KUMARAGURU COLLEGE OF TECHNOLOGY,

An autonomous Institution affiliated to Anna University, Chennai

COIMBATORE – 641 049.

M. E. INDUSTRIAL ENGINEERING

REGULATIONS 2018

CURRICULUM & SYLLABI

I-IV SEMESTERS

VISION

To emerge as a center, that imparts quality higher education through the programme in the domain of Mechanical Engineering and to meet the changing needs of the society

MISSION

The Department involves in sustained curricular and co-curricular activities with competent faculty through teaching and research that generates technically capable Mechanical Engineering professionals to serve the society with delight and gratification

PROGRAM EDUCATIONAL OBJECTIVES(PEOs):

PEO1: Graduates will be mid to higher level management / engineering professionals with responsibilities in engineering management, data analysis and business operations.

PEO2: Graduates will be engineering professionals, and technology leaders who would manage such functions as plant engineering, production, supply chain and quality management.

PEO3: Graduates would function as educators or researchers in academic institutions

PROGRAM OUTCOMES (POs)

PO1: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4: Apply knowledge and competencies in manufacturing, analytics, supply chain, quality and engineering management.

PO5: Apply principles of industrial engineering to solve problems in industry.

PO6: An ability to work as part of interdisciplinary teams, communicate effectively, model and design engineering systems optimally.

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KUMARAGURU COLLEGE OF TECHNOLOGY, COIMBATORE – 641 049
REGULATIONS 2018
M.E. INDUSTRIAL ENGINEERING CURRICULUM

Semester I							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18INT0001	Research Methodology and Statistics	Theory	3	0	0	0	3
P18IET1001	Inventory and Materials Management	Theory	3	0	0	0	3
P18IET1002	Industrial Automation	Theory	3	0	0	0	3
P18IET1003	Supply Chain Management	Theory	3	0	0	0	3
P18IET1004	Quality Engineering	Theory	3	0	0	0	3
						Total Credits	**15**
						Total Hours per week	**15**
SEMESTER-II							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18INT0002	Product Design and Development	Theory	3	0	0	0	3
P18IET2005	Deterministic Operations Research	Theory	3	0	0	0	3
P18IET2006	Work Design and Human Factors Engineering	Theory	3	0	0	0	3
P18IET2007	Facilities Design	Theory	3	0	0	0	3
P18IET2008	System Modeling and Simulation	Theory	3	0	0	0	3
E1	Program Elective I	Theory	3	0	0	0	3
P18INR0002	Research Ethics	Theory	1	0	0	0	0
P18IEP2509	Industrial Engineering Lab	Laboratory	0	0	2	0	1
						Total Credits	**19**
						Total Hours per week	**20**
SEMESTER-III							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
E2	Program Elective II	Theory	3	0	0	0	3
E3	Program Elective III	Theory	3	0	0	0	3
P18IEP3701	Project Phase I	Project	0	0	0	30	12
						Total Credits	**18**
						Total Hours per week	**36**
SEMESTER-IV							
Course Code	**Course Title**	**Course Mode**	**L**	**T**	**P**	**J**	**C**
P18IEP4701	Project Phase II	Project	0	0	0	30	15
						Total Credits	**15**
						Total Hours per week	**30**

GRAND TOTAL CREDITS: 67

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List of Program Electives

Code No.	Course Title	Course Type	L	T	P	J	C
P18IEE2010	Concepts in Business Analytics	Theory	3	0	0	0	3
P18IEE2011	Industrial Safety and Hygiene	Theory	3	0	0	0	3
P18IEE2012	Services Operations Management	Theory	3	0	0	0	3
P18IEE3013	Productivity and Reengineering	Theory	3	0	0	0	3
P18IEE3014	Value Engineering	Theory	3	0	0	0	3
P18IEE3015	Engineering Economic Analysis	Theory	3	0	0	0	3
P18IEE3016	Data Analytics	Theory	3	0	0	0	3
P18IEE3017	Entrepreneurial Finance	Theory	3	0	0	0	3
P18IEE3018	Maintenance and Reliability Engineering	Theory	3	0	0	0	3
P18IEE3019	Concurrent Engineering	Theory	3	0	0	0	3
P18IEE3020	Decision Support Systems	Theory	3	0	0	0	3
P18IEE0025	Condition Monitoring	Theory	3	0	0	0	3

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P18INT0001	RESEARCH METHODOLOGY AND STATISTICS	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES:

After successful completion of this course, the students should be able to

CO 1: Understand and apply the concepts of research.
CO 2: Contrast population and sample and recognize the importance of data.
CO 3: Infer the importance of statistical analysis and tests.
CO 4: Operationalize the steps involved in Research design.
CO 5: Demonstrate skills in writing research topics.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S				M
CO2	M	S				M
CO3	M	S				M
CO4	M	S				S
CO5	M	S				S

COURSE ASSESSMENT METHODS:

Direct
1. Mid Term Assessment
2. Research Assignment, Group Presentation
3. End Semester Examination
Indirect
1. Course-End Survey

INTRODUCTION TO RESEARCH METHODS **9 Hours**

Definition and Objectives of Research, Scientific Methods, Various Steps in Scientific Research, Research planning, Selection of a Problem for Research, Formulation of the Selected Problems, Purpose of the Research, Formulation of research objectives, Formulation of research questions, Hypotheses Generation and Evaluation, Literature search, and review, Research abstract

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INTRODUCTION TO STATISTICS **9 Hours**

Population and Sample, Sampling and sample size, Population Proportion and Population Mean, Sample Proportion and Sample Mean, Estimation of Standard Error and confidence Interval, Identifying the dependent and independent variables, Introduction to data, Types of data and their importance, Descriptive Statistics and Inferential Statistics, Summarizing and describing data, Measures of Central Tendency and Measures of Dispersion, Mean, Median, Mode, Range, Variance, Standard Deviation

STATISTICAL MODELING AND ANALYSIS **12 Hours**

Probability Distributions, Normal, Binomial, Poisson, Fundamentals of Statistical Analysis and Inference, Hypothesis Testing, Confidence interval, Test of Significance, Comparison of Means (T test, Z test), Analysis of variance (ANOVA), Measures of association/Relationship, Chi-square test, Simple Regression Analysis, Multiple Regression analysis, Correlation, Data visualization techniques

RESEARCH DESIGN/PLAN **6 Hours**

Types and Methods of Research, Classification of Research, Research Ethics, Sampling Techniques, Methods of Collecting Primary Data, Use of Secondary Data, Experimentation, Design of Experiments, Survey Research and Construction of Questionnaires, Pilot Studies and Pre-tests, Data Collection methods, Processing of Data, Editing, Classification and Coding, Transcription, Tabulation, Validity and Reliability,

RESEARCH REPORTS **9 Hours**

Structure and Components of Research Report/thesis, Types of Report, Planning of Report/thesis Writing, Research Report Format, Layout of Research Report, Presentation of data and Data Analysis Reporting, Mechanism of writing a research report, Principles of Writing, Writing of Report

REFERENCE BOOKS:

1. C.R. Kothari, Research Methodology Methods and Techniques, 3/e, New Age International Publishers, 2014.
2. Ranjit Kumar, Research Methodology, A Step-by-Step Guide for Beginners, 4th Edition, Sage Publishing, 2014
3. R. Pannerselvam, Research Methodology, 2nd edition, Prentice Hall India, 2014
4. Devore, J.L., Probability and statistics for Engineering and the Sciences, Cengage Learning, e book, 8th edition, 2010

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

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P18IET1001	INVENTORY AND MATERIALS MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Generalize the view of the inventory system and outline its distribution.

CO 2: Differentiate fixed orders and fixed interval systems and formulate inventory models.

CO 3: Explain the importance of inventory control techniques and determine safety stocks.

CO 4: Discuss on purpose, inputs and outputs of MRP and review resource planning and ERP.

CO 5: Infer principles of world class manufacturing, VMI and vendor relationships in JIT.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	W	S	M	S	S	M
CO2	W	S		S	S	M
CO3	W	S	M	S		M
CO4	M	S	M	S		M
CO5	M	S				

COURSE ASSESSMENT METHODS

DIRECT
1.Mid Term Assessment (Theory Component) 2.Assignment, Group Presentation (Theory Component) 3.End Semester Examination (Theory component)
INDIRECT
1.Course-End survey

INVENTORY MANAGEMENT 9 Hours

Basic Inventory systems – Functions of Inventory – Objectives – Inventory Systems – Inventory systems under risk – Distribution inventory management.

INVENTORY MODELS 9 Hours

Inventory models – Fixed Order Versus Fixed Interval systems – Developing Special Quantity Discount Models – Inventory Model for Manufactured Items – Economic Lot Size when Stock Replenishment is instantaneous.

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INVENTORY CONTROL TECHNIQUES **9 Hours**

Inventory classification, use in controlling inventory – Setup time and inventory control – safety stock determination considering service level- Strategies to increase Inventory Turns – Reduce throughput time, Reduce WIP, eliminate waste, and reduce inventory.

MATERIAL REQUIREMENT PLANNING **9 Hours**

MRP – Purpose of MRP – Inputs to MRP – MRP Logic – Outputs to MRP – Planning Factors – Resource Planning – ERP.

MATERIALS MANAGEMENT **9 Hours**

JIT– Zero inventory concept, Excess Inventory – Materials management in JIT – The Lean and World Class Manufacturing environment – Vendor Managed Inventory – Vendor Relationship in JIT.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Lee J. Krajewski, Larry P. Ritzman, Operations Management Strategy and Analysis, Addison Wesley, 5th Edition, 1999.
2. Spencer B. Smith, Computer Based Production and Inventory Control, Prentice Hall, 1994.
3. Seetharama L. Narasimhan, Dennis W. Mc Leavy, Peter J. Billington, Production Planning and Inventory Control, Prentice education(US), 1997.
4. Richard J. Tersine, Principles of Inventory and Materials Management, 4th , Prentice Hall PTR, 1993.
5. Paul H Zipkin, Foundations of Inventory Management , McGraw Hill, 2002.

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P18IET1002	INDUSTRIAL AUTOMATION	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Appraise the applications of industrial automation and robotics.
CO2: Categorize manual and worker machine systems and outline automation principles.
CO3: Organize the role of automated transportation and storage systems.
CO4: Recall role of Group Technology and design Cellular manufacturing systems.
CO5: Model Flexible Manufacturing Systems and study its performance measures.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		S	M	S	M	
CO2	M	S	M	M		
CO3		S	M	S	S	
CO4		S		S	S	
CO5	M	S		M	M	

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component)
2. Assignment, Group Presentation (Theory Component)
3. End Semester Examination (Theory component)
INDIRECT
1. Course-End survey

INDUSTRIAL AUTOMATION AND ROBOTICS 9 Hours

Introduction to automation- Architecture of industrial automation systems- Introduction to Robotics - Classification of Robots and Characteristics- NC - CNC – Part programming – DNC – Adaptive control – Robot anatomy – Specifications – End effectors – Industrial applications.

PRODUCTION SYSTEM 9 Hours

Production systems- Facilities – Manual work systems- worker-machine systems and automated systems - Manufacturing support Systems-Automation in Production systems – Automated Manufacturing systems -Computerized manufacturing support systems - Manual labour in Production systems-Automation principles and strategies.

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AUTOMATED TRANSPORTATION AND STORAGE **9 Hours**

Automated Guided Vehicle (AGV) Systems-Types of vehicles- AGV Applications-Vehicle Guidance Technology-Vehicle Management and Vehicle Safety-Automated Storage/Retrieval Systems (ASRS) and Carousel Storage Systems - Vehicle Management and Vehicle safety.

CELLULAR MANUFACTURING SYSTEMS (CMS) **9 Hours**

Role of Group Technology(GT) in Computer Aided Manufacturing- Features of GT- Cellular manufacturing- Role of similarity in GT- Coding-Classification and clustering- Production flow analysis-CMS design factors.

FLEXIBLE MANUFACTURING SYSTEM (FMS) **9 Hours**

Types of automation, Flexibility- Types of FMS- FMS Layout configuration- Automated work piece flow-Material handling and machining- Performance measures – Bottleneck model – Extended bottleneck model – Sizing of FMS- FMS Scheduling and Control.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. John Nicholas, Competitive Manufacturing Management – Continuous Improvement, Lean Production, and Customer-Focused Qualities, McGraw-Hill International Editions,1998.
2. Sing N, and Rajamani, D, Cellular Manufacturing Systems: Design, Planning & Control, First Edition, Chapman & Hall,1996.
3. Mikell P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 2nd Edition, Prentice Hall of India Private Limited, 2001.
4. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill, New Delhi 2009.
5. Askin, R. G, and Standridge, C. R, Modelling and Analysis of Manufacturing Systems, John Wiley & sons Inc.,1993.

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P18IET1003	SUPPLY CHAIN MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Identify the factors affecting logistics and summarize basic tasks of SC.
CO 2: Outline PLC grid and recall the evolution of ERP systems and extend its best practices.
CO 3: Model economies of scale in SC and build levers for supply chain profitability.
CO 4: Analyze various transportation modes and study their performance characteristics.
CO 5: Organize factors for supply chain coordination and analyze framework of e-business.

CO / PO MAPPING
(S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	S	M	S	S	
CO2		S		S		
CO3		S		S		
CO4	M	S		S	S	
CO5		S		S	S	M

COURSE ASSESSMENT METHODS

DIRECT
1.Continuous Assessment Test (Theory Component) 2.Assignment, Group Presentation (Theory Component) 3.End Semester Examination (Theory component)
INDIRECT
1.Course-end survey

OVERVIEW 9 Hours

Logistics and supply chain - Factors affecting logistics –Basic tasks of supply chain -Supply chain approaches – Factors of Supply chain -New corporate model and paradigm - The modular company - Supply process - Procurement process.

SUPPLY CHAIN MODELS AND ERP 9 Hours

Strategy and Supply Chain Structure- PLC grid – Supply Chain and new products - Functional roles –CRM and ERP – Evolution and Components of ERP, Importance and Vendors of ERP, Implementation phases, Best practices and Future of ERP.

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SUPPLY CHAIN INVENTORY **9 Hours**

Inventory in Supply Chain-Economies of scale and Quantity discounts –Lot size based models - Managing cycle inventory- Safety stock – Product availability -Impact of aggregation on safety inventory - Managerial levers to improve supply chain profitability- Replenishment policies.

LOGISTICS AND DISTRIBUTION **9 Hours**

Logistics and Distribution Management – Transportation -Factors affecting transportation decisions – Transportation modes - Performance characteristics – Routing and Scheduling – Savings Matrix models.

SUPPLY CHAIN COORDINATION AND E-BUSINESS **9 Hours**

Bull whip effect – Supply chain coordination – Managerial levers to achieve coordination - Building strategic partnerships and trust – Designing relationships with cooperation and trust – Achieving coordination in practice-E-business and supply chain performance –Categories and framework- Setting up E-Business in practice.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Sunil Chopra and Peter Meindl, Supply Chain Management – Strategy, Planning, and Operation, 6th edition, Pearson Education, 2015.
2. Scharj, P.B., Lasen, T.S., Managing the global supply chain, Viva Books, New Delhi, 2007.
3. Ayers, J.B., Handbook of Supply Chain Management, The St. Lencie press, 2006.
4. Alexis Leon, Enterprise Resource Planning, Tata McGraw Hill – Publishing Company Ltd., New Delhi, 2nd Edition, 2008.

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P18IET1004	QUALITY ENGINEERING	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Define quality objectives and differentiate quality control and quality assurance.

CO 2: Use OC curves for drawing conclusions in sampling and determine ATI, ASN, AOQL.

CO 3: Demonstrate factorial experiments and use orthogonal arrays and Taguchi methods.

CO 4: Use the quality tools to improve the production process.

CO 5: Apply the reliability concept on system design.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		S	M	S	S	M
CO2		S		S	S	
CO3		S	W	S	S	
CO4	M	S	M	S	S	
CO5		S		M	S	

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component)
2. Assignment, Group Presentation (Theory Component)
3. End Semester Examination (Theory component)
INDIRECT
1. Course-End survey

STATISTICAL PROCESS CONTROL (SPC) 9 Hours

Quality objectives – Quality control – Quality Assurance – Process variability – Control charts for variables and attributes, multivarichart - process capability studies.

ACCEPTANCE SAMPLING 9 Hours

Economics of sampling – Acceptance sampling by variables and attributes – Single, double and sequential plans – OC curves – ATI, ASN, AOQL – Standard sampling tables.

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DESIGN OF EXPERIMENTS **9 Hours**

Factorial experiments – single factor, multi factor, 2^K design– Taguchi methods – use of orthogonal arrays.

QUALITY MANAGEMENT **9 Hours**

ISO 9000 and TQM concepts - Quality circles, tools – Zero defect management, 6 sigma – Quality Function Deployment (QFD).

RELIABILITY **9 Hours**

Reliability concepts - Reliability prediction - Statistical distributions – Series and Parallel systems – Reliability allocation – Redundancy.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Logothetis, N, Managing for total quality from Deming to Taguchi and SPC, PHI, 1997.
2. Srinath L S, Reliability Engineering, Affiliated East-West Press Pvt Ltd, New Delhi, 4th Edition, 2013.
3. Douglas, C. Montgomery, Introduction to Statistical quality control, 2nd Edition, Edition, John Wiley & Sons, 2008.
4. Grant E L, Leavenworth R S, Statistical Quality Control, 7th Edition,TMH,2000.
5. Birolini.A, Reliability Engineering Theory and Practice, 4th Edition, Springer International, 2004.

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P18INT0002	PRODUCT DESIGN AND DEVELOPMENT	L	T	P	J	C
		3	0	0	0	3

(Common to all branches)

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Apply concepts of product development and outline product planning process.
CO2: Apply relative importance of customer needs in establishing product specifications.
CO3: Identify concept generation activities and summarize the methodology involved in concept selection and testing.
CO4: Outline supply chain considerations in product architecture and understand the industrial design process.
CO5: Apply principles of prototyping in product development economics and highlight importance of managing projects.

CO / PO MAPPING
(S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1		S	M	M	M	M
CO2		S		S	M	
CO3		S	M	S	S	
CO4		S	M	S	S	S
CO5		S	M	S	M	S

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component) 2. Assignment, Group Presentation (Theory Component) 3. End Semester Examination (Theory component)
INDIRECT
1. Course-End survey

INTRODUCTION - DEVELOPMENT PROCESSES AND ORGANIZATIONS – PRODUCT PLANNING **9 Hours**

Characteristics of successful product development to Design and develop products, duration and cost of product development, the challenges of product development.
A generic development process, concept development: the front-end process, adapting the generic product development process, the AMF development process, product development organizations, the AMF organization. The product planning process, identify opportunities.
Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process.

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IDENTIFYING CUSTOMER NEEDS - PRODUCT SPECIFICATIONS 9 Hours

Gathering raw data from customers, interpreting raw data in terms of customer needs, organizing the needs into a hierarchy, establishing the relative importance of the needs and reflecting on the results and the process. Specifications, establish specifications, establishing target specifications setting the final specifications.

CONCEPT GENERATION - CONCEPT SELECTION - CONCEPT TESTING 9 Hours

The activity of concept generation clarify the problem search externally, search internally, explore systematically, reflect on the results and the process, Overview of methodology, concept screening, concept scoring, caveats. Purpose of concept test, choosing a survey population and a survey format, communicate the concept, measuring customer response, interpreting the result, reflecting on the results and the process.

PRODUCT ARCHITECTURE - INDUSTRIAL DESIGN - DESIGN FOR MANUFACTURING 9 Hours

Meaning of product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, is assessing the quality of industrial design. Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

PROTOTYPING - PRODUCT DEVELOPMENT ECONOMICS - MANAGING PROJECTS 9 Hours

Prototyping basics, principles of prototyping, technologies, planning for prototypes, Elements of economic analysis, base case financial mode, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis. Understanding and representing task, baseline project planning, accelerating projects, project execution, postmortem project evaluation.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Karl Ulrich,T, Steven Eppinger,D, Product Design and Development, McGraw Hill, 2015.
2. Chitale, AK, Gupta, RC, Product Design and Manufacturing, PHI, 2013.
3. Tim Jones, New Product Development:An Introduction to a multifunctional process, Butterworth-Heinemann, 1997.
4. Geoffery Boothroyd, Peter Dewhurst and Winston Knight, A, Product Design for Manufacture and Assembly, CRC Press, 2011.

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P18IET2005	DETERMINISTIC OPERATIONS RESEARCH	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Formulate mathematical models for engineering problems.

CO 2: Apply the linear and integer programming techniques to solve problems on linear programming extensions.

CO 3: Employ transportation, assignment and networking models for industrial problems.

CO 4: Understand dynamic programming solutions through principles of optimality.

CO 5: Apply classical optimization theory for constrained and unconstrained optimization models.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	M	S	M	M		S
CO2		S	M	S	S	S
CO3		S	M	S	S	S
CO4		S	M	S	S	M
CO5		S		S	M	W

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component) 2. Assignment, Group Presentation (Theory Component) 3. End Semester Examination (Theory component)
INDIRECT
1. Course-End survey

INTRODUCTION TO LINEAR PROGRAMMING 9 Hours

Concepts of OR, development, applications, LP Definitions, assumptions, formulation, graphical method, Simplex algorithm.

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LINEAR PROGRAMMING EXTENSIONS **9 Hours**

Dual Simplex –Primal dual relationships- Sensitivity analysis, Integer Programming-Cutting plane method, Branch and bound methods.

NETWORKS **9 Hours**

Transportation models, Assignment models, Travelling Salesmen Problems, Maximal flow models, Shortest route algorithms, Project Networks.

DYNAMIC PROGRAMMING **9 Hours**

Dynamic Programming-Principle of Optimality-characteristics and algorithms, applications, computational procedure, recursive approach.

CLASSICAL OPTIMIZATION THEORY **9 Hours**

Introduction to constrained and unconstrained optimization - Applications of Lagrange multipliers, Kuhn Tucker conditions, Newton Raphson method.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Handy M. Taha, Operations research, an introduction, 7th edition, PHI, 2003.
2. Don T. Phillips, A. Ravindran and James J. Solberg, Operations Research: Principles and practice, 2nd edition, John Wiley, India, 2006.
3. G. Srinivasan, Operations Research Principles and Applications, PHI, 2008
4. Singiresu S Rao, Engineering Optimization-Theory and Practice, John Wiley,1996.

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P18IET2006	WORK DESIGN AND HUMAN FACTORS ENGINEERING	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Analyze situations to enhance productivity and design jobs.
CO 2: Apply work study procedures and analyze outcomes.
CO 3: Apply time study procedures to determine standard time and propose O&M procedures.
CO 4: Analyze human performance involving ergonomic considerations.
CO 5: Analyze ergonomic factors in design of displays and controls.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	M	S		S	M	
CO2	M	S		S	M	M
CO3	M	S		S	M	M
CO4	M	S		S	M	W
CO5	M	S		S	M	

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component) 2. Assignment, Presentation (Theory Component) 3. End Semester Examination (Theory component)
INDIRECT
1. Course-End survey

PRODUCTIVITY AND JOB DESIGN **9 Hours**

Production Vs Productivity, productivity types, productivity and living standards, job design and productivity.

OPERATIONS ANALYSIS **9 Hours**

Work study, method study, micro motions economy, work content and ineffective time, process charts and flow diagrams to record and analyze work.

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WORK MEASUREMENT AND O&M **9 Hours**

Stopwatch time study – procedure, forms, equipment, Performance rating, Allowances, learning effect, work sampling procedure, Organization and Methods (O & M), form design.

HUMAN FACTORS ENGINEERING **12 Hours**

Ergonomics, human performance in physical work, Hawthorne Effect, Illumination, anthropometry.

DESIGN FACTORS IN ERGONOMICS **6 Hours**

Ergonomic factors to be considered in design of displays and controls, design for maintainability.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Ralph M. Barnes, Motion and Time Study – Design and Measurement of Work, John Wiley, 7th Edition,2009.
2. Bridger R.S., Introduction to Ergonomics, McGraw Hill,3rd edition,1995.
3. Khanna. O.P., Work Study – Motion and Time Study, Dhanpat Rai Publications, 19th Edition,2013.
4. McCormick, J., Human Factors in Engineering and Design, McGraw Hill, 8th Edition,1987.
5. Martin Helander, A Guide to human factors and ergonomics, Taylor and francis, 6th Edition,2005.

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P18IET2007	FACILITIES DESIGN	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Identify factors in facility location decisions and models for facility location analysis.
CO 2: Classify types of layout and label layout planning algorithms.
CO 3: Infer line balancing and build the importance of capacity planning decisions.
CO 4: Outline types of material handling equipment and examine its categories.
CO 5: Dramatize the meaning of warehouses and deduce the operating principles of warehouses.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S		S	M	S
CO2		S	M	S	M	
CO3		S	M	S	M	
CO4	M	S	M	S	M	
CO5	M	S		S	M	M

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component)
2. Assignment, Group Presentation (Theory Component)
3. End Semester Examination (Theory component)
INDIRECT
1. Course-end survey

THEORY COMPONENT CONTENTS

FACILITY LOCATION ANALYSIS 10 Hours

Facility location decisions and sequence - Factors affecting country, region and site- Qualitative and quantitative Factors-Location strategies for services and manufacturing-Facility Location Analysis-Factor rating method, Load distance method, Center of gravity method-Break even analysis method-Transportation method.

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LAYOUT DESIGN AND ALGORITHMS **10 Hours**

Facilities Requirement-Location and Layout-Need for a layout study - Objectives and Features of a good Layout-Factors influencing layout - Classification- product, process, cellular and fixed position layouts - Layouts for service businesses and warehouses - Product design cycle-Systematic Layout Planning procedure- Layout planning algorithms.

CAPACITY PLANNING **10 Hours**

Line Balancing – Meaning of Capacity -Design and effective capacity- Capacity utilization and considerations, Making Capacity planning decisions – Capacity and strategy – Managing demand – Approaches to Capacity Expansions - Strategy Driven Investments - Return on Investment and Net Present Value considerations.

MATERIAL HANDLING **8 Hours**

Material handling working definition -Importance, objectives, principles, Unit load concepts, Phases in design, Types-fixed, semi fixed and variable path models, Selection criteria in material handling–Material handling equipment and categories-Containers and packaging.

WAREHOUSE DESIGN **7 Hours**

Meaning, Benefits, Operations- Consolidation and Break bulk Warehouses-Performance measures, Operating principles- Alternative warehouse strategies- Receiving and put away principles -Planning the distribution warehouse.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Tompkins, J.A. and J.A. White, Facilities planning, John Wiley, 2010.
2. Richard Francis. L. and John A. White, Facilities Layout and location -An analytical approach, Prentice Hall Inc., 2002.
3. James Apple, M, Plant layout and Material Handling, John Wiley,3rd Edition, 1977.
4. Sundaresh S Heragu, Facilities Design,4th edition, CRC press,2016.
5. Edward Frazelle, World-Class Warehousing and Material Handling, McGraw Hill Publishers,2016.

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P18IET2008	SYSTEM MODELING AND SIMULATION	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Illustrate the concept of simulation, types of simulation and types of models.
CO 2: Generate random variates and random numbers using distributions.
CO 3: Manipulate the tests on random numbers to check the uniformity.
CO 4: Model the system using GPSS.
CO 5: Develop simulation models for queuing systems, production and inventory models.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		S	M	S	M	S
CO2		S		S		S
CO3	M	S		S		S
CO4	M	S		S	S	S
CO5	M	S	M	S	S	S

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component) 2. Assignment, Group Presentation (Theory Component) 3. End Semester Examination (Theory component)
INDIRECT
1. Course-end survey

INTRODUCTION 7 Hours

Systems, modeling, general systems theory, concept of simulation, simulation as a decision making tool, types of simulation, Types of models.

RANDOM NUMBERS 7 Hours

Pseudo random numbers, methods of random number generation, methods of generating random varieties, discrete and continuous distributions.

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TESTS FOR RANDOM NUMBERS **9 Hours**

Tests for Uniformity – Frequency test – Kolmogorov Smirnov test, Chi-square test; Tests for independency – Run tests – Runs up & down, Runs above & below mean, Run length test; Gap test, Poker test, Auto correlation test.

SIMULATION LANGUAGES **13 Hours**

Simulation languages - study of GPSS and Applications.

CASE STUDIES **9 Hours**

Development of simulation models using the simulation language studied for systems like, queuing systems, production systems and inventory systems.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Jerry Banks and John S.Carson, Barry L Nelson, David M.Nicol, Discrete event system simulation, Prentice Hall India, 5th Edition 2009.
2. Shannon, R.E. Systems simulation, The art and Science, Prentice Hall, 1975.
3. Thomas J. Schriber, Simulation using GPSS, John Wiley, 1991.
4. Subramanian KRV and Sundaresan R Kadayam, System Simulation – An Introduction to GPSS, CBS Publishers, New Delhi, 1995.
5. Zaven A. Karian and Edward J. Dudewicz, Modern Statistical, Systems, and GPSS Simulation, CRC Press, Washington DC, 1999.

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P18INR0002	RESEARCH ETHICS	L	T	P	J	C
		1	0	0	0	0

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Comprehend the importance of ethical practices in research.

CO 2: Distinguish ethical practices from unethical practices in Research Design.

CO 3: Understand ethical practices in conducting research and its dissemination.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1				S		
CO2				S		
CO3				S		

COURSE ASSESSMENT METHODS

DIRECT
1. End Semester Examination (Theory component)

INTRODUCTION TO ETHICAL PRACTICE IN RESEARCH **2 Hours**

Values Underlying Research Integrity; Framework for Good Academic Research Practices

ETHICS IN RESEARCH DESIGN & CONDUCTING RESEARCH **5 Hours**

Planning; Research Questions and Documentation; Literature Review; Data, Precision, Accuracy & errors, Research Execution, Documentation & Manuscript writing; Checks for Plagiarism, Falsification, Fabrication, and Misrepresentation.

COLLABORATIVE RESEARCH & IPR **5 Hours**

Collaboration and Authorship; Sharing of Credits; Intellectual Property

DISSEMINATION **3 Hours**

Selection of the Right Medium for Publication; Choosing the Right Journal for Publication; Translation of Research

Theory: 15	Tutorial: 0	Practical: 0	Project: 0	Total: 15 Hours

REFERENCES:

1.Chaddah, P. (2018). Ethics in competitive research: Do not get scooped; do not 1. get plagiarized Pothy. com.

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2. Beall, J. (2012). Predatory publishers are corrupting open access. Nature News, 489(7415), 179.
3. Muralidhar, K. (2019). Ethics in science education, research and governance.
4. Griffiths, P. A. (1995). On being a scientist: Responsible conduct in research. Washington (DC): National Academy Press.
5. Krause, S. D. (2007). The process of research writing. Steven D. Krause.
6. Lowry, C. (Ed.). (2016). Choosing & Using Sources: A Guide to Academic Research. Ohio State University Libraries.

Web References:

1. Guidance Document: Good Academic Research Practices. New Delhi: University Grants Commission, Sep 2020
2. UGC Regulation: Promotion of Academic Integrity and Prevention of Plagiarism in HEI's, Regulation 2018
3. NPTEL Course - Introduction to Research
4. Swayam Course - Research Ethics

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P18IEP2509	INDUSTRIAL ENGINEERING LAB	L	T	P	J	C
		0	0	2	0	1

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Identify time study importance and classify graphical tools in method study.
CO 2: Test for work sampling and MTM for better productivity.
CO 3: Solve LPP using LINDO/LINGO/MATLAB.
CO 4: To study the influence of quality using DOE.
CO 5: Model manufacturing systems using ARENA.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	S	S		S	M	M
CO2	S	S		S	M	
CO3	S	S		M	M	
CO4	S	S		M	M	M
CO5	S	S		M	M	S

COURSE ASSESSMENT METHODS

DIRECT
1. Pre/Post Experiments Test/Viva (Lab component)
2. Experimental Reports (Lab component)
3. Model examination (Lab component)
4. End Semester Examination (Lab component)
INDIRECT
1. Course-end survey

LIST OF EXPERIMENTS – Work Design Lab **15 Hours**

1. Pegboard experiment and Stop watch time study
2. Graphic tools for method study
3. Work sampling
4. MTM practice
5. Pendulum experiment

LIST OF EXPERIMENTS – Computer Applications Lab **15 Hours**

1. Solving LPP using LINDO
2. Solving LPP using LINGO
3. Solving LPP using MATLAB
4. Basic process modeling and Simulation using ARENA
5. Design of Experiment using MiniTab

Theory: 0	Tutorial: 0	Practical: 30	Project: 0	Total: 30 Hours

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P18IEP3701	PROJECT PHASE I	L	T	P	J	C
		0	0	0	24	12

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Identify or reach out to industries for a problem in the domain of Industrial Engineering.

CO 2: Interpret the objectives of the project.

CO 3: Illustrate the methodology for achieving the project objectives.

CO 4: Collect data and estimate the efficiency/productivity/effectiveness of the present system.

CO 5: Propose the project findings and present the project efficiently.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	M	S		S	M	
CO2	M	S		S		
CO3	M	S		S		M
CO4	M	S		S	M	M
CO5	M	S	S	S	M	M

COURSE ASSESSMENT METHODS:

DIRECT
1. Presentations 2. End semester viva voce examinations
INDIRECT
1. Course-End survey

PROJECT COMPONENT CONTENTS:

The scholar individually works on a topic approved by the Head of the Department who also assigns a project supervisor based on the domain of work. The scholar is permitted to identify an industry problem or otherwise within the domain of Industrial Engineering which can be even an inhouse project or a theoretical case study. A series of presentations are made by the scholar based on the review dates approved by CoE/Head of the Department which is evaluated by the project review committee. At the end of the semester, projects are also evaluated by an external examiner and internal examiner through the viva voce examination.

Theory: 0	Tutorial: 0	Practical: 0	Project: 360	Total: 360 Hours

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P18IEP4701	PROJECT PHASE II	L	T	P	J	C
		0	0	0	30	15

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Correlate the various Industrial Engineering tools relevant to the project.
CO 2: Test for the feasibility studies of the proposed methodology/tool.
CO 3: Practice or propose implementation policies on the existing system.
CO 4: Perform gap analysis and draw conclusions.
CO 5: Prepare a technical report of the project findings and present the project efficiently.

CO / PO MAPPING
(S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M	S		S	S	
CO2	M	S		S	S	
CO3	M	S		M	M	S
CO4	M	S		W	M	
CO5	M	S	S			

COURSE ASSESSMENT METHODS:

DIRECT
1. Presentations 2. Project Reports 3. End Semester Viva voce Examination
INDIRECT
1. Course-End survey

PROJECT COMPONENT CONTENTS:

The scholar shall continue Project Phase I under the same supervisor. As before, a series of presentations are made by the scholar based on the review dates approved by CoE/Head of the Department which is evaluated by the project review committee. At the end of the semester, based on completing the work to the satisfaction of the Industry/ Project Supervisor and the Project Review committee, a report is prepared on the project findings and attested by the Head of the Department. The scholars are finally evaluated by the internal and external examiners based on the project report and the viva voce examination.

Theory: 0	Tutorial: 0	Practical: 0	Project: 450	Total: 450 Hours

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P18IEE2010	CONCEPTS IN BUSINESS ANALYTICS	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Interpret business process analysis and initiate improvement methods.
CO 2: Recall critical elements of business processes and model associated activities.
CO 3: Value the importance of resource capacities and flexibility in business performance.
CO 4: Explain the role of business process management in operations improvement.
CO 5: Assess the importance of lean-six-sigma green-belt certification for business performance.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			M	S	S	S
CO2			M	S	S	
CO3			M	S	S	
CO4	M		M	S	M	M
CO5	M		M	S	M	M

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component) 2. Assignment, Group Presentation (Theory Component) 3. End Semester Examination (Theory component)
INDIRECT
1. Course-end survey

BUSINESS PROCESS (BP) ANALYSIS AND IMPROVEMENT METHODS 9 Hours

BP perspective of operations and its critical importance of process management in manufacturing and service organizations -Key Process, Performance Metric; Process Flow Times and Capacity Calculations

CRITICAL ELEMENTS OF BUSINESS PROCESSES 9 Hours

Six-Sigma: DMAIC - DEFINE Phase-Six-Sigma: DMAIC - MEASURE Phase, critical elements of BP in manufacturing and service firms,Modeling using a process modeling software(customers or entities, activities, resources, queues, storages, routings, decisions, processing logic)

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RESOURCE CAPACITIES AND FLEXIBILITY **9 Hours**

The impact of resource capacities and flexibility, process efficiencies on BP performance metrics-Six-Sigma: ANALYZE Phase-Six-Sigma: DMAIC – IMPROVE Phase

BP MANAGEMENT IN OPERATIONS IMPROVEMENT **9 Hours**

Understand the role of BP management in operations improvement strategies-Six-Sigma: DMAIC – CONTROL Phase.

LEAN-SIX-SIGMA GREEN CONCEPTS **9 Hours**

Lean-six-sigma green-belt certification - requirements of a Fortune 500 organization-Six-Sigma: DFSS (Design for Six-Sigma)

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Garg, V.K. and Venkitakrishnan, N.K., Enterprise Resource Planning concepts and practice, Prentice Hall of India, 2nd Edition, 2006.
2. Barbara G Tabachnick and Linda S Fidell, Using multivariate statistics, Pearson Education(UK), 7th edition, 2014.
3. Malhotra, N. K., Marketing research: An applied orientation, Pearson Education India,5th edition, 2008.
4. Cohen, J., Cohen, P., West, S. G., and Aiken, L. S. Applied multiple regression/correlation analysis for the behavioral sciences, Lawrence Erlbaum associates, 3rd edition, 2003.
5. Han, J., Kamber, M., & Pei, J. Data mining: concepts and techniques: concepts and techniques, Elsevier, 2011

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P18IEE2011	INDUSTRIAL SAFETY AND HYGIENE	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Label emergency management in industry and plan for security and risk assessment.

CO 2: Model human safety at work and experiment with HAZOP training practices.

CO 3: Dissect problems related to occupational health and its prevention.

CO 4: Justify industrial hygiene attainment by maintenance of safety and health standards.

CO 5: Summarize deployment of modern safety management concepts for productivity.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	M			S	S	S
CO2	M		M	S	S	W
CO3	M		M	S	S	M
CO4	M		M	S	S	S
CO5	M	M	M	S	S	S

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component)
2. Assignment, Group Presentation (Theory Component)
3. End Semester Examination (Theory component)
INDIRECT
1. Course-end survey

OPERATIONAL SAFETY 9 Hours

Hot metal operation, boiler, pressure vessels – heat treatment shop – gas furnace operation – electroplating – hot bending pipes – safety in welding and cutting, Cold – metal operation – safety in machine shop – cold bending and chamfering of pipes- metal cutting – shot blasting, grinding, painting – power press and other machines. Management of toxic gases and chemicals – industrial fires and prevention – road safety – highway and urban safety – safety of sewage disposal and cleaning – control of environmental pollution – managing emergencies in industries – planning security and risk assessments, on – site and off site. Control of major industrial hazards.

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SAFETY APPRAISAL AND ANALYSIS **9 Hours**

Human side of safety – personal protective equipment – causes and cost of accidents. Accidents prevention program – specific hazard control strategies – HAZOP training and development of employees – first aid – fire fight devices – accident reporting, investigation. Measurement of safety performance, accident reporting and investigation – plant safety inspection, job safety analysis – safety permit procedures. Product safety – plant safety rules and procedures – safety sampling – safety inventory systems. Determining the cost effectiveness of safety measurement.

OCCUPATIONAL HEALTH **9 Hours**

Concept and spectrum of health functional units and activities of operational health service – occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chloride, So2, H2s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

SAFETY AND HEALTH REGULATIONS **9 Hours**

Safety and health standards – industrial hygiene – occupational diseases prevention welfare facilities. The object of factories act 1948 with special reference to safety provisions, model rules 123a, history of legislations related to safety – pressure vessel act – Indian boiler act – the environmental protection act – electricity act – explosive act.

SAFETY MANAGEMENT **9 Hours**

Evaluation of modern safety concepts – safety management functions – safety organization, safety department- safety committee, safety audit – performance measurements and motivation – employee participation in safety - safety and productivity.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Singh, U.K and Dewan, J.M., Safety, Security And Risk Management, APH publishing company, New Delhi, 1996.
2. John V Grimaldi and Rollin. H Simonds, Safety Management, AITB publishers, 2003.

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P18IEE2012	SERVICES OPERATIONS MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Identify characteristics and nature of services and model service strategies.
CO 2: Build decision making framework and analyze its influencing factors.
CO 3: Deduce the importance of quality and correlate the models for service quality.
CO 4: Outline Operations issues and assess prominence of forecasting and scheduling.
CO 5: Analyze tools for data envelopment analysis, queuing and vehicle routing models.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1				**M**	**M**	**M**
CO2	**M**			**M**	**S**	**M**
CO3	**M**		**M**	**S**		**M**
CO4			**M**	**S**	**S**	
CO5	**M**		**M**	**S**	**S**	

DIRECT
1. Mid Term Assessment (Theory Component)
2. Assignment, Group Presentation (Theory Component)
3. End Semester Examination (Theory component)
INDIRECT
1. Course-end survey

SERVICES INTRODUCTION AND STRATEGIES 12 Hours

Manufacturing and Services, Definition of Service, Characteristic of Service, Nature of Services, Importance of Activity, Impact of technology, Types of Globalized services, Outsourcing, Issues in globalization, Service strategies.

OPERATIONS DECISION MAKING AND QUALITY 10 Hours

Framework for managing operations, International dimensions of productivity, influencing factors, Operations Decision Making, Methodology, Characteristics of decisions, Framework for decision making, Importance of Quality, Models for Service Quality, GAPS model.

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OPERATIONS ISSUES **13 Hours**

Forecasting process and accuracy, Sources of data, Demand patterns, Forecasting models – Inventory Modeling – Capacity planning - Aggregate Planning Objectives and strategies, Methods, Master scheduling objectives, Master scheduling methods, Line balancing –Balancing efficiency calculations - Critical ratios of scheduling.

TOOLS FOR SERVICES **10 Hours**

Data Envelopment Analysis, Queuing models, Vehicle Routing models

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Fitzsimmons, J.A. and Fitzsimmons, M.J, Service Management, Tata Mc Graw Hill India, 2006.
2. Haksever C, Render B, Russell RA and Murdick RG, Service Management and Operations, Prentice Hall International, USA, 2000.
3. Edward S Buffa, Modern Production/Operations Management, Wiley Eastern Ltd, 8th edition, 2003.
4. Chase Jacobs Aquilano, Operations Management for Competitive Advantages, Mcgraw Hill, 10th Edition, 2004.

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P18IEE3013	PRODUCTIVITY AND REENGINEERING	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Apply and analyze the productivity measures and models.
CO 2: Deduce the working definition of business process reengineering and its importance.
CO 3: Discuss steps to create vision, mission and guiding principles and applying the three. to five years strategic plans by using various reengineering approaches.
CO 4: Analyze the business process creation and evaluation in reengineering steps.
CO 5: Contrast roles of leaders, process owners, reengineering team and czar.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	W			S	S	S
CO2				S	M	W
CO3	M			S	M	
CO4				S	S	
CO5	M			S	S	

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component)
2. Assignment, Group Presentation (Theory Component)
3. End Semester Examination (Theory component)
INDIRECT
1. Course-End survey

PRODUCTIVITY 9 Hours

Definition of Productivity-Production and productivity-dynamics of productivity change-benefits of productivity-productivity measures -Partial productivity measure, Total productivity measure, Total factor productivity measure- Productivity measurement models -Factors influencing productivity -Techniques in improving productivity.

INTRODUCTION TO REENGINEERING 9 Hours

Business Process Re-engineering: Introduction - historical outlook – working definition of BPR – overview on four phases of Re-engineering process -Setting the Foundation for Re-

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engineering: Fallacy of programme change – elements of effective change –Importance of planning for Re-engineering - limitations – key points on planning for Re-engineering.

REENGINEERING APPROACHES **9 Hours**

Creating vision, missing and guiding principles – developing three to five-year strategic plan – scenario approach – critical issues approach-goal approach- developing yearly operational or breakthrough plans.

REENGINEERING STEPS **9 Hours**

Identification of current business processes – establishing the scope of the process – mapping project – mapping and analyzing the process. Process Creation: Creating the ideal process – testing the new process – implementing the new process. Evaluation: Evaluating the improvement (criteria) of measurements hurdles foreseen in designing and implementing meaningful measures.

ORGANIZATION FOR RE-ENGINEERING **9 Hours**

Exploration by the top management for Re-engineering – work force preparation for involvement and change planning for the future-Responsibilities and roles of leader, process owner, Re-engineering team steering committee and Re-Engineering Czar – key points for succeeding at Re-engineering – case studies.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Martand Telsang, Industrial engineering and production management, S Chand and company, 5th Edition, 2012.
2. Jeffrey N. Lowenthal, Re-engineering the organization– A step-by-step Approach to Corporate Revitalization, Tata McGraw Hill Publishing Co. Ltd., New Delhi, India, 1994.
3. Michael Hammer and James Champy, Re-engineering the corporation – A Manifesto for Business Revolution, Nicholar Barkey Publishing, London, UK, Revised Edition 2006.
4. Michael Hammer, The Re-Engineering Revolution Handbook, Herper – Collins Publishers, London, UK, 2000.

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P18IEE3014	VALUE ENGINEERING	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Understand the concepts of value stream mapping for improving process performance.
CO 2: Apply Value engineering techniques for real time industrial problems.
CO 3: Understand the importance of Team approach in Value engineering.
CO 4: Classify the various cost models of Value Engineering and phases involved in a job plan.
CO 5: Extend the value engineering knowledge with reference to industrial case studies.

CO / PO MAPPING
(S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	W		M	M	S	W
CO2	W			S	S	M
CO3				S	S	S
CO4	M		W	S	S	S
CO5			S	S	S	S

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component) 2. Assignment, Group Presentation (Theory Component) 3. End Semester Examination (Theory component)
INDIRECT
1. Course-End survey

CONCEPTS **10 Hours**

Introduction – status of VE in India and origin country – impact of VE application – types of values – types of function – function identification on product – function matrix – function analysis – elements of costs – calculation of costs – cost allocation to function – evaluation of worth in VE methodology.

TECHNIQUES **10 Hours**

General techniques: brain storming – Godson feasibility ranking – morphological analysis – ABC analysis – probability approach – make or buy. Function – cost worth analysis – function analysis – system techniques – function analysis matrix – customer oriented FAST diagram – fire

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alarm – long range plan – evaluation methods – matrix in evaluation – break even analysis.

TEAM APPROACH IN VE **9 Hours**

Team structure – team building – selection of consultant – starting training – selection of remembers – conduct of VE project study – task flow diagram – pre study phase – workshop phase, host study phase.

COST MODELS **8 Hours**

Matrix cost models – functional cost models – uses of project models – Life Cycle Costing (LCC) – purpose and implication– economic principles of LCC – types of LCC – steps in LCC.

VALUE ENGINEERING PHASES **8 Hours**

Orientation phase – information phase – functional analysis – creative phase – evaluation phase – recommendation phase – implementation phase – audit phase – Industrial case studies.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Richard J Park, Value Engineering – A Plan for Inventions, St. Lucie Press, London, 1999.
2. Mukhophadhyaya Anil Kumar, Value Engineering – Concepts, techniques and applications, Sage Publications, 2003.
3. Glen Hart and Larry W Zimmerman, Value Engineering –A Practical Approach for Owners Designers and Contractors, CBSPublishers, Delhi, 1992.
4. Arthus E Mudge, Value Engineering, McGraw Hill, 1971.
5. Miles, L.D., Techniques of Value Engineering and Analysis, McGraw Hill Book Co., 2nd Edition, 1972.

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P18IEE3015	ENGINEERING ECONOMIC ANALYSIS	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Understand and discuss the importance of economic analysis in business.
CO 2: Explain about the Value of money, banking and capital budgeting.
CO 3: Categorize the money and banking functions.
CO 4: Discuss the cost analysis concepts.
CO 5: Examine the impact of capital budgeting and depreciation in industrial economics.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	M		M	S	S	
CO2	M		M	S	S	
CO3	M		M	S	S	
CO4	M		M	S	S	
CO5	M		M	S	S	W

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component)
2. Assignment, Group Presentation (Theory Component)
3. End Semester Examination (Theory component)
INDIRECT
1. Course-end survey

DEMAND AND SUPPLY ANALYSIS — 9 Hours

Nature and scope of engineering economics – definition and scope of study-importance of economic analysis in business –Demand and supply analysis – Demand Determinants-Law of demand – elasticity of demand – Demand forecasting- Law of supply – elasticity of supply – market price.

COST ANALYSIS — 9 Hours

Types of cost - Fixed cost, variable cost, marginal cost. Cost output relationship in short and long run. Pricing decisions – situations demanding pricing decisions, pricing techniques in practice – full cost pricing, marginal cost pricing, going rate pricing, bid pricing, price fixing for a rate of return. Statutory requirements.

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MONEY AND BANKING **9 Hours**

Value of money – inflation – deflation, banking- commercial bank and its functions, central bank and its functions. New economic environment – globalization, liberalization and privatization.

CAPITAL BUDGETING **9 Hours**

Need for capital budgeting – method of apprising project profitability – rate of return method, payback period method, present value comparisons method, cost benefit analysis. Preparation of feasibility report, appraisal process, economic and commercial feasibility, financial feasibility, technical l feasibility.

DEPRECIATION AND COST ANALYSIS **9 Hours**

Causes of depreciation, objectives, methods of computing depreciation, simple problems. Breakeven analysis, break-even point – assumptions, breakeven chart, uses of breakeven analysis, simple problems. Financial statements – cash flow statement, profit and loss account, balance sheet and evaluation of projected financial statements.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. D.N. Dwivedi, Managerial Economics, Vikas Publishing House, 7th edition, 2010.
2. Samuelson P A and Nordhaus W D, Economics, Tata McGraw Hill, 2001
3. James Riggs, David D. Bedworth, Engineering Economics, McGraw Hill Education, (India) Private Limited, 4thedition, January 2004
4. G.J. Thuesen, W J.Fabrycky, Engineering economy, 9thedition, Prentice hall international series in industrial and systems engineering, 2001.
5. Aryasri, Managerial Economics and financial analysis, Tata Mc Graw-hill Education, 3rd edition, 2008.

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P18IEE3016	DATA ANALYTICS	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Recognize the importance of multivariate statistics in data analytics.
CO 2: Analyze linear and nonlinear techniques on multiple regression models.
CO 3: Compare Simple Discriminant Analysis and Multiple Discriminant analysis models.
CO 4: Explain the methodology involved in Factor analysis and Cluster Analysis.
CO 5: Review Latent variable models and introduced big data management.

CO / PO MAPPING
(S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	W		M	M	S	
CO2	W		M	M	S	
CO3			M	M	S	
CO4			M	M	S	
CO5			M	M	S	

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component)
2. Assignment, Group Presentation (Theory Component)
3. End Semester Examination (Theory component)
INDIRECT
1. Course-End survey

INTRODUCTION 9 Hours

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

BASIC CONCEPTS 9 Hours

Multiple Regression- Linear and Nonlinear techniques- Backward-Forward-Stepwise Hierarchical regression-Testing interactions (2way interaction) - Analysis of Variance and Covariance (ANOVA & ANCOVA) - Multivariate Analysis of Variance and Covariance (MANOVA & MANCOVA).

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REGRESSION AND FACTOR ANALYSIS **9 Hours**

Logistic regression: Regression with binary dependent variable -Simple Discriminant Analysis Multiple Discriminant analysis-Assessing classification accuracy- Conjoint analysis (Full profile method).

DISCRIMINANT AND CLUSTER ANALYSIS **9 Hours**

Principal Component Analysis -Factor Analysis- Orthogonal and Oblique Rotation-Factor Score Estimation-Multidimensional Scaling-Perceptual Map-Cluster Analysis (Hierarchical Vs Nonhierarchical Clustering).

ADVANCED TECHNIQUES **9 Hours**

Latent Variable Models an Introduction to Factor, Path, Structural Equation Analysis- Time series data analysis (ARIMA model) – Decision tree analysis (CHAID, CART) - Introduction to Big Data Management.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Gujarati, D. N., Basic econometrics, Tata McGraw-Hill Education, 2012.
2. Malhotra, N. K., Marketing research: An applied orientation, Pearson Education India,5th edition, 2008.
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.
5. Tabachnick, B. G., & Fidell, L. S., Using multivariate statistics, Pearson Prentice Hall, 5th edition,2001.

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P18IEE3017	ENTREPRENEURIAL FINANCE	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Identify the role of Entrepreneurship and study factors affecting entrepreneurial growth.
CO 2: Identify ownership structures for better project formulation and business growth.
CO 3: Model effective stress management and summarize causes of industrial sickness.
CO 4: Apply knowledge on sources of finance for managing working capital.
CO 5: Apply break even analysis and network analysis in costing management.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			M	M	S	S
CO2	M		M	M	S	S
CO3	M		M	M	S	S
CO4	M		M	M	S	S
CO5			M	S	S	S

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component) 2. Assignment, Group Presentation (Theory Component) 3. End Semester Examination (Theory component)
INDIRECT
1. Course-End survey

ENTREPRENEURSHIP AND ECONOMIC DEVELOPMENT 9 Hours

Evolution – Characteristics of entrepreneur – Functions of entrepreneur – Differences between entrepreneur and manager –Types of entrepreneur - Differences between entrepreneur and intrapreneur –Entrepreneurship in Economic Growth of Country –Entrepreneur and Entrepreneurship - Factors affecting entrepreneurial growth.

GROWTH STRATEGIES IN BUSINESS 10 Hours

Role of enterprises – Ownership structure – Sole proprietorship, Partnership – Project formulation and Significance - Contents of a project - Objectives and stages of business growth – Internal growth strategies –Expansion, Diversification -External growth strategies – Franchising – Joint Ventures – Acquisition – Mergers and Subcontracting-Steps for business startups.

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STRESS AND INDUSTRIAL SICKNESS **7 Hours**

Business game – Stress Management – Symptoms and causes of stress – Coping with stress - Concept and magnitude of Industrial Sickness - Process Signals and symptoms – Causes and consequences – Corrective measures –Government policies for SSI - Role of EDP.

FINANCING AND ACCOUNTING **10 Hours**

Need for financing - Financial planning for entrepreneurs- Fixed capital and working capital – Sources of finance – Term loans – Financial institutions –Working capital Management -Types of working capital –Gross working capital - Net working capital –Factors determining working capital.

COSTING **9 Hours**

Definition – Methods of costing –Classification of costs –Elements of costs –Breakeven point analysis - Network analysis -Taxation – Income Tax – Sales Tax – Excise duties.

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. S.S.Khanka, Entrepreneurial Development, S.Chand & Company Ltd., 2013.
2. Gautam, Vinayshil (Ed.), Technical Entrepreneurship, Global Business Press, New Delhi, 1992.
3. Hisrich R.D., and Peters M.P., Entrepreneurship:Strategy, Developing, and Managing a New Enterprise, Irwin, Chicago, 1995.
4. Timmons J., New Venture Creation:Entrepreneurship in the 1990's, Irwin, 1998.
5. Dollinger M.J., Entrepreneurship:Strategies and Resources, Irwin, Illionis, 1995.

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P18IEE3018	MAINTENANCE AND RELIABILITY ENGINEERING	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Extend the concept and function of maintenance department and costs associated.
CO 2: Test for reliability in terms of maintenance and study the concept of MTTF and MTBF.
CO 3: Construct statistical models for preventive and breakdown maintenance.
CO 4: Deduct pillars of TPM and analyze steps involved in FMEA.
CO 5: Analyze the role of condition monitoring techniques and expert systems in maintenance.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	M		M	M	S	S
CO2	M		M	M	S	S
CO3	M		M	M	S	S
CO4	W		M	S	S	S
CO5	W		W	M	S	S

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Assessment (Theory Component)
2. Assignment, Group Presentation (Theory Component)
3. End Semester Examination (Theory component)
INDIRECT
1.Course-End survey

MAINTENANCE CONCEPT **9 Hours**

Maintenance objectives and functions – Responsibilities of maintenance department – Five zero concept – Maintenance costs – Maintenance organization.

RELIABILITY IN MAINTANANCE **9 Hours**

Introduction – Failure analysis - Failure data - Failure functions - MTTF – MTBF – Statistical distribution -Failure time distribution– Availability – Maintainability.

MAINTENANCE MODELS **9 Hours**

Maintenance policies – Types of Maintenance - Statistical models for preventive and breakdown maintenance – Inspection and repair - Spare parts management.

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TOTAL PRODUCTIVE MAINTENANCE **9 Hours**

TPM philosophy – Policy and objectives – Pillars - Zero breakdown – loss prevention – Overall Equipment Effectiveness (OEE) – Failure Mode Effect Analysis (FMEA) – Risk Priority Number (RPN).

ADVANCED TECHNIQUES **9 Hours**

Condition monitoring- WDM, Vibration and corrosion monitoring – Signature analysis – MMIS – Expert systems – Reliability centered maintenance (RCM).

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. Charles E. Ebeling, An introduction to Reliability and Maintainability Engineering, Tata Mc Graw Hill Edition, 2009.
2. Gopalakrishnan, P. Banerji, A.K, Maintenance and spare parts management, Prentice Hall of India, 2nd Edition, 2004.
3. Seiichi Nakagima, Introduction to TPM, Productivity Press (India) Pvt.Ltd., 1993.
4. Mishra, R.C., K.Rathak, Maintenance Engineering and Management, Prentice Hall of India, 2nd Edition, 2012.

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P18IEE3019	CONCURRENT ENGINEERING	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Understand basic concepts of concurrent engineering and relevant computer applications.
CO 2: Develop the Process models and understand relationship between models.
CO 3: Discuss concurrent engineering approaches for manufacturing systems.
CO 4: Extend concurrent engineering principles to automated fabrication systems.
CO 5: Analyse manufacturing costs and evaluate investment alternatives.

CO / PO MAPPING
(S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	M		W	M	S	S
CO2	W			M	S	S
CO3			M	M	S	S
CO4			M	M	S	S
CO5	M		S	M	S	S

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Examination (Theory component) 2. Assignment, Group Presentation 3. End Semester Examination
INDIRECT
1.Course-End survey

CONCURRENT ENGINEERING **9 Hours**

Introduction - basic concepts - traditional Vs concurrent approach -schemes and tools of concurrent engineering - application of computers in the practice of concurrent engineering.

BASIC PROCESS ISSUES **9 Hours**

Process models - types - importance. Relation between models, specifications, technology, automation and process improvement. Fabrication processes – assembly processes - models of manufacturing, testing and inspection.

CONCURRENT ENGINEERING IN MANUFACTURING SYSTEMS **9 Hours**

System design procedure - features - intangibles - assembly resource alternatives - task assignment - tools and tool changing - material handling alternatives.

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CONCURRENT AUTOMATED FABRICATION SYSTEMS **9 Hours**

Introduction - methodology -preliminary and detailed work content analysis - alternatives - human resource considerations -Technical -Economic performance evaluation – concurrent assembly work station - strategic issues - technical issues - economic analysis.

ECONOMIC ANALYSIS OF SYSTEMS **9 Hours**

Types of manufacturing cost - proforma, cash-flow, determining allowable investment - evaluation of investment alternatives - sensitivity analysis - effect of recycling and rework.

Theory: 45	Tutorial: 0	Practical: 0	Project: 0	Total: 45 Hours

REFERENCES:

1. James L Nevins and Daniel E Whitney, "Concurrent Design of Products and Processes", McGraw Hill Publishing Company,1989.
2. David D Bedworth, Mark R Handerson and Philip M Wilze, "Computer Integrated Design and Manufacturing", McGraw Hill International Edition, 1991.
3. Proceedings of the "Summer School on Applications of Concurrent Engineering to Product Development" held at PSG College of Technology, May 1994.
4. Josip Stjepandic, Nel Wognum , Wim J.C. Verhagen "Concurrent Engineering in the 21st Century: Foundations, Developments and Challenges", Springer, January , 2015

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P18IEE3020	DECISION SUPPORT SYSTEMS	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO 1: Understand concept of managerial decision systems and outline its various phases.
CO 2: Demonstrate DSS components and identify sources of data for business intelligence.
CO 3: Categorize the methodologies involved in DSS development.
CO 4: Analyze evolution of enterprise DSS and knowledge management initiatives.
CO 5: Infer AI and Expert systems evolution and probe advances in intelligent support systems.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	M		M	M	S	S
CO2				M	S	S
CO3				M	S	S
CO4				M	S	S
CO5	W		M	M	S	S

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Examination (Theory component) 2. Assignment, Group Presentation 3. End Semester Examination
INDIRECT
1.Course-End survey

DECISION MAKING **9 Hours**

Managerial decision making and information systems - framework and concept for decision support, Decision making - introduction – definition - systems and models, phases of decision making process - Personality Types – Gender - Human Cognition - and Decision Styles.

MODELING AND ANALYSIS **6 Hours**

Definition – Characteristics and capabilities of DSS – DSS components - Modeling and issues – Static and dynamic models – Certainty, Uncertainty and Risk – Influence Diagrams – Structure of Mathematical models.

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BUSINESS INTELLIGENCE **6 Hours**

Nature and Sources of data – Data collection, problems and quality – Database organizations and structures -Data warehousing, Data mining and Data visualization.

DSS DEVELOPMENT **6 Hours**

Introduction – Traditional and alternative development methodologies - Change Management – DSS Technology Levels and Tools – Development Platforms – Tool Selection.

ENTERPRISE DSS AND KNOWLEDGE MANAGEMENT **9 Hours**

Communication support – Collaboration support - Group support systems and technologies – GSS meeting process – Creativity and idea generation – Enterprise information systems – Evolution – Characteristics and capabilities of executive support systems – Organizational DSS - Organizational learning and transformation – Knowledge management initiatives – approaches – implementation.

INTELLIGENT SUPPORT SYSTEMS AND ITS ADVANCEMENTS **9 Hours**

Artificial intelligence – definition and evolution - expert systems-concepts, structure, types and applications – capabilities and limitations of expert systems – Scope and types of knowledge - Knowledge acquisition methods - Knowledge verification and validation, Knowledge representation – Machine learning techniques – Fundamentals of Genetic Algorithm, Neural networks and fuzzy logic systems

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Efraim Turban, Jay E Aronson, Ting Peng Liang, Decision Support and Intelligent Systems, Prentice Hall of India, 7th Edition 2005.
2. Elain Rich and Kevin Knight, Artificial intelligence, TMH, 2006.
3. Efraim Turban, Ramesh Sharda, Dursun Delen, Decision support and Business Intelligence systems, Pearson Education, 9th Edition, 2011.

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P18IEE0025	CONDITION MONITORING	L	T	P	J	C
		3	0	0	0	3

COURSE OUTCOMES

After successful completion of this course, the students should be able to

CO1: Illustrate the fundamental principles of machinery vibration.
CO2: Explain signal analysis, fundamentals of FFT and signal conditioning.
CO3: Choose instrumentation for condition monitoring.
CO4: Explain the vibration and noise based condition monitoring techniques.
CO5: Describe Machine tool condition monitoring.

CO / PO MAPPING (S/M/W indicates strength of correlation) S- Strong, M – Medium, W - Weak						
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	M		M		M	S
CO2	M		M		M	S
CO3	M		W		S	S
CO4	W		W		S	S
CO5	W		W		S	S

COURSE ASSESSMENT METHODS

DIRECT
1. Mid Term Examination (Theory component) 2. Assignment, Group Presentation 3. End Semester Examination
INDIRECT
1.Course-End survey

FUNDAMENTALS OF MACHINERY VIBRATION **10 Hours**

Simple harmonic motion and vibration, Vibration and Spring Mass system, Degrees of freedom, Free vibration and Natural frequency, Forced vibration and Vibration isolation, Single Degree-of-Freedom Motion, Forced Vibration Response, Base Excitation, Force Transmissibility and Vibration Isolation, Tuned Vibration Absorber, Unbalanced Response, Characteristics of Vibrating Systems, Vibration of Continuous Systems, Mode Shapes and Operational Deflection Shapes

DIGITAL SIGNAL PROCESSING **08 Hours**

Classification of Signals, Signal Analysis, Frequency Domain Signal Analysis, Fundamentals of Fast Fourier Transform, Computer-Aided Data Acquisition, Signal Conditioning, Signal Demodulation, Cepstrum Analysis, Illustrative examples: Representation of signals in the

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frequency domain, Example: Natural frequency of cantilever beam, Compressor Vibration and Engine Vibration

INSTRUMENTATION **09 Hours**

Static and dynamic measurements, Frequency Response, Dynamic Range, Basic Measuring Equipment: RMS/Peak Meters, Signal Amplifiers, Oscilloscope, Counters, Instruments: Vibration, Force, Rotational Speed, Noise, Temperature, Laser-Based, Current Measurements, Ultrasonic Thickness Measurement, Data Recorders

VIBRATION AND NOISE MONITORING **09 Hours**

Principles of Vibration Monitoring, Misalignment Detection, Eccentricity Detection, Cracked Shaft, Bowed and Bent Shaft, Unbalanced Shaft, Looseness, Rub, Bearing Defects, Faults in Fluid Machines, Acoustical Terminology, Noise Sources, Sound Fields, Noise Measurements, Noise Source Identification

MACHINE TOOL CONDITION MONITORING **09 Hours**

Tool Wear, Sensor Fusion in TCM, Sensors for Tool Condition Monitoring, Direct Tool Wear Measurements, Indirect Tool Wear Measurements, Tool Condition Monitoring System: Tool Wear Estimation in a Face Milling Operation

Theory: 45	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total: 45 Hours**

REFERENCES:

1. Amiya R. Mohanty, “Machinery Condition Monitoring: Principles and Practices”, CRC Press, 2015.

2. R.A. Collacott, “Mechanical Fault Diagnosis and Condition Monitoring”, Springer, 2012.

3. V.P. Singh, “Mechanical Vibrations”, Dhanpat Rai & Co., 2014.

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