ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
REGULATIONS 2017
M.E. INDUSTRIAL ENGINEERING
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS):

I. To prepare the students with scientific, mathematical and engineering fundamentals required to excel in the field of industrial engineering.

II. To prepare the students to excel in research in India/abroad through global, rigorous post graduate education.

III. To provide the students with in depth research based knowledge in Industrial engineering to recognize, comprehend, analyze and to solve complex real life problems.

IV. To inculcate the students with the competencies to work well in local and international team environments, communication skills, professional and ethical attitude.

V. Graduates will continue to engage in life-long learning, understanding and applying knowledge and ideas of Industrial Engineering in allied disciplines.

PROGRAMME OUTCOMES:
On successful completion of the programme,

1. Graduates will demonstrate the knowledge of mathematics, science and engineering.

2. Graduates will be able to identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions.

3. Graduates will demonstrate an ability to design a system, component or process as per the needs and specifications.

4. Graduates will demonstrate an ability to use research methods including design of experiments, analysis and synthesis of the information to provide valid conclusions.

5. Graduates will demonstrate the techniques, skills, and modern engineering tools necessary for industrial engineering practice.

6. Graduates will demonstrate the knowledge of professional and ethical responsibility.

7. Graduates will demonstrate an ability to function effectively as an individual member or a leader in diverse teams, and in multidisciplinary activities.

8. Graduates will be able to communicate effectively in oral and written form.

9. Graduates will demonstrate an ability to apply project, financial management principles and techniques individually/collaboratively in project planning, implementation and control.

10. Graduates will engage in independent and life-long learning for personal and societal development.

PEO/PO Mapping

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# LIST OF ELECTIVES FOR M.E. INDUSTRIAL ENGINEERING

## SEMESTER I (Elective I)

<table>
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<tr>
<th>SL. NO</th>
<th>COURSE CODE</th>
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<td>1.</td>
<td>IL5001</td>
<td>Scheduling Algorithms</td>
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<td>Productivity Management and Re-Engineering</td>
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## SEMESTER II (Elective II & III)

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## SEMESTER III (Elective IV & V)

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OBJECTIVES:
This course is designed to provide the solid foundation on topics in applied probability and various statistical methods which form the basis for many other areas in the mathematical sciences including statistics, modern optimization methods and risk modeling. It is framed to address the issues and the principles of estimation theory, testing of hypothesis and multivariate analysis.

UNIT I  PROBABILITY AND RANDOM VARIABLES  12

UNIT II  TWO DIMENSIONAL RANDOM VARIABLES  12
Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

UNIT III  ESTIMATION THEORY  12

UNIT IV  TESTING OF HYPOTHESIS  12
Sampling distributions – Type I and Type II errors – Small and large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

UNIT V  MULTIVARIATE ANALYSIS  12
Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components - Population principal components – Principal components from standardized variables

TOTAL : 60 PERIODS

OUTCOMES:
After completing this course, students should demonstrate competency in the following topics:

- Basic probability axioms and rules and the moments of discrete and continuous random variables.
- Consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- Use statistical tests in testing hypotheses on data.
- Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.
- The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.

REFERENCES:
OBJECTIVE:
- To impart knowledge in the area of Method study and Time study so that students implement these principles and techniques to improve productivity in manufacturing and service sectors.

UNIT I  METHOD STUDY  9
Work design and Productivity – Productivity measurement - Total work content, Developing methods – operation analysis, motion & micro motion study, graphic tools.

UNIT II  WORK MEASUREMENT  9
Stop watch time study, Performance rating, allowances, standard data-machining times for basic operations, learning effect

UNIT III  APPLIED WORK MEASUREMENT  9
Methods Time Measurement (MTM) - Work sampling - Organization and Methods (O & M) - Wage incentive plans.

UNIT IV  PHYSICAL ERGONOMICS  9
Physical work load and energy expenditure, Anthropometry – measures – design procedure, Work postures-sitting, standing - measurement – ergonomic implications. design of displays and controls,

UNIT V  ENVIRONMENTAL FACTORS  9

TOTAL: 45 PERIODS

OUTCOMES:
- The students should be able to measure productivity of a work system through work system design and apply various above mentioned techniques.

REFERENCES
3. Introduction to work study, ILO, 3rd edition, Oxford & IBH publishing, 2001

OBJECTIVE:
- To learn the basics of deterministic optimization tools.

UNIT I  INTRODUCTION-LP  12
Concepts of OR, development, applications, LP Definitions, assumptions, formulation, graphical method, Simplex algorithm.

UNIT II  LP-EXTENSIONS  12
Duality- primal dual relationships -Dual Simplex — sensitivity analysis, Data Envelopment Analysis.

UNIT III  NETWORKS  12
Transportation, Assignment, Maximal flow, Shortest route, Spanning tree problems, Project Net Works.
UNIT IV  DYNAMIC PROGRAMMING  12
Dynamic Programming - Concepts, formulation, recursive approach; applications

UNIT V  WAITING LINES  12
Queuing characteristics and terminology - poison and non-poison models.

TOTAL: 60 PERIODS

OUTCOMES:
- The students can solve optimization problems of deterministic nature.

REFERENCES

IL5103   OPERATIONS MANAGEMENT   L T P C
4 0 0 4

OBJECTIVE:
- To impart knowledge in the areas of production planning and control applicable to various types of manufacturing systems.

UNIT I  INTRODUCTION  6

UNIT II  FORECASTING:  15
Need for forecasting, the forecasting process, Forecasting methods- qualitative methods, Quantitative models-Time series forecasting models, moving averages, exponential smoothing with trend and seasonal adjustment, multi-item forecasting, Simple and multiple linear regression models, monitoring and controlling forecasts.

UNIT III  INVENTORY MANAGEMENT:  15
Types of inventory, Inventory classification methods, Inventory costs Inventory models - deterministic models, probabilistic models - safety stock and reorder points – Inventory control systems.

UNIT IV  PLANNING ACTIVITIES:  15
Capacity planning- short term and long term capacity, capacity of facilities, break even capacity, use of decision trees, aggregate production planning - strategies, methods, Master Production Schedule, MRP- lot sizing, MRP II, CRP, ERP.

UNIT V  PRODUCTION CONTROL ACTIVITIES:  9
Production Activity Control, Just-in-time systems, Scheduling in Manufacturing, Theory of constraints and synchronous manufacturing.

TOTAL: 60 PERIODS

OUTCOMES:
Upon completion of this course, the students will be able to demonstrate the knowledge in fundamental concepts and issues of operations management in creating and enhancing firm’s competitive advantages.
REFERENCES

IL5104  FACILITIES DESIGN  L T P C  3 0 0 3

OBJECTIVE:
- To explain the basic principles in facilities planning, location, layout designs and materials handling systems.

UNIT I  PLANT LOCATION  9
Plant location analysis – factors, costs, location decisions – single facility location models, multi facility location models- set covering problems – warehouse location problems.

UNIT II  FACILITIES LAYOUT  9
Facilities requirement, need for layout study – types of layout, Designing product layout-Legal aspects in layout design.

UNIT III  LAYOUT DESIGN  9
Design cycle – SLP procedure, computerized layout planning procedure – ALDEP, CORELAP, CRAFT

UNIT IV  GROUP TECHNOLOGY AND LINE BALANCING  9
Group technology – Production Flow analysis (PFA), ROC (Rank Order Clustering) – Line balancing.

UNIT V  MATERIALS HANDLING  9
Principles, unit load concept, material handling system design, handling equipment types, selection and specification, containers and packaging.

TOTAL: 45 PERIODS

OUTCOMES:
- Students will be able to analyze, design and apply layout principles for layout problems, material handling and packaging.

REFERENCES

IL5111  WORK SYSTEM DESIGN LABORATORY  L T P C  0 0 2 1

AIM:
To understand the theory better and apply in practice, practical training is given in the following areas:

LIST OF EXPERIMENTS
1. Graphic tools for method study
2. Performance rating exercise
3. Stop watch time study
4. Peg board experiment
5. Work sampling
6. MTM practice
7. Study of physical performance using tread mill and Ergo cycle
8. Physical fitness testing of individuals
9. Experiments using sound level and lux meters
10. Experiments using Ergonomics software

TOTAL: 30 PERIODS

LABORATORY EQUIPMENTS REQUIREMENTS
1. Time study Trainer
2. Peg board
3. Stop watches
4. Tread mill
5. Ergo cycle
6. Any one Ergonomics software (Eg.: Ergomaster, Human CAD)

OUTCOMES:
- Students should able to design, analyze and apply the above mentioned techniques to measure productivity.

IL5112 TECHNICAL SEMINAR - I

OBJECTIVE:
To enrich the communication skills of the student through presentation of topics in recent advances in engineering/technology.

OUTCOME:
Students will develop skills to read, write, comprehend and present research papers. Students shall give presentations on recent areas of research in manufacturing engineering in two cycles. Depth of understanding, coverage and quality of presentation material (PPT/OHP) and communication skill of the student will be taken as measures for evaluation.

TOTAL: 30 PERIODS

IL5201 MANUFACTURING SYSTEMS AND MODELS

OBJECTIVES:
- To introduce the students different models used to describe the manufacturing systems and use them for effective operations of manufacturing industries.

UNIT I INTRODUCTION
Manufacturing systems – types and concepts, manufacturing automation - Performance measures – types and uses of manufacturing models.

UNIT II FOCUSSED FACTORIES
GT/CMS, FMS planning, design and control. Process planning – variant and generative approaches of CAPP, general serial systems – analysis of paced and unplaced lines.

UNIT III LEAN SYSTEMS
Characteristics of Lean systems for services and Manufacturing, Pull method of work flow, Small lot sizes, Kanban system, Value stream mapping, JIT

UNIT IV QUEUING MODELS OF MANUFACTURING
Basic Queuing models, Queuing networks, application of queuing models for AMS.
UNIT V       MARKOV AND PETRINET MODELS OF MANUFACTURING

Stochastic processes in manufacturing, discrete and continuous time Markov chain models. Concepts of Petri nets, ET0PN and GSPN models.

TOTAL: 45 PERIODS

OUTCOMES:
- The students will be able to apply the principles behind focused factory, Markov and petrinet Models, Queuing models, lean system to modern manufacturing systems.

REFERENCES

IL5202       SYSTEMS AND SIMULATION

OBJECTIVES:
- To cover various aspects of discrete dynamic, stochastic systems modeling and conducting experiments with those models on a computer.

UNIT I       INTRODUCTION

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

UNIT II      RANDOM NUMBERS AND VARIATES

Pseudo random numbers, methods of generating random variates, testing of random numbers and variates.

UNIT III     DESIGN OF SIMULATION EXPERIMENTS

Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow chart, starting condition, run size, experimental design consideration, output analysis and interpretation validation.

UNIT IV      SIMULATION LANGUAGES

Comparison and selection of simulation languages, study of any one simulation language.

UNIT V       APPLICATIONS

Development of simulation models using the simulation language studied for systems like, queuing systems, production systems, inventory systems, maintenance and replacement systems, investment analysis and network.

TOTAL: 45 PERIODS

OUTCOMES:
- The students will be able to analyze, models and simulate experiments to meet real world systems and evaluate the performance.

REFERENCES
OBJECTIVES:

- To facilitate the students in knowing the application of statistical techniques in Quality control and assurance.

UNIT I INTRODUCTION
Statistical concepts for quality- Fundamentals of quality- history, Quality definitions, Quality dimensions, Quality terminology- Inspection, Quality control, SQC, Quality Assurance, Quality planning- policies & objectives, Quality costs – Economics of quality, Quality loss function, Quality Vs productivity, Quality Vs reliability.

UNIT II STATISTICAL PROCESS CONTROL
Process variation, Control charts for variables- $\bar{X}$, R and S charts- preliminary decisions, computation of control limits, Construction and interpretation, Relation between process in control and specification limits, modified and warning control limits, O.C. curve for $\bar{X}$ chart, Control procedure, adjustment for trend in process mean.

UNIT III SPECIAL CONTROL PROCEDURES
Control charts for attributes- p, np, c and u charts, demerits control chart, O.C curve for p-chart, Control charts for individual measurements- X-chart, moving average and moving range charts, cumulative-sum and exponentially weighted moving average control charts, multi-vari chart.

UNIT IV PROCESS AND MEASUREMENT SYSTEM CAPABILITY
Process stability, process capability analysis using a Histogram or normal probability plot and control chart, process capability indexes, Gauge capability studies, setting specification limits.

UNIT V ACCEPTANCE SAMPLING

TOTAL: 60 PERIODS

OUTCOMES:

- Control the quality of processes using contro charts for variables in manufacturing industries.
- Control the occurrence of defective product and the defects in manufacturing companies.
- Control the occurrence of defects in service.

REFERENCES
3. IS 2500 Standard Sampling plans.
OBJECTIVES:
- To impart the fundamental knowledge in logistics and supply chain management.

UNIT I INTRODUCTION

UNIT II LOGISTICS MANAGEMENT

UNIT III SUPPLY CHAIN NETWORK DESIGN
Distribution in Supply Chain - Factors in Distribution network design - Design options - Network Design in Supply Chain - Framework for network Decisions

UNIT IV SOURCING AND REVENUE MANAGEMENT IN SUPPLY CHAIN
Supplier selection and Contracts - Design collaboration - Procurement process. Revenue management in supply chain

UNIT V COORDINATION AND INFORMATION TECHNOLOGY IN SUPPLY CHAIN
Supply chain coordination - Bullwhip effect - Effect of lack of coordination and obstacles - IT and SCM - supply chain IT framework - E Business and SCM. Metrics for SC performance - Case Analysis

OUTCOMES:
- The students should apply information, demand forecasting, inventory management, transportation, warehousing & distribution, protective packaging, order processing, material handling, purchasing & sourcing management techniques to manufacturing systems.

REFERENCES:
1. David J. Bloomberg, Stephen Lemay and Joe B. Hanna, Logistics, PHI 2010
3. Jeremy F. Shapiro, Modeling the supply chain, Thomson Duxbury, 2002
OBJECTIVES:
- To understand the theory better and apply in practice, practical training is given in the following areas.
- Development of Simple Programs for Statistical analysis: Frequency distribution, Applications of Graphics. (Charts, Graphs etc).
- Programs for OR applications like Initial solution of Transportation Problems, Net Works etc
- Solving optimization problems using software packages like LINDO, LINGO, TORA.Excel Solver.
- Development of Random number generator, Testing of random number generator. Non-uniform Random varieties generation and testing.Single server Queuing simulation, Case Studies
- Program for Simulation of Single server Queueing System – Use of Simulation software. Case studies.

TOTAL: 30 PERIODS

LABORATORY EQUIPMENTS REQUIREMENTS
1. TURBO C++ Software
2. LINDO Software
3. LINGO Software
4. TORA Software
5. GPSS Software
6. MS EXCEL

OBJECTIVE:
To enrich the communication skills of the student through presentation of topics in recent advances in engineering/technology

OUTCOME:
Students will develop skills to read, write, comprehend and present research papers. Students shall give presentations on recent areas of research in manufacturing engineering in two cycles. Depth of understanding, coverage, quality of presentation material (PPT/OHP) and communication skill of the student will be taken as measures for evaluation.

TOTAL: 30 PERIODS

OBJECTIVES:
- To impart knowledge to design experiments to a problem situation using traditional experimental designs as well as Taguchi methods.
- To develop skill to conduct experiments and analyze the data to determine the optimal process parameters that optimize the process.
UNIT I  EXPERIMENTAL DESIGN FUNDAMENTALS  12
Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps in experimentation, sample size, normal probability plot, linear regression models.

UNIT II  SINGLE FACTOR EXPERIMENTS  12
Completely randomized design, Randomized block design, Latin square design. Statistical analysis, estimation of model parameters, model adequacy checking, pair wise comparison tests.

UNIT III  MULTIFACTOR EXPERIMENTS  12
Two and three factor full factorial experiments, Randomized block factorial design, Experiments with random factors, rules for expected mean squares, approximate F-tests. 2^K factorial Experiments.

UNIT IV  SPECIAL EXPERIMENTAL DESIGNS:  12
Blocking and confounding in 2^K designs. Two level Fractional factorial design, nested designs, Split plot design, Response Surface Methods.

UNIT V  TAGUCHI METHODS  12
Steps in experimentation, design using Orthogonal Arrays, data analysis, Robust design- control and noise factors, S/N ratios, parameter design, Multi-level experiments, Multi-response optimization.

TOTAL: 60 PERIODS

OUTCOMES:
- The students will be able to apply experimental techniques to practical problems to improve quality of processes/products by optimizing the process/product parameters.

REFERENCES

IL5001  SCHEDULING ALGORITHMS  L T P C
3 0 0 3

OBJECTIVE:
- To impart knowledge on various scheduling algorithms applicable to single machine, parallel machines, flow shop and job shop models.

UNIT I  SCHEDULING THEORY  9

UNIT II  SINGLE MACHINE SCHEDULING  9
Pure sequencing model – Hodgson’s algorithm – Smith’s rule – Wilkerson Irwin algorithm – Neighborhood search – Dynamic programming technique – Branch and Bound algorithm – Non simultaneous arrivals – Minimizing $\bar{T}$ and $\bar{F}$ for dependent jobs – Sequence dependent set up times.
UNIT III   PARALLEL MACHINE SCHEDULING  9
Preemptive jobs: McNaughton’s algorithm – Non preemptive jobs – Heuristic procedures –
Minimizing $\bar{F}_w$: H₁ & Hₘ heuristics – Dependent jobs: Hu’s algorithm – Muntz Coffman algorithm.

UNIT IV   FLOW SHOP SCHEDULING  9
Despatch index heuristic.

UNIT V   JOB SHOP SCHEDULING  9
Characteristics –Graphical tools – Jackson’s algorithm – Feasible, Semi-active and Active
schedules – Single pass approach – Non delay schedule – Priority dispatching rules – Heuristic
schedule generation – Open shop scheduling.

OUTCOMES:
- Students will be able to design, analyze and implement single machine, parallel machine, flow shop, and job shop scheduling algorithms.

REFERENCES
OUTCOMES:
- The need for innovation in product design and development and the technology developed can be known by this subject.

REFERENCES

IL5003 PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING L T P C
3 0 0 3

OBJECTIVE:
- To introduce the basic principles of Productivity models and the applications of Re-Engineering concepts required for various organizations.

UNIT I PRODUCTIVITY 9
Productivity Concepts – Macro and Micro factors of productivity – Dynamics of Productivity - Productivity Cycle Productivity Measurement at International, National and Organisation level - Productivity measurement models

UNIT II SYSTEMS APPROACH TO PRODUCTIVITY MEASUREMENT 9
Conceptual frame work, Management by Objectives (MBO), Performance Objectivated Productivity (POP) – Methodology and application to manufacturing and service sector.

UNIT III ORGANISATIONAL TRANSFORMATION 9
Elements of Organisational Transformation and Reengineering-Principles of organizational transformation and re-engineering, fundamentals of process re-engineering, preparing the workforce for transformation and re-engineering, methodology, guidelines, LMI CIP Model – DSMC Q & PMP model.

UNIT IV RE-ENGINEERING PROCESS IMPROVEMENT MODELS 9
PMI models, PASIM Model, Moen and Nolan Strategy for process improvement, LMICIP Model, NPRDC Model.

UNIT V RE-ENGINEERING TOOLS AND IMPLEMENTATION 9
Analytical and process tools and techniques – Information and Communication Technology – Implementation of Reengineering Projects – Success Factors and common implementation Problem – Cases.

TOTAL: 45 PERIODS

OUTCOMES:
The student will be able to:
- Measure and evaluate productivity.
- Plan and implement various productivity techniques.
- Re-Engineer the process for improving the productivity.
- Implement BPR tools for improving the productivity.
REFERENCES

IL5004 TOTAL QUALITY MANAGEMENT  L  T  P  C
3  0  0  3

OBJECTIVES:
- To understand the various principles, practices of TQM to achieve Quality.
- To learn the various statistical approaches for Quality control.
- To understand the TQM tools for continuous process improvement.
- To learn the importance of ISO and Quality systems.

UNIT I INTRODUCTION

UNIT II TQM PRINCIPLES
Leadership, Customer Satisfaction, Employee Involvement, Continuous Process Improvement, Supplier Partnership, Performance Measures, Cost of Quality.

UNIT III TOOLS AND TECHNIQUES–I
Benchmarking, Information Technology, Quality Management Systems and environmental management systems.

UNIT IV TOOLS AND TECHNIQUES–II
QFD, FMEA, Quality Circles, TPM, Traditional Quality Tools and Management tools.

UNIT V IMPLEMENTATION OF TQM
Steps in TQM implementation, national and international quality awards, case studies.

TOTAL: 45 PERIODS

OUTCOMES:
- The student would be able to apply the tools and techniques of quality management to manufacturing and service processes.

REFERENCES
OBJECTIVES:
- Studying the work procedure and understanding the relationships between the workers and working environments.
- To study the applications of ergonomic principles and physiology of workers.
- To know the concepts of personal protective equipment and its usages.
- To create the knowledge in process and equipment design in safety aspects.

UNIT I  ERGONOMICS AND ANATOMY  9
Introduction to ergonomics: The focus of ergonomics, ergonomics and its areas of application in the work system, a brief history of ergonomics, attempts to humanize work, modern ergonomics, future directions for ergonomics.
Anatomy, Posture and Body Mechanics: Some basic body mechanics, anatomy of the spine and pelvis related to posture, posture stability and posture adaptation, low back pain, risk factors for musculoskeletal disorders in the workplace, behavioural aspects of posture, effectiveness and cost effectiveness, research directions.

UNIT II  HUMAN BEHAVIOR  9

UNIT III  ANTHROPOMETRY AND WORK DESIGN FOR STANDING AND SEATED WORKS  9
Designing for a population of users, percentile, sources of human variability, anthropometry and its uses in ergonomics, principals of applied anthropometry in ergonomics, application of anthropometry in design, design for everyone, anthropometry and personal space, effectiveness and cost effectiveness.
Fundamental aspects of standing and sitting, an ergonomics approach to work station design, design for standing workers, design for seated workers, work surface design, visual display units, guidelines for design of static work, effectiveness and cost effectiveness, research directions.

UNIT IV  MAN - MACHINE SYSTEM AND REPETITIVE WORKS AND MANUAL HANDLING TASK  9
Applications of human factors engineering, man as a sensor, man as information processor, man as controller – Man vs Machine.
Ergonomics interventions in Repetitive works, handle design, key board design- measures for preventing in work related musculoskeletal disorders (WMSDs), reduction and controlling, training Anatomy and biomechanics of manual handling, prevention of manual handling injuries in the work place, design of manual handling tasks, carrying, postural stability.

UNIT V  HUMAN SKILL AND PERFORMANCE AND DISPLAY, CONTROLS AND VIRTUAL ENVIRONMENTS  9
A general information-processing model of the users, cognitive system, problem solving, effectiveness.
Principles for the design of visual displays- auditory displays- design of controls- combining displays and controls- virtual (synthetic) environments, research issues.

TOTAL: 45 PERIODS
OUTCOMES:
- Students can have the knowledge in work procedure and applications in hazardous workplaces.
- Students can design their own safety devices and equipment to reduce the accidents possibilities.
- Students will be able to incorporate human factors in design of Personal protective equipment.
- They know the risk factors, guide lines for safe design of man machine systems considering human factors.

REFERENCES
1. Introduction to Ergonomics, R.S. Bridger, Taylor and Francis
2. Ergonomic design for organizational effectiveness, Michael O’Neill
3. Human factors in engineering and design, MARK S.SANDERS
4. The Ergonomics manual, Dan Mc Leod, Philip Jacobs and Nancy Larson

IL5005 SOFTWARE QUALITY ENGINEERING

OBJECTIVE:
- To gain knowledge in the application of Quality Engineering in software industries.

UNIT I SOFTWARE QUALITY
Definition of Software Quality, Quality Planning, Quality system – Quality Control Vs Quality Assurance – Product life cycle – Project life cycle models.

UNIT II SOFTWARE ENGINEERING ACTIVITIES

UNIT III SUPPORTING ACTIVITIES
Metrics, Reviews –SCM – Software quality assurance and risk management.

UNIT IV SOFTWARE QUALITY MANAGEMENT TOOLS
Seven basic Quality tools – Checklist – Pareto diagram – Cause and effect diagram – Run chart – Histogram – Control chart – Scatter diagram – Poka Yoke – Statistical process control – Failure Mode and Effect Analysis – Quality Function deployment – Continuous improvement tools – Case study.

UNIT V QUALITY ASSURANCE MODELS

TOTAL: 45 PERIODS

OUTCOMES:
- The practice of Quality control and Assurance in software industries can be best understood after studying this subject.

REFERENCES
OBJECTIVES:
- To study and understand the concept of Engineering Economics and apply the same in the real world.
- To gain knowledge in the field of cost estimation to enable the students to estimate the cost of various manufacturing processes.

UNIT I  DEMAND ANALYSIS

UNIT II  PRODUCTION FUNCTION AND COST ANALYSIS

UNIT III  MARKET COMPETITION AND PRICING

UNIT IV  PROFIT ANALYSIS
The concept of profit: Profit planning, control and measurement of profits. Profit maximization – Cost volume profit analysis – Investment Analysis.

UNIT V  COSTING
Job costing-Process costing-Operating costing and Standard Costing (variance analysis).

REFERENCES
1. Jawaharlal, Cost Accounting, Tata McGraw Hill,

OBJECTIVE:
- To make the students acquire the basic knowledge in lean six-sigma and make them understand the various phases involved in the implementations.

UNIT-I  INTRODUCTION TO LEAN AND SIX-SIGMA
Introduction to Lean- Definition, Purpose, features of Lean ; top seven wastes, Need for Lean, Elements of Lean Manufacturing, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six-sigma, origin of six-sigma, six-sigma concept, and Critical success factors for six-sigma. Evolution of lean six-sigma, the synergy of Lean and six sigma, Definition of lean six-sigma, the principles of lean six-sigma, Scope for lean six sigma, Features of lean six-sigma, the laws of lean six-sigma, Benefits of lean six-sigma.

UNIT-II  INITIATION, RESOURCE AND PROJECT SELECTION FOR LEAN SIX SIGMA
Top management commitment – Infrastructure and deployment planning, Process focus, organizational structures, Measures – Rewards and recognition, Infrastructure tools, structure of transforming event, Launch preparation. Resource and project selection, Selection of Black belts,
Selecting projects – Benefit/Effort graph, Process mapping, value stream mapping, Balanced score card for project identification, project suitable for lean six sigma.

UNIT-III TEAM BUILDING AND THE DMAIC PROCESS  6
Predicting and improving team performance, nine team roles, Team leadership, Team building & Team exercise. DMAIC process and toll gate reviews.

UNIT-IV THE TOOLS FOR LEAN SIX- SIGMA  12
Define tools- Project Definition Form(PDF) and SIPOC; Measure tools- Process mapping, Parato chart, cause and effect matrix, FMEA, Brain-storming, NGT, Multi-voting, Cause & Effect diagram, Check sheets, Gauge R&R, Run charts, Control charts and process capability analysis; Analyze tools- scatter plots, ANOVA, Regression analysis and time trap analysis; Improve tools- Mistake proofing, KAIZEN, Reducing congestions and delays, SMED, TPM, Design of Experiments and the pull system; Control tools-SPC.

UNIT-V INSTITUTIONALIZING AND DESIGN FOR LEAN SIX-SIGMA  6
Need for institutionalizing Lean Six- Sigma, Comply, commit, embed and encode; Steps in institutionalizing the Lean Six- Sigma; Objectives of Design for Lean Six-Sigma,Improving design velocity,Reducing product line complexity, Design for Lean Six-Sigma-QFD,TRIZ, Robust design.

TOTAL: 45 PERIODS

OUTCOMES:
• To develop a comprehensive set of skills that will allow students to function effectively by using Lean six-sigma for quantitative analysis.

REFERENCES
5. Rother M. and hook J., Learning to See: Value Stream Mapping to add value and Eliminate Muda, Lean Enterprise Institute, Brookline, MA.

IL5008 DECISION SUPPORT AND INTELLIGENT SYSTEMS

OBJECTIVE:
• To impart knowledge on basics of DSS and knowledge based systems.

UNIT I DECISION MAKING  5
Managerial decision making, system modeling and support-preview of the modeling process-phases of decision making process.

UNIT II MODELING AND ANALYSIS  12
DSS components- Data warehousing, access, analysis, mining and visualization-modeling and analysis-DSS development.

UNIT III KNOWLEDGE MANAGEMENT  12
Group support systems- enterprise DSS- supply chain and DSS-knowledge management methods, technologies and tools.
UNIT IV  INTELLIGENT SYSTEMS  12
Artificial intelligence and expert systems-concepts, structure, types-knowledge acquisition and validation, knowledge representation

UNIT V  IMPLEMENTATION  4
Implementation, integration and impact of management support systems.

TOTAL: 45 PERIODS

OUTCOMES:
- The students will be able to make decisions in the semi-structured and un-structured problem situations using systems and semantic networks.

REFERENCES

IL5009  DESIGN AND ANALYSIS OF ALGORITHMS  L T P C
3 0 0 3

OBJECTIVE:
- To learn the basic concepts in design and analysis of algorithms.

UNIT I  INTRODUCTION:
Algorithms, basic steps in development.

UNIT II  REVIEW OF ANY ONE OF THE STRUCTURED LANGUAGES  10
ALGOL, PL/I, Ada, Pascal, XPL

UNIT III  BASIC TOOLS:
Top down, Structured programming, networks, data structure.

UNIT IV  METHODS OF DESIGN:
Sub goals, hill climbing and working backward, heuristics, back track programming, Branch and bound recursion process, program testing, documentation, Meta heuristics.

UNIT V  APPLICATION:
Development of sorting, searching, algorithms-combinatorial problems, shortest path, probabilistic algorithms.

TOTAL: 45 PERIODS

OUTCOMES:
- The students will get the skills to design and develop algorithms for solving industrial engineering related problems.

REFERENCES
Objective:

• To learn the basic concepts of object oriented programming.

Unit I  Fundamentals of Object Oriented Programming  5
Elements of OOP, classes, subjects, messaging, inheritance, polymorphism, OOP paradigm versus procedural paradigm, object-oriented design.

Unit II  C++ Basics  15
Expression and statements, operators, precedence, type conversion, control statements, loops, Arrays structures, functions, argument passing, reference argument, overloaded function.

Unit III  C++ Class  5
Definition, class objects, member functions, class argument, operator overloading, user defined conversions.

Unit IV  Class Derivation  10
Derivation specification, public and private base classes, standard conversions under derivation, class scope, initialization and assignment under derivation.

Unit V  Application  10
OOP’s applications in Industrial Engineering.

Total: 45 Periods

Outcomes:

• The students will acquire exposure in logical thinking and programming skills in solving real time problems.

References

UNIT III    BUDGETING                  10
Requirements for a sound budget, Fixed budget – Preparation of sales and Production budget,
Flexible budgets, Zero base budgeting and budgetary control.

UNIT IV    FINANCIAL MANAGEMENT      10
Investment decisions – Capital investment process, Type of investment proposals, Investment
appraisal techniques – Payback period method, Accounting rate of return, Net present value
method, Internal rate of return and Profitability index method.

UNIT V    FINANCIAL DECISIONS        5
Cost of capital – Capital structure – Dividend policy – Leasing.

TOTAL : 45 PERIODS

OUTCOMES:
- To possess the principles and techniques of accounting and managing finance in an
  organization.

REFERENCES
   Publishing house, New Delhi, 1996.
2. Charles, T.Horn Green – “Introduction to Management Accounting”, Prentice Hall, New Delhi,
   1996.

IL5012    INDUSTRIAL AUTOMATION

OBJECTIVES:
- This course introduces the fundamental concepts and elements of computer-integrated
  manufacturing.
- The course exposes students to various aspects of automated manufacturing such as fixed
  automation and programmable automation.

UNIT I    AUTOMATION            5
Types of production – Functions – Automation strategies – Production economics – Costs in
manufacturing – Break-even analysis.

UNIT II   AUTOMATED FLOW LINES    10
Transfer mechanism - Buffer storage – Analysis of transfer lines - Automated assembly systems.

UNIT III  NUMERICAL CONTROL AND ROBOTICS 10
effectors - Sensors - Robot cell design – CAD/CAM.

UNIT IV   AUTOMATED HANDLING AND STORAGE 10
Automated material handling systems – AGV- AS/RS – carousel storage – Automatic data capture
– bar code technology- RFID

UNIT V    MANUFACTURING SUPPORT SYSTEMS 10
Product design and CAD, CAD/CAM and CIM, Computer aided process planning- variant and
generative approaches, Concurrent engineering and design for manufacture, Lean production,
Agile manufacturing.

TOTAL: 45 PERIODS
OUTCOMES:
Students will be able to:
- Select automated equipment based on break-even quantity and compute cost per component.
- Analyze an automated flow line with buffer for its performance measures.
- Identify the elements of manufacturing automation; these include CNC, Robotics, automated assembly and material handling.
- Understand manufacturing planning and control systems.

REFERENCES

IL5013 OPTIMIZATION TECHNIQUES

OBJECTIVES:
- To understand the non-linear problem.
- To know about multi-objective problem.
- To create awareness of Meta heuristic algorithms.

UNIT I INTRODUCTION
Classification of optimization problems, concepts of design vector, Design constraints, constrains surface, objective function surface and multi-level optimization, parametric linear programming

UNIT II DECISION ANALYSIS
Decision Trees, Utility theory, Game theory, Multi Objective Optimization, MCDM- Goal Programming, Analytic Hierarchy process, ANP

UNIT III NON-LINEAR OPTIMIZATION
Unconstrained one variable and multi variable optimization, KKT Conditions, Constrained optimization, Quadratic programming, Convex programming, Separable programming, Geometric programming, Non-Convex programming

UNIT IV NON-TRADITIONAL OPTIMIZATION -1
Classes P and NP, Polynomial time reductions, Introduction to NP- Hard problems, Overview of Genetic algorithms, Simulated Annealing, neural network based optimization.

UNIT V NON-TRADITIONAL OPTIMIZATION -2
Particle Swarm optimization, Ant Colony Optimization, Optimization of Fuzzy Systems.

TOTAL: 45 PERIODS

OUTCOMES:
- The students will gain familiarity with some of the well-known optimization techniques and their applicability in a real setting.
- The students will gain awareness on the usefulness and limitation of optimization.

REFERENCES
CM5094  PROJECT MANAGEMENT  L T P C  3 0 0 3

OBJECTIVE:
- To develop the skills that professionals need to become effective project managers. With a specific focus on developing practical project management skills for the students to apply proven methodologies to projects within their individual fields.

UNIT I  PROJECT SELECTION AND PROJECT ORGANISATION:  9
Project selection and nature of selection, project portfolio process, Analysis under uncertainty, Project organisation, Matrix organisation, Mixed organisational systems.

UNIT II  PROJECT PLANNING:  9
Project Co-ordination, sorting out the projects, Work breakdown structure, system integration, Interface co-ordination, Project life cycle, Conflict and negotiation.

UNIT III  PROJECT IMPLEMENTATION:  12
Estimating project budgets, Process of cost estimation, Scheduling : Network techniques PERT and CPM, crashing a project, Resource loading and leveling, Multiproduct scheduling and resource allocation.

UNIT IV  MONITORING AND INFORMATION SYSTEMS:  9
Planning-Monitoring-Controlling cycle, Information needs and the reporting process, Computerized PMIS, Earned value analysis, Types of project control processes, control as a function of management, control of change and scope.

UNIT V  PROJECT TERMINATION:  6
Construction and use of audit report, Project audit life cycle, Essentials of audit and evaluation, Varieties of project termination, termination process, Final report – A project history.

TOTAL: 45 PERIODS

OUTCOME:
Students will gain a solid understanding of current Project Management methodologies and techniques that are being applied worldwide. They will also learn relevant management skills to ensure success in working with teams and entire organization

REFERENCES

IL5014  BUSINESS EXCELLENCE MODELS  L T P C  3 0 0 3

OBJECTIVE:
- To make the students to understand the business excellence models, which are applied in all aspects of business like manufacturing, software (IT) as well as service industry oriented organization like health centre, hospitality,etc.,

UNIT I  BUSINESS EXCELLENCE MODELS  8
Business Excellence Concepts – Need for BE models – Pioneers in the model MBNQA , EFQM and DEMING award
UNIT II MBNQA
Criteria: LEADERSHIP, Strategic planning, Customer and Market focus, Measurement analysis and Knowledge Management, Human resource focus, process management, business results

UNIT III BUSINESS EXCELLENCE AWARDS IN INDIA
Models in Business excellence: RBNQA CII EXIM Award, Tata BE Model etc

UNIT IV IMPLEMENTING BUSINESS EXCELLENCE MODEL
Basic concepts - Training - Report writing - Internal audit - Report submission - Initial assessment - Site visit - Scoring - Criteria for Award, Award finalization

UNIT V CASE STUDY

OUTCOMES:
- After studying this subject, the students will get a clear idea about the business excellence models applied in the industries.

REFERENCES
2. Web sites

IL5015 SYSTEMS SCIENCE AND ENGINEERING

OBJECTIVES:
- This course is intended to introduce the students to the systems engineering process used to create multi-disciplinary solutions to complex problems.

UNIT I SYSTEMS SCIENCE CONCEPTS

UNIT II SYSTEMS ENGINEERING PROCESSES

UNIT III ANALYSIS OF ALTERNATIVES
Uncertain/ Imperfect information; Cross-impact analysis, Hierarchical inference, logical reasoning inference; Structural modeling; System Dynamics.

UNIT IV INTERPRETATION OF ALTERNATIVES AND DECISION MAKING
Types of decisions – descriptive, prescriptive, normative; Decision assessment efforts types – under certainty, probabilistic uncertainty, probabilistic imprecision, information imperfection, conflict and cooperation; Prescriptive normative decision assessments; Utility theory; Group decision making, Game Theory.

UNIT V SYSTEMS ENGINEERING MANAGEMENT CONCEPTS
Organizational structures, SE management plan; Network based systems planning and management methods; Cognitive factors in SE.

TOTAL: 45 PERIODS
OUTCOMES:
- This course will enable the students to better understand the functions, capabilities and limitations of systems engineering in the context of large developmental programs.

REFERENCES

IL5016 INDUSTRIAL SAFETY AND HYGIENE

OBJECTIVE:
- To impart knowledge on fundamentals of safety engineering and hygiene.

UNIT I OPERATIONAL SAFETY

UNIT II SAFETY APPRAISAL AND ANALYSIS

UNIT III OCCUPATIONAL HEALTH
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 Chlorise, So2, H2s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

UNIT IV SAFETY AND HEALTH REGULATIONS

UNIT V SAFETY MANAGEMENT

OUTCOMES:
- The students will get awareness on safety appraisal, analysis techniques, regulations and issues in occupational health and safety manager practices in industries

REFERENCES
3. Managing emergencies in industries, loss prevention of India Ltd., proceedings, 1999
4. Occupational Safety Manual BHEL.

IL5017 SERVICES OPERATIONS MANAGEMENT  L T P C  3 0 0 3

OBJECTIVES:
• To enhance the students’ understanding of the nature and importance of the service sector in the economy.
• To improve the students’ analytical abilities in solving problems that service managers’ face.

UNIT I INTRODUCTION TO SERVICES  6
Manufacturing and Services, Definition of Service, Characteristic of Service, Nature of Services, Importance of Activity, Impact of technology

UNIT II GLOBALIZATION AND STRATEGY  7
Types of Globalized Services, Outsourcing, issues in Globalization, Service strategies

UNIT III OPERATIONS ISSUES  12
Forecasting, Inventory, capacity Planning, Scheduling

UNIT IV SERVICE QUALITY AND PRODUCTIVITY  10
Importance of Quality, Models for Service Quality, GAPS model, issues in productivity measurement, Work measurement

UNIT V TOOLS FOR SERVICES  10
Data Envelopment Analysis, Queuing models, Vehicle Routing models

TOTAL: 45 PERIODS

OUTCOMES:
• The students become effective decision maker in the management of a service organization.
• Students become aware of the environmental impacts and ethical issues involved in a service organization’s actions.

REFERENCES
IL5018  MULTIVARIATE DATA ANALYSIS

OBJECTIVE:
- To impart knowledge on the applications of multivariate statistical analysis.

UNIT I  REGRESSION
Simple Regression and Correlation – Estimation using the regression line, Correlation analysis, Multiple regression and Correlation analysis – Finding the Multiple Regression equation, Modelling techniques, Making inferences about the population parameters.

UNIT II  MULTIVARIATE METHODS
An overview of Multivariate methods, Multivariate Normal distribution, Eigen values and Eigen vectors.

UNIT III  FACTOR ANALYSIS

UNIT IV  DISCRIMINANT ANALYSIS
 Discriminant analysis – Discrimination for two multivariate normal Populations – Discriminant functions.

UNIT V  CLUSTER ANALYSIS
Cluster analysis – Clustering methods, Multivariate analysis of Variance.

TOTAL : 45 PERIODS

OUTCOME:
- Can able to apply the multivariate, regression, factor, discriminant and cluster analysis techniques for statistical analysis.

REFERENCES

IL5091  DATA ANALYTICS

OBJECTIVES:
The Student should be made to:
- Be exposed to big data
- Learn the different ways of Data Analysis
- Be familiar with data streams
- Learn the mining and clustering
- Be familiar with the visualization

UNIT I  INTRODUCTION TO BIG DATA

UNIT II  DATA ANALYSIS
UNIT III MINING DATA STREAMS

UNIT IV FREQUENT ITEMSETS AND CLUSTERING

UNIT V FRAMEWORKS AND VISUALIZATION
Map Reduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed file systems – Visualizations - Visual data analysis techniques, interaction techniques; Systems and applications:

TOTAL : 45 PERIODS

OUTCOMES:
The student should be made to:
• Apply the statistical analysis methods.
• Compare and contrast various soft computing frameworks.
• Design distributed file systems.
• Apply Stream data model.
• Use Visualisation techniques

REFERENCES:

IL5019 SYSTEMS ANALYSIS AND DESIGN

OBJECTIVES:
• To provide a basic knowledge in system analysis and design and its implementation.

UNIT I SYSTEMS ANALYSIS FUNDAMENTALS
Information systems analysis overview, Classification of information systems, Systems development life cycle, Role of systems analyst, and Role of case tools

UNIT II INFORMATION REQUIREMENT ANALYSIS
Sampling and investigating hard data, Interviewing, Using Questionnaires, Developing prototype, System requirements specification, Feasibility analysis

UNIT III ANALYSIS PROCESS
Data flow diagrams, Data dictionary, Process specifications, Presenting the systems proposal
UNIT IV ESSENTIALS OF DESIGN
Designing effective output, designing the database, designing the user interface, Designing data entry procedures

UNIT V SOFTWARE ENGINEERING AND IMPLEMENTATION
Quality assurance through software engineering, Implementation approaches, Implementing distributed systems, Object oriented systems analysis and design

TOTAL: 45 PERIODS

OUTCOMES:
- The students will be able to design and manage information system and to apply them for business organizations.

REFERENCES

IL5020 CELLULAR MANUFACTURING SYSTEMS

OBJECTIVES:
- To impart knowledge on planning, design, implementation and control of Group Technology and Cellular Manufacturing.

UNIT I INTRODUCTION
Introduction to Group Technology, limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

UNIT II CMS PLANNING AND DESIGN
Problems in GT/CMS - Design of CMS – Production Flow Analysis, Optimization Models, traditional approaches and non-traditional approaches- Simulated Annealing, Genetic Algorithms,

UNIT III IMPLEMENTATION OF GT/CMS
Inter and intra cell layout and capacity planning. Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS. Linkages to JIT systems

UNIT IV PERFORMANCE MEASUREMENT AND CONTROL
Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework.

UNIT V ECONOMIC OF GT/CMS
Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

TOTAL: 45 PERIODS

OUTCOMES:
- The students will be able to apply the tools, techniques and methodology used in planning, design, implementation and control of Group Technology and Cellular Manufacturing.

REFERENCES
OBJECTIVES:
- To impart knowledge in reliability concepts, reliability estimation methods and reliability improvement methods.

UNIT I  RELIABILITY CONCEPTS  9

UNIT II  LIFE DATA ANALYSIS  11

UNIT III  RELIABILITY ASSESSMENT  10
Different configurations – Redundancy – k out of n system – Complex systems: RBD – Baye’s approach – Cut and tie sets – Fault Trees – Standby systems.

UNIT IV  RELIABILITY MONITORING  8

UNIT V  RELIABILITY IMPROVEMENT  7

TOTAL: 45 PERIODS

OUTCOMES:
- Students will be able to conduct reliability assessment and failure analysis on any complex systems.

REFERENCES

IS5091  MAINTAINABILITY ENGINEERING  L T P C
3 0 0 3

OBJECTIVES:
- To enable the students know about the basic concept of maintainability engineering.
- To impart knowledge on various maintenance models, maintenance policies and replacement model of various equipment.
- To provide knowledge on logistics for the effective utilization of existing resources and facilities availability of spares parts.

UNIT I  MAINTENANCE CONCEPT  6
UNIT II MAINTENANCE MODELS

UNIT III MAINTENANCE LOGISTICS

UNIT IV MAINTENANCE QUALITY

UNIT V TOTAL PRODUCTIVE MAINTENANCE
TPM features – Chronic and sporadic losses – Equipment defects – Six major losses – Overall Equipment Effectiveness – TPM pillars – Autonomous maintenance – TPM implementation

TOTAL: 45 PERIODS

OUTCOMES:
The students will be able to
1. Understand the various terms and terminologies about the maintenance concept.
2. Understand the various maintenance modes and logistics meant for the execution of various services.
3. Apply their knowledge in areas where the down time, over replacement are existing and could lead to improve the productivity and quality.

REFERENCES