2024-25

CURRICULUM FRAMEWORK FOR PG PROGRAMMES

NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI

VISION OF THE INSTITUTE

- To be a university globally trusted for technical excellence where learning and research integrate to sustain society and industry.

MISSION OF THE INSTITUTE

- To offer undergraduate, postgraduate, doctoral and modular programmes in multi-disciplinary / inter-disciplinary and emerging areas.
- To create a converging learning environment to serve a dynamically evolving society.
- To promote innovation for sustainable solutions by forging global collaborations with academia and industry in cutting-edge research.
- To be an intellectual ecosystem where human capabilities can develop holistically.

VISION OF THE DEPARTMENT

- To establish a world class academy for Manufacturing and Industrial Engineering.

MISSION OF THE DEPARTMENT

- Curriculum development with state-of-the-art technologies.
- Pursue research interests of manufacturing and industrial engineering.
- Consultancy in design, manufacturing and industrial engineering.
- Industry-Institute interaction.
- Equipping Laboratories with state-of-the-art equipment.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1	Graduates of the programme will be capable of integrating Engineering fundamentals and advanced Industrial Engineering concepts.
PEO2	Graduates of the programme will be professionally competent for gainful employment in Industrial Engineering and Management functions and sustain future challenges.

PROGRAMME OUTCOMES (POs)

PO1	An ability to independently carry out research /investigation and development work to solve practical problems in contemporary Industrial Engineering and Management topics.
PO2	An ability to write and present a substantial technical report/document on the investigations and solutions developed for the practical problems.
PO3	Students should be able to demonstrate a degree of mastery in Industrial Engineering and Management.

CURRICULUM

SEMESTER I

Code	Course of Study	Credit
PR651	Data Analytics	4
PR652	Modeling ,Simulation and Analysis	4
PR653	Analysis and Control of Manufacturing Systems	4
---	Programme Elective I	3
---	Programme Elective II	3
---	Programme Elective III / Online (NPTEL)	3
PR657	Data Analytics Lab	2
PR658	Simulation Lab	2
		25

SEMESTER II

Code	Course of Study	Credit
PR654	Advanced Operations Research	4
PR655	Project Management	4
PR656	Supply Chain Management	4
---	Programme Elective IV	3
---	Programme Elective V	3
---	Programme Elective VI / Online (NPTEL)	3
PR659	Supply Chain Management Lab.	2
		23

SUMMER TERM (evaluation in the III semester)

Code	Course of Study	Credit
PR660	Internship / Industrial Training / Academic Attachment (I/A) (6 weeks to 8 weeks)	2

SEMESTER III

Code	Course of Study	Credit
PR690	Project Work-Phase I	12

SEMESTER IV

Code	Course of Study	Credit
PR691	Project Work-Phase II	12

OPEN ELECTIVES (OE) / ONLINE COURSE* (OC) (To be completed between I to IV semester)

Sl. No.	Code	Course of Study	Credit
1.	---	Elective VII (OE / OC)	3
2.	---	Eletive VIII (OE / OC)	3

*Online courses shall be dynamically updated based on the students request and due approval through circulation.

PROGRAMME ELECTIVES (PE)

Sl. No.	Code	Course of Study	Credit
INDUSTRIAL ENGINEERING STREAM			
1	PR661	Industrial Engineering Economic Analysis	3
2	PR662	Intelligent Manufacturing Systems	3
3	PR663	Research Methodology	3
4	PR664	Design and Analysis of Experiments	3
5	PR665	Lean and Agile Manufacturing	3
6	PR666	Facilities Planning and Design	3
7	PR667	Production Management Systems	3
8	PR668	Industry 4.0 and Cloud Manufacturing	3
9	PR669	Work Design and Ergonomics	3
10	PR670	Sustainable Manufacturing	3
11	PR671	Quality & Reliability Engineering	3
12	PR672	Value Engineering	3
13	PR673	Cost Measurement and Productivity Measurement	3
MANAGEMENT STREAM			
1	PR674	Industrial Engineering and Productivity Management	3
2	PR675	Financial Management	3
3	PR676	Marketing Management	3
4	PR677	Total Quality Management & Six Sigma	3
5	PR678	Human Resource Management	3
6	PR679	Product Life Cycle Management	3
7	PR680	Technology Management	3
8	PR681	Advanced Optimization Techniques	3
9	PR682	Product Design and Development	3
10	PR683	E-waste Assessment and Management	3
INDUSTRIAL INFORMATION SYSTEM STREAM			

1	PR684	Enterprise Resource Planning	3
2	PR685	Decision Support Systems	3
3	PR686	Knowledge Management	3
4	PR687	Multi-Criteria Decision Making Techniques	3
5	PR688	Intelligent Industrial Systems	3
6	PR689	Human Machine Interaction for Manufacturing	3

OPEN ELECTIVES (OE) (List some courses from Programme Electives, that will be Open Electives for other Specialization, if it is offered as Programme Elective for the respective specialization)

Sl. No.	Code	Course of Study	Credit
1.	PR669	Work Design and Ergonomics	3
2.	PR670	Sustainable Manufacturing	3
3.	PR675	Financial Management	3
4.	PR680	Technology Management	3
5.	PR682	Product Design and Development	3
6.	PR684	Enterprise Resource Planning	3

MICROCREDITS (MC) (Students can opt 3 courses of 1 credit (4 weeks) each as microcredits instead of 1 OE/OC)

Sl. No.	Code	Course of Study	Credit
1.	Microcredits courses shall be dynamically updated based on the students request and due approval through circulation.		

M.Tech. (Industrial Engineering & Management) *Min. Total Credits required: 80*

CODE	Semester 1	L	T	P	C	CODE	Semester 2	L	T	P	C
PR651	Data Analytics	3	1	0	4	PR654	Advanced Operations Research	3	1	0	4
PR652	Modeling ,Simulation and Analysis	3	1	0	4	PR655	Project Management	3	1	0	4
PR653	Analysis and Control of Manufacturing Systems	3	1	0	4	PR656	Supply Chain Management	3	1	0	4
------	**Elective I (PE)**	3	0	0	3	------	**Elective IV (PE)**	3	0	0	3
------	**Elective II (PE)**	3	0	0	3	------	**Elective V (PE)**	3	0	0	3
------	**Elective III (PE)**	3	0	0	3	------	**Elective VI (PE)**	3	0	0	3
------	**Elective VII (OE/OC)***	3	0	0	3	------	**Elective VIII (OE/OC)***	3	0	0	3
PR 657	Data Analytics Lab	0	0	4	2	PR659	Supply Chain Management Lab.	0	0	3	2
PR658	Simulation Lab	0	0	4	2	**TOTAL**		**21**	**3**	**4**	**26**
	TOTAL	**21**	**3**	**8**	**28**						

***Elective IV & VIII (OE/OC)** **To be completed between I to IV semester**

CODE	Semester 3	L	T	P	C	CODE	Semester 4	L	T	P	C
PR690	Project Work-Phase I	**0**	**0**	**24**	**12**	PR691	Project Work-Phase II	**0**	**0**	**24**	**12**
PR660	Summer internship	**0**	**0**	**0**	**2**						

LIST OF ELECTIVES

CODE	INDUSTRIAL ENGINEERING STREAM	L	T	P	C	CODE	MANAGEMENT STREAM	L	T	P	C
PR661	Industrial Engineering Economic Analysis	3	0	0	3	PR675	Financial Management	3	0	0	3
PR662	Intelligent Manufacturing Systems	3	0	0	3	PR676	Marketing Management	3	0	0	3
PR663	Research Methodology	3	0	0	3	PR677	Total Quality Management & Six Sigma	3	0	0	3
PR664	Design and Analysis of Experiments	3	0	0	3	PR678	Human Resource Management	3	0	0	3
PR665	Lean and Agile Manufacturing	3	0	0	3	PR679	Product Life Cycle Management	3	0	0	3
PR666	Facilities Planning and Design	3	0	0	3	PR680	Technology Management	3	0	0	3
PR667	Production Management Systems	3	0	0	3	PR681	Advanced optimization techniques	3	0	0	3
PR668	Industry 4.0 and Cloud Manufacturing	3	0	0	3	PR682	Product Design and Development	3	0	0	3
PR669	Work Design and Ergonomics	3	0	0	3	PR683	E-waste Assessment and Management	3	0	0	3
PR670	Sustainable Manufacturing	3	0	0	3	**CODE**	**INDUSTRIAL INFORMATION SYSTEM STREAM**	**L**	**T**	**P**	**C**
PR671	Quality & Reliability Engineering	3	0	0	3	PR684	Enterprise Resource Planning	3	0	0	3
PR672	Value Engineering	3	0	0	3	PR685	Decision Support Systems	3	0	0	3
PR673	Cost Measurement and Productivity Measurement	3	0	0	3	PR686	Knowledge Management	3	0	0	3
PR674	Industrial Engineering and Productivity Management	3	0	0	3	PR687	Multi-Criteria Decision Making Techniques	3	0	0	3
						PR688	Intelligent Industrial Systems	3	0	0	3
						PR689	Human Machine Interaction for Manufacturing	3	0	0	3

COURSE OUTCOME AND PROGRAMME OUTCOME MAPPING

PROGRAMME CORE (PC)

Course Outcomes: On successful completion of the course, students will be able to:

Course Code	Course Title	CO	Course outcomes At the end of the course student will be able to	PO1	PO2	PO3
PR651	Data Analytics	CO1	Recognize the importance of data analytics.	1	1	3
		CO2	Exhibit competence on data analytics packages.	2	2	2
		CO3	Apply solution methodologies for industrial problems.	3	3	3
PR652	Modelling, Simulation and Analysis	CO1	Develop manufacturing models of discrete event systems	3	2	3
		CO2	A generation of uncertainty using random numbers and random variates	3	2	3
		CO3	Perform input, output analysis: Verification and validation of models and optimization	3	2	3
PR653	Analysis and Control of Manufacturing Systems	CO1	The students will be able to understand importance of production management and its concepts.	3	2	3
		CO2	The various models of sub systems will be known to them.	3	2	3
		CO3	Will be able to solve industrial problems involved in inventory, MRP andscheduling.	3	2	3
PR654	Advanced Operations Research	CO1	To understand the various Linear programming methods.	2	3	2
		CO2	To know about duality analysis, sensitivity analysis and integer programming problems with examples.	2	3	2
		CO3	To understand different dynamic programming concepts and its applications.	2	3	2
		CO4	To solve various network models including crashing of project networks.	2	3	1
		CO5	The basics of non-linear programming techniques.	3	2	1
PR655	Project Management	CO1	Understand the process of project planning, project scheduling, cost estimation and budgeting, resource allocation, monitoring and control,	3	2	3

			and risk assessment			
		CO2	Develop and analyze quantitative models for project selection and scheduling.	3	2	3
		CO3	Apply engineering and management principles to manage real time projects considering constraints.	3	2	3
		CO4	Apply tools for managing complex projects and to analyze the outcome and offer suggestions for improvement	3	2	3
PR656	Supply Chain Management	CO1	Explain the major building blocks, major functions, major business processes, performance metrics, and major decisions in supply chain networks.	3	2	3
		CO2	Summarize the foundation for design and analysis of supply chains and synthesize advanced and specialized concepts, principles and models for operational and strategic improvement.	3	2	3
		CO3	Analytically examine the supply chain of organizations and measure performance improvement.	3	2	3

LABORATORY

Course Code	Course Title	CO	Course Outcomes At the end of the course student will be able	PO1	PO2	PO3
PR657	Data Analytics Lab	CO1	Exhibit competence on data analytics packages.	2	2	3
		CO2	Apply solution methodologies for case/industrial problems.	3	2	3
		CO3	Apply statistical methods and data analysis techniques to engineering problems	3	2	3
PR658	Simulation Lab	CO1	Understand Simulation Tools and Programming	3	2	3
		CO2	Develop Skills in Random Number and Variate Generation	3	2	3
		CO3	Apply Simulation Techniques to Industrial Systems	3	2	3
PR659	Supply Chain Management Lab	CO1	Define and understand the basic supply chain concepts, Model building and execution of the same.	3	2	3
		CO2	Planning and managing the Internal Supply Chain during uncertainties.	3	2	3
		CO3	Forecast demand using sales history and perform replenishment	3	2	3

			planning and reordering.			
		CO4	Experience operations management packages like OM Expert, CPLEX, LINDO, GAMS, TORA extra	3	2	3

PROGRAMME ELECTIVES (PE)

Course Code	Course Title	CO	Course outcomes	PO1	PO2	PO3
PR661	Industrial Engineering Economic Analysis	CO1	Define and understand basic Productivity Concepts, Productivity Measurement Approaches of the Organizations.	3	2	3
		CO2	Perform Work design and facility planning.	3	2	3
		CO3	Outline the basics of Value Engineering (VE) and System Engineering.	3	2	3
PR662	Intelligent Manufacturing Systems	CO1	Apply various knowledge based techniques.	3	2	3
		CO2	Practice diagnosis and trouble shooting.	3	2	3
		CO3	Adopt intelligent system.	3	2	3
PR663	Research Methodology	CO1	Develop understanding on various kinds of research, objectives of doing research, research process, research designs and sampling.	3	2	3
		CO2	Have basic knowledge on qualitative research techniques	3	2	3
		CO3	Have adequate knowledge on measurement & scaling techniques as well asthe quantitative data analysis	3	2	3
		CO4	Have basic awareness of data analysis-and hypothesis testing procedures	3	2	3
PR664	Design and Analysis of Experiments	CO1	Appreciate the advantages and disadvantages of a design for a particularexperiment	1	1	2
		CO2	Construct optimal or good designs for a range of practical experiments	2	1	2
		CO3	Describe how the analysis of the data from the experiment should be carried out	2	2	2
		CO4	Apply experimental techniques to practical problems to improve quality ofprocesses / products by optimizing the process / product parameters	3	2	3
PR665	Lean and Agile Manufacturing	CO1	Demonstrate the principles of lean and agile manufacturing	1	-	2
		CO2	Recognize the potential applications of lean and agile manufacturing	2	2	3
		CO3	Apply the tools/techniques of lean and agile manufacturing to industrial problems	3	2	3
PR666	Facilities Planning and Design	CO1	Assess the value of facility planning on the strategy of a firm.	3	2	3
		CO2	Describe the product, process and schedule design and their interaction with facility planning and develop a systematic facility layout	3	2	3

		CO3	Explain design and analyze material handling used in the warehousing, manufacturing and supporting operations.	3	2	3
PR667	Production Management Systems	CO1	Explain the role of Production Management System.	3	2	3
		CO2	Identify the recent trend of manufacturing like Just in Time (JIT) and Pull Pushsystem.	3	2	3
		CO3	Outline the basics of Value Engineering.	3	2	3
PR668	Industry 4.0 and Cloud Manufacturing	CO1	Understand trends of Industry 4.0 and cloud manufacturing	2	1	2
		CO2	Competence on systems and technologies of Industry 4.0 & cloud system.	3	2	3
		CO3	Recognize industrial applications of Industry 4.0 in manufacturing	3	2	3
PR669	Work Design and Ergonomics	CO1	Various methods for productivity measurement and improvement	3	2	3
		CO2	To understand the methods study for managing resources	3	2	3
		CO3	To know the work measurement techniques for managing resources	3	2	3
		CO4	To acquire the knowledge in measuring work by physiological methods	3	2	3
		CO5	To analyze the ergonomic methods for workplace design	3	2	3
PR670	Sustainable Manufacturing	CO1	Realize the importance of sustainable manufacturing	1		2
		CO2	Exhibit competence on the usage and applicability of sustainability tools	2	2	3
		CO3	Recognize applications of sustainability concepts in various domains	3	2	3
PR671	Quality and Reliability Engineering	CO1	Control the quality of processes using control charts for variables in manufacturing industries.	1	2	2
		CO2	Control the occurrence of defective product and the defects in manufacturing companies.	2	2	2
		CO3	Able to perform process capability studies and to control the occurrence of defects in services through proper sampling methods.	1	2	2
		CO4	Able to conduct reliability assessment and failure analysis on any complex systems	2	2	3
		CO5	Understand the design concepts for reliable system and prediction aspects in industries	1	2	2

PR672	Value Engineering	CO1	Apply Value Engineering Techniques	3	2	3
		CO2	Implement Value Management Tools	3	2	3
		CO3	Evaluate and Apply Value Analysis	3	2	3
PR673	Cost Measurement ad Productivity Measurement	CO1	Understand the practical application of cost modelling and its role in industries	3	2	3
		CO2	Measure, evaluate, Plan and implement various productivity techniques.	3	2	3
		CO3	Reengineer the process for improving the productivity	3	2	3
PR674	Industrial Engineering and Productivity Management	CO1	Define and understand basic Productivity Concepts, Productivity Measurement Approaches of the Organizations.	2	3	3
		CO2	Perform Work design and facility planning.	3	2	1
		CO3	Outline the basics of Value Engineering (VE) and System Engineering.	2	3	2
PR675	Financial Management	CO1	To start and manage new business	3	2	3
		CO2	To evaluate and monitor short term and long term investments	3	2	3
		CO3	To evaluate and monitor current asset	3	2	3
PR676	Marketing Management	CO1	Explain marketing concepts and segmentation factors	3	2	3
		CO2	Classify various pricing methods	3	2	3
		CO3	Explain various sales promotion aspects	3	2	3
PR677	Total Quality Management and Six Sigma	CO1	Recognize the importance of TQM in industrial scenario	3	1	2
		CO2	Competence to apply specific TQM tool for the problems	2	3	1
		CO3	Execute various phases of Six Sigma for real time projects	3	2	1
PR678	Human Resource Management	CO1	Evaluate and apply theories of social science disciplines to workplace issues	3	2	3
		CO2	Select, develop, and motivate workers using HRM functional capabilities	3	2	3
		CO3	Express analytical, communication, and decision making skills considering ethics.	3	2	3
PR679	Product Life Cycle Management	CO1	Recognize the importance of Product Life Cycle Management.	2	1	2
		CO2	Realize potential for Collaborative Product Development and digital manufacturing in contemporary manufacturing applications.	3	2	3
		CO3	Competence to develop PLM strategy and conduct PLM assessment	3	2	3
PR680	Technology Management	CO1	Develop an awareness of the range, scope, and complexity of technological innovation, and the issues related to managing technological change.	3	2	3

		CO2	Explain different approaches to managing innovation with multi-criteria decision-making techniques	3	2	3
		CO3	Clearly identify drivers and barriers to technological innovation within anorganization.	3	2	3
PR681	Advanced Optimization Techniques	CO1	To learn the Traditional optimization techniques and apply it in engineering field.	3	2	1
		CO2	To learn the Non Traditional optimization techniques and apply it in engineering field.	2	2	1
		CO3	To apply both techniques to solve real engineering problems	1	1	3
PR682	Production Design and Development	CO1	Understand the challenges and advancements of product development process.	3	2	3
		CO2	Execute various phases of product development.	3	2	3
		CO3	Develop environmental friendly products/processes.	3	2	3
PR683	E-waste Assessment and Management	CO1	Understand the e-waste management practices	3	2	3
		CO2	Develop and analyze quantitative models for e-waste estimation	3	2	3
		CO3	Apply tools for managing e-waste sustainably	3	2	3
		CO4	Analyse the outcome and offer suggestions for sustainable e-waste management	3	2	3
PR684	Enterprise Resource Planning	CO1	Summarize basic concepts, tools and techniques of Enterprise Resource Planning	3	2	3
		CO2	Describe the key implementation issues of ERP	3	2	3
		CO3	Reorganize the current and future trends in ERP	3	2	3
PR685	Decision Support Systems	CO1	Recognize the importance of decisions in the work and use DSS Software Tools	3	2	3
		CO2	Discuss the advantages/disadvantages of different types of decision support systems and evaluate their Success/Failure	3	2	3
		CO3	Identify the types of problems that may be addressed effectively through the use of Decision Support Systems and Intelligent Systems.	3	2	3
		CO4	Analyze practical cases from different real world problems (technical, management)	3	2	3
		CO5	Recognize the role of Decision (and other Management) Support Systems	3	2	3

			and their potential for assisting in organizational and individual decision making.			
PR686	Knowledge Management	CO1	Appreciate the role and use of knowledge in organizations and institutions, and thetypical obstacles that KM aims to overcome	3	2	3
		CO2	Describe the core concepts, methods, techniques, and tools for computer supportof knowledge management	3	2	3
		CO3	Apply and integrate appropriate components and functions of various knowledgemanagement systems	3	2	3
PR687	Multi-Criteria Decision Making Techniques	CO1	Recognize the importance of multi criteria decision making.	2	1	1
		CO2	Understand various MCDM methods.	3	2	3
		CO3	Apply MCDM methods for real life applications.	3	2	3
PR688	Intelligent Industrial System	CO1	Apply various knowledge based techniques.	3	2	3
		CO2	Practice diagnosis and trouble shooting.	3	2	3
		CO3	Adopt intelligent system.	3	2	3
PR689	Human Machine Interaction for Manufacturing	CO1	Analyze and apply cognitive psychology principles and ergonomic design principles to enhance human-machine interactions and improve system usability in manufacturing settings.	2	2	2
		CO2	Evaluate and implement usability testing methods, including statistical hypothesis testing, to assess and refine interfaces and systems to solve manufacturing challenges.	2	2	3
		CO3	Comprehend the effectiveness of Augmented Reality (AR), Virtual Reality (VR), and haptics technologies in enhancing manufacturing processes	2	2	2

3 - High; 2 - Medium; 1 - Low

Course Code	:	PR651
Course Title	:	Data Analytics
Type of Course	:	PC
Prerequisites	:	Nil
Contact Hours	:	4
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To realize the importance of data analytics.
CLO2	To gain competence on data analytics packages.
CLO3	To explore industrial applications of data analytics methodologies.

Course Content

Introduction to Multivariate Statistics-Degree of Relationship among Variables-Reviewof Univariate and Bivariate Statistics-Screening Data Prior to Analysis-Missing Data, Outliers, Normality, Linearity, and Homoscedasticity.

Statistics – Descriptive, Inferential, Hypothesis Testing - Testing interactions - Analysis of Variance and Covariance - Multivariate Analysis of Variance and Covariance - Regression, Linear and Nonlinear techniques - Backward-Forward-Stepwise - Hierarchical regression

Logistic regression: Regression with binary dependent variable -Simple Discriminant Analysis- Multiple Discriminant analysis -Assessing classification accuracy- Conjoint analysis

Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation- Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis

Latent Variable Models an Introduction to Factor, Path, and Structural EquationAnalysis-Time series data analysis– Decision tree analysis - Introduction to Big Data Management, Internet of Things and Artificial Intelligence.

References

1.	Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. “Multivariate data analysis”, (7thedition). Pearson India.2015
2.	Tabachnick, B. G., &Fidell, L. S., “Using multivariate statistics”, (5thedition). PearsonPrentice Hall,2001
3.	Shah, Chirag, A Hands-on Introduction to Data Science, Cambridge University Press, 2020
4.	James Gareth; Witten Daniela; Hastie Trevor; Tibshirani Robert; Taylor Jonathan, An introduction to Statistical learning with applications in Python, Springer, 2023
5.	Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. “ Applied multiple regression/correlation analysis for the behavioral sciences”, Routledge.,2013
6.	Han, J., Kamber, M., & Pei, J. “Data mining: concepts and techniques: concepts and

	techniques", Elsevier,2011
7.	Anil Mahershwari , Data Analytics, McGraw Hill Education; First edition (1 July 2017)

Course Outcomes (CO)

At the end of the course student will be able

CO1	Recognize the importance of data analytics.
CO2	Exhibit competence on data analytics packages.
CO3	Apply solution methodologies for industrial problems.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	1	1	3
CO2	2	2	2
CO3	3	3	3

Course Code	:	PR652
Course Title	:	Modelling, Simulation and Analysis
Type of Course	:	PC
Prerequisites	:	Nil
Contact Hours	:	4
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Building of Models with logic
CLO2	Develop routines to capture uncertainty in systems
CLO3	Modelling and Simulation of Discrete Event Systems

Course Content

Introduction to systems and modelling Discrete and continuous system - Monte Carlo Simulation. Simulation of Single Server Queuing System Simulation of a manufacturing shop Simulation of Inventory System

Random number generation, properties - Generation of Pseudo Random Numbers Tests for Random Numbers

Random variates-Inverse Transform Technique –Direct Transform Techniques Convolution Method Acceptance Rejection – Routines for Random Variate Generation

Testing -Analysis of simulation data-Input modelling Verification and validation of simulation models – output analysis for a single model.

Simulation languages and packages Case studies in WITNESS; FLEXSIM, ARENA, SIMQUICK Simulation based optimization-Modelling and Simulation with Petrinets Case studies in manufacturing systems

References

1.	Jerry Banks & John S.Carson, Barry L Nelson, “Discrete event system simulation” ,Prentice Hall
2.	Law A.M, “Simulation Modelling and Analysis”, Tata Mc Graw Hill
3.	NarsinghDeo, “System Simulation with Digital Computer”, Prentice H
4.	Geoffrey Jordon, “System Simulation”, Prentice hall India Ltd

Course Outcomes (CO)

At the end of the course student will be able

CO1	Develop manufacturing models of discrete event systems
CO2	A generation of uncertainty using random numbers and random variates
CO3	Perform input, output analysis: Verification and validation of models and optimization

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR653
Course Title	:	Analysis and Control of Manufacturing Systems
Type of Course	:	PC
Prerequisites	:	Nil
Contact Hours	:	4
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To enable the students to understand the production and operations functionand its subsystem.
CLO2	To study the manufacturing planning and control activities in the organization.
CLO3	To study the production control concepts, strategies, policies in organization.

Course Content

Basics of product management–Forecast models, errors, tracking signals.Inventory costs – Types of systems – Policies – Analysis & static models

Concept of aggregate production planning – Types of Production Strategies – Charting techniques –Case Studies and Practical Applications

Value stream management- Introduction, Value Stream Analysis, Implementation Strategies, Case Studies and Practical Applications

MRP concepts – Problems – Lot sizing – Techniques

Scheduling concepts– Various types of scheduling – Methods and tools to solve scheduling problems – Assembly line balancing problems

References

1.	Elsayed A. Elsayed and Thomas O. Boucher, “Analysis and Control of Production Systems”,Prentice Hall, 1994.
2.	Monks J.G., “Operations Management”, John Wiley, 1992.
3.	Buffa.E.S. and Sarin, R.K., “Modern production /Operations Management”, John Wiley & Sons, 1994.
4.	Panneerselvam.R. “Production and Operations Management”, PHI, 2005.
5.	Chary S.N., “Production and Operations Management”, McGraw Hill Education (India) Private Limited, 2013.

Course Outcomes (CO)

At the end of the course student will be able

CO1	The students will be able to understand importance of production managementand its concepts.
CO2	The various models of sub systems will be known to them.
CO3	Will be able to solve industrial problems involved in inventory, MRP and scheduling.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR654
Course Title	:	Advanced Operations Research
Type of Course	:	PC
Prerequisites	:	Nil
Contact Hours	:	4
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand Linear programming, Dynamic programming & Non-linear programming techniques.
CLO2	To make use of duality and sensitivity analysis for real time applications.
CLO3	To analyse network models and crashing of various project networks.

Course Content

Linear programming- Simplex method – Big M method – Two phase method –Dual simplex method – Problems in all the above methods.

Duality analysis, sensitivity analysis-Changes in right- hand side constants of constraints-changes in objective function co-efficient-adding a new constraint-adding a new variable. Integer programming algorithm - Cutting plane algorithm- Branch and Bound technique – Problems.

Deterministic dynamic programming –Recursive nature of computations in dynamic programming - Applications of dynamic programming - Cargo loading model – Work force size model – Equipment replacement model-Inventory model.

Crashing of project network – Problems. Network models - Shortest path model – Systematic Method; Dijkstra's Algorithm; Floyd's Algorithm – Minimum Spanning Tree Problem – PRIM Algorithm; Kruskal's Algorithm; Maximal flow problem.

Unconstrained nonlinear algorithms-Constrained algorithms- Separable programming - Quadratic programming-Geometric programming-Stochastic programming.

References

1.	Handy M.Taha, "Operations Research, an introduction", 7th edition, PHI, 2003.
2.	Don T.Phillips, A.Ravindran& James Solberg, Operations Research: Principles and practice, John Wiley, India, 2006.
3.	G.Srinivasan , "Operations Research Principles and Applications" ,PHI 2008
4.	Panneerselvam, R, "Operations Research", Prentice – Hall of India, New Delhi,2002

Course Outcomes (CO)

At the end of the course student will be able

CO1	To understand the various Linear programming methods.

CO2	To know about duality analysis, sensitivity analysis and integer programming problems with examples.
CO3	To understand different dynamic programming concepts and its applications.
CO4	To solve various network models including crashing of project networks.
CO5	The basics of non-linear programming techniques.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	2	3	2
CO2	2	3	2
CO3	2	3	2
CO4	2	3	1
CO5	3	2	1

Course Code	:	PR655
Course Title	:	Project Management
Type of Course	:	PC
Prerequisites	:	Nil
Contact Hours	:	4
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To deliver concepts and skills that are used to propose, plan, secure resources, budget, and lead project teams from the project concept to successful commissioning.
CLO2	To understand the methods for project identification and appraisal.
CLO3	To plan and schedule a project with resource and environmental constraints
CLO4	To develop quantitative methods for project selection, risk assessment, monitoring and control.

Course Content

Introduction - Project Management-Overview - Types, Characteristics of Projects - Project life cycle. Organization systems for project implementation.

Identification of investment opportunities - Screening and Selection, Project Appraisal. Market and demand analysis- market survey-demand forecasting methods-Technical analysis - manufacturing process, materials-product mix, plant location-project charts and layouts.

Budgeting and cost estimation-Financial analysis - cash flows for project appraisal-Investment evaluation using capital budgeting techniques - net present value, profitability index internal rate of return, payback period, accounting rate of return,

Mathematical Techniques for project evaluation - Linear programming, goal programming, Network technique for Project Management - CPM, PERT, Multiple projects and constraints, scheduling. Single and multiple projects. Project Risk analysis -Performance metrics for project evaluation-Earned Value Analysis.

Work Breakdown-coordination and control- Project Management Software, Role of AI in project management

References

1.	Prasanna Chandra, “Projects – Planning, Analysis, Financing, Implementation and Review”, Tata McGraw Hill,8th Ed, 2017
2.	S.Choudry “Project Management”, ”, Tata McGraw Hill,5th Ed, 1995
3.	Mike Field and Laurie Keller, “Project Management”, Thompson Business press, 2002
4.	Eric W. Larson Clifford F. Gray and,Rohit Joshi "Project Management: The

	Managerial Process", 8th Edition, McGraw-Hill, 2021
5.	http://nptel.ac.in/courses/110104073/

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the process of project planning, project scheduling, cost estimation and budgeting, resource allocation, monitoring and control, and risk assessment
CO2	Develop and analyze quantitative models for project selection and scheduling.
CO3	Apply engineering and management principles to manage real time projects considering constraints.
CO4	Apply tools for managing complex projects and to analyze the outcome and offer suggestions for improvement

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3

Course Code	:	PR656
Course Title	:	Supply Chain Management
Type of Course	:	PC
Prerequisites	:	Nil
Contact Hours	:	4
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To demonstrate operational purchasing methods and techniques on supplier management and supply in specific business contexts.
CLO2	To explain the strategic importance of logistic elements and describe how theyaffect supply chain management.
CLO3	To analyze the creation of new value in the supply chain for customers, society and the environment.

Course Content

Introduction to supply chain management -Supply Chain Performance: Achieving Strategic Fit and Scope -Supply Chain Drivers and Metrics.

Planning in Supply chain -Demand Forecasting in a Supply Chain -Aggregate Planningin a Supply Chain – Planning and Managing Inventories in a supply chain.

Designing the Supply chain network –Distribution networks –Transportation networks– Network Design in Supply chain, Network Design in an Uncertain Environment - supply chain optimization.

Managing cross-functional drivers in supply chain -Sourcing Decisions in a Supply Chain - Pricing and Revenue Management in Supply Chain-Information Technology inSupply Chain -Coordination in Supply Chain.

Modern Supply chain management -Reverse supply chain strategies –Green and sustainable practices of Supply chain –Supply chain cases.

Ecosystem Resource Management, Customer Relationship Management (CRM), and Supplier Relationship Management (SRM).

References

1.	Sunil Chopra And Peter Meindl, “Supply Chain Management, strategy, planning, and operation”6/e –PHI, second edition, 2014
2.	V.V.Sople, “Supply Chain Management, text and cases”, Pearson Education South Asia,2012
3.	Janat Shah, “Supply Chain Management, text and cases”, Pearson Education SouthAsia,2009
4.	Balkan Cetinkaya, Richard Cuthbertson, Graham Ewer,“Sustainable Supply Chain Management: Practical ideas for moving towards best practice”, Springer, 2011
5.	Jeremy F.Shapiro, Thomson Duxbury, “Modeling the Supply Chain”, 2002.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explain the major building blocks, major functions, major business processes, performance metrics, and major decisions in supply chain networks.
CO2	Summarize the foundation for design and analysis of supply chains and synthesize advanced and specialized concepts, principles and models for operational and strategic improvement.
CO3	Analytically examine the supply chain of organizations and measure performance improvement.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR657
Course Title	:	Data Analytics Lab
Type of Course	:	ELR
Prerequisites	:	Nil
Contact Hours	:	4
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand data analytics methods
CLO2	To gain competence on data analytics packages
CLO3	To gain competence in applying statistical methods and data analysis techniques in engineering problems

Course Content

LIST OF EXERCISES

1. Basic Statistics and Correlation using Systat
2. Correlation and Regression using Systat
3. One Sample and Two Sample T-test using Systat
4. Basic Statistics and Hypothesis Testing using R-Programming
5. Basic Statistics and Linear Regression using Python
6. ANOVA -One Way & Two Way using Python
7. Hypothesis Testing using Python
8. Clustering Analysis using SPSS
9. Life Cycle Assessment using GaBi
10. Research paper/Case study based Exercise

References

1.	Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. "Multivariate data analysis", (7th edition). Pearson India. 2015
2.	Tabachnick, B. G., &Fidell, L. S., "Using multivariate statistics", (5th edition).Pearson Prentice Hall, 2001
3.	Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. " Applied multiple regression/correlation analysis for the behavioral sciences", Routledge., 2013
4.	Han, J., Kamber, M., & Pei, J. "Data mining: concepts and techniques: concepts and techniques", Elsevier, 2011

Course Outcomes (CO)

At the end of the course student will be able

CO1	Exhibit competence on data analytics packages.
CO2	Apply solution methodologies for case/industrial problems.
CO3	Apply statistical methods and data analysis techniques to engineering problems

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	2	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR658
Course Title	:	Simulation Lab
Type of Course	:	ELR
Prerequisites	:	Nil
Contact Hours	:	2
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Proficient Use of Simulation Tools and Programming
CLO2	Expertise in Random Number and Variate Generation
CLO3	Application of Simulation to Diverse Industrial Systems

Course Content

(Packages: ARENA, Flexsim, QUEST, Simquick & Witness and other emerging packages, Programming in C and Matlab)
LIST OF EXERCISES

1. Random Number Generation approaches
2. Random Variate Generation
3. Simulation of Manufacturing Shop
4. Simulation of Multiple Servers Queuing System
5. Simulation of Supply Chain Inventory System
6. Simulation of Batch Production System
7. Simulation of Multi Machine Assignment System
8. Simulation of Manufacturing and Material Handling Systems
9. Simulation of a Shop Floor
10. Simulation of Material Handling Systems

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand Simulation Tools and Programming
CO2	Develop Skills in Random Number and Variate Generation
CO3	Apply Simulation Techniques to Industrial Systems

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR659
Course Title	:	Supply Chain Management Lab
Type of Course	:	ELR
Prerequisites	:	Nil
Contact Hours	:	2
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To gain sound knowledge on creating the Bill of Materials, and model uncertainties to manage the Internal Supply Chain.
CLO2	To generate Sales Order, Work Order and generate Gantt Chart & Supply Chain Diagram.
CLO3	To forecast demand and plan for replenishment and reorder.
CLO4	To have practical exposure on operations management packages like OM Expert, CPLEX, LINDO, GAMS, TORA extra and to study on the ergonomic aspects of human evaluation.

Course Content

LIST OF EXPERIMENTS:

1. Creating a Base Model.
2. Generate Sales Order and Work Order from the given base model.
3. Modeling for Uncertainties in Resources, Routing and BOM.
4. Modeling for Alternate routing.
5. Modeling for Additional resources.
6. Modeling for Alternate BOM and Alternate Item.
7. Exercise on By-Products.
8. Demand forecasting over a horizon using various forecasting models.
9. Generating Replenishment plan using Demand Forecast.
10. Forecasting Model, Inventory Models, Scheduling Case Studies
11. Material Requirements Planning, Project Management, Facilities Layout
12. Peg Board Experiment, Fitness Study Using Treadmill, Fitness Study Using Ergo Cycle

Course Outcomes (CO)

At the end of the course student will be able

CO1	Define and understand the basic supply chain concepts, Model building and execution of the same.
CO2	Planning and managing the Internal Supply Chain during uncertainties.

CO3	Forecast demand using sales history and perform replenishment planning and reordering.
CO4	Experience operations management packages like OM Expert, CPLEX, LINDO, GAMS, TORA extra

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3

Course Code	:	PR661
Course Title	:	Industrial Engineering Economic Analysis
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To gain sound knowledge on the need to increase productivity with techniques that eliminate waste, efficient operations, and effective resource utilization.
CLO2	To learn methods and tools for improving operations and controlling the production costs and enhancing quality.
CLO3	To understand the principles of facility layout, value engineering, and systems engineering, and their application in optimizing production processes and facility planning.

Course Content

Productivity: Concept, Productivity improvement factors, Productivity appraisal, productivity analysis in the enterprise- The Kurosawa structural approach, Lawlor's approach, Gold's approach, Quick Productivity Appraisal approach (QPA), Inter-Firm Comparison (IFC).

Work Design: Work study, Method study, Work measurement, Standard output, Timestudy, Work sampling, Process analysis.

Facility Layout: Principles of layout and facilities planning, Material flow patterns, Material handling systems, Types of material handling equipment.

Value Engineering: Fundamental concepts and applications of value engineering, Function Analysis System Technique (FAST).

Systems Engineering: Introduction to Systems Engineering, Management Information System, Phases in System Engineering, System Life Cycle, System Maintenance.

References

1.	Prokopenko, J. "Productivity Management, A Practical Handbook", InternationalLabourOrganisation, 1992.
2.	ILO, "Introduction to Work Study", George Kanawaty, 4th revised edition, Universal Book Corporation 2007.
3.	Apple, J.M. "Plant layout and materials handling", Ronald Press Company, Newyork, 1977.
4.	Tutty Herald G, "Compendium on Value Engineering", Indo-American Society,1983.
5.	Andrew P Sage & James E Armstrong, "Introduction to Systems Engineering", Wiley series (2000).

Course Outcomes (CO)

At the end of the course student will be able

CO1	Define and understand basic Productivity Concepts, Productivity Measurement Approaches of the Organizations.
CO2	Perform Work design and facility planning.
CO3	Outline the basics of Value Engineering (VE) and System Engineering.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR662
Course Title	:	Intelligent Manufacturing Systems
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To apply various knowledge based techniques
CLO2	To practice diagnosis and trouble shooting
CLO3	To adopt intelligent system

Course Content

Basic concepts of Artificial intelligence and expert systems - System Components - System architecture and Data flow – System Operations.

Knowledge based systems - knowledge representation – knowledge acquisition and optimization - Knowledge based approaches to design mechanical parts and mechansims and design for automated assembly.

Knowledge based system for material selection – Intelligent process planning system. Intelligent system for equipment selection - Intelligent system for project management& factory monitoring.

Scheduling in manufacturing – scheduling the shop floor – Diagnosis & troubleshooting. The role of Artificial Intelligence in the factory of the future – Intelligentsystems.

References

1.	Kenneth R.Baker, “Introduction to sequencing and scheduling”, John Wiley & Sons, New York, 2000.
2.	Richard W. Conway, William L.Maxwell and Louis W. Miller, “Theory of Scheduling”, Dover Publications, 2003.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Apply various knowledge based techniques.
CO2	Practice diagnosis and trouble shooting.
CO3	Adopt intelligent system.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3

CO2	3	2	3
CO3	3	2	3

Course Code	:	PR663
Course Title	:	Research Methodology
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To familiarize participants with basic of research and the research process.
CLO2	To enable the participants in conducting research work and formulating research synopsis and report.
CLO3	To familiarize participants with Statistical packages such as SPSS etc.
CLO4	To impart knowledge for enabling students to develop data analytics skills and meaningful interpretation to the data sets so as to solve the business/Research problem

Course Content

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem,necessity of defining the problem, importance of literature review in defining a problem,literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools,data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.),hypothesis testing.

Computer and its role in research, Use of statistical software SPSS, GRETL etc. in research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization offuzzy systems.

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual propertyrights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of theResearch Report, Types of Reports, Oral Presentation, Mechanics of Writing aResearch Report, Precautions for Writing Research Reports, Conclusions.

References

1.	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction

	toResearch Methodology, RBSA Publishers.
2.	Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3.	Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
4.	Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5.	Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Develop understanding on various kinds of research, objectives of doingresearch, research process, research designs and sampling.
CO2	Have basic knowledge on qualitative research techniques
CO3	Have adequate knowledge on measurement & scaling techniques as well asthe quantitative data analysis
CO4	Have basic awareness of data analysis-and hypothesis testing procedures

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3

Course Code	:	PR664
Course Title	:	Design and Analysis of Experiments
Type of Course	:	PE
Prerequisites	:	Basic probability and statistics concepts
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To design experiments to a problem situation using traditional experimental designs as well as Taguchi Methods
CLO2	To develop skill to conduct experiments and analyze the data for engineering problems
CLO3	To develop skill to determine the optimal parameters to optimize the process

Course Content

Introduction- Planning of experiments – Steps – Need, Terminology: Factors, levels, variables, experimental error, replication, Randomization, Blocking, Confounding.

Single Factor Experiments- ANOVA - Sum of squares – Completely randomized design, Randomized block design, effect of coding, Comparison of treatment means – Newman Kuel's test, Duncan's Multiple Range test, Latin Square Design.

Factorial Experiments-Main and interaction effects –Two and three Factor full factorial Designs, 2k designs with Two and Three factors- Yate's Algorithm

Special Experimental Designs- Blocking and Confounding in 2k design

Taguchi Techniques- Fundamentals of Taguchi methods, Quality Loss function,orthogonal designs, application to Process and Parameter design.

References

1.	Krishnaiah, K. and Shahabudeen, P. Applied Design of Experiments and TaguchiMethods, PHI learning private Ltd., 2012.
2.	Montgomery, D.C., Design and Analysis of experiments, John Wiley and Sons,Eighth edition, 2012.
3.	Nicolo Belavendram, Quality by Design; Taguchi techniques for industrial experimentation, Prentice Hall, 1995.
4.	Phillip J.Rose, Taguchi techniques for quality engineering, McGraw Hill, 1996

Course Outcomes (CO)

At the end of the course student will be able

CO1	Appreciate the advantages and disadvantages of a design for a particular experiment
CO2	Construct optimal or good designs for a range of practical experiments
CO3	Describe how the analysis of the data from the experiment should be carried out
CO4	Apply experimental techniques to practical problems to improve quality of processes / products by optimizing the process / product parameters

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	1	1	2
CO2	2	1	2
CO3	2	2	2
CO4	3	2	3

Course Code	:	PR665
Course Title	:	Lean and Agile Manufacturing
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the concepts of lean and agile manufacturing
CLO2	To gain competence on tools/techniques of lean and agile manufacturing
CLO3	To explore the industrial applications of tools/techniques of lean and agile manufacturing

Course Content

Introduction to Lean Manufacturing, Comparison of Mass Manufacturing andLean Manufacturing, Lean Principles, Types of Wastes – Seven basic categories, Types of activities – Value Added, Non Value Added and Necessarybut Non Value Added activities, Examples

Primary Tools of Lean Manufacturing- 5S, Process Mapping and Value Stream Mapping, Work Cells, Total Productive Maintenance – Principle, Procedural steps and Advantages-Secondary Lean Tools.

Lean rules, Production Planning for lean system, Training and Implementation for lean systems, How to succeed with lean manufacturing, Leanness assessment – Indicators, methods and illustrativeexample.

Fundamentals of Agile Manufacturing, Agile Principles, Conceptual models of Agile Manufacturing, Product Development Strategies for agility, Developing theagile enterprise, Managing People in agile organizations.

Strategic approach to agile manufacturing, Information Technology applicationsin Agile Manufacturing, Assessment of agility – Activity Based Costing - Application Case studies and Research issues in Lean and Agile Manufacturing.

References

1.	Montgomery, J.C and Levine, L. O., "The transition to agile manufacturing – Staying flexible for competitive advantage", ASQC Quality Press, Wisconsin, 1996.
2.	Gopalakrishnan "Simplified Lean Manufacture – Elements, Rules Tools and Implementation", PHI Learning Private Limited, New Delhi, India,2010.
3.	Hobbs, D.P. "Lean Manufacturing Implementation", Narosa Publisher, 2004.
4.	Devadasan, S.R., Sivakumar, V., Mohan Murugesh, R., Shalij, P, R. "Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities", Prentice Hall India, 2012.
5.	Lonnie Wilson, How to implement lean manufacturing, McGraw Hill

	Education; 2nd edition (8 January 2015)

Course Outcomes (CO)

At the end of the course student will be able

CO1	Demonstrate the principles of lean and agile manufacturing
CO2	Recognize the potential applications of lean and agile manufacturing
CO3	Apply the tools/techniques of lean and agile manufacturing to industrialproblems

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	1		2
CO2	2	2	3
CO3	3	2	3

Course Code	:	PR666
Course Title	:	Facilities Planning and Design
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To assess the value of facility planning on the strategy of a firm.
CLO2	To describe the product, process and schedule design and their interaction with facility planning and develop a systematic facility layout
CLO3	To explain design and analyze material handling used in the warehousing, manufacturing and supporting operations.

Course Content

Facilities planning – need and objectives of facilities planning – facilities planningprocess –

Facilities planning strategies, Facilities Location Analysis- Single facility locationmodels Multi-facility location problems

Facilities Layout design- product design – process design – schedule design - Spaceand Area

Requirements of Facilities Layout design procedure-Algorithmic approach –

Computerized layout planning CRAFT, ALDEP and CORELAP

Group technology - Methods of grouping – Algorithms and models for Group technology – Line Balancing Material handling design – Material handling principles -Classification of material handling equipment - Material handling models

References

1.	Tompkins, J.A. and J.A.White, “Facilities planning”, JohnWiley, 2010.
2.	Richard Francis.l. and John A.White, “Facilities layout and location- An analytical approach”, PHI, 2002.
3.	James Apple. M , “Plant layout and Material handling”, John Wiley, 1977.
4.	Pannerselvam,R, “Production and Operations management”, PHI,2012
5.	B. Mahadevan, “Operations management: Theory and Practice”,2nd Edition, Pearson education South Asia, 2010.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Assess the value of facility planning on the strategy of a firm.
CO2	Describe the product, process and schedule design and their interaction withfacility

	planning and develop a systematic facility layout
CO3	Explain design and analyze material handling used in the warehousing, manufacturing and supporting operations.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR667
Course Title	:	Production Management Systems
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To give a fair understanding of the role of production management in business processes
CLO2	To make familiarization of various production processes and service systems.
CLO3	To develop the skills needed to apply productivity measurement models, work study techniques, and value engineering approaches to enhance production and service systems.

Course Content

Productivity: Productivity measurement models, Role of work study, Work measurement techniques, Ergonomics.

CIM and Production Management Systems: Capacity Requirement Planning (CRP), Master Production Schedule, MRP, MRPII, Lot sizing in MRP- Lot for lot, Economic order quantity, Periodic order quantity, Part period balancing.

Just in Time and Lean Operations: Characteristics of Lean systems for services and Manufacturing, Element of JIT manufacturing, Pull and Push method of work flow, Small lot sizes, Kanban system, Value stream mapping.

Introduction to optimized production technology (OPT) - OPT philosophy improvementtools-Requirement and assumption of OPT. Introduction to product development process.

Value Engineering: Approaches of value analysis and engineering, effective organization for value work function analysis system techniques, FAST diagram, CaseStudy

References

1.	Browne, Hairnet &Shimane, “Production management – A CIM perspective”, Addison Wesley publication Co., 1989.
2.	Orlicky, J; “Material Requirement Planning: the new way of life in production and inventory management”, McGraw Hill, 1975.
3.	Parker, D.E., “Value engineering theory”, Sundaram publishers, 2000.
4.	Panneerselvam, R. “Production and Operation management”, PHI, 2005.
5.	Schonlenger, R.L., “Japanese manufacturing techniques: 9 hidden lessons simplicity”, The Free press, 1982.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explain the role of Production Management System.

CO2	Identify the recent trend of manufacturing like Just in Time (JIT) and Pull Push system.
CO3	Outline the basics of Value Engineering.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR668
Course Title	:	Industry 4.0 and Cloud Manufacturing
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To recognize need and trends of Industry 4.0 and Cloud manufacturing
CLO2	To understand concepts and technologies supporting Industry 4.0 and Cloud Systems
CLO3	To explore challenges and Industrial applications of Industry 4.0in manufacturing

Course Content

Various Industrial Revolutions, Compelling Forces and Challenges for Industry 4.0, Comparison of Industry 4.0 Factory and Today's Factory, Lean Production Systems.

Internet of Things (IoT)- IoT design methods, physical devices and enabling technologies, Industrial Internet of Things (IIoT), Smart Manufacturing.

Cyber physical Systems, Support System for Industry 4.0, Cyber Security, Collaborative Platform and Product Lifecycle Management, Artificial Intelligence, Big Data and Predictive analytics.

Introduction to cloud computing and manufacturing- cloud models, cloud manufacturing examples, cloud based manufacturing, Cloud service and platforms formanufacturing.

Industry 4.0 integration with manufacturing systems, Application domains, Casestudies on IoT cloud system in manufacturing and other domains - Overview and Scope of Industry 5.0.

References

1.	Gilchrist, A. (2016). Industry 4.0: the industrial internet of things. (1st ed.), New York, NY: Apress.
2.	Garbie, I. (2016). Sustainability in manufacturing enterprises: Concepts, analyses and assessments for industry 4.0. (1st ed.), Switzerland: Springer International Publishing.
3.	T. Erl, Z. Mahmood, and R. Puttini (2013), Cloud Computing: Concepts, Technology & Architecture. (1st ed.), Prentice Hall.
4.	Velte, A. T., Velte, T. J., Elsenpeter, R. C., & Elsenpeter, R. C. (2009). Cloud computing: a practical approach. (1st ed.) New York: McGraw-Hill.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand trends of Industry 4.0 and cloud manufacturing
CO2	Competence on systems and technologies of Industry 4.0 & cloud system.

CO3	Recognize industrial applications of Industry 4.0 in manufacturing

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	2	1	2
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR669
Course Title	:	Work Design and Ergonomics
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know and apply various productivity measurement techniques in real time situations.
CLO2	To understand method study and work management techniques.
CLO3	To establish time standards by physiology methods.
CLO4	To acquire the basic knowledge in motion economy and ergonomic practices

Course Content

Introduction to work study - Productivity – productivity measures-productivity measurement models-Kurosawa structural approach, Lawlor's approach, Gold's approach Quick Productivity Appraisal approach (QPA) / American Productivity Centre (APC) model-scope of work study for improving productivity

Methods study -process analysis – process chart – flow diagram – assembly process chart – Man and machine chart – two handed process chart – Photographic Techniques - Micro motion and memo motion study - Cycle Graph – Chrono Cycle Graph

Work measurement and its methods. Time study-Stop watch method, Rating factor, Allowances - Work sampling - Determining time standards from standard data and formulas-Predetermined motion time standards – Work factor system – methods time measurement, Basic Motion Time study. Analytical Estimation.

Measuring work by physiological methods – Heart rate measurement– measuring oxygen consumption– Establishing time standards by physiology methods.

Principles of Motion Economy- related to use of human body, related to workplace, related to design of tools and equipment - Ergonomics practices – human body measurement – layout of equipment– seat design - design of controls and compatibility – environmental control – vision and design of displays. Design of work space, chair table

References

1.	Barnes, Raeph.M., "Motion and Time Study – Design and Measurement of Work ",John Wiley &sons, New York, 1990
2.	Mc.Cormick, E.J., "Human Factors in Engineering and Design", McGraw Hill ILO, "Introduction to Work study" , Geneva, 1974

Course Outcomes (CO)

At the end of the course student will be able

CO1	Various methods for productivity measurement and improvement
CO2	To understand the methods study for managing resources
CO3	To know the work measurement techniques for managing resources
CO4	To acquire the knowledge in measuring work by physiological methods
CO5	To analyze the ergonomic methods for workplace design

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

Course Code	:	PR670
Course Title	:	Sustainable Manufacturing
Type of Course	:	PE/OE
Prerequisites	:	
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To recognize the importance of sustainable manufacturing
CLO2	To understand and apply appropriate sustainability tools/techniques
CLO3	To explore practical applications of sustainability concepts

Course Content

Concepts of sustainability and sustainable development – Sustainable Development Goals, Need for sustainable development - Components of sustainability- Social, Economic, Environmental dimensions - Linkages between technology and sustainability - Sustainable Manufacturing –Scope, Need and Benefits.

Tools and Techniques of Sustainable Manufacturing – Environmental Conscious Quality Function Deployment, Life cycle assessment, Design for Environment, R3 and R6 cycles, Design for Disassembly -Sustainable Product Development – VariousPhases.

EIA Methods –CML, EI 95 and 99, ISO 14001 EMS and PAS 2050 standards, Environmental Impact parameters - Interactions between energy and technology andtheir implications for environment and sustainable development.

Design for recycling – Eco friendly product design methods – Methods to infuse sustainability in early product design phases – Multi-Criteria Decision Making in Sustainability.

Frameworks for measuring sustainability- Indicators of sustainability – Environmental, Economic, Societal and Business indicators - Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment– Corporate Social Responsibility.

References

1.	G. Atkinson, S. Dietz, E. Neumayer, —"Handbook of Sustainable Development". Edward Elgar Publishing Limited,2008.
2.	D. Rodick, "Industrial Development for the 21st Century: Sustainable DevelopmentPerspectives", UN New York,2007.
3.	Rogers, P.P., Jalal, K.F. and Boyd, J.A., "An Introduction to Sustainable Development", Earthscan, London, 2008.
4.	P. Lawn, "Sustainable Development Indicators in Ecological Economics", Edward Elgar Publishing Limited, 2006
5.	S. Asefa, "The Economics of Sustainable Development", W.E. Upjohn Institute for Employment Research, 2005.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Realize the importance of sustainable manufacturing
CO2	Exhibit competence on the usage and applicability of sustainability tools
CO3	Recognize applications of sustainability concepts in various domains

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	1		2
CO2	2	2	3
CO3	3	2	3

Course Code	:	PR671
Course Title	:	Quality and Reliability Engineering
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To facilitate the students in knowing the application of statistical techniques in Quality control and assurance
CLO2	To impart knowledge in reliability concepts, reliability estimation methods and reliability improvement methods
CLO3	To equip students with the ability to design and implement sampling plans and perform risk assessments using tools such as FMEA and Fault Tree Analysis.

Course Content

Quality Dimensions – Quality definitions – Inspection - Quality control – Quality Assurance – Quality planning - Quality costs – Economics of quality – Quality loss function - Quality Gurus and their philosophies

Chance and assignable causes of process variation, statistical basis of the control chart, control charts for variables- X , R and S charts, attribute control charts - p, np, c and u-Construction and application. Process stability, process capability analysis using a Histogram or probability plots and control chart. Gauge capability studies, setting specification limits.

The acceptance sampling fundamental, OC curve, sampling plans for attributes, simple, double, multiple and sequential, sampling plans for variables, MIL-STD-105D and MIL-STD-414E & IS2500 standards.

Definition of reliability – Performance and reliability - Reliability requirements – System life cycle – Mean time between failures – Mean time to failure – Mortality Curve – Availability – Maintainability – Bathtub curve – Time dependent failure models – Distributions – Normal, Weibull, Lognormal – Life distribution measurements – Accelerated life tests – Data requirements for reliability.

Reliability of system and models – Serial, parallel and combined configuration – Markove analysis, load sharing systems, standby systems, covarient models, static models, dynamic models - Failure rate estimates – Effect of environment and stress – RDB analysis – Standby Systems – Complex Systems – Reliability demonstration testing – Reliability growth testing – Duane curve – Risk assessment – FMEA and Fault tree analysis.

References

1.	Douglas, C. Montgomery, “Introduction to Statistical Quality Control”, 2nd Edition, John Wiley & Sons, 2001.
2.	K Krishnaiah, Applied Statistical Quality control and Improvement, PHI, 2014
3.	Smith, D.J. “Reliability Maintainability and Risk; Practical methods for

	engineers", Butterworth-Heinemann, New Delhi, 2001
4.	Grant, E.L. and Leavenworth, R.S., "Statistical Quality Control", TMH, 2000.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Control the quality of processes using control charts for variables in manufacturing industries.
CO2	Control the occurrence of defective product and the defects in manufacturing companies.
CO3	Able to perform process capability studies and to control the occurrence of defects in services through proper sampling methods.
CO4	Able to conduct reliability assessment and failure analysis on any complex systems
CO5	Understand the design concepts for reliable system and prediction aspects in industries

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	1	2	2
CO2	2	2	2
CO3	1	2	2
CO4	2	2	3
CO5	1	2	2

Course Code	:	PR672
Course Title	:	Value Engineering
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand and analyze the theory and methodology of Value Engineering, including the guidelines, performa, and checklist, for systematic and step-by-step application of the technique to current industrial problems.
CLO2	To gain knowledge about the principles of Reengineering and the various models used in the industry.
CLO3	To acquire insights into the implementation methods of Reengineering principles and their application in real-world industrial contexts.

Course Content

Definition of Value, Value Analysis, Value Engineering, Value management, Value Analysis versus Value Engineering, Value Analysis versus Traditional cost reduction techniques, uses, applications, advantages and limitations of Value analysis.

Brain storming technique, Gordon technique, Feasibility Ranking technique, Morphological Analysis Technique, ABC Analysis, Probabilistic approach, Make or Buy decisions.

Advanced Value Engineering techniques: Function, Cost- Worth Analysis (FCWA) technique, Function Analysis System (FAST) technique, Weighted Evaluation method, Evaluation matrix, Break Even Analysis, Life cycle cost (LCC); Applications of value analysis/ Value Engineering.

Orientation phase – information phase – functional analysis – creative phase – evaluation phase – recommendation phase – implementation phase – audit phaseVE benefits in service, problems using VE, case studies in different sectors.

References

1.	Richard J Park, “Value Engineering – A Plan for Inventions”, St.Lucie Press, London, 2017.
2.	Anil Kumar Mukopadhaya, “Value Engineering Concepts Techniques and Applications”, Response Books, 2003.
3.	Mukhophadhyaya A K, “Value Engineering”, Sage PublicationsPvt. Ltd., New Delhi, 2003.
4.	Larry W Zimmesman , “VE –A Practical Approach for Owners Designers and Contractors”, CBS Publishers, Delhi, 1992.
5.	Arthus E Mudge, “Value Engineering”, McGraw Hill Book Company, 1971

Course Outcomes (CO)

At the end of the course student will be able

CO1	Apply Value Engineering Techniques
CO2	Implement Value Management Tools
CO3	Evaluate and Apply Value Analysis

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR673
Course Title	:	Cost Measurement ad Productivity Measurement
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To build awareness of phenomena that influence cost of engineering systems across a variety of contexts
CLO2	To introduce the basic principles of Productivity Models and the applications of Re-Engineering Concepts required for various organizations.
CLO3	To apply cost estimation and risk management techniques in project management

Course Content

Cost Estimation Approaches, Sizing and Work Breakdown Structures, – Advanced Cost Modelling Concepts, Economic Principles, Measurement Systems, Enablers and barriers to adoption of process improvement, Risk Estimation & Project Management

Productivity concepts – Macro and Micro factors of productivity, productivity benefit model, productivity cycles.

Need for Productivity Planning – Short term and long term productivity planning – Productivity improvement approaches, Principles – Productivity Improvement techniques – Technology based, Material based, Employee based, Product based techniques – Managerial aspects of Productivity Implementation schedule, Productivity audit and control.

Productivity Models: Productivity Measurement at International, National and organization level, total productivity models. Productivity Management in manufacturing and service sectors.

References

1.	Hubbard, D. W., How to Measure Anything: Finding the Value of "Intangibles" in Business, Wiley, 2010.
2.	Sumanth, D.J, Productivity Engineering and Management, TMH, New Delhi, 1990
3.	Sudit, Ephraim F., "Productivity Based Management", Springer 1984
4.	References:
5.	Edosomwan, J.A, Organizational Transformation and Process re- Engineering, British Cataloging in publications,1996.
6.	Premvrat, Sardana, G.D. and Sahay, B.S, Productivity Management – A systems approach, Narosa Publications, New Delhi, 1998.
7.	Rotini, Federico, Borgianni, Yuri, Cascini, Gaetano, "How to Achieve Global Success in the Changing Marketplace", Springer 2012.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the practical application of cost modelling and its role in industries
CO2	Measure, evaluate, Plan and implement various productivity techniques.
CO3	Reengineer the process for improving the productivity

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR674
Course Title	:	Industrial Engineering and Productivity Management
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the importance of increasing productivity through techniques that eliminate waste and optimize operations.
CLO2	To develop proficiency in methods and tools for improving operational efficiency and resource utilization in manufacturing processes.
CLO3	To acquire the skills needed to control production costs and enhance product quality effectively.

Course Content

Productivity: Concept, Productivity improvement factors, Productivity appraisal, productivity analysis in the enterprise- The Kurosawa structural approach, Lawlor's approach, Gold's approach, Quick Productivity Appraisal approach (QPA), Inter-Firm Comparison (IFC).

Work Design: Work study, Method Engineering, Work measurement, Standard output, Time study, Work sampling, Process analysis.

Facility Layout Plan: Principles of layout and facilities planning, Material flow patterns, Material handling systems, Types of material handling equipment.

Value Engineering: Fundamental concepts and applications of value engineering, Function Analysis System Technique (FAST).

Systems Engineering: Introduction to Systems Engineering, Management Information System, Phases in System Engineering, System Life Cycle, System Maintenance.

References

1.	Prokopenko, J. "Productivity Management, A Practical Handbook", International LabourOrganisation, 1992.
2.	ILO, "Introduction to Work Study", George Kanawaty, 4th revised edition, Universal Book Corporation 2007.
3.	Apple, J.M. "Plant layout and materials handling", Ronald Press Company, Newyork, 1977.
4.	Tutty Herald G, "Compendium on Value Engineering", Indo-American Society, 1983.
5.	Andrew P Sage & James E Armstrong, "Introduction to Systems Engineering", Wiley series (2000**).**

Course Outcomes (CO)

At the end of the course student will be able

CO1	Define and understand basic Productivity Concepts, Productivity Measurement Approaches of the Organizations.
CO2	Perform Work design and facility planning.
CO3	Outline the basics of Value Engineering (VE) and System Engineering.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	2	3	3
CO2	3	2	1
CO3	2	3	2

Course Code	:	PR675
Course Title	:	Financial Management
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To start and manage new business
CLO2	To evaluate and monitor short term and long term investments
CLO3	To evaluate and monitor current asset

Course Content

Financial management – An overview - Nature, Scope, Objectives, Decisions - Management of Current asset - Short and intermediate financing

Capital budget, Nature of capital budgeting- Identifying relevant cash flows - Evaluation

Techniques: Payback, Accounting rate of return, Net Present Value, Internal Rate of Return, Profitability Index - Comparison of DCF techniques investment and evaluation

Financial and operating leverage - capital structure - Cost of capital and valuation – designing Capital structure. Dividend policy - Aspects of dividend policy - practical consideration

Principles of working capital: Concepts, Needs, Determinants, issues and estimation of working Capital - Accounts Receivables Management and factoring - Inventory management – Cash Management – Working capital finance

Long term financing -Indian capital and stock market, New issues market Long term finance: Shares, debentures and term loans, lease, hire purchase, venture capital financing, Private Equity

References

1.	Bhattacharya, S.K. and John Deardon, "Accounting for Management – Text and Cases", VikasPublishingHouse, New Delhi, 1996.
2.	Charles, T.Horn Green – "Introduction to Management Accounting", Prentice Hall,New Delhi, 1996.
3.	James, C.Van Horne, "Fundamental of Financial Management", Pearson Education, 12th Edition,2002.
4.	Prasanna chandra, "Financial Management theory and practice", TMH, Vth edition, 2001.

Course Outcomes (CO)

At the end of the course student will be able

CO1	To start and manage new business
CO2	To evaluate and monitor short term and long term investments
CO3	To evaluate and monitor current asset

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR676
Course Title	:	Marketing Management
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the marketing management strategies and segmentation factors.
CLO2	To understand the product pricing and marketing research methodologies.
CLO3	To understand the techniques of advertising, sales promotion and distribution

Course Content

Concepts in Marketing - Marketing Process, Marketing concepts, Environment-Buying Behaviour and Market Segmentation-factors, Motives, Types, Buying Decision, Segmentation factors, Demographic, Psychographic and Geographic Segmentation, Process, Patterns

Product Pricing and Marketing Research- Pricing, Decisions and Pricing Methods, Pricing Management-Marketing Planning and Strategy Formulation-Portfolio Analysis,BCG, GEC Grids

Advertising, Sales Promotion and Distribution-Impact, Goals, Types, Sales Promotion - Point of purchase, Unique Selling propositions, Characteristics, Wholesaling,Retailing, Channel Design, Logistics Modern Trends in Retailing.

References

1.	Kotler Philip, Kevin Lane Keller, “Marketing Management”, 13th Ed., Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2007.
2.	ZikmundDAmico, “The power of Marketing”, 7th edition, South Western , Thomson Learning Publications, 2006.
3.	Michael J. Etzel, Bruce J. Walker, William J. Stanton, Ajay Pandit, “Marketing – concepts and cases”, special Indian edition, McGraw Hill

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explain marketing concepts and segmentation factors
CO2	Classify various pricing methods
CO3	Explain various sales promotion aspects

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR677
Course Title	:	Total Quality Management and Six Sigma
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To realize the importance of TQM in industrial scenario
CLO2	To gain competence on applying TQM tool for the problems
CLO3	To deploy various phases of Six Sigma for real time projects

Course Content

Principles of Quality Management, Quality Management Gurus and their contributions, Introduction to Total Quality Management (TQM), Concepts of TQM, Obstacles to TQM implementation, Benefits of TQM implementation.

Basic and Advanced Quality Control tools, Quality Function Deployment, Failure Mode and Effect Analysis – Scope, steps, illustrative examples and applications.

ISO 9000 standards, ISO 9001:2008, ISO 9001:2015, ISO 14001, Quality Management System – Eight clauses, Registration, Implementation steps, Quality Planning , Quality Audit, Product and Process audit – Scope, Steps and Benefits

Introduction to Six Sigma, Six Sigma DMAIC and DMADV Methodologies, Six Sigma and Lean Management, Benchmarking.

Quality Costing – Cost categories, Prevention, Appraisal and Failure cost, construction of PAF model, TQM and Six Sigma in Service Sector, Application case studies of TQM and SixSigma, Advancements in Six Sigma methodologies

References

1.	Besterfield Dale H., BesterfieldCarol ,Besterfield Glen H., Besterfield Mary, Urdhwareshe Hemant, UrdhwareshеRashmi, Total Quality Management (TQM) 5e by Pearson, Pearson Education (30 October 2018).
2.	John Bank, “The essence of Total Quality Management”, PHI1993.
3.	Logothetis N., “Managing for Total Quality – From Deming to Taguchi and SPC”,Prentice Hall of India Pvt. Ltd.1996.
4.	Thomas Pyzdek, “Six Sigma Hand book”, Tata McGraw-Hill,2010.
5.	C.M.Creveling, L.Slutsky&D.Autis.Jr., “Design for Six Sigma”, Pearson education,2003.
6.	M.P.Poonia, Total Quality Management, Khanna Publishing; First edition (1 May 2017)

Course Outcomes (CO)

At the end of the course student will be able

CO1	Recognize the importance of TQM in industrial scenario
CO2	Competence to apply specific TQM tool for the problems
CO3	Execute various phases of Six Sigma for real time projects

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	1	2
CO2	2	3	1
CO3	3	2	1

Course Code	:	PR678
Course Title	:	Human Resource Management
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand individual and Group behavior of decision making in Organization
CLO2	To recognize Human Resource Planning for the development of Management
CLO3	To analyze the importance of values, ethics, and social responsibility in engineering, with a focus on sustainability and the role of engineers as responsible experimenters.

Course Content

Individual Behavior-Personality –Attribute – Perception –Motivation Theories

Group Behavior-Group Dynamics, Group decision making, Inter personal Relations-Dynamics of Organizational Behavior- Organizational Climate–Organizational change –the Change Process& Change Management

Human Resources Planning–HR audit, Recruitment-Selection-Interviews -Human Resources

Development-Employee Training-CareerDevelopment-PerformanceAppraisal-Compensation-safety and Health-Employee Relation-Management Development.

Values and Ethics-Engineering as experimentation-Engineers as responsible experimenters Social Responsibility, and Sustainability.

References

1.	Stephen R. Robbins, “Organizational Behavior”, PHI, 1998.
2.	Gary Dessler “Human resources Management” Prentice Hall of India 9 th edn., 2003.
3.	David A. Decenzo & Stephen R. Robbins, “Personnel/Human Resources Management”, PHI,1997.
4.	Fred Lutherans, “Organizational Behavior”, Oxford University Press, 2000.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Evaluate and apply theories of social science disciplines to workplace issues
CO2	Select, develop, and motivate workers using HRM functional capabilities
CO3	Express analytical, communication, and decision making skills considering ethics.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR679
Course Title	:	Product Life Cycle Management
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To realize the scope of product life cycle management.
CLO2	To explore the possibility of Collaborative Product Development and digital manufacturing in practical applications.
CLO3	To develop strategy for PLM applications

Course Content

Introduction to Product Life Cycle Management (PLM)- Definition, PLM Lifecyclemodel, Need for PLM, Opportunities and benefits of PLM, Components and Phases of PLM, PLM feasibility study

PLM Concepts, Processes and Workflow - Characteristics of PLM, Environment driving PLM, PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM.

Collaborative Product Development- Engineering vaulting, product reuse, smart parts, engineering change management, Bill of materials and process consistency, Digital mock-up and prototype development, design for environment, virtual testing and validation, marketing collateral

Digital Manufacturing – PLM Digital manufacturing, benefits manufacturing, manufacturing the first-one, Ramp up, virtual learning curve, manufacturing the rest,production planning

Developing a PLM strategy and conducting a PLM assessment- Strategy, Impact of strategy, implementing a PLM strategy, PLM initiatives to support corporate objectives. Infrastructure assessment, assessment of current systems and applications

References

1.	Antti Saaksvuori, AnselmiImmonen, “Product Lifecycle Management”, Springer, 2005.
2.	John Stark, “Product lifecycle management: 21st century paradigm for product realization”, Springer 2006 London, 3rd printing-2006. 441 pp., ISBN: 1-85233-810-5.
3.	Michael Grieves, “Product lifecycle management: Driving the next generation of Lean thinking”, McGraw-Hill, 2006.
4.	Kari Ulrich and Steven D. Eppinger, “Product Design & Development”, McGraw Hill, 5th Edition, 2011.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Recognize the importance of Product Life Cycle Management.
CO2	Realize potential for Collaborative Product Development and digital manufacturing in contemporary manufacturing applications.
CO3	Competence to develop PLM strategy and conduct PLM assessment

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	2	1	2
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR680
Course Title	:	Technology Management
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand technology development process
CLO2	To recognize technology management issues in the context of advanced manufacturing systems
CLO3	To equip students with knowledge on technology forecasting and planning

Course Content

Definition-scope-components-Issues in managing new technology, Life cycle approach to technology management-Approaches to forecasting, Technologyperformance parameters.

Use of Experts in technology forecasting, planning technological process, Morphological analysis of a Technology system-Techno-Economic feasibility study

Application of multi-criteria decision-making techniques in technologies evaluation and selection- AHP, fuzzy AHP-Modes of global technology transfer- Technology– Human Interface-

Organization structures and Technology Implementation issues in new technology – Technology Management issues in the context of lean, agile and sustainable systems – Intellectual Property Rights

References

1.	Joseph M. Putti, “Management – A Functional Approach”, McGraw Hill, 1997
2.	Kenneth C. Lauden ,“MIS: Organisation and Technology”, Prentice Hall, 1995
3.	James A.Senn, “Information technology in Business”,Prentice Hall, 1995
4.	Ronald J. Jordan, “Security analysis and Portfolio Management”, Prentice Hall,1995

Course Outcomes (CO)

At the end of the course student will be able

CO1	Develop an awareness of the range, scope, and complexity of technological innovation, and the issues related to managing technological change.
CO2	Explain different approaches to managing innovation with multi-criteria decision-making techniques
CO3	Clearly identify drivers and barriers to technological innovation within an

	organization.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR681
Course Title	:	Advanced Optimization Techniques
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To gain the knowledge of Traditional optimization techniques.
CLO2	To gain the knowledge of Non-Traditional optimization techniques
CLO3	To apply the appropriate optimization technique for real problems

Course Content

Classification of Optimization Problems - Optimization Techniques

Classical Optimization Techniques- Single-Variable Optimization - Multivariable Optimization with No Constraints - Multivariable Optimization with Equality Constraints- Multivariable Optimization with Inequality Constraints- Transportation

Nonlinear Programming I: One-Dimensional Minimization Methods - Unimodal Function, ELIMINATION METHODS-Unrestricted Search -Exhaustive Search - Dichotomous Search- Interval Halving Method-Fibonacci Method- Golden Section Method, INTERPOLATION METHODS -Quadratic Interpolation Method - Cubic Interpolation Method -Direct Root Methods -Newton Method-Quasi-Newton Method - Secant Method

Nonlinear Programming II: Unconstrained Optimization Techniques -DIRECT SEARCH METHODS -INDIRECT SEARCH (DESCENT) METHODS, Nonlinear

Programming III: Constrained Optimization Techniques- DIRECT METHODS-INDIRECT METHODS , Geometric Programming , Dynamic Programming , Integer Programming - INTEGER LINEAR PROGRAMMING - Stochastic Programming.

Modern Methods of Optimization - Genetic Algorithms -Simulated Annealing -Particle Swarm Optimization -Ant Colony Optimization -Optimization of Fuzzy Systems - Neural-Network-Based Optimization, Practical Aspects of Optimization.

References

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

Course Outcomes (CO)

At the end of the course student will be able

CO1	To learn the Traditional optimization techniques and apply it in engineering field.
CO2	To learn the Non Traditional optimization techniques and apply it in engineering field.
CO3	To apply both techniques to solve real engineering problems

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	1
CO2	2	2	1
CO3	1	1	3

Course Code	:	PR682
Course Title	:	Production Design and Development
Type of Course	:	PE/OE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the challenges and advancements of product development process.
CLO2	Execution of various phases of product development.
CLO3	Development of environmental friendly products/processes.

Course Content

Product development process – various phases, reverse engineering and redesigning product development process, Illustrations of product development process, S-curve, new product development.

Gathering customer needs, organizing and prioritizing customer needs, establishing product function, FAST method, establishing system functionality. Tear Down and Experimentation-Tear down method, post teardown report, benchmarking and establishing engineering specifications, product portfolios.

Generating concepts-Information gathering, brain ball, C-sketch/6-3-5 method, morphological analysis, concept selection, technical feasibility, ranking, measurement theory.

Robust design, Design for Manufacture and Assembly, axiomatic design, TRIZ, value engineering, industrial design Poka Yoke-Lean principles-Six sigma concepts.

Design for the Environment: DFE methods, life cycle assessment, weighted sum assessment method, techniques to reduce environmental impact – disassembly, recyclability, remanufacturing regulations and standards.

References

1.	Kevin Otto and Kristin Wood, -Product Design – Techniques in Reverse Engineering and New Product Development, Pearson Education, 2004.
2.	Karl T Ulrich and Steven Eppinger, Product Design and Development, McGraw Hill, 2011, Fifth Edition.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the challenges and advancements of product development process.
CO2	Execute various phases of product development.
CO3	Develop environmental friendly products/processes.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR683
Course Title	:	E-waste Assessment and Management
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To enable the students to understand the e-waste management system towards sustainability.
CLO2	To understand models and approaches for material flow assessment of e-waste.
CLO3	To understand models and approaches for quality, functionality and reverse logistics and EPR.

Course Content

E-waste, types- Materials from E-Waste- Classification- Evolution of e-waste management system- Challenges and Opportunities of E-Waste Management in Developing Countries

Models for e-waste assessment- volume estimation-market supply method- consumption and use method-regression-system dynamics-Markov chain

Quality issues related to e-waste reuse-remanufacture-models for cost effective refurbishment

Reverse logistics models for e-waste-centralized versus decentralized collection- LP, MILP, stochastic programming – Multi attribute decision making techniques- traditional and non-traditional techniques- simulation models

-waste rules and regulations in India-EPR-sustainable e-waste recycling –life cycle approach- Material Flow Analysis (MFA)-industrial case studies

References

1.	Rakesh Johri, E-waste: Implications, regulations and management in India and current global best practices, The Energy and Resources Institute, 2008.
2.	R E Hester, R M Harrison, Electronic Waste Management: Design, Analysis and Application, RSC Publishing, 2009.
3.	Vannessa Goodship, Ab Stevels, Waste Electrical and Electronic Equipment (WEEE) Handbook, Woodhead Publishing, 2012.
4.	Sunil Chopra, Peter Meindl, Supply Chain Management: Strategy, Planning and Operations-, Prentice Hall India, 3rd ed. (2007)

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the e-waste management practices

CO2	Develop and analyze quantitative models for e-waste estimation
CO3	Apply tools for managing e-waste sustainably
CO4	Analyse the outcome and offer suggestions for sustainable e-waste management

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3
CO4	3	2	3

Course Code	:	PR684
Course Title	:	Enterprise Resource Planning
Type of Course	:	PE/OE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To develop a thorough knowledge on ERP.
CLO2	To solve ERP related industrial problems
CLO3	To examine the current trends and future directions in ERP, preparing students for evolving challenges in enterprise integration

Course Content

Introduction to ERP: Enterprise – An Overview Integrated Management Information, Business Modelling, Integrated Data Model, Benefits of ERP,ERP and Related Technologies, Business Process Reengineering (BPR), Data Warehousing, Data Mining, OLAP, SCM.

ERP Implementation: ERP Implementation Lifecycle, Implementation Methodology, Organizing the Implementation, Vendors, Consultants and Users, Contracts with Vendors, Consultants and Employees, Project Management and Monitoring. Precautions in ERP Implementation, ERP Post Implementation Options, Guidelines for ERP Implementation

ERP Modules: Business Modules- Manufacturing, Materials Management, Finance, Plant Maintenance, Quality Management, Human Resources and Marketing. ERP forMake to Order Companies.

ERP Market: ERP Market Place, SAP AG, PeopleSoft, Baan, JD Edwards, Oracle, QAD, SSA, Enterprise Integration Applications (EIA), ERP and E-Commerce, ERP and Internet.

ERP Present and Future: Future Directions and Trends in ERP.

References

1.	Alexis Leon, “ERP demystified”, Tata McGraw–Hill publishing company Ltd., NewDelhi, 2002.
2.	Brady, “Enterprise Resource Planning”, Thomson Learning, 2001.
3.	S. Sadagopan, “ERP: A Managerial perspective”, Tata McGraw–Hill publishingcompany Ltd., New Delhi, 1999.
4.	Vinod Kumar Garg and Venkitakrishnan N K, “Enterprise Resource Planning Concepts and Practice”, PHI, New Delhi, 2003.
5.	Mary Sumner, “Enterprise Resource Planning”, Pearson Education, 2007.
6.	Garg V. K. and Venkitakrishnan N.K. *Enterprise Resource Planning: Concepts andPractice* Prentice – Hall of India Private Limited.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Summarize basic concepts, tools and techniques of Enterprise Resource Planning
CO2	Describe the key implementation issues of ERP
CO3	Reorganize the current and future trends in ERP

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR685
Course Title	:	Decision Support Systems
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce decision support systems and show their relationship to other computer-based information systems.
CLO2	To introduces the software systems that coordinate data, modeling, algorithms and user-friendly interfacing to create an environment for automated or interactive decision making
CLO3	To introduce technologies such as OLAP, GSS, AI, Organizational learning and Knowledge management
CLO4	To demonstrates development approaches, and to utilize DSS capacities to support different types of decisions

Course Content

DSS components- Data warehousing, access, analysis, mining and visualization-modeling and analysis-DSS development

Group support systems- enterprise DSS- supply chain and DSS-knowledgemanagement methods, technologies and tools

Artificial intelligence and expert systems- Representation in logic and schemas,semantic networks, production rules and frames, inference techniques – DSS applications

References

1.	Efraim Turban and Jay E Aronson, Decision Support and Intelligent Systems, Pearson education Asia, Seventh edition, 2005.
2.	Elain Rich and Kevin Knight, Artificial intelligence, TMH, 2006.
3.	Vicki L. Sauter, Decision Support Systems for Business Intelligence John Wiley & Sons. Turban, Decision Support And Business Intelligence Systems, 8/E, Pearson Education India, 2011.
4.	FradaBurnstein, Clyde W. Holsapple., Handbook on Decision Support Systems Springer,2008.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Recognize the importance of decisions in the work and use DSS Software Tools
CO2	Discuss the advantages/disadvantages of different types of decision support systems andevaluate their Success/Failure
CO3	Identify the types of problems that may be addressed effectively through the use of Decision Support Systems and Intelligent Systems.
CO4	Analyze practical cases from different real world problems (technical, management)

CO5	Recognize the role of Decision (and other Management) Support Systems and theirpotential for assisting in organizational and individual decision making.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	2
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

Course Code	:	PR686
Course Title	:	Knowledge Management
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the fundamental concepts in the study of knowledge and its creation, acquisition, representation, dissemination, use and re-use, andmanagement.
CLO2	To analyze and design KM systems, including infrastructural development, strategic alignment, and the role of Chief Knowledge Officers (CKOs) in organizations.
CLO3	To explore the integration of KM with social networking, technology components, and internal systems, while addressing knowledge security, change management, and Intellectual Property Rights (IPR).

Course Content

Knowledge society- Drivers of knowledge management-Intellectual capital- KM and learning organizations-Strategic alignment- Evaluation and strategic alignment

Infrastructural development and deployment- Role of CKO-Analyzing business environment-knowledge audit and analysis – designing KM team, system–Technology components- Intranet and Groupware solutions- tools for collaborative intelligence

Social networking-package choices- knowledge security-Integrating with web - based and internal operational & support systems- change management- rewardsystems- continuous improvement – Intellectual Property Rights.

References

1.	Guus Schreiber, Hans Akkermans, “Knowledge Engineering and Management”, Universities Press, 2004
2.	Elias M.Awad& Hassan M. Ghaziri, “Knowledge Management”, Pearson Education, 2004

Course Outcomes (CO)

At the end of the course student will be able

CO1	Appreciate the role and use of knowledge in organizations and institutions, and the typical obstacles that KM aims to overcome
CO2	Describe the core concepts, methods, techniques, and tools for computer support of knowledge management
CO3	Apply and integrate appropriate components and functions of various knowledge management systems

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR687
Course Title	:	Multi-Criteria Decision Making Techniques
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To provide an overview of various MCDM techniques.
CLO2	Apply MCDM techniques to solve industrial engineering problems.
CLO3	To explore the application of advanced and hybrid MCDM methods in real-world scenarios.

Course Content

Multi-Criteria Decision Making – An Overview – Classification of MCDM methods – Simple Additive Weighting method – Weighted Product method – Principle, steps and illustrative examples.

Network based MCDM methods – Analytic Hierarchy Process – Revised Analytic Hierarchy Process – Analytic Network Process – Principle, steps and illustrative examples.

Outranking MCDM methods – PROMETHEE, ELECTRE, TOPSIS - Compromise Ranking method - VIKOR, ORESTE – DEMATEL – Principle, steps and illustrative examples.

Fuzzy based MCDM methods – Hybrid MCDM methods – Group Decision Making- Graph Theory and Matrix approach – Principle, steps and illustrative examples.

Goal Programming – Balanced Scorecard Approach - MCDM application areas – Casestudies on application of MCDM techniques.

References

1.	Belton, V., Stewart, T.J. "Multiple Criteria Decision Analysis: An Integrated Approach", Kluwer Academic Publishers, Dordrecht, 2003.
2.	Triantaphyllou, E., "Multi-Criteria Decision Making Methods: A Comparative Study", Springer, 2010.
3.	Pedrycz, W., Ekel, P., Parreiras, R., "Fuzzy Multi Criteria Decision-Making: Models, Methods and Applications", John Wiley & Sons, 2011.
4.	Kahraman, C., "Fuzzy Multi-criteria Decision Making: Theory and Applications with Recent Developments", Springer, 2008.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Recognize the importance of multi criteria decision making.
CO2	Understand various MCDM methods.
CO3	Apply MCDM methods for real life applications.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	2	1	1
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR688
Course Title	:	Intelligent Industrial System
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To apply various knowledge based techniques
CLO2	To practice diagnosis and trouble shooting
CLO3	To adopt intelligent system

Course Content

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system – CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems – MAP/TOP, OSI Model, Data Redundancy, Top- down andBottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

Components of Knowledge Based Systems – Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge RepresentationSchemes, Interference Engine, Knowledge Acquisition.

Machine Learning – Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks – Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

Automated Process Planning – Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning.Knowledge Based System for Equipment Selection (KBSES) – Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing EquipmentSelection Problem.

Group Technology in Automated Manufacturing System. Structure of Knowledgebased system for group technology (KBST) — Data Base, Knowledge Base, Clustering Algorithm.

References

1.	Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
2.	Automation, Production Systems and CIM / Groover M.P./PHI/2007
3	Neural networks in Computer intelligence/ Li Min Fu/ TMH/2003
4.	Neural networks/ James A Freeman David M S kapura/ Pearson education/2004

Course Outcomes (CO)

At the end of the course student will be able

CO1	Apply various knowledge based techniques.
CO2	Practice diagnosis and trouble shooting.
CO3	Adopt intelligent system.

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	3	2	3
CO2	3	2	3
CO3	3	2	3

Course Code	:	PR689
Course Title	:	Human Machine Interaction for Manufacturing
Type of Course	:	PE
Prerequisites	:	Nil
Contact Hours	:	3
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand and apply cognitive psychology and ergonomics principles in the design and evaluation of human-machine interactions to improve usability and performance in manufacturing environments.
CLO2	To equip students with practical skills in usability evaluation methods, including statistical hypothesis testing.
CLO3	To explore the applications of AR/VR and haptics technologies in enhancing manufacturing processes.

Course Content

Introduction to Cognitive Science - Cognitive Psychology in Manufacturing - Basic principles of Visual and Auditory perception - Memory Structure - Classification and retrieval of errors - Rapid Aiming Movement - Fitts' Law - Implication in interaction design - User Modelling.

Introduction to Ergonomics - Anthropometry and Biomechanics - Sensory Capability and Display Design - Manual and VR Interactions - Human Error Causes and Mitigation.

Ergonomic Principles - Usability Evaluation – Heuristics evaluation - User Trial Design - Statistical Hypothesis Testing - t- test – ANOVA - AR/VR/Haptics Technologies in Manufacturing - History of AR/VR.

References

1.	Shneiderman B. "Designing The User Interface - Strategies for Effective Human-Computer Interaction." Pearson Education.
2.	Buxton B., Sketching User Experiences: Getting the Design Right and the Right Design, Morgan Kaufmann Publisher.
3.	Field A. Discovering Statistics Using SPSS, SAGE Publications Ltd., 2009.
4.	The Wiley Handbook of Human Computer Interaction Set, John Wiley & Sons

Course Outcomes (CO)

At the end of the course student will be able

CO1	Analyze and apply cognitive psychology principles and ergonomic design principles to enhance human-machine interactions and improve system usability in manufacturing settings.
CO2	Evaluate and implement usability testing methods, including statistical hypothesis testing, to assess and refine interfaces and systems to solve manufacturing challenges.
CO3	Comprehend the effectiveness of Augmented Reality (AR), Virtual Reality (VR), and haptics technologies in enhancing manufacturing processes

CO-PO Mapping

CO / PO	PO1	PO2	PO3
CO1	2	2	2
CO2	2	2	3
CO3	2	2	2