and Control (DCC-III)	3		4.	IE1202	Dept. Elective Course (DEC-II)	3
5.	IE1201	Dept. Elective Course (DEC-I)	3		5.	-	Open Elective-I	3
6.	IE1001	Research Methodology	3		6.	IE4001	Industrial Tour*	0
					7.	SC1001/ MS1001	Soft Computing/Soft Skill & Management	3
Total			18				Total	18

Semester-III					Semester-IV			
S.N.	Course Code	Courses	Credits		S.N.	Course Code	Courses	Credits
1.	IE5001	Seminar and Report Writing	2		1.	IE8001	Dissertation-II	18
2.	RP6001	Research and Publication Ethics	2					
3.	IE7001	Dissertation-I	14					
		Total	18				Total	18

Total Credits = 18+18+18+18 = 72

*Industrial tour will be held in winter vacation after 1st semester and it will be recorded in 2nd semester

** In the first and second semesters, at least one of the Department Core Course should have a laboratory component

Department Core Courses (DCC)

Sr. No.	Course Code	Core Course	Course Name
1	IE1101	Dept. Core Course (DCC)-1	Advanced Ergonomics and Work Study
2	IE1102	Dept. Core Course (DCC)-2	Advanced Operations Research
3	IE1103	Dept. Core Course (DCC)-3	Operations Planning and Control
4	IE1104	Dept. Core Course (DCC)-4	Optimization Techniques
5	IE1105	Dept. Core Course (DCC)-5	Logistics and Supply Chain Management
6	IE1106	Dept. Core Course (DCC)-6	Modelling and Simulation

Department Elective Courses (DEC)

Sr. No.	Course Code	Dept. Elective Courses	Course Name
1	IE1201	DEC-1	Industrial Economics and Cost Management
2	IE1202	DEC-2	Deep Learning and Data Mining
3	IE1203	DEC-3	Sustainability Management
4	IE1204	DEC-4	Energy Management and Industrial Safety
5	IE1205	DEC-5	Advanced Human Resource Management
6	IE1206	DEC-6	Quality and Reliability Engineering
7	IE1207	DEC-7	Materials and Maintenance Management
8	IE1208	DEC-8	Product Design and Development
9	IE1209	DEC-9	Industrial Waste Management
10	IE1210	DEC-10	Spatial Topics in Industrial Engineering
11	IE1211	DEC-11	Industrial Internet of Things (IIoT)
12	IE1212	DEC-12	Design for Additive Manufacturing
13	IE1213	DEC-13	Project Management
14	IE1214	DEC-14	Multivariate Statistical Modelling

Sr. No.	Course Code	Open Elective (OE)	Course Name
1	IE3001	Open Elective-1	Advanced Operations Research
2	IE3002	Open Elective-2	Product Design and Development
3	IE3003	Open Elective-3	Technology Management
4	IE3004	Open Elective-4	Design Thinking and Innovation Management
5	IE3005	Open Elective-5	Quality and Reliability Engineering
6	IE3006	Open Elective-6	Logistics and Supply Chain Management

Proposed Credits Break-up for M. Tech Programme (2022–23 onwards)

Curricular Components	Credits
A) Department Core Courses (DCC)	18
B) Department Elective Courses (DEC)	6
C) Institute Open Elective Courses	3
D) Research Methodology	3
E) Seminar and Report Writing	2
F) Statistics and Data Analytics	3
G) Soft Computing / Soft Skills & Management	3
H) Industrial Tour	0
I) Research and Publication Ethics	2
J) Dissertation / Industry Project*	32
Grand Total	**72**

Course Name	**:**	**Statistics and Data Analytics**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives	
1	To apply the real implementation of Descriptive Statistics and various Probability Distributions.
2	To analyze the basic concepts of Inferential Statistics through hypothesis testing.
3	To explore the applications of various mathematical algorithms for system optimization.
4	To understand the algorithms for Supervised and Unsupervised Learning/Machine Learning.

Total No. of Lectures: 42

Sr. No.	**Course Contents**	**No. of Lectures**
1.	Introduction to the course, Measure of Central Tendency and Dispersion in Frequency Distribution, Exploratory Data Analysis, Frequency distributions, histograms, scatter plots Probability Rules and Probability Distributions	**7**
2.	Point and Interval Estimation, Inferential Statistics through hypothesis tests, Permutation & amp; Randomization Test	**6**
3.	Chi-square Test, Regression and Correlation Analysis, ANOVA (Analysis of Variance), Inferences about Population Variances, Non-Parametric Methods	**7**
4.	Data Analytics Overview, Importance of Data Analytics, Types of Data Analytics, Descriptive Analytics, Diagnostic Analytics, Predictive Analytics, Prescriptive Analytics, Benefits of Data Analytics	**4**
5	Data Handling for Systems Optimization by using different Tools/Methods/Approaches	**6**
6.	Machine Learning Introduction and Concept, Python Data Structures and Data Types, String Operations, Simple Input and Output, Formatting, Deep and Shallow Copy, Operations, Challenges for Big Data Analytics, Clustering, Associative Rule Mining, Challenges for big data analytics.	**6**

Course Outcomes

At the end of the course, students will be able to:	
1.	Students will be able to know the physical significance of Descriptive Statistics and various Probability Distributions in real life situations
2.	Students will be able to apply the Inferential Statistics through hypothesis testing for data analysis
3.	Students will be able to develop a framework in order to handle the practical criticality through mathematical algorithms.
4.	Students will be able to take decision for improving the system performance through decision theory approaches.
5.	Students will be able to apply the concept of Supervised and Unsupervised Learning/Machine Learning and Python based algorithms

Bibliography:

Sr. No.	Book Detail	Year of Publication
1.	The elements of statistical learning. Hastie, Trevor, et al. New York: Springer.	**2009**
2.	Applied Statics and Probability for Engineers Montgomery, Douglas C. and George C. Runger.	**2016**
3.	Statistics for Management, Richard I. Levin, David S. Rubin Pearson	**2011**
4.	Python for Data Analysis Wes Mckinney, OREILLY	**2017**

Reference Books

Name of Book/Authors/Publishers	Year of Publication
Mining of Massive Datasets, Anand Rajaramanand Jeffrey David Ullman, Cambridge University Press.	**2012**
Analytics in Practice, Soumendra Mohanty, Tata McGraw Hill Education	**2011**

Equivalent MOOCs Courses

Course Links	Offered by
https://archive.nptel.ac.in/courses/110/106/110106072/	**NPTEL**
https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ma34	**Swayam**
https://nptel.ac.in/courses/110104513?utm	**NPTEL**

PO-CO Mapping Matrix

	PO1	PO2	PO3	PO4
CO1	2	2	1	1
CO2	3	2	1	1
CO3	3	2	1	1
CO4	2	2	2	1
CO5	3	3	1	1

Course Name	**:**	**Advanced Ergonomics and Work Study**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives	
1.	To understand the concept of designing a job for a worker.
2.	To consider various factors affecting a human ergonomically while designing a job for a worker.

Total No. of Lectures: 28
Total No. of Lab Hrs.:28

Sr. No.	**Course Contents**	**No. of Lectures**
1.	Introduction, definition, objectives and scope of ergonomics, 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,	**3**
2.	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	**5**
3.	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.	**6**
4.	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.	**5**
5.	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.	**6**
6.	Human Factors Applications: Human Error, Accidents and Safety, Human Factors in the Automobile. Human Factors in Systems design	**3**

Lab Work

Sr. No.	Lab. Contents	No.of Hours
1.	To carry out anthropometric investigation of student population.	4
2.	To carry out posture analysis of industrial worker using RULA and REBA.	4
3.	To carry out assessment of MMH task using NIOSH equation.	6
4.	Stop watch time study on drilling machine, lathe machine and CNC machine	6
5.	To carry out ergonomics evaluation of a factory work cell.	4
6.	Method to improve the assembly and dis-assembly of a Bolt, a nut and three washers /bulb holder	4

Course Outcomes

At the end of the course, students will be able to:	
1.	Understand human factors &systems and human output &control.
2.	Evaluate Ergonomically factory work cell and office work station
3.	Understandinganddesigningajobforaworkerconsideringvariousfactorsaffectinga human ergonomically.
4.	Analyze Anthropometric Data for industry/office
5.	Know Application of Anthropometric Data in industry/office
6.	Design a workplace for defined wording condition

Bibliography:

Sr. No.	Book Detail	YearofPublication
1.	Mark Sanders, Ernest Mc Cormick, Human Factors In Engineering and Design, 7th edition, McGraw-Hill International Editions.	1993
2.	Martin Helander, A Guide to human factors and ergonomics, Taylor and Francis.	2005
3.	Stanton Netal, Handbook of human factors and ergonomic methods, CRC press.	2004
4	Gallwey TJ, Ergonomics Laboratory Exercises, CRC Press.	2009
5.	International Labour organization, Work-study, Oxford and IBH publishing company Pvt. Ltd., N. Delhi 2010	2010

Equivalent MOOCs Courses

Course Links	Offered by
https://nptel.ac.in/courses/112107249	NPTEL
https://nptel.ac.in/courses/107103004	NPTEL
https://nptel.ac.in/courses/110105162	NPTEL

PO-CO Mapping Matrix

	PO1	PO2	PO3	PO4
CO1	2	2	1	1
CO2	3	2	3	1
CO3	3	2	3	2
CO4	2	2	2	3
CO5	3	2	3	2
CO6	3	3	3	2

Course Name	**:**	**Advanced Operations Research**
Course Code	**:**	
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Course Objectives:	
1.	Todevelopanabilityinthestudentstounderstandandanalyzemanagerialproblemsin industry
2.	To understand the notions of different resources (capitals, materials, staffing, and machines) Mathematically and using software's.

Total number of lectures:42

Sr. No.	**Course contents**	**No. of Lectures**
1.	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. Dual simplex method, revised simplex method.	**10**
2.	Transportation algorithm and optimality, assignment model, Hungarian method. Decision making under certainty, risk and uncertainty, game theory, two-person zero-sum game, mixed strategy.	**8**
3.	Integer programming algorithm – Cutting plane algorithm- Zero-one implicit enumeration algorithm. One-dimensional cutting stock problem. Dantzig Wolfe decomposition algorithm.	**6**
4.	Dynamic Programming- Fibonacci numbers, Floyd Warshall Algorithm, Min Cost Path, Subset sum problems, Weighted job scheduling etc. Goal programming- Utility optimization, Multi criteria optimization, Programming models etc	**6**
5.	Waiting line problems: classification of queuing situations; Kendall's notation, Poisson arrival with exponential or Erlang service time distribution; finite and infinite queues; optimal service rates; application of queuing theory to industrial problems.	**6**
6.	Genetic algorithms, Binary/Real coded, Gas for constrained optimization, and simulated annealing, ant colonies, particle swarm optimization.	**6**

COURSEOUTCOMES:

1.	Students shall be able to use variables for formulating complex mathematical models in management science, industrial engineering, and transportation science.
2.	Students shall be able to use various software packages such as LINGO, Solver, and TORA for solving linear programming and integer programming models.
3.	Students will be able to solve real life problems related with transportation and assignment problems, queuing theory etc.
4.	Understand and apply different algorithms for solving goal or integer programming, nonlinear programming problems.
5.	Development of different models and assessment through Dynamic and Goal programming approach.
6.	Understand genetic algorithms, Binary/Real coded Gas for constrained optimization, and simulated annealing, ant colonies, particle swarm optimization.

Bibliography:

Sr. No.	Book Details	Year of Publication
1.	Taha, H.A., Operations Research–An Introduction, Sixth Edition, Prentice Hall of India Private Limited, New 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

Equivalent MOOCs Courses	
Course Links	**Offered by**
https://nptel.ac.in/courses/112106131	NPTEL
https://nptel.ac.in/courses/112103774	NPTEL

PO-CO Mapping Matrix

	PO1	PO2	PO3	PO4
CO1	3	3	2	2
CO2	3	3	2	1
CO3	3	3	3	2
CO4	3	3	2	2
CO5	3	3	3	2
CO6	3	3	2	3

Course Name	**:**	**Operations Planning and Control**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives:	
1.	Learn about different production systems, including job shop, batch, and continuous flow production, and how to manage them efficiently.

Total No. of Lectures: 42

S. No.	**Course contents**	**No. of Lectures**
1.	Production Operations Planning & Control Systems: Classification, activities and matching of PPC system with the Firm. Lean, Concurrent and Agile Systems.	**8**
2.	Basic Material and Information Flow: Material Requirements Planning (MRP-I and MRP-II) and Lot Sizing, Just-In-Time Production.	**8**
3.	Capacity Planning: Tools and Techniques, Operations Control principles and Techniques. Short-range Forecasting Techniques.	**8**
4.	Independent demand Inventory Management: EOQ Models and order timing decisions, Safety Stock and reorder level decisions. Order quantity and reorder point. Interactions with other functions and multi-item management. Distribution Requirement Planning. Spare parts inventory control.	**12**
5.	Line Balancing: Concepts, Applications and Case studies	**6**

Course Outcomes

At the end of the course, students would be able to:	
1.	Understand the terminologies in Operations and planning systems.
2.	Differentiate between different types of production systems
3.	Identify wastes and methodologies to reduce them.
4.	Develop Forecasting methodologies.
5.	Apply and Evaluate Line balancing systems for assemblies.

Bibliography:

Sr. No.	**Book Detail**	**Year of Publication**
1.	Chopra S. and Meindl. P., Supply Chain Management: Strategy, Planning, and Operations, 5th. Edition, Pearson Prentice Hall, (2013).	2013
2.	S.L. Narasimhan, D.W. Mc Leavy, and P.J. Billington, Production Planning and Inventory Control, PHI, 2nd Edition.	1995
3.	Sipper, D. and Bulfin, R. Production: Planning, Control, and Integration. McGraw Hill. (1997).	1997
4.	Vollmann, T.E., Berry, W.L., Whybark, D.C. and Jacobs, F.R., Manufacturing Planning and Control for Supply Chain Management, McGraw-Hill	2005
5.	Silver, E. A., D. F. Pyke and R. Peterson, Inventory Management and Production Planning and Scheduling, John Wiley, 3rd edition	1998

Equivalent MOOCs Courses	
Course Links	**Offered by**

https://nptel.ac.in/courses/112107238?utm	**NPTEL**
https://nptel.ac.in/courses/110106045?utm	**NPTEL**
https://nptel.ac.in/courses/110105755?utm	**NPTEL**

PO-CO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	2	2	1	-
CO2	2	3	2	-
CO3	3	2	3	1
CO4	3	3	2	2
CO5	3	3	3	1

Course Name	**:**	**Research Methodology**
Course Code	**:**	
Credits	**:**	**3**
LTP	**:**	**2-0-2**

Course Objectives:	
1.	To introduce objective of research for various types of research
2.	To enhance competence analysing experimental results
3.	To enhance competence in understanding mathematical relation between process variables and results
4.	To introduce contribution of Taguchi in designing, analyzing and interpreting experiments.

Total No. of Lectures: 28
Total No. of Labs Hrs: 28

Sr. No.	**Course contents**	**No. of Lectures**
1.	Overview of Scientific Research & Engineering Research: Nature and objective of research, research topic, literature review, steps in conducting literature review, formulation of problem, research questions and hypothesis, types of hypothesis, evaluation of hypothesis, research design, sampling design, measurement and scaling technique, methods of data collection, statistical and sensitivity analysis of data, interpretation of result.	**4**
2.	Analyzing results from experiment: Various tests of significance based on type of input and output data, steps involved in testing for significance, concept of p-value, testing for means, testing for variance, chi-square test – goodness of fit, test of independence.	**3**
3.	Regression & Correlation: Linear and nonlinear regression, multivariable linear regression.	**3**
4.	Classification of experimental designs, Analysis of Variance (ANOVA), ANOVA for detecting sources of variation – statistical procedure for one-way ANOVA, procedure for two-way ANOVA.	**3**
5.	Engineering Research: Planning and management of experiments; conventional method for experiment: one factor at a time (OFAT) experiment, concept of design of experiments: common terms, designed experiment, full factorial experiments: orthogonality of experiments, Y = F(x) for DoE, main effect analysis, interaction analysis, and results.	**4**
6.	Taguchi Methods: Fractional factorial experiments, Resolution of design, screening DoE, Difference between conventional DoE and Taguchi methods, Orthogonal arrays, Taguchi's Robust parameter design, Noise factors, S/N ratio, Selection of right orthogonal array, practicing with excel and statistical software, Introduction to Response Surface Methodology (RSM).	**4**
7.	Technical report and manuscript writing: steps of writing a report, layout of report, layout of research paper, ethical issues related to publishing, Plagiarism and Self-Plagiarism.	**5**

Lab work

Performing following analysis using statistical software		**No. of Lab Hours**
1.	Hypothesis tests (Z-test, t-test, two-sample t-test, paired t-test, chi-square test, and test of equal variance, etc.)	5
2.	Correlation analysis between independent events, regression analysis for dependent variables (having cause & effect), and developing Y = F(x).	5

3.	One-way ANOVA, two-way ANOVA, General Linear Model.	5
4.	Creating and analysing 2^k experiments (full and fractional factorial) and General Full Factorial Design.	5
5.	Development of model using Response Surface Methodology.	4
6.	Creating and analysing Taguchi design.	4

Course Outcomes:

After successful completion of the course, students will be able to	
1.	Understand the concepts of sample design, scaling, data collection and analysis
2.	Understand the concepts of sampling distribution
3.	Apply the required statistical analysis for a research/experiment
4.	Analyze the relationship between process variables and output
5.	Evaluate the Residual error for a statistical model
6.	Design the appropriate orthogonal array for a Taguchi design

Bibliography:

Sr. No.	**Book Details**	**Year of Publication**
1.	Design and Analysis of Experiment, Douglas C Montgomery, John Wiley & Sons	2016
2.	Taguchi Techniques for Quality Engineering Phillip, J. Ross; The Tata McGraw-Hill	2017
3.	Research Methodology- Methods and Techniques, C.K.Kothari,NewAgeInternational,2ndEdition	2004
Equivalent MOOCs Courses		
Course Links		**Offered by**
https://nptel.ac.in/courses/121106007		**NPTEL**
https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ge43		**Swayam**

PO-CO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	3	2	1	1
CO2	2	2	1	1
CO3	3	2	1	1
CO4	3	2	3	1
CO5	2	2	1	1
Co6	3	2	1	1

Course Name	**:**	**Optimization Techniques**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives	
1	To explore the concept of linearity and non-linearity.
2	To analyzethe system through optimization-based algorithm.
3	To develop the model and analysis through advanced optimization techniques to provide the solution of real-life problems.
4	To apply the concept of hybrid optimization for system analysis.

Total Number of Lectures: 42

S. No.	**Course Content**	**Number of Lectures**
1	**Optimization:** Maximum and minimum conditions, optimization parameters, levels of optimization, mathematical representation of problem, optimization procedures including introduction to some non-traditional methods	**8**
2	**Linear and Integer Optimization:** Advanced linear programming, revised simplex and dual simplex methods, duality theory, integer and mixed integer programming, branch and bound, cutting plane methods	**6**
3	**Unconstrained Optimization Techniques:** Introduction to optimum design - general principles of optimization – problem formulation & their classifications - single variable and multivariable optimization, techniques of unconstrained minimization – golden section, random, pattern and gradient search methods – interpolation methods.	**8**
4	**Constrained Optimization Techniques:** Optimization with equality and inequality constraints – Lagrange function and Kuhn tucker conditions	**8**
5	**Modern Optimization Algorithms:** Multi stage optimization, dynamic programming; stochastic programming; multi objective optimization, genetic algorithms and simulated annealing techniques; fuzzy set theory principles in optimization.	**8**
6	**Practical Applications of Optimization:** Illustration on engineering problems with single and multiple objectives, Concept of system analysis through optimization algorithms	**4**

Course Outcomes	
1	Students are able to distinguish between linear and nonlinear models.
2	Students will be able to apply the concept of constrained and un-constrained optimization in real industrial problems.
3	Students are able to form mathematical model of optimization problems.
4	Students can analyze and validate the system performance through sensitivity analysis.
5	Students will be able to apply the different advanced optimization techniques in model analysis.

Bibliography:

Text Book		
S. No.	**Name of Book/Authors/Publishers**	**Yearof Publication**
1	Practical Genetic Algorithms", Haupt, R. L. and Haupt, S.E., John Wiley & Sons	**1998**
2	Genetic Algorithm in Search, Optimization and Machine Learning", Goldberg, D.E., Addison Wesley.	**1989**
3	Optimization for Engineering design algorithms and Examples, Kalyanmoy Deb, Prentice Hall of India Pvt. 2004.	**2012**
4	Fuzzy Set theory with Engineering Applications, by T J Ross, John-Wiley & Sons, USA	**2004**
5	Linear and Nonlinear Programming, 4th Edition, Springer, David G. Luenberger and Yinyu Ye	**2016**
6	Engineering Optimization: Theory and Practice, 5th Edition, Wiley S. S. Rao,	**2019**
Reference Books		
S. No.	**Name of Book/Authors/Publishers**	**Year of Publication**
1	Introduction to Operations Research, Hillier, F. J. and Lieberman, G. J., 7th Ed., Holden Day	**2001**
2	Operations Research Models and Methods, Jensen, P. A, and Bard, J. F., John Wiley and Son	**2008**
3	Nature-Inspired Optimization Algorithms, Elsevier, Xin-She Yang	**2014**
Equivalent MOOCs Courses		
Course Links		**Offered by**
https://archive.nptel.ac.in/courses/111/105/111105039/		**NPTEL**

PO-CO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	3	3	1	1
CO2	3	3	2	2
CO3	3	3	2	2
CO4	3	3	3	2
CO5	3	3	2	3

Course Name	**:**	**Logistics and Supply Chain Management**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives	
1	The enable the student's, knowledge of strategic importance of good supply chain design, planning, and operation for industries.
2	To explore how good supply chain management can lead to competitive advantages and understand weaknesses that could hurt the performance of industries.
3	To analyze the various Drivers in supply chain performance its practical relevance and understanding the knowledge of various distribution networks along with their applications.
4	To analyze the various factors governing design of a supply chain network.
5	To interpret the various critics behind the supply chain decisions and operation analytics.

Total Number of Lectures: 42

S. No.	**Course Content**	**Number of Lectures**
1	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**.** Framework for structuring drivers, analysis of drivers in supply chain.	**4**
2	**S**upply 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. Sourcing in supply chains, supplier assessment, vendor assessment, design coordination and collaboration, planning and analysis, market sourcing decisions in practice.	**6**
3	Role of cycle inventory in a supply chain, various inventory costs, cost trade-off, Inventory Models-Deterministic and Probabilistic, ABC Analysis	**6**
4	Factors influencing distribution 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.	**5**
5	Forecasting in supply chain, Static and adaptive forecasting methods, Measures of forecast errors, case studies	**6**
6	Facilities affecting transportation decisions, modes of transportation and their performance characteristics, design options for a transport network, tradeoffs in transportation decision, tailored transportation, routing, scheduling and sequencing in transportation, transportation decisions for real life problems	**6**
7	Bullwhip effect and its causes, remedial actions to cover-up the bullwhip effect, lack of supply chain coordination and the, effect of lack of coordination on performance, obstacles to coordination, managerial levers to achieve coordination, information technology and its use in supply chain, case studies.	**4**
8	Decision science theory- coupling theory-graph theory-classical set theory-fuzzy set theory for multi attribute decision making in case of model assessment and real world problems.	**5**

Course Outcomes	
1	Students will be able to know the different supply chain cycles used in industry.
2	Students will be able to apply the concept of economic analysis towards overall supply chain profit maximization.
3	Students will be able to develop a framework in order to handle the practical criticality through mathematical algorithms.
4	Students will be able to determine the demand through various forecasting methods.
5	Students will be able to design different transportation and distribution networks with proper coordination among the different stages.

Bibliography:

Text Book		
S. No.	**Name of Book/Authors/Publishers**	**Year of Publication**
1	Marketing logistics: A Supply Chain Approach", Kapoor K K, Kansal Purva, Pearson Education Asia.	**2003**
2	Logistics and Supply Chain Management", Christopher Martin, Pearson Education Asia.	**2004**
3	Supply Chain Management, For Global Competitiveness, B S Sahay, Laxmi Publications (P) Ltd	
Reference Books		
S. No.	**Name of Book/Authors/Publishers**	**Year of Publication**
1	Designing and Managing the Supply Chain: Concepts, Strategies, and Case Studies, Levi D. S., Kaminsky P. and Levi E. S., McGraw Hill Inc. New York.	**2000**
2	Supply Chain Management – Strategy, Planning and Operation", Sunil Chopra and Peter Meindl, Pearson/PHI, 3rd Edition.	**2007**
3	Logistics Management: An Analytics-Based Approach, Matthew J. Liberatore, Tan Miller, Business Expert Press	**2020**
Equivalent MOOCs Courses		
Course Links		**Offered by**
https://archive.nptel.ac.in/courses/110/107/110107074/		**NPTEL**
https://www.edx.org/learn/supply-chain-design/massachusetts-institute-of-technology-supply-chain-fundamentals?		**GIAN**

PO-CO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	2	3	2	1
CO2	3	3	2	1
CO3	3	3	2	3
CO4	3	3	2	2
CO5	3	3	3	2

Course Name	**:**	**Modelling & Simulation**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives	
1	To apply the concept of Probability Distributions in engineering applications.
2	To analyze the system through hypothesis testing and validation through simulation.
3	To develop and simulate the model for real life problems solution.
4	To explore the concept of modelling and assessment of system through sensitivity analysis.

Total Number of Lectures: 42

S. No.	**Course Content**	**Number of Lectures**
1	**Introduction to Modeling** Concept of system, continuous and discrete systems, types of models, steps in simulation study. Basic Simulation Modeling Fundamental concepts of System Simulation: Discrete event simulation	**8**
2	**Basic Concepts from Probability and Statistics** Random variables, correlation, estimation, probability distributions, selection of aappropriate probability ddistributions parameterization of ccontinuous ddistributions and discrete distributions empirical distributions	**8**
3	**Random Varieties Generation and Testing of Random Numbers** Random numbers and vectors, correlated random varieties and stochastic processes. input modeling; hypothesizing families of distributions, confidence intervals estimation of parameters, testing goodness of fit.	**8**
4	Model development and evaluation for real life problems using different modelling approaches and Monte-Carlo / discrete event with the use of languages such as python/r/ with case studies	**6**
5	**Simulation Output Data Analysis for a Single System** Variance reduction techniques, case validation, sensitivity analysis and simulation-based optimization.	**6**
6	**Simulation of Manufacturing Systems** Introduction, objectives of simulation in manufacturing, simulation software in manufacturing applications. simulation case study in primary and secondary manufacturing	**6**

Course Outcomes	
1	Students will be able to know the physical significance of simulation and various probability distributions in real life situations
2	Students will be able to apply the concept of probability and hypothesis testing for system analysis
3	Students will be able to know the significance of Monte-Carlo simulation in real life problems
4	Students can analyze and validate the system performance through sensitivity analysis.
5	Students will be able to apply the different languages like Python in system performance measurement.

Bibliography:

Text Book		
S. No.	**Name of Book/Authors/Publishers**	**Year of Publication**
1	Simulation Modeling & Analysis, Averill M. Law and W David Kelton McGraw Hill	**1991**
2	Modeling and Simulation for Mechanical Engineers, Kishore V. Pochiraju, Wiley–Blackwell	**2021**
3	Richard I. Levin, David S. Rubin, Statistics for Management, Pearson	**2008**
4	Wes Mckinney Python for Data Analysis, OREILLY	**2017**
Reference Books		
S. No.	**Name of Book/Authors/Publishers**	**Year of Publication**
1	System Simulation, Gordon, G., Prentice Hall.	**1978**
2	Numerical Recipes: The Art of Scientific Computing", W. H., Teukolsky, S. A., Vetterling, W. T. and Flannery, B. P., Third Edition, Cambridge University Press	**2007**
Equivalent MOOCs Courses		
Course Links		**Offered by**
https://archive.nptel.ac.in/courses/112/107/112107220/		**NPTEL**

PO-CO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	2	3	1	1
CO2	3	3	2	2
CO3	3	3	2	2
CO4	3	3	3	2
CO5	3	3	2	3

Course Title	**:**	**Industrial Economics and Cost Management**
Course Code	**:**	
Credits	**:**	**3**
L-T-P	**:**	**3-0-0**

Course Objectives	
1.	To familiarise students with the behaviour and performance of firms in markets.
2.	To develop the ability to assess market structure, entry barriers and competitive strategy using standard industrial-economics frameworks.
3.	To introduce costing techniques used in manufacturing and service organisations.
4.	To build analytical skills in cost-volume-profit analysis for decisions such as pricing, make-versus-buy etc.
5.	To develop competence in budgeting, variance analysis and strategic cost-management tools for performance benchmarking.

No. of Lectures 42

S. No.	**Course Content**	**No. of Lectures**
1.	**Firms, Markets and Competitive Behaviour**: Defining the firm; Consumers as rational agents; Welfare analysis of market outcomes; The perfectly competitive paradigm and its limitations; Imperfect competition: Concepts of strategy in markets; Overview of models and analytical material used in industrial economics	7
2.	**Strategic Interaction and Market Structure**: Price competition: Bertrand model; Price competition with uncertain costs and differentiated products; Quantity competition: Cournot model; Price versus quantity competition; Stackelberg leadership; Free entry, endogenous number of firms, industry concentration and firm turnover; Product differentiation (horizontal and vertical); Advertising, Competition and Social welfare	7
3.	**Market Power, Entry Barriers and Competition Policy**: Assessing market power: SSNIP test/hypothetical monopolist test; Traditional versus Econometric approaches; Market power, welfare, allocative and productive efficiency; Structure-Conduct-Performance hypothesis (Bain, Sylos-Labini) and extensions; Market concentration (Sutton approach); Collusion, horizontal and vertical mergers; Strategic barriers to entry; Predatory pricing and Price discrimination	7
4.	**Cost Concepts and Costing Systems**: Foundations of a costing system; Role of the management accountant; Cost concepts (direct, indirect, prime costs); Job order costing and overhead allocation; Customer profitability analysis; Process costing: cost objects, cost segregation, overhead allocation; Activity-Based Costing (ABC) as a tool for managerial decision-making	7
5.	**Cost Behaviour, CVP Analysis and Managerial Decisions**: Cost behaviour: Fixed, variable, mixed and step costs; Cost-Volume-Profit (CVP) analysis and break-even analysis; Incremental/differential analysis for short-term decisions; Variable costing and segment reporting; Applications: Make-versus-buy, pricing of joint products/by-products, special/export orders, product-mix optimisation, product-line discontinuation, profit planning	7
6.	**Planning, Budgeting and Strategic Cost Management**: Budgetary planning; Master	7

	budgeting; Identifying the budget key factor; Flexible budgets and performance analysis; Standard costing and variance analysis for performance benchmarking; Financial Planning & Analysis (FP&A); Costing in new product development (NPD); Balanced Scorecard (BSC); Structure of Management Information Systems (MIS); Decision analytics and reporting tools	

Course Outcome	
1.	Explain how firms behave and compete in markets, including price and quantity competition, product differentiation and entry dynamics.
2.	Assess market power, entry barriers and the welfare implications of collusion, mergers and anti-competitive practices.
3.	Apply job-order, process and activity-based costing systems to determine product/service costs and support pricing decisions.
4.	Use cost behaviour and CVP analysis to support decisions such as make-versus-buy, product-mix optimisation and special-order pricing.
5.	Prepare budgets, conduct variance analysis, and apply strategic cost-management tools (FP&A, Balanced Scorecard, MIS) for performance benchmarking and decision-making.

Bibliography:

Text Book		
S. No.	**Name of Book/Authors/Publishers**	**Year of Publication**
1.	M. Motta, Competition Policy: Theory and Practice, Cambridge University Press.	**2004**
2.	D. W. Carlton & J. M. Perloff, Modern Industrial Organization, 4th ed., Prentice Hall,	**2004**
3.	L. M. B. Cabral, Introduction to Industrial Organization, 1st ed., The MIT Press.	**2000**
4.	J. Tirole, The Theory of Industrial Organization, 1st ed., The MIT Press	**1988**
5.	J. Lipczynski, J. O. S. Wilson & J. Goddard, Industrial Organization: Competition, Strategy and Policy, 4th ed., Pearson	**2013**
6.	P. Belleflamme & M. Peitz, Industrial Organization: Markets and Strategies, 2nd ed., Cambridge University Press,	**2015**
7.	Ray H. Garrison, Eric Noreen & Peter C. Brewer, Managerial Accounting, 16th ed., McGraw Hill.	**2004**
Reference Books		
S. No.	**Name of Book/Authors/Publishers**	**Year of Publication**
1.	Robert S. Kaplan & David P. Norton, The Balanced Scorecard: Translating Strategy into Action, Harvard Business School Press.	**1991**
2.	Shields, M. D. & Young, S. M., Managing product life cycle costs: An organisational model. Journal of Cost Management (Fall): 39–51.	**1992**
3.	Hertenstein, J. H. & Platt, M. B., Why product development teams need management accountants. Management Accounting (April): 50–55.	**1998**
Equivalent MOOCs Courses		
Course Links		**Offered by**
https://nptel.ac.in/courses/110105067?utm		**NPTEL**
https://nptel.ac.in/courses/112107209?utm		**NPTEL**
https://nptel.ac.in/courses/110101149?utm		**NPTEL**

CO–PO Mapping Matrix

	PO1	PO2	PO3	PO4
CO1	2	2	1	1
CO2	3	2	2	1
CO3	3	3	2	1
CO4	3	3	3	1
CO5	3	3	3	2

Course Name	**:**	**Deep Learning and Data Mining**
Course Code	**:**	
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Course Objectives	
1.	To introduce the fundamental concepts, processes, and techniques of data mining for knowledge discovery from large datasets.
2.	To familiarize students with data mining techniques including association rule mining, classification, clustering, and outlier detection.
3.	To develop a strong foundation in the principles of artificial neural networks and deep learning.
4.	To impart knowledge of deep learning architectures such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), and Long Short-Term Memory (LSTM) networks.
5.	To enable students to analyze and apply data mining and deep learning techniques to solve real-world problems.

Total No. of Lectures: 42

S. No	Course Contents	No. of Lectures
1	**Introduction to Data Mining and Data Preprocessing** Motivation & Applications of Data Mining, Knowledge Discovery in Databases (KDD) Process, Data Mining Approaches, Types of Data, Data Objects and Attributes, Data Quality Issues, Challenges in Data Mining, Data Similarity and Dissimilarity Measures, Data Preprocessing: Data Cleaning, Data Integration, Data Reduction (Feature Selection, Feature Extraction, Principal Component Analysis (PCA), Sampling), Data Transformation, Data Discretization, Feature Scaling and Encoding, Exploratory Data Analysis (EDA), Data Visualization (Histogram, Box Plot, Scatter Plot, Correlation Heatmap).	**07**
2	**Frequent Pattern Mining and Association Rules and Classification Techniques** Frequent Pattern Mining and Association, Apriori Algorithm, Frequent Pattern Growth (FP-Growth) Algorithm, Mining Closed and Maximal Frequent Patterns, Pattern Evaluation Measures, Constraint-Based Frequent Pattern Mining, Classification Techniques, Decision Tree Classifier (ID3, C4.5, CART), Rule-Based Classification, k-Nearest Neighbour (k-NN), Naïve Bayes Classifier, Artificial Neural Networks (ANN), Support Vector Machine (SVM), Ensemble Learning (Random Forest), Model Overfitting and Underfitting, Cross Validation, Confusion Matrix, Accuracy, Precision, Recall, F1-Score, ROC-AUC.	**09**
3	**Clustering Techniques & Outlier Detection** Clustering Techniques, Types of Clustering Methods, Partitioning Methods (K-Means, K-Medoids), Hierarchical Clustering (Agglomerative and Divisive), Density-Based Clustering (DBSCAN), Grid-Based Clustering, Cluster Validation Measures (Silhouette Coefficient, Dunn Index), Clustering with Constraints, Outlier Detection, Statistical Approaches, Distance/Proximity-Based Approaches, Density-Based Approaches (LOF), Clustering-Based Approaches, Classification-Based Approaches, Applications of Outlier Detection in Fraud Detection, Healthcare and Industrial Predictive Maintenance.	**08**

4	**Foundations of Neural Networks and Deep Learning** Neural Network, The Human Brain, Models of a Neuron, Neural Networks Viewed as Directed Graphs, Feedback, Network Architectures, Rosenblatt‟s Perceptron, The Perceptron Convergence Theorem, Relation Between the Perceptron and Bayes Classifier for a Gaussian Environment, Multilayer Perceptrons, Batch Learning and On-Line Learning, The Back-Propagation Algorithm, XOR Problem, Heuristics for Making the Back- Propagation Algorithm Perform Better, Back Propagation and Differentiation. Regularization for Deep Learning: Parameter Norm Penalties - L2 Parameter Regularization, Dataset Augmentation, Semi-Supervised Learning, Optimization for Training Deep Models	**10**
5	**Convolution Neural Networks and Sequence Modeling:** Convolution neural networks, The Convolution Operation, Motivation, Pooling, Convolution and Pooling as an Infinitely Strong Prior, Variants of the Basic Convolution Function, Structured Outputs, Data Types, Efficient Convolution Algorithms, Convolutional Networks and the History of Deep Learning, Sequence Modeling, Recurrent and Recursive Nets: Unfolding Computational Graphs, Recurrent Neural Networks, Bidirectional RNNs, Encoder-Decoder Sequence-to- Sequence Architectures, Deep Recurrent Networks, Recursive Neural Networks, The Long Short-Term Memory and Other Gated RNNs	**08**

Course Outcomes:	
1	Explain the concepts of data mining, KDD, and data preprocessing techniques.
2	Apply frequent pattern mining, classification, clustering, and outlier detection techniques to analyze datasets.
3	Demonstrate the principles of artificial neural networks and deep learning.
4	Design and evaluate deep learning models using CNNs, RNNs, and LSTM networks.
5	Select appropriate data mining and deep learning techniques for solving real-world problems. Explain the concepts of data mining, KDD, and data preprocessing techniques.

Bibliography:

Textbooks

Sr. No.	**Name of Book/Authors/Publisher**	**Year of Publication**
1	J. Han, J. Pei, and M Kamber. “Data mining: concepts and techniques”. Elsevier, 3rd edition	2011
2	P.N. Tan, M. Steinbach, A. Karpatne, and V. Kumar. “Introduction to data mining”. Pearson Education India, 2nd edition	2016
3	C.C. Aggarwal. “Data mining: the textbook”. Springer, 1st edition	2015
4	Simon Haykin, Neural networks and Learning Machines, Third Edition, Pearson	2016
5	Deep Learning: An MIT Press Book by Ian Goodfellow and Yoshua Bengio Aaron Courville.	2016
6	Michael Nielson, Neural Networks and Deep Learning, Determination Press,2015.	2015
7	Satish Kumar, Neural networks: A classroom Approach, Tata McGraw-Hill Education	2004

Reference Books:

Sr. No.	**Name of Book/Authors/Publisher**	**Year of Publication**

1	C.C. Aggarwal, and C. Zhai. “Mining text data”. Springer, 1st edition.	2012
2	J. Leskovec, A. Rajaraman, and J.D. Ullman. “Mining of massive datasets”. Cambridge University Press, 3rd edition.	2019
3	J. Dean. “Big data, data mining, and machine learning: value creation for business leaders and practitioners”. John Wiley & Sons, 1st edition.	2014
4	Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press. https://www.deeplearningbook.org/lecture_slides.html	2016
5	Deep Learning with Python, Francois Chollet, Manning publications	2018
6	Advanced Deep Learning with Keras, Rowel Atienza, PACKT Publications	2018

Equivalent MOOCs courses

Course Links	**Offered by**
https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_cs06	**NPTEL/ SWAYAM**
https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_cs62	**NPTEL/ SWAYAM**

CO–PO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	3	2	1	1
CO2	3	3	2	2
CO3	3	2	2	2
CO4	3	3	3	3
CO5	3	3	3	3

Course Name	**:**	**Sustainability Management**
Course Code	**:**	
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Course objectives	
1.	To introduce the evolution, principles and frameworks of corporate sustainability and CSR
2.	To develop competence in ESG analysis and its integration into business strategy
3.	To build practical skills in designing, monitoring and evaluating CSR and sustainability projects, including impact assessment
4.	To familiarise students with sustainability reporting standards, disclosures and the ESG investment landscape
5.	To explore social entrepreneurship as a vehicle for sustainable value creation and examine the emerging role of AI in sustainability leadership

Total No. of Lecture: 42

S No.	**Course Contents**	**No. of Lecture:**
1.	**Foundations of Sustainability and CSR** Evolution of CSR and sustainability: From philanthropy to shared value; Triple Bottom Line (TBL); Creating Shared Value (Porter & Kramer); Sustainable Development Goals (SDGs) and circular economy principles; Net-zero commitments; The twin revolutions of AI and sustainability reshaping organisations	**8**
2.	**Environmental, Social and Governance Factors (ESG) of Sustainability** Understanding sustainability and its impact on business; Environmental factors in ESG; Sustainable supply chain management; Strategies for reducing environmental impact; Climate change and adaptation; Social factors in ESG; Building human capital for competitive advantage; Governance factors in ESG; Risks and opportunities in governance	**9**
3.	**CSR Project Design, Implementation and Impact Assessment** Implementing agencies of CSR: in-house teams, foundations, NGOs, hybrid models; Needs assessment and baseline survey methods; Monitoring and Evaluation (M&E) frameworks; OECD-DAC evaluation criteria; Impact assessment methodologies; Social Return on Investment (SROI); CSR and branding/communication	**8**
4.	**Sustainability Standards, Reporting and ESG Investment** Sustainability standards and regulations (national and international); Business response to sustainability challenges; Sustainability frameworks in practice; Building a sustainability strategy; ESG reporting and disclosures: BRSR (SEBI) and GRI Standards; ESG investment and financing; Embedding ESG into business strategy and operations	**9**
5.	**Social Entrepreneurship and AI for Sustainable Business** Social entrepreneurship and the SDGs; Business planning for social ventures; Organisational structures, governance, funding and scaling of social ventures; Measuring, communicating and marketing social impact; AI and sustainability: core concepts and leading responsibly	**8**

Course Outcomes:	
1.	Explain the evolution of CSR/sustainability and articulate core frameworks
2.	Analyse environmental, social and governance factors affecting business performance and identify sustainability-related risks and opportunities.
3.	Design and evaluate CSR/sustainability projects using needs assessment, monitoring and evaluation frameworks, and Social Return on Investment (SROI).
4.	Prepare sustainability disclosures aligned with BRSR/GRI and evaluate considerations relevant to ESG investment and financing.
5.	Formulate a social enterprise or sustainability business plan and critically assess the role of AI in sustainability decision-making.

Bibliography:

Text Book		
S. No.	**Name of Book/Authors/Publishers**	**Year of Publication**
1	Arthur C. Brooks, Social Entrepreneurship: A Modern Approach to Social Value Creation, Pearson Prentice Hall,	**2009**
2	David Bornstein & Susan Davis, Social Entrepreneurship: What Everyone Needs to Know, Oxford University Press,	**2010**
3	Kate Raworth, Doughnut Economics: Seven Ways to Think Like a 21st Century Economist	**2017**
4	Prasanna Chandra, Finance Sense: Finance for Non-finance Executives, 6th ed., McGraw Hill.	**2025**
Reference Books		
S. No.	**Name of Book/Authors/Publishers**	**Year of Publication**
1.	Michael E. Porter & Mark R. Kramer, Creating Shared Value, Harvard Business Review,	**2011**
2.	Wayne Visser, CSR 2.0: Transforming Corporate Sustainability and Responsibility, Springer,	**2011**
3.	Andrew J. Hoffman & John G. Woody, Climate Change: What's Your Business Strategy?	**2008**
Equivalent MOOCs Courses		
Course Links		**Offered by**
From Theory to Practice: Implementing ESG and Sustainability in Business : Indian Institute of Management, Bangalore, NPTEL.(https://onlinecourses.swayam2.ac.in/e-learning/preview/imb25_mg164)		**NPTEL**
CSR, ESG and Sustainability : Indian Institute of Corporate Affairs (IICA), NPTEL. (https://onlinecourses.swayam2.ac.in/e-learning/preview/imb26_mg298)		**NPTEL**
Social Entrepreneurship and Sustainability: JAIN (Deemed to be University), NPTEL. (https://onlinecourses.swayam2.ac.in/e-learning/preview/imb26_mg118)		**NPTEL**
AI and Sustainability: Leading Responsibly: University of Oxford, Coursera.(		**NPTEL**

https://www.coursera.org/learn/ai-sustainability-leading-responsibly	

CO–PO Mapping Matrix

	PO1	PO2	PO3	PO4
CO1	2	1	1	-
CO2	3	2	2	1
CO3	3	2	3	2
CO4	2	2	1	1
CO5	3	2	2	2

Course Name	**:**	**Energy Management and Industrial Safety**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**3 0 0**

Course Objectives:	
1.	Students should be able -
2.	Understand energy resources, conversion and utilization.
3.	Apply principles of energy conservation and efficiency.
4.	Conduct basic energy audits and analyze energy performance.
5.	Evaluate techno-economic aspects of energy projects.
6.	Understand renewable energy integration and energy policies.

Total No. of Lectures – 42

S. No.	Course Contents	No. of Lectures
1	**Energy Resources and Sustainability** Energy concepts, forms and units, conventional and renewable energy resources, Indian and global energy scenario, energy demand and supply, sustainability, energy security, energy conversion and utilization.	**6**
2	**Energy Conservation and Industrial Utility Systems** Principles of energy conservation, energy efficiency in industrial systems, efficient lighting systems, electric motors and drives, HVAC systems, boilers and furnaces, steam systems, compressed air systems, pumps, fans and blowers, waste heat recovery techniques.	**8**
3	**Energy Auditing and Performance Assessment** Need and types of energy audits, walk-through and detailed energy audits, energy monitoring and targeting, data acquisition, measuring instruments, material and energy balance, benchmarking, Energy Performance Indicators (EnPIs), preparation of audit reports, industrial case studies.	**8**
4	**Energy Economics and Management Strategies** Electricity tariffs, demand-side management, load management, power factor improvement, energy costing, life-cycle costing, payback period, net present value (NPV), internal rate of return (IRR), cost-benefit analysis, financial appraisal and project evaluation.	**8**
5	**Unit 5** Renewable Energy Technologies and Emerging Energy Systems Solar photovoltaic and solar thermal systems, wind energy, biomass energy, hydrogen and fuel cells, energy storage technologies, smart grids, electric vehicles and charging infrastructure, net-zero energy buildings, AI and IoT applications in energy management.	**6**
6	**Industrial Safety, Energy Policies and Management Standards** Industrial safety principles, hazard identification and risk assessment, accident prevention techniques, fire safety, electrical safety, personal protective equipment	**6**

	(PPE), occupational health and safety, emergency preparedness and disaster management, Energy Conservation Act, Bureau of Energy Efficiency (BEE), ISO 50001 Energy Management Systems, Energy Conservation Building Code (ECBC), carbon footprint and sustainable industrial practices.	

Course Outcomes:	
1	Explain energy fundamentals and Indian energy scenario.
2	Analyze energy use in industrial utilities.
3	Conduct basic energy audits using measurements and EnPIs.
4	Evaluate energy-saving projects using economic tools.
5	Recommend renewable and smart energy solutions.
6	Apply BEE guidelines and ISO 50001 concepts.

Bibliography

Text Book:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Barney L. Capehart, Wayne C. Turner & William J. Kennedy/ *Guide to Energy Management*, 9th Edition, CRC Press.	2020
2	Wayne C. Turner & Steve Doty Energy Management Handbook, 9th Edition, Fairmont Press.	2020
3	Albert Thumann & Terry Niehus Handbook of Energy Audits, 9th Edition, CRC Press.	2021
4	S. C. Tripathy Utilization of Electrical Energy and Energy Conservation, McGraw-Hill Education.	2019

Reference Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	**Eastop & McConkey** *Applied Thermodynamics for Engineering Technologists*, Pearson.	1993
2	**John Twidell & Tony Weir** *Renewable Energy Resources*, Routledge.	2021
3	**C. P. Arora** *Refrigeration and Air Conditioning*, McGraw-Hill	2021

Equivalent MOOCs Courses

Course Links	**Offered by**
https://nptel.ac.in/courses/110105094?utm_source	**NPTEL**
https://nptel.ac.in/courses/103106071?utm_source	**NPTEL**
https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ge33	**Swayam**

CO–PO Mapping Matrix

	PO1	PO2	PO3	PO4
CO1	3	2	-	-
CO2	2	3	2	2
CO3	2	3	2	3
CO4	2	2	2	2
CO5	2	2	3	2
CO6	2	3	3	2

Course Title	**:**	**Advanced Human Resource Management**
Course Code	**:**	
Credits	**:**	**3**
L-T-P	**:**	**3-0-0**

Course Objective	
The main objectives of this course are:	
1	To develop an understanding of strategic Human Resource Management concepts and practices.
2	To familiarize students with competency-based HR systems, recruitment, and talent management.
3	To develop skills in performance management, compensation, and employee development.
4	To understand industrial relations, labour welfare, and career planning in organizations.
5	To introduce HR analytics, digital HR technologies, and emerging trends in Human Resource Management.

Total No. of Lecture: 42

S.No.	Course Contents	Hours
1	**Strategic Human Resource Management and Human Resource Planning:** Concepts and perspectives of HRM; Strategic role of HRM in competitive business environment; HR functions and responsibilities; Human Resource Planning (HRP): objectives, importance, process, forecasting techniques, Markov Analysis; Workforce planning and strategic alignment..	**7**
2	**Job Analysis, Recruitment and Talent Acquisition:** Job analysis, competency approach to job analysis, job description, job specification, role analysis; Recruitment: sources, methods, constraints and challenges; Selection process, interview techniques, onboarding; Talent acquisition and competency-based hiring.	**7**
3	**Competency Management and Performance Management Systems:** Competency concepts, Competency Iceberg Model, competency classification and measurement; Performance and Competency Management System (PCMS); Balanced Scorecard (BSC); Competency frameworks and competency mapping; Behaviourally Anchored Rating Scales (BARS); Performance planning and Key Performance Indicators (KPIs).	**7**
4	**Performance Appraisal, Assessment Centres and Employee Development:** Performance appraisal systems, performance review models, rating methods, common appraisal errors; Assessment centres: concepts, design, assessment matrix and techniques; Training and Development process, learning objectives, training methods, evaluation of training programmes; Career planning, career development and succession planning.	**7**
5	**Compensation, Industrial Relations and Employee Engagement:** Compensation planning, wage and salary administration, reward systems, incentive plans; Industrial Relations (IR), employee welfare, occupational health and safety, employee grievances, discipline, collective bargaining, trade unions and employer associations; Employee participation, empowerment and engagement.	**7**
6	**HR Analytics, Digital HR and Emerging Trends:** Performance analysis and	**7**

	improvement, root cause analysis, learning interventions and evaluation; HR Analytics and People Analytics; Human Resource Information Systems (HRIS); Artificial Intelligence in HRM; Future of work, digital transformation, sustainability in HRM, diversity and inclusion, contemporary HR practices and industrial case studies.	

Course Outcome	
1.	Explain strategic Human Resource Management concepts and workforce planning practices.
2.	Apply competency-based HR practices, recruitment, and talent management techniques.
3.	Evaluate performance management systems using competency mapping and Balanced Scorecard.
4.	Apply compensation, training, industrial relations, and career development practices.
5.	Analyze HR decisions using HR analytics, HRIS, AI, and emerging HR practices.

Bibliography

Text Book:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Gary Dessler, Human Resource Management, 16th ed., Pearson Education.	2020
2	Michael Armstrong, Armstrong's Handbook of Human Resource Management Practice, 15th ed., Kogan Page.	2020
3	Raymond A. Noe, John R. Hollenbeck, Barry Gerhart & Patrick M. Wright, Fundamentals of Human Resource Management, McGraw-Hill Education.	2022
4	Jeffrey A. Mello, Strategic Human Resource Management, 5th ed., Cengage Learning.	2018
5	K. Aswathappa, Human Resource Management: Text and Cases, McGraw-Hill Education.	2024

Reference Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	Brian E. Becker, Mark A. Huselid & Dave Ulrich, The HR Scorecard: Linking People, Strategy and Performance, Harvard Business School Press.	2001
2	Wayne F. Cascio & John W. Boudreau, Investing in People: Financial Impact of Human Resource Initiatives, FT Press.	2008
3	David G. Collings, Geoffrey T. Wood & Paula M. Caligiuri, The SAGE Handbook of Human Resource Management, SAGE Publications.	2024
4	Monir H. Tayeb, International Human Resource Management, Oxford University Press.	2005
5	Ulrich, D., HR from the Outside In: Six Competencies for the Future of Human Resources, McGraw-Hill.	2012

Equivalent MOOCs Courses	
Course Links	**Offered by**
https://onlinecourses.swayam2.ac.in/	**NPTEL**
https://nptel.ac.in/courses/103106071?utm_source	**Swayam**
https://onlinecourses.swayam2.ac.in/e-learning/preview/nou26_ge33	**NPTEL**
https://www.coursera.org/specializations/human-resource-management	**Corsera**
https://www.coursera.org/learn/strategic-hrm-talent-performance-compensation-design	**Corsera**
https://www.coursera.org/learn/people-analytics	**Corsera**

CO–PO Mapping Matrix

CO \ PO	**PO1**	**PO2**	**PO3**	**PO4**
CO1	2	3	2	1
CO2	3	3	2	1
CO3	3	3	3	2
CO4	3	2	3	1
CO5	3	3	2	3

Course Name	**:**	**Quality and Reliability Engineering**
Course Code	**:**	
Credits	**:**	**3**
LTP	**:**	**2-0-2**

Total No. of Lectures:28
Total No. of Lab hours :28

Course Objectives:	
The main objectives of this course are:	
1.	To understand the concept of variation and its impact on competitiveness.
2.	To develop competence in computing process capability.
3.	To develop competence in constructing control charts.

Course Contents:

Sr. No.	Course Contents	No. of Lectures
1.	**Introduction:** Quality control, application of statistics in quality control: Statistical Process Control, acceptance sampling, concept of variation, causes of variation: common cause and special cause of variation, natural control limits of process, stable vs. capable process, impact of variability in competitive environment, loss function: traditional loss function, Taguchi's loss function.	**5**
2.	**Control Charts for Variables:** $\bar{X}$–R charts, $\bar{X}$–S charts, Individual-Moving Range (IMR) charts, Exponentially Weighted Moving Average (EWMA) control charts, and **Control Charts for Attributes:** p-charts, np-charts, c-charts, and u-charts.	**6**
3.	**Process Capability Analysis:** Process capability indices: Cp, Cpk, Cpm; process performance analysis from short pre-production: Pp, Ppk; process capability for attribute data: DPU (defects per unit), DPMO (defects per million opportunities), RTY (Rolled Throughput Yield).	**5**
4	**Acceptance Sampling Plans:** Single, double, multiple, and sequential sampling plans for attributes, minimum inspection per lot, formulation of inspection lots and selection of samples, OC curve, Dodge–Romig tables, and Deming Kp rule.	**4**
5	**Reliability Engineering:** Relationship between reliability, maintainability, and availability; availability – operational, inherent, and achieved; MTBF and MTTR.	**4**
6	**System Reliability:** Basics of redundancy – standby redundancy systems, use of Reliability Block Diagrams, system with components in series, system with components in parallel, mixed system, K-out-of-N redundancy, fault tree construction and analysis, design for reliability: basic parameters, reliability allocation, redundancy, failure analysis.	**4**

Lab Work:

Sr. No.	Lab Contents	No. of Hours
Application of the following tools in real-life scenarios by selecting a process/machine from the institute or industry.		
1.	Process capability from pre-production run	2
2.	X-bar–R control chart	4
3	X bar and S and Moving range control chart	4
4	Process capability Analysis	2
5	P-chart/NP-chart	3
6	C-chart/U-chart	3
7	OC curve and Design of sampling plan	4
8	Failure density and Failure rate analysis	2

Course Outcomes:

After successful completion of the course, students will be able to	
1.	Evaluate process capability from pre-production runs as well as from a stable process.
2.	Analyze and evaluate DPMO and RTY for processes generating discrete quality data.
3.	Draw and understand control charts for variables as well as attribute data for different types of manufacturing processes and service activities.
4	Create/Design a Reliability model of sub components for a desired reliability of system

Bibliography:

Sr. No.	Book Detail	Year of Publication
1.	Statistical Quality Control by Eugene L. Grant, McGraw-Hill Series in Industrial Engineering and Management	2017
2.	Introduction to Statistical Quality Control by Douglas C. Montgomery, John Wiley &Sons	2016
3.	Fundamentals of Quality Control and Improvement; by Mitra, Amitava; Wiley	2013
4.	Automotive Industry Action Group (AIAG) manual of Statistical Process Control	2005

Equivalent MOOCs Courses	Offered By
https://nptel.ac.in/courses/127105234	NPTEL
https://onlinecourses.swayam2.ac.in/e-learning/preview/nou24_me03	Swayam
https://nptel.ac.in/courses/110105094?	NPTEL

CO–PO Mapping Matrix

	PO1	PO2	PO3	PO4
CO1	3	3	3	2
CO2	3	3	3	2
CO3	3	3	3	2
CO4	3	3	2	3

Course Name	**:**	**Materials and Maintenance Management**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives	
The main objectives of this course are:	
1.	To introduce students to the basic concepts of purchase and supply of materials for the production process in an industry.
2.	To expose students about the various policies, strategies and schedules of maintenance applicable to Industries.

Sr. No.	**Course contents**	**No. of Lectures**
1.	Introduction: Material Requirement Planning, Bills of materials, Capacity Management, Definition of capacity, capacity planning, Capacity requirement planning, capacity available and required.	**4**
2.	Scheduling orders, Data requirements, Order preparation, load levelling, Scheduling bottlenecks, production reporting and MIS.	4
3.	Purchasing fundamentals: Establishing specifications, selecting suppliers, price determination, demand management, demand forecasting, seasonality, tracking the forecast, inventory and flow of materials, supply and demand pattern, functions of inventories, ABC, VED and FSN system of selective inventory, EOQ, variation of EOQ models, period order quantity, quantity discount.	6
3.	Introduction to Maintenance management: Importance, Objectives, duties, functions and responsibilities of maintenance engineering department, Organization and structure of maintenance systems.	6
4.	Maintenance Policies and Planning: Maintenance strategies, advantages and disadvantages of each strategy, Planned maintenance procedure, advantage of planned maintenance, Scientific maintenance, Safety in maintenance.	5
5.	System Reliability: Quantitative estimation of reliability economies of introducing a standby unit into the production system, Optimum design configuration of a series/parallel system, Breakdown time distribution.	5
6.	Maintenance Activities: Optimal overhaul/repair or replacement policies for equipment subject to breakdown, Budgeting and control, Production maintenance integration.	4
7.	Economic models, Block replacement policy, age replacement policy, replacement policies to minimize downtime, Economics of preventive maintenance.	4
8.	Computer applications in materials and maintenance management, Management information system for maintenance and Case studies	4

Course Outcomes:	
At the end of the course, students will be able:	
1.	Understand the basic concepts and terminologies in materials and maintenance management.
2.	Identifying different Terminologies and types of Purchase Orders
3.	Develop techniques for Analyzing and evaluating the vendors.
4.	Distinguish the different types of maintenance and its implications.
5.	Evaluate and understand the costs incurred in materials and maintenance management

Bibliography:

Sr. No.	Book Detail	Year of Publication
1.	Arnold J. R. T. and Chapman S. N., "Introduction to Materials Management", 4th Edition, Pearson Education Asia. 2001	2001
2.	Dhillon B.S., "Engineering Maintenance: a Modern Approach". 1 edition, CRC.	2002
3.	Kelly A., "Maintenance Planning and Control", Butterworth-Heinemann. Ltd, London.	1983
4.	Materials Management: An Integrated Approach, P. Gopalakrishnan and M. Sundaresan, PHI.	2011

Suggested MOOC References	Offered By
https://nptel.ac.in/courses/127105234	**NPTEL**
https://nptel.ac.in/courses/110105755	**NPTEL**
https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_me13	**Swayam**

CO–PO Mapping Matrix

	PO1	PO2	PO3	PO4
CO1	3	3	1	1
CO2	3	3	2	1
CO3	3	3	2	2
CO4	3	3	3	1
CO5	3	3	3	2

Course Name	**:**	**Product Design and Development**
Course Code	**:**	
Credits	**:**	**3**
L-T-P	**:**	**3-0-0**

Course Objectives:
• To explore the concept of design in different contexts.
• To analyse the various design phases for product development.
• To develop the model for new product development and assessment of it through different conceptual approaches.
• To apply the concept of system level design for maintainability.

Total Number of Lectures: 42

S. No.	**Course Contents**	**Number of Lecture**
1	Introduction: Characteristics of successful product development, design and development of products, duration, and cost of product development, the challenges of product development. Development Processes and Organizations: Generic development process, concept development: the frontend process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization	9
2	Product planning: Product planning process, identify opportunities, evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process Identifying customer needs: Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.	9
3	Concept Generation: Activities of concept generation, need for systems level thinking, TRIZ and its comparison with brainstorming and lateral thinking, TRIZ tools Ideality and IFR, problem formulation and functional analysis, use of 40 principles to solve contradiction, use of S-curves and technology evolution trends. Concept selection: Overview of methodology, concept screening, and concept scoring, Pugh matrix and its application. Concept testing: Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process, Failure Mode Effect Analysis (DFMEA and PFMEA).	8
4	Product architecture: implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Industrial design: Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assessing the quality of industrial design. Design for X (DFX): Design for manufacturing: Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors, design for assembly, service and quality.	8
5	Prototyping: Prototyping basics, principles of prototyping, technologies, planning for prototypes Product development economics: Elements of economic analysis, base case financial mode, sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.	8

Course Outcomes:	
After the completion of this course, students should be able to:	
1.	Describe the characteristics used for product design and development.
2.	Assess the customer requirements in product design.
3.	Apply structural approach to concept generation, selection and testing.
	Identify various aspects of design such as industrial design, design for manufacture, assembly, service and quality and product architecture.
	Explain various principles and technologies used for the preparation of prototype.

Text Book:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	A K Chitale and R C Gupta, Product Design and Manufacturing, 6th Edition, PHI, New Delhi	2003
2	Karl. T. Ulrich and Steven D Eppinger Irwin, Product Design and Development, 5th Edition, McGraw-Hill	2011
Reference Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1	George E Deiter, Engineering Design, 5th Edition, McGraw-Hill	2012
2	Boothroyd G, Dewhurst P and Knight W, Product Design for Manufacture and Assembly, 2nd Edition, Marcel Dekker, New York	2002
3	G Altshuller, H Altov, Lev Shulyak, And Suddenly the Inventor Appeared: TRIZ, The theory of Inventive Problem Solving, Technical Innovation Centre, 2nd Edition	1996
4	Vladimir Petrov, Theory of Inventive Problem Solving, Level 1, Springer Series, ISBN: 978-3-030-04253-0.	2019
Equivalent MOOCs Courses		
Course Links		**Offered By**
https://nptel.ac.in/courses/112107217		**NPTEL**
https://nptel.ac.in/courses/112105316		**NPTEL**
https://nptel.ac.in/courses/112107258		**NPTEL**

CO–PO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	2	3	2	1
CO2	3	2	3	1
CO3	3	3	3	2
CO4	3	3	3	2
CO5	3	3	2	3

Course Name	**:**	**Industrial Waste Management**
Course Code	**:**	
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Course Objectives:	
Students will be able-	
1.	To introduce the sources, characteristics, and regulatory framework of industrial wastes.
2.	To develop an understanding of industrial wastewater, solid waste, and hazardous waste management techniques.
3.	To familiarize students with waste minimization, cleaner production, resource recovery, and circular economy principles.
4.	To impart knowledge of environmental management systems, environmental risk assessment, and sustainable waste management practices.
5.	To enable students to analyze and design sustainable industrial waste management strategies for various industrial sectors.

Total No. of Lectures – 42

S. No.	**Course Contents**	**No. of Lectures**
1	**Industrial Waste and Regulatory Framework:** *Industrial Waste:* Sources, classification and generation of industrial wastes (liquid, solid, hazardous and gaseous); waste characterization and sampling; industrial waste audit (input-output/material balance approach); pollution load assessment; environmental and human health impacts. *Regulatory Framework:* Environment (Protection) Act, 1986; Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention and Control of Pollution) Act, 1981; Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016; Plastic Waste Management Rules; E-Waste Management Rules; Biomedical Waste Management Rules (overview); role of CPCB and SPCBs; Extended Producer Responsibility (EPR); environmental clearance and consent mechanisms.	**08**
2	**Industrial Wastewater Management:** Characteristics of industrial wastewater (BOD, COD, TDS, TSS, TOC, heavy metals, oil & grease); wastewater sampling and analysis; equalization, neutralization and proportioning. *Physico-chemical Treatment:* Coagulation-flocculation, precipitation, adsorption, ion exchange. *Advanced Treatment:* Membrane processes (MF, UF, NF, RO), Advanced Oxidation Processes (AOPs), air stripping. *Biological Treatment:* Aerobic and anaerobic processes, activated sludge process, UASB reactors, sludge treatment and disposal. Zero Liquid Discharge (ZLD), industrial water reuse and recycling; case studies from textile, tannery, dairy, distillery, pulp & paper, pharmaceutical and electroplating industries.	**08**

3	**Industrial Solid and Hazardous Waste Management:** Classification of industrial solid and hazardous wastes; hazardous waste characteristics (ignitability, corrosivity, reactivity, toxicity); Toxicity Characteristic Leaching Procedure (TCLP); waste identification and coding. Collection, segregation, labelling, packaging, storage, transportation and manifest system. Treatment technologies: stabilization/solidification, chemical treatment, incineration, co-processing in cement kilns. Treatment, Storage and Disposal Facilities (TSDF): site selection, design principles and monitoring. Electronic waste (e-waste), plastic waste and battery waste: recycling technologies, environmental impacts and Extended Producer Responsibility (EPR).	**08**
4	**Waste Minimization, Cleaner Production and Resource Recovery:** Waste minimization hierarchy (5R: Refuse, Reduce, Reuse, Recycle, Recover); cleaner production; eco-efficiency; industrial ecology; industrial symbiosis; circular economy principles. Waste-to-energy technologies: incineration with energy recovery, pyrolysis, gasification, refuse-derived fuel (RDF), anaerobic digestion and biomethanation. Resource recovery from industrial wastes; recycling economics; carbon footprint reduction and sustainable industrial practices.	**09**
5	**Environmental Management, Risk Assessment and Case Studies:** Environmental Impact Assessment (EIA); Environmental Management Plan (EMP); ISO 14001 Environmental Management Systems (EMS); environmental auditing. Life Cycle Assessment (LCA); environmental risk assessment; carbon footprint and greenhouse gas emissions from industrial waste. Industry case studies: Iron & Steel, Thermal Power Plants (Fly Ash), Refineries, Fertilizer Industry, Textile Industry, Pharmaceutical Industry, Mining and Acid Mine Drainage Emerging contaminants (PFAS, pharmaceuticals, microplastics); Sustainable Development Goals (SDGs); Swachh Bharat Mission; Smart Cities Mission.	**09**

Course Outcomes:	
1	Explain the characteristics, classification, and regulatory framework of industrial wastes.
2	Apply appropriate treatment techniques for industrial wastewater, solid waste, and hazardous waste management.
3	Evaluate waste minimization, cleaner production, resource recovery, and waste-to-energy technologies for sustainable industrial practices.
4	Apply environmental management systems, life cycle assessment, and environmental risk assessment in industrial waste management.
5	Analyze industrial waste management problems and propose sustainable solutions using appropriate technologies and regulatory guidelines.

Text Book:		
Sr. No.	**NameofBook/Authors/Publisher**	**Year of Publication / Reprint**
1	Tchobanoglous G., Theisen H., Vigil S.A. Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill.	1993
2	Metcalf & Eddy Inc. (Tchobanoglous, Burton, Stensel). Wastewater	2002

	Engineering: Treatment and Reuse, 5th Ed., Tata McGraw-Hill	
3	Eckenfelder W.W. Industrial Water Pollution Control, 2nd Ed., McGraw Hill.	1999
Reference Books:		
Sr. No.	**Name of Book/Authors/Publisher**	**Year of Publication / Reprint**
1	Pichtel J. Waste Management Practices: Municipal, Hazardous, and Industrial, CRC Press.	2014
2	LaGrega M.D., Buckingham P.L., Evans J.C. — Hazardous Waste Management, 2nd Ed., McGraw Hill.	2010
3	Arceivala S.J., Asolekar S.R. Wastewater Treatment for Pollution Control and Reuse, 3rd Ed., Tata McGraw Hill.	2017

Equivalent MOOCs courses

Course Links	**Offered by**
Physico-Chemical Processes for Wastewater Treatment https://onlinecourses.nptel.ac.in/noc26_ch50	**(NPTEL / SWAYAM)**
Biological Process Design for Wastewater Treatment https://nptel.ac.in/courses/103107217	**(NPTEL / SWAYAM)**

CO–PO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	2	3	2	1
CO2	3	3	3	2
CO3	3	3	3	2
CO4	3	3	3	3
CO5	3	3	3	3

Course Name	**:**	**SPECIALTOPICSININDUSTRIAL ENGINEERING**
Course Code	**:**	
Credits	**:**	**3**
LTP	**:**	**3-0-0**

Course Objectives:	
1	The objective of the subject is to introduce the concepts of business process, Six Sigma, Reverse Engineering, 6 sigma, Lean and Agile manufacturing
2	The objective of the subject is to make students learn and apply the various concepts of Six Sigma, Reverse Engineering, Lean Manufacturing, and Agile Manufacturing.

Total Number of Lectures–42

S. No.	**Course Content**	**Number of Lectures**
1.	**Business Process:** Introduction, Study of Various Business Tools, Methodologies, Strategies and Decision Making Through Case Studies of Different Business Organizations and Projects, Business Process Re-engineering	**4**
2.	**Six Sigma:** Basic Concepts In Quality Management, TQM, Cost of Quality, Quality Engineering and Six Sigma, Review of Probability and Statistics, Test of Hypothesis, DMAIC Process for Process and Design Improvement, Acceptance Sampling, SPC (Statistical Process Control), Process Capability, Gape Reproducibility and Repeatability Quality Function Deployment	**5**
3.	Just in time Inventory strategy, KANBAN Cards,5S AND 5P Continuous Improvement tools, Learning Curve time vs Cost, case studies: manufacturing and service industries of these tools	**4**
4	**Concurrent Engineering:** Sequential vs. Concurrent Engineering: Linear product development processes versus integrated, parallel development. Need and Benefits: Reduced time-to-market, cost savings, improved product quality, and enhanced corporate competitiveness. The 7 T's of CE: Teamwork, talents, tools, time, techniques, tasks, and total quality	**4**
6.	**Lean Manufacturing and its Concepts:** Objectives Of Lean Manufacturing, Key Principles and Implications of Lean Manufacturing, Traditional Vs Lean Manufacturing**,** Value Creation and Waste Elimination-Main Kinds of Waste, Pull Production- Different Models of Pull Production, Continuous Flow-Continuous Improvement, Kaizen-WorkerInvolvement-CellularLayout-Administrative Lean, Toyota Production System	**5**
7.	**Agile Manufacturing:** Definition, Business Need, Conceptual Framework, Characteristics, Generic Features, CAPPF or Agile Manufacturing, Aggregate Capacity Planning and Production Line Design/Redesign in Agile Manufacturing., Cellular Manufacturing, Concepts, Examples, Robust Design Approach, Approaches to Enhance Agility in Manufacturing, Role Of QFD, Managing People in Agile Organization, Approaches, Applications of Multimedia to Improve Agility in Manufacturing	**5**
8.	**Cellular and Flexible Manufacturing Systems:** Part Families, Parts Classification and Coding, Production Flow Analysis. Cellular Manufacturing, Applications Of Group Technology, Concept Of FMS and basic components of an FMS. Flexibility Types**:** Machine flexibility, routing flexibility, product flexibility, and volume flexibility. FMS Planning And Applications, Material Handling for FMS, AGVS, Automated Storage System	**6**
9	**REVERSE ENGINEERING** Introduction, scope and tasks of Reverse Engineering, process of duplicating,	4

	definition and use of Reverse Engineering, Reverse Engineering as a generic process.	
10.	**Concepts and approaches of value analysis and engineering:** Concept of value, maximum value, normal degree of value, importance of value, value-oriented work, use of value resources, value work expands market and jobs, approach to prepare the mind for the value analysis techniques.	**5**

Course Outcomes:	
1	Learn and apply the concepts, Six Sigma, Flexibility, and Agility in manufacturing industries
2	Understand and apply the concept of Reverse Engineering in manufacturing and design
3	Evaluate and analyses the value of a product and system
4	Analyze and apply lean manufacturing tools in manufacturing industries
5	Understand and design/select various cells and AGVs for Group Technology and FMS
6	Understand and apply the concept of Concurrent Engineering in manufacturing

Bibliography:

S. No.	**Name of Book/Authors/Publisher**	**Year of Publication**
1	*Toyota Production System*, Ohno Taiichi, McGraw-Hill	2001
2	*Reverse Engineering*, Katheryn A. Ingle, McGraw-Hill	1994
3	*Data Reverse Engineering*, Peter Aiken, McGraw-Hill	1996
4	*An Introduction to Six Sigma and Process Improvement*, James R. Evans and William M. Lindsay, Cengage	2005
5	*Value Analysis Tear-Down: A New Process for Product Development and Innovation*, Yashihiko Sato, Industrial Press	2004
6	*Automation, Production Systems, and CIM*, Mikell P. Groover, Prentice Hall	2007

Equivalent MOOCs courses	
Course Links	**Offered By**
https://nptel.ac.in/courses/110105039	**NPTEL**
https://nptel.ac.in/courses/110105088	**NPTEL**

CO–PO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	2	3	2	2
CO2	2	2	2	2
CO3	2	1	2	2
CO4	2	2	2	1
CO5	2	2	2	2
CO6	2	2	2	1

Course Name	**:**	**Industrial Internet of things (IIoT)**
Course Code	**:**	
Credits	**:**	**3**
L-T-P	**:**	**3-0-0**

Course Objective	
1 .	Develop an advanced understanding of Industry 4.0 concepts, Industrial Internet of Things (IIOT), Cyber-Physical Systems (CPS), and smart manufacturing technologies.
2 .	Enable students to design and analyse secure, scalable, and intelligent IIOT systems using industrial communication protocols, edge-cloud computing, and data analytics.
3 .	To equip students with the knowledge to apply Artificial Intelligence, Digital Twin, and cybersecurity techniques for industrial automation, predictive maintenance, and digital transformation.

Total Number of Lectures -42

S. No.	**Course Contents**	**Number of Lecture**
1	**Industry 4.0 Foundations and Digital Manufacturing** Industrial Revolutions; Smart Factory Architecture; Industry 4.0 Design Principles; Cyber-Physical Systems (CPS); Reference Architectures (RAMI 4.0, IIRA); Industrial Digital Transformation; Smart Manufacturing; Mass Customization; Industrial Value Chain Digitization; Global Industry 4.0 Initiatives (Germany, USA, China, Japan, India).	6
2	**Industrial Internet of Things (IIOT)** IIOT Architecture; Industrial Sensors and Smart Devices; Industrial Data Acquisition; Edge, Fog and Cloud Computing; Industrial Gateways; MQTT, OPC-UA, DDS, AMQP, CoAP; Industrial Wireless Networks; Industrial IoT Platforms; Industrial Data Management and Time-Series Databases	8
3	**Industrial Communication and Automation Systems** Industrial Ethernet; Modbus TCP/IP; PROFINET; EtherCAT; CAN Bus; HART; Wireless HART; ISA100.11a; SCADA Systems; PLC Integration; Distributed Control Systems (DCS); Human Machine Interface (HMI); Industrial Networking Design and Performance Evaluation.	7
4	**Industrial Analytics and Artificial Intelligence** Industrial Big Data Analytics; Predictive Maintenance; Machine Learning for Manufacturing; Anomaly Detection; Process Optimization; Digital Twin Modeling; Industrial Simulation; AI-enabled Decision Support Systems; Explainable AI in Manufacturing; Industrial Case Studies	7
5	**Industrial Cybersecurity and System Integration** Industrial Cybersecurity Frameworks (IEC 62443, NIST); Secure IIOT Architecture; Authentication and Access Control; Blockchain in Industrial Systems; Secure Firmware Updates; Industrial Risk Assessment; Safety and Reliability; Functional Safety; Interoperability Standards; Industrial Middleware.	8
6	**Emerging Trends and Industrial Applications** Autonomous Manufacturing; Industrial Robotics Integration; Additive Manufacturing; Digital Twin Applications; Sustainable Manufacturing; Industry 5.0; Research Challenges; Industrial Case Studies and Recent Advances.	6

Course Outcome

After the completion of this course, students should be able to:	
1.	Analyse the architecture, technologies, and enabling frameworks of Industry 4.0 and Industrial Internet of Things (IIOT).
2.	Design and evaluate IIOT-based industrial systems using industrial communication protocols, edge computing, and cloud platforms.
3.	Apply AI, machine learning, and digital twin technologies for predictive maintenance, process optimization, and intelligent manufacturing.
4.	Assess cybersecurity challenges and implement secure, reliable, and interoperable Industrial IoT solutions using international standards.
5.	Evaluate emerging trends such as Industry 5.0, sustainable manufacturing, and intelligent industrial automation to solve complex engineering problems and support research and innovation.

Bibliography:

Text Books		
S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1.	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", Apress, by Alasdair Gilchrist	2017
2.	A. Bahga and V. Madisetti, Internet of Things, A hands-on approach, CreateSpace Independent Publishing Platform, 1st edition, ISBN: 9780996025515.	2014
3.	T. Erl, Z. Mahmood, and R. Puttini, Cloud Computing: Concepts, Technology & Architecture, Prentice Hall, 1st edition, ISBN: 9780133387520.	2013
4.	The Fourth Industrial Revolution, Portfolio Penguinby Klaus Schwab	2017

Equivalent MOOCs Courses

Course Links	**Offered by**
https://www.coursera.org/learn/introduction-to-internet-of-things	Coursera
https://nptel.ac.in/courses/106105166	NPTEL
https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_cs69	SWAYAM

CO–PO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	2	3	2	2
CO2	3	3	3	2
CO3	3	3	3	3
CO4	3	3	2	3
CO5	3	3	3	3

Course Name	**:**	**Design of Additive manufacturing**
Course Code	**:**	
Credits	**:**	**3**
L-T-P	**:**	**3-0-0**

Course Objective	
1 .	To learn the concept of designing in additive manufacturing
2 .	Understand the design of complex architecture with their feasibility in additive manufacturing.
3 .	Understand algorithms of the slicing for fabrication of the desired component with intended features.
4.	Understand the concept of topological optimization in 3D printing

Total Number of Lectures: 42

S.No.	**Course Contents**	**Number of Lecture**
1	Additive Manufacturing (AM); Fundamentals of Additive Manufacturing; Additive Manufacturing Process chain; Application levels of additive manufacturing; Benefits enabled by additive manufacturing; Current areas of additive manufacturing. Classification of additive manufacturing processes, Common additive manufacturing technologies; Fused Deposition Modeling (FDM), Selective Laser Sintering (SLS), Stereo Lithography (SLA), Selection Laser Melting (SLM), Jetting, 3D Printing, Laser Engineering Net Shaping (LENS), Laminated Object Manufacturing (LOM), Electron Beam Melting (EBM). Overview of design for Additive Manufacturing (DFAM); Motivation; Potential of additive Manufacturing on Design; Generalizable DFAM strategies; Different design strategies of AM.	**9**
2	Design for Manufacturing and Assembly; Core DFAM Concepts and Objectives: Complex Geometry, Customized Geometry, Integrated Assemblies, Elimination of Conventional DFM Constraints; AM Unique Capabilities: Shape Complexity, Hierarchical Complexity, Functional Complexity, Material Complexity; Exploring Design Freedoms: Part Consolidation and Redesign, Hierarchical Structures, Industrial Design Applications.	**9**
3	Topology optimization for AM; Motivation towards topology optimization for AM design; Topology optimization methods; Opportunities for Topological Optimization applied to AM; Parametric optimization; Topology optimization and generative design; Steps for topological optimization in AM; Case study	**8**
4	Advanced Design for Additive Manufacturing; 3D CAD slicing; Unidirection slicing; Multidirection slicing; 2D path planning; Raster path; Zigzag path; Contour path; Spiral path; Hybrid path; Continuous path; Hybrid and continuous path; Medial axis transformation (MAT) path; Adaptive MAT path	**8**
5	Design Analysis and Optimisation: Aims of Using Design Analysis for AM; Special Considerations for Analysis of AM Parts; Mesh; Boundary Conditions; Optimisation; Topology Optimisation; Parametric or Size Optimisation; Build Process Simulation. Guidelines for AM Design: AM Tooling Design; Design for Polymer AM; Design for Metal AM	**8**

Course Outcome

After the completion of this course, students should be able to:	
1	Explain the fundamentals, process chain, classifications, technologies, applications, and design concepts of Additive Manufacturing (AM).
2	Apply Design for Additive Manufacturing (DFAM) principles to develop innovative and manufacturable product designs.
3	Analyze and implement topology optimization, parametric optimization, and generative design techniques for AM components.
4	Develop appropriate slicing strategies and tool-path planning methods for efficient additive manufacturing.
5	Evaluate and optimize AM designs using design analysis, build process simulation, and material-specific design guidelines.

Bibliography:

Text Books		
S. No.	**Name of Book/Authors/Publisher**	**Year of Publication**
1	Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer	2010.
2	Martin Leary, "Design for Additive Manufacturing", Springer	2019.
3	Olaf Diegel, Axel Nordin, Damien Motte, "A Practical Guide to Design for Additive Manufacturing", Springer	2020.
4	Igor Shishkovsky, "New Trends in 3D Printing", Intech Open	2016.

Reference Books		
S. No.	**Name of Book/Authors/Publisher**	**Year of Publication**
1.	Amit Bandyopadhyay, Susmita Bose, "Additive Manufacturing: Second Edition", Taylor & Francis, CRC Press	**2019**
2.	Neil Hopkinson, Richard Hague, Philip Dickens, "Rapid manufacturing-an industrial revolution for the digital age", Wiley	**2006**
Equivalent MOOCs Courses		
Course Links		**Offered By**
https://nptel.ac.in/courses/112103306?utm		**NPTEL**
https://nptel.ac.in/courses/112101005?utm		**NPTEL**
https://nptel.ac.in/courses/112101005?utm		**NPTEL**

CO–PO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	2	3	2	1
CO2	3	3	3	2
CO3	3	3	3	3
CO4	3	3	3	2
CO5	3	3	3	3

Course Name	**:**	**Project Management**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Total No. of Lectures: 28
Total No. of Lab Hours: 28

Course Objectives	
The main objectives of this course are:	
1.	Teach students to create detailed project plans and schedules, utilizing tools like Gantt charts, Critical Path Method (CPM), and Program Evaluation and Review Technique (PERT) to manage project timelines and resources effectively.
2.	Enable students to manage project scope, budget, and quality, focusing on tools and techniques to monitor and control project costs, ensure quality standards, and deliver projects that meet stakeholder expectations.

Course Contents:

Sr. No.	**Course contents**	**No. of Lectures**
1.	Introduction: Foundations of Project Management, Project Life Cycle, The Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure.	4
2.	Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modelling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations, PERT/COST Accounting.	6
3.	Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT.	6
4.	Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress	4
5.	Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress	4
6.	Project Appraisal and Selection, Recent Trends in Project Management	4

Sr. No.	**Lab Exercises**	**Hours**
1.	Exercise and Case studies on Gantt chart	**4**
2.	Exercise on Scheduling	**4**
3.	Exercise on Project Life cycle process	**4**
4.	Exercise on Project costing	**4**
5.	Exercise on PERT	**4**
6.	Exercise on CPM	**4**

7.	Recent trends and case studies on applications of Project Management	**4**

Course Outcomes	
At the end of the course, students will be able:	
1.	Develop and manage project schedules using techniques like Gantt charts, Critical Path Method (CPM), and Program Evaluation and Review Technique (PERT), ensuring efficient time management and resource allocation.
2.	Demonstrate the ability to define project scope, control costs, and maintain quality standards, ensuring projects meet requirements within the allocated budget and timeline.
3.	Gain skills in identifying, analyzing, and mitigating project risks, allowing for proactive risk management and improved project outcomes.
4.	Develop the ability to communicate project progress, issues, and requirements effectively with stakeholders, ensuring alignment and collaboration throughout the project lifecycle.
5.	Learn to assess project performance using key performance indicators (KPIs), such as budget variance, schedule variance, and earned value analysis, to ensure project goals are achieved.

Bibliography:

Text Books		
Sr. No.	**Book Detail**	**Year of Publication**
1.	Projects: Planning, Analysis, Selection, Implementation & Review, Prasanna Chandra, 5th Edition	**2002**
2.	Project Management: A systems approach to planning and controlling, Harold Kerzner, CBS Publisher, New Delhi, 2nd Ed.	**2000**

Equivalent MOOCs Courses	
Course Links	**Offered By**
https://nptel.ac.in/courses/112103306?utm	**NPTEL**
https://nptel.ac.in/courses/112101005?utm	**NPTEL**
https://nptel.ac.in/courses/112101005?utm	**NPTEL**

CO–PO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	3	3	3	1
CO2	3	3	3	2
CO3	3	3	2	2
CO4	3	2	2	1
CO5	3	3	3	2

Course Name	**:**	**Applied Multivariate Statistical Modelling**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Total No. of Lectures– 42

Course Objectives	
The main Objectives of this course are:	
1.	Develop a strong understanding of multivariate statistical concepts and their applications in engineering, science, and research.
2.	Apply multivariate statistical techniques to analyze complex datasets involving multiple variables.
3.	Select appropriate multivariate methods for solving real-world problems and support data-driven decision-making.

S. No.	**Course contents**	**No. of lectures**
1	Definitions and basic concepts of multivariate modelling – variate, type of variables, measurement scale, measurement error, multivariate measurement; types of multivariate techniques, classification of multivariate techniques, guidelines for multivariate analysis, structured approach to multivariate model building, and cases for multivariate modelling.	**04**
2	Multivariate basics – multivariate descriptive statistics, statistical distance, multivariate normal distribution and its properties, examining data and outliers' detection, and multivariate sampling distributions. Comparison of several multivariate means paired comparisons.	**04**
3	ANOVA: Basic concepts, Gauss Markov theorem, one-way classification, comparison of more than two means, statistical model and analysis for one-way layout, two-way classification, statistical model and analysis for two-way layout, analysis of variance using linear models.	**06**
4	Test for significant overall regression, Partial F and Multiple F Tests, Partial and Multiple correlation and their relationship with Multivariate Normal Distribution	**04**
5	Confounding and Interaction in Regression, Regression diagnostics, Residual analysis, Collinearity.	**04**
6	Polynomial Regression: second and higher order models their fitting and testing, Lac-of-fit Tests, Orthogonal Polynomials, Strategies for choosing polynomial model problems. Selecting the Best Regression Equation.	**06**

Course Outcomes:

By the end of the course, the students will be able to:	
1.	Aanalyze and interpret multivariate data sets, understanding the relationships between multiple variables and their implications for research and decision-making.
2.	Apply ANOVA, including one-way and two-way classification and linear models, to analyze experimental data and compare group means.
3.	Develop and validate multivariate statistical models for prediction, classification, clustering, and dimensionality reduction.

4.	Understand and assess the underlying assumptions of multivariate statistical models, ensuring the validity and reliability of the analyses performed.
5	Apply multivariate statistical techniques to solve real-world problems across various fields, including marketing, psychology, health sciences, and finance
6	Evaluate and select suitable multivariate modeling techniques to solve real-world engineering and research problems.

Bibliography

S. No	**Name of Book/Authors/Publisher**	**Year of Publication/Reprint**
1.	Multivariate statistical modeling in engineering and management by Jhareswar Maiti, First Edition, CRC Press, 6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487- 2742, 2023 (e-print August 2022)	2023
2.	Kleinbaun, D.G., Kupper, L.L., Muller, K.E. and Nizam, A.: Applied Regression Analysis and other Multivariable Methods, 3rd edition, Duxbury Press CA	2012
3.	Multivariate data analysis by Joseph F. Hair Jr, Rolph E. Anderson, Ronald L Tatham, and William C. Black, Fifth Edition, Pearson Education	1998
4.	Anderson, T. W : An Introduction to Multivariate Statistical Analysis, 3rd Edition, John Wiley & Sons.	2003
5.	Analyzing multivariate data by James Latin, J Dooglas Carrol and Paul E Green, Cengage Learning India Pvt. Ltd	2003

Equivalent MOOCs courses:

Course Links	**Offered by**
https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ma34	(NPTEL/SWAYAM)
http://digimat.in/nptel/courses/video/110105060/L08.html	(NPTEL/SWAYAM)

CO–PO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	3	3	2	3
CO2	3	3	2	3
CO3	3	3	2	3
CO4	2	3	2	3
CO5	3	3	2	3
CO6	3	3	3	3

Course Name	**:**	**Technology Management**
Course Code	**:**	
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives:	
1.	To describe the evolution in the technology management.
2.	To contribute along with inputs for facing the changing technology.
3.	To support the overall business strategy and provide a roadmap for technology-related decisions and investments.
4.	To assess the current state of technology, identifying gaps and opportunities, and formulating a plan to acquire, develop, deploy, and manage technology resources to create competitive advantage and value for the organization.
5.	To learn the concept of performance management measures and evaluate the performance of technology resources, assets, and services in alignment with the organization's objectives.

Total No. of Lectures–42

S. No.	**Course Contents**	**No. of Lectures**
1	**Technology Management:** Issues and applications, concepts of technology; role and importance of technology management, dimensions of technology management, technology management in India.	**5**
2	**Technology Change:** Nature of technology change, motivation for technology change. invention and innovation, technology life cycle, technology monitoring	**5**
3	**Technology Forecasting:** Objectives and approaches, methodology of technological forecasting, Delphin Technique, growth curves, morphological analysis technological discontinuities, Indian Technology Vision 2020.	**5**
4	**Management of R & D:** Corporate strategy, selection of R & D projects, managing R & D, radical and cyclic innovation processes. technology strategy and innovation	**5**
5	**Technology Absorption and Diffusion:** Technology dependence, concepts in technology absorption, constraints in technology absorption. management of technology absorption, technology absorption and adaptation scheme (TAAS), concept of diffusion of technology, perspective on diffusion, developing diffusion strategies	**5**
6	**Technology Transfer:** Models of technology transfer, technology transfer modes, dimensions of technology transfer, dimensions of technology transfer, pricing of technology government policies of technology transfer.	**5**
7	**Role of Intellectual Property Rights:** Nature of IPR, patent, trademark and copy rights legal aspects	**3**
8	**Managing Process Technology:** Continuous improvement Technology Integration, Product and Process Technology, Techniques of Improvement, Economics If Improvement.	**4**

9	**Technology as a Competitive Strategy:** Competitive analysis, core competitive competencies, technology leadership, adoption of new technology, marketing of new technology. case studies on technology management.	**5**

Course Outcomes:	
1	**Remember** the advanced concepts, theories, frameworks, and emerging trends in technology management, innovation, and digital transformation.
2	**Understand** the principles of technology forecasting, research and development management, technology commercialization, intellectual property management, and strategic technology planning.
3	**Apply** advanced technology management tools, analytical techniques, and decision-making frameworks to solve complex industrial, technological, and organizational problems.
4	**Evaluate** emerging technologies, innovation strategies, technology transfer mechanisms, and technology investment decisions to enhance organizational competitiveness and sustainable development.
5	**Develop** strategic technology management solutions, innovation roadmaps, and technology commercialization plans through research, critical analysis, and multidisciplinary approaches to address real-world engineering and management challenges.

Bibliography

Text Book

Sr. No.	**Name of Book/Authors/ Publisher**	**Year of Publication**
1.	"Strategic Technology Management", Frederick Betz, McGraw Hill	2009
2.	Technology, Innovation, and Educational Change: A Global Perspective", Robert B. Kozma, Lawrence Erlbaum Associates, Inc.	2003
3.	"Total Quality Management for Engineers", M Zaire, Woodhead Publishing Ltd.	2015

Reference Books

Sr. No.	**Name of Book/Authors/Publisher**	**Year of Publication**
1	"The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail" by Clayton M. Christensen, Harvard Business Review Press	2017
2	"Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers" by Geoffrey A. Moore , Harper Business	1991

Equivalent MOOCs courses

Course Links	**Offered by**
https://nptel.ac.in/courses/110106157	NPTEL
https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_de20	SWAYAM

CO–PO Mapping Matrix

	PO1	PO2	PO3	PO4
CO1	2	3	2	2
CO2	3	3	2	2
CO3	3	3	3	2
CO4	3	3	3	3
CO5	3	3	3	3

Course Title	**:**	**Design Thinking and Innovation Management**
Course Code	**:**	
Credits	**:**	3
L-T-P	**:**	3-0-0

Course Objective	
The main objectives of this course are:	
1	To develop an understanding of design thinking and innovation management concepts.
2	To familiarize students with innovation processes, idea management, and business model innovation.
3	To develop skills in technology management, research and development, and commercialization.
4	To understand intellectual property rights, innovation ecosystems, and strategic alliances.
5	To apply innovation and design thinking tools for solving industrial and entrepreneurial problems.

Total No. of Lecture: 42

S. No.	**Course Contents**	**Hours**
1	**Introduction to Design Thinking and Innovation:** concepts, innovation process, types of innovation, entrepreneurship, technology and startups.	7
2	**Innovation Models and Idea Management:** open innovation, design thinking, idea management, divergent/convergent thinking, prototyping and incubation.	7
3	**Managing Innovation and Business Models:** innovation life cycle, business model innovation, commercialization.	7
4	**Technology & R&D Management:** technology forecasting, transfer, R&D management, strategic alliances and innovation networks.	7
5	**Innovation Strategy & IPR:** innovation planning, marketing, patents, copyrights and IPR in India.	7
6	**Innovation Ecosystem:** Startup India, National Innovation Fund, AI-enabled innovation, sustainability and case studies.	7

Course Outcomes	
CO1	Explain design thinking, innovation processes and innovation models.
CO2	Apply idea management and design thinking tools.
CO3	Analyze business model innovation and technology management.
CO4	Apply innovation strategies, R&D management and IPR concepts.
CO5	Evaluate innovation ecosystems and entrepreneurship initiatives.

Bibliography

Text Book

Sr. No.	**Name of Book/Authors/ Publisher**	**Year of Publication**
1	Joe Tidd & John R. Bessant, Managing Innovation: Integrating Technological, Market and Organizational Change, 7th ed., Wiley	2021
2	Vijay Kumar, 101 Design Methods: A Structured Approach for Driving Innovation in Your Organization, Wiley	2013

3	Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, Revised & Updated ed., Harper Business	2019
4	Allan Afuah, Innovation Management: Strategies, Implementation and Profits, 2nd ed., Oxford University Press	2003
5	Joe Tidd & John R. Bessant, Strategic Innovation Management, 2nd ed., Wiley	2020

Reference Books

Sr. No.	**Name of Book/Authors/Publisher**	**Year of Publication**
1.	Henry Chesbrough, Open Innovation: The New Imperative for Creating and Profiting from Technology, Harvard Business School Press	2003
2.	Eric Ries, The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Crown Business	2011
3.	Alexander Osterwalder & Yves Pigneur, Business Model Generation, Wiley	2010
4.	Peter F. Drucker, Innovation and Entrepreneurship, Harper Business	2006
5.	Clayton M. Christensen, The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail, Harper Business	2016
6.	World Intellectual Property Organization (WIPO), Understanding Industrial Property, WIPO Publications	2016

Suggested MOOC References

Course Links	**Offered By**
Innovation, Business Models and Entrepreneurship: IIT Roorkee, NPTEL (https://nptel.ac.in/)	NPTEL
Design Thinking – A Primer: NPTEL/SWAYAM (https://onlinecourses.swayam2.ac.in/)	NPTEL
Technology and Innovation Management: IIT Kharagpur, NPTEL (https://nptel.ac.in/)	NPTEL
Design Thinking for Innovation: University of Virginia, Coursera.	Coursera.
Innovation Management: Erasmus University Rotterdam, Coursera.	Coursera.

CO–PO Mapping Matrix

	PO1	**PO2**	**PO3**	**PO4**
CO1	2	3	2	2
CO2	3	3	3	2
CO3	3	3	2	3
CO4	3	3	2	3
CO5	3	3	3	3