UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

VII SEMESTER

MECHANICAL - STREAM - INDUSTRIAL ENGINEERING

SCHEME -2013

VII SEMESTER

MECHANICAL - STREAM - INDUSTRIAL ENGINEERING (N)

Course No	Name of subject	Credits	Weekly load, hours			C A Marks	Exam Duration Hrs	U E Max Marks	Total Marks
			L	T	D/ P				
13.701	Heuristics for Decision Making (N)	4	3	1	-	50	3	100	150
13.702	System Analysis and Design (N)	4	3	1	-	50	3	100	150
13.703	Reliability Engineering (N)	3	2	1	-	50	3	100	150
13.704	Quality Engineering (N)	4	3	1	-	50	3	100	150
13.705	Enterprise Resource Planning (N)	4	3	1	-	50	3	100	150
13.706	ELECTIVE - III	4	3	1	-	50	3	100	150
13.707	System Simulation and Enterprise Resource Planning Lab (N)	2	-	-	2	50	3	100	150
13.708	Quality Control and Non Destructive Testing Lab (N)	2	-	-	2	50	3	100	150
13.709	Project and Project Seminar (MNPSU)	2	-	-	2	100			100
	Total	**29**	**17**	**6**	**6**	**500**		**800**	**1300**

13.706 Elective III

13.706.1	Entrepreneurship Development (N)
13.706.2	Total Productive Maintenance (N)
13.706.3	Advanced Numerical Methods (N)
13.706.4	Customer Relationship Management (N)
13.706.5	Non Destructive Testing Techniques (N)
13.706.6	Value Engineering and Analysis (N)

13.701 HEURISTICS FOR DECISION MAKING (N)

Teaching Scheme: 3(L)-1(T)-0(P) **Credits**: 4

Course Objectives:

- *To introduce the students to various metaheuristic solution algorithms.*
- *To demonstrate the applications of these algorithms for solving large real life problems.*

Module – I

Introduction to Non-traditional optimization, Computational Complexity – NP-Hard, NP-Complete. Heuristics: classification, Construction Heuristics, Local Search, Multi-Start Procedures, Assessing the Quality of Heuristics. Metaheuristics: Definition, Classification. Introduction to evolutionary computation: Biological and artificial evolution, Evolutionary computation and AI-different historical branches of EC. Genetic Algorithm: Genetic Algorithms, Basic concepts, Encoding, Selection, Crossover, Mutation-Binary GA, Continuous GA, Hybrid GA, Parallel GA-Application of GA in solving Constrained and Combinatorial Optimization problems, Reliability problem, Sequencing problem, Scheduling problem, Transportation problem etc. Scatter Search-Components, Algorithm, Applications. Multi objective evolutionary optimization: Pareto optimality, Multi-objective evolutionary algorithms.

Module – II

Greedy Randomized Adaptive Search Procedure, Ant Colony Algorithms: Overview, Basic algorithm, Variants, Formalization and properties of ant colony optimization, Applications. Particle Swarm Optimization: Basic Concepts, Social Concepts, Swarm Intelligence Principles, Computational Characteristics. PSO in Real Number Space: Velocity Updating, Topology of the Particle Swarm, Parameter Selection, Discrete PSO, PSO Variants, Hybrid PSO, Adaptive PSO, Multiobjective Particle Swarm Optimization etc., PSO Applications in TSP, Knapsack Problems, Quadratic Assignment Problem etc. Lagrangean Relaxation: Basic methodology, Lagrangean heuristic and problem reduction, Lagrangean multipliers, Dual Ascent algorithm, Tree search. Applications of Lagrangean Relaxation in solving facility location problems, Logistics, Inventory Problems etc.

Module – III

Local Search Algorithms, Tabu Search, Tabu Search Principles, Neighborhood, Candidate list, Short term and Long term memory, Threshold Accepting, Application of TS in Planning and Scheduling, Telecommunications, Portfolio management, Facility layout, Transportation, Routing and Network Design. Heuristic Concentration, Algorithm, Applications, Heuristic

Concentration vs Tabu search. Simulated Annealing, Main Components of Simulated Annealing, Homogenous vs. Inhomogenous Simulated Annealing, Annealing Schedules, Applications in sequencing and scheduling, travelling salesman problem etc. Variants of Simulated Annealing.

Module – IV

Artificial Neural Networks- Biological and Artificial Neural Networks, Basic Concepts, Generic Algorithm, Application Areas, Application of ANN to solve TSP, Knapsack Problems etc. Constraint Programming- Problem Formulation in Constraint Programming, Basic Search and Constraint Propagation, Constraint Programming vs Mathematical Programming, Application of Constraint Programming in Bin Packing, Scheduling, Sequencing, Facility Location problems etc. Use of Metaheuristics in Constraint Programming.

References:

1. Baeck T., D. B. Fogel and Michalewicz Z., *Handbook on Evolutionary Computation*, IOP Press.
2. Michalewicz Z., *Genetic Algorithms + Data Structures = Evolution Programmes*, Springer-Verlag, Berlin.
3. Goldberg D. E., *Genetic Algorithms in Search, Optimization & Machine Learning*, Addisson Wesley.
4. Banzhaf W., Nordin P., Keller et al., *Genetic Programming: An Introduction*, Morgan Kaufmann.
5. Yao X, *Evolutionary Computation: Theory and Applications*, World Scientific Publ.Co,Singapore.
6. Dreo J., A. Petrowski, Eric Taillard, *Metaheuristics for Hard Optimization: Methods and Case Studies*, Springer.
7. Fred Glover, Tabu Search.
8. Zbigniew Michalewicz, David B. Fogel, *How to Solve It: Modern Heuristics*, ACM Press.
9. Marco Dorigo Thomas Stützle, *Ant Colony Optimization*, MIT Press.
10. GüntherZäpfel, Roland Braune, Michael Bögl, *Metaheuristic Search Concepts-A Tutorial with Applications to Production and Logistics*, Springer.
11. Maurice Clerk, *Particle Swarm Optimization*, ISTE Ltd.

Internal Continuous Assessment Pattern: *(Maximum Marks: 50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 3) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Five short answer questions of 4 marks each. All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

***Note:** If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course outcome:

After completion of this programme, the students will have knowledge of various metaheuristic solution algorithms and applications of the same. They will have the skill to model real life problems and to select and apply proper heuristic techniques to solve them.

13.702 SYSTEM ANALYSIS AND DESIGN (N)

Teaching Scheme: 3(L)-1(T)-0(P) **Credits**: 4

Course Objectives:

- *To study the tools for modeling dynamic systems.*
- *To evolve mathematical model and conduct dynamic analysis of real world systems.*
- *To validate and optimize the system dynamic models.*

Module – I

System characteristics, classifications, System theories, Evolution of System Dynamics as a System Enquiry Methodology. Elements of System Dynamics Modeling: physical flows, information flows, level & rate variables, flow diagrams, delays, information smoothing, table functions and table function multipliers. Tools for systems thinking: Causal loop diagramming.

Module – II

Analytical approach to behavior of linear low-order systems - First order positive and negative feedback systems, Pure second order positive and negative feedback systems. Introduction to complex feedback systems. Structure and Behavior of Dynamic systems: - fundamental modes of dynamic behavior – Exponential growth, goal seeking, oscillation and process point – interactions of fundamental modes.

Module – III

Steps in system dynamics modeling: problem identification/conceptualization, fixing model aggregates and boundary, validation of system dynamics models, model analysis. Principles of simulation modeling, Developing model equations, Algorithm for Euler integration, Hand simulation of system dynamics models. Qualitative Study of model behavior and policy.

Module – IV

Dynamics of growth: S-Shaped growth, the Bass diffusion model. Tools for modeling dynamic systems: delays, formulation of rate equations, formulation of nonlinear relations. Case of new product growth, price stabilization, Manpower flow in R&D organizations, environmental impact analysis, the manufacturing Supply Chain, etc. Policy design, Algorithms for resource allocation and dynamic policy option selection. Optimization with system dynamics models. Introduction to Software packages for System Dynamics modeling and simulation.

References:

1. Sterman, *Business Dynamics*, McGraw Hill.
2. Mohapatra, *System Dynamics*, Prentice Hall India.
3. Ogata, *System Dynamics*, Pearson Education.

Internal Continuous Assessment: *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as homework, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern: (Maximum Marks: 100)

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

***Note:** If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course outcome:

After the completion of this course, students will apply system dynamic modeling concepts on various engineering and business scenarios. They will be in a position to follow a step-by-step approach towards modeling real world systems.

13.703 RELIABILITY ENGINEERING (N)

Teaching Scheme: 2(L)-1(T)-0(P) **Credits**: 3

Course Objectives:

- *To stress the importance of reliability engineering.*
- *To know the application of reliability while designing a product.*
- *To understand the evaluation methods of reliability, maintainability and availability.*

Module – I

Reliability concepts: Definition of reliability, Reliability vs. Quality, Reliability function, MTTF, hazard rate function, bathtub curve, derivation of the reliability function, Failure and Failure modes, Causes of Failures and Unreliability. Reliability Models: constant failure rate model, time dependent failure models. Weibull distribution, Normal distribution, lognormal distribution. Serial configuration, parallel configuration, combined series parallel systems, K-out-of-m systems.

Module – II

Redundancy Techniques in System design: Component vs Unit redundancy, Weakest-link Technique, Mixed redundancy, Standby redundancy, Redundancy optimization, Double failures and Redundancy. Markov analysis, load sharing systems, standby system, degraded systems, three state devices, covariate models.

Module – III

Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, optimal, Arinc, Agree methods. Fault Tree Analysis, Tie-set and Cut-set methods, Use of Boolean Algebra in reliability analysis.

Module – IV

Maintainability and Availability: Definitions and basic concepts, Relationship between reliability, availability and maintainability, Inherent availability, Achieved availability, Operational availability, Repairable systems, Markovian models. Reliability Allocation: for series system.

References:

1. Balagurusamy E., *Reliability Engineering*, Tata McGraw Hill.
2. Srinath L. S., *Reliability Engineering,* East West Press.

3. Patrick D. T. O'Connor, *Practical Reliability Engineering,* John Wiley& Sons.
4. Joel A. Nachlas, *Reliability Engineering – Probability Models and Maintenance Methods,* Taylor & Francis.
5. Mohammad Modarres, *Risk Analysis in Engineering – Techniques, Tools and Trends,* Taylor & Francis.
6. Duffuaa, *Planning and control of Maintenance Systems- modeling and analysis,* John Willey & Sons.
7. Jardine, *Maintenance, Replacement and Reliability,* Pitman Publishing.
8. Charles E. Ebeling, *An introduction to Reliability & Maintainability Engineering,* McGraw-Hill Publishers.
9. Carter A. D. S., *Mechanical Reliability,* Macmillan Education Ltd.
10. Govil A. K., *Reliability Engineering-*
11. Rowland Caplan, *A practical approach to Reliability-*
12. Trivedi K. S., *Probability and Statistics with Reliability, Queuing and Computer science applications*, John Wiley& Sons.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as homework, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern: (Maximum Marks: 100)

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

***Note:** If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course outcome:

After completion of this programme, students acquire the knowledge of fundamentals of Reliability engineering, failure modes and causes, Understand the evaluations of reliability models, MTTF, Markov model and its applications, Understand the series, parallel models, multi-state devices, redundancy techniques, quantification of maintainability and availability.

13.704 QUALITY ENGINEERING (N)

Teaching Scheme: 3(L)-1(T)-0(P) **Credits**: 4

Course Objectives:

- *Should develop knowledge on theories, tools and practices in quality engineering.*
- *Should be able to construct, use and interpret the various control charts for solution of problems in the area of quality.*
- *Should acquire knowledge on acceptance sampling plans and able to use them in sampling inspection.*
- *Should be able to use the advanced tools in quality engineering for quality improvement.*

Module – I

Philosophies of Deming, Juran and Crosby etc., Quality objectives – Quality of design, Quality of conformance, Quality of performance, Quality function, Quality control – Quality Assurance – Quality value and engineering-Quality systems- Cost of quality, Quality engineering in product design - quality engineering in design of production processes - quality engineering in production - quality engineering in service.

Loss function: Derivation –use-loss function for products/system- justification of improvements - loss function and inspection- quality evaluations and tolerances.

Module – II

Statistical process control, systematic approach, process variability. Process control and Control Chartsfor variables and attributes. CUSUM and Exponentially Weighted Moving Average (EWMA) Control charts.

Process capability analysis - process capability indices, Process Capability analysis using histogram and control charts. Specifications and tolerances: Setting of tolerances, Statistical Tolerance analysis, Tolerances for assemblies and subassemblies.

Module – III

Acceptance sampling plans – single, double, multiple and sequential - for attributes and variables. OC curves- for single and double sampling plans. Evaluating sampling plans - AOQ, ATI and ASN. minimum inspection per lot, formulation of inspection lots and selection of samples, Standard sampling plans - MIL-STD 105E sampling method and its equivalents, Dodge - Romig tables and ABC standards, AOQL and LTPD plans.

Module – IV

Quality tools–fault tree analysis, event tree analysis, failure mode and effect analysis, Cost of quality, Quality Standards-ISO 9000 series, Quality Function Deployment, Quality Circles, KAIZEN. Six Sigma: Introduction- definition-methodology-DMAIC method-roles and responsibilities. Management of Software Quality, CMM, Taguchi's Methods, Quality in R&D, Total Quality Management and Total Productive maintenance. Introduction to Software packages for SQC.

References:

1. Amitava Mithra, *Fundamentals of Quality Control and Improvement,* Pearson Education.
2. Grant, *Statistical Quality Control,* McGraw Hill.
3. Montgomery, *Introduction to Statistical Quality Control*, John Wiley & Sons.
4. Gupta R. C., *Statistical Quality Control*, Khanna Publishers.
5. *Quality Control Handbook*, Tata McGraw Hill.
6. *Industrial Engineering Handbook,* Maynard.
7. Zaidi A., *SPC - Concepts, Methodologies, and Tools*, PHI.
8. De Feo J. A. and W. W. Barnard, *Six Sigma: Breakthrough and Beyond,* Tata McGraw-Hill, New Delhi, 2005.
9. Taguchi G., E. A. Elsayed and T. C. Hsiang, *Quality Engineering in Production Systems*, McGraw Hill, Singapore, 1989.
10. Pyzdek T. and R. W. Berger, *Quality Engineering Handbook*- Tata McGraw Hill, New Delhi, 1996.

Internal Continuous Assessment Pattern: *(Maximum Marks: 50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 3) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Note: *If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course outcome:

After the course the student will be able to

- *Understand various statistical theories, tools and practices in quality engineering.*
- *Will be able to use control charts for solving quality problems.*
- *Acquire knowledge on acceptance sampling plans and will be able to use them in sampling inspection.*
- *Will be able to use advanced tools in quality engineering for quality improvement.*

13.705 ENTERPRISE RESOURCE PLANNING (N)

Teaching Scheme: 3(L)-1(T)-0(P) **Credits**: 4

Course Objectives:

- *To introduce the students to the basics, implementation issues and business modules of ERP*
- *To be aware of some popular products in the area of ERP*
- *To appreciate the current and future trends in ERP*

Module – I

Introduction to ERP and Enterprise Applications: Definition, Need, History, Enterprise Applications; ERP Implementation—Life Cycle, Methodologies; Cost and Benefit of ERP Implementation; selection of ERP consulting partner; selection of ERP package; ERP Project Management; Business Process Reengineering; Business Process Modeling and Business Modeling; ERP Training; Change Management; Application Support.

Module – II

ERP Functional Modules: Human Capital Management; Financial Management; Procurement and Inventory Management; Supplier Relationship Management; Production Planning and Execution; Supply Chain Planning; Sales and Service; Warehouse and Transport Management; Customer Relationship Management; Quality Management; Maintenance Management and Enterprise Asset Management; Product Lifecycle Management.

Module – III

Portal, Content Management and Knowledge Management; Data Warehousing, Data Mining, Business Intelligence and Analytics - Data Warehousing, Data Extraction, Transformation, Online Transaction Processing (OLTP) and Online Analytical Processing (OLAP), Data Mining, Analytics, Business Intelligence-Types, Business Performance Management, The Balanced Scorecard; ERPs for Manufacturing Industries and Service Industries; Cases of ERP and Enterprise Application, Failed ERP Implementations.

Module – IV

ERP Auditing and Risk: Key Risks and Control Issues, Audit Methodology, Audit Scope, Integrated Audit, Audit Process, Internal Control Regulation, IT Application Controls and General Controls, Program Change Controls, Information Security Controls, Computer

Operations Controls, Controls over Outsourcing Business and IT Functions, Control Objectives for Information and related Technology (COBIT), Governance, Risk, and Compliance, Roles for the Auditor. ERP and the cloud: Cloud/SaaS ERP, Benefit of Cloud-Based ERP Implementations. Overview and comparison of market leading ERP Software Packages; ERP and E-Business; Emerging trends in ERP.

References:

1. Rajesh Ray, *Enterprise Resource Planning*, McGraw Hill.
2. Vinodkumar Garg and Venkitakrishnan, *Enterprise Resource Planning,* Prentice Hall India.
3. Alexis Leon, *Enterprise Resource Planning*, Tata McGraw Hill.
4. Bradford M., *Modern ERP Systems: Select, Implement and Use Today's Advanced Business Systems*, Lulu.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as homework, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern: (Maximum Marks: 100)

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Five short answer questions of 4 marks each. All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

***Note:** If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course outcome:

After completion of this programme, students will identify basic business functional areas and explain how they are related, understand how Enterprise Resource Planning software is used to optimize business processes.

13.706.1 ENTREPRENEURSHIP DEVELOPMENT (N) (Elective III)

Teaching Scheme: 3(L)-1(T)-0(P) **Credits**: 4

Course Objectives:

- *To provide basics on the process of entrepreneurship.*
- *To make the students aware of the scope of an entrepreneur and current areas of development.*
- *To provide the students some basic ideas on financial assistance, taxation and tax benefits.*

Module – I

Entrepreneurship: Concepts, Definition, Characteristics, Role of entrepreneurs, Growth of entrepreneurs, Environment for entrepreneurship, Entrepreneurial initiative, Entrepreneurial involvement, Entrepreneurial skills, Traditional managers vs. Entrepreneurs, Entrepreneur vs. Intrapreneurs, Qualities of an Entrepreneur, Entrepreneurial network, Entrepreneurship stimulants.

Module – II

Entrepreneurial functions, Steps to improved innovation, Elements of innovation management, Classification of entrepreneurs, Role of Information for Entrepreneurial transformation, Use of Information systems. Growth of small industries in developing countries, Role of small scale industries in the national economy, Characteristics and types of small scale industries, Government policies for small scale industries, Indian small industry sector.

Module – III

Entrepreneurial Environment: Political, Economic, Social, Technological, Legal and Cultural environments, Significance of environments, Environmental analysis, The Green arm of the Law, Private enterprise and development, Entrepreneurial urge. Ownership structures, Project formulation, Steps involved in setting up a business, Identification, Selecting a good business opportunity, Market survey and research, Techno economic feasibility assessment.

Module – IV

Sources of Finance: Term loans, Capital structure, Financial institution, Taxation - Income tax, Excise duty, Sales tax. Business sickness: Concepts, Causes and consequences, Corrective measures, Growth strategies - Expansion, Diversification, Joint venture, Merger and Sub contracting. Entrepreneurship Development programs, Entrepreneurship development cycle, Entrepreneurial discipline.

References:

1. Hisrich R. D. and M. P. Peters, *Entrepreneurship,* Tata McGraw-Hill.
2. Kuratko and Hodgetts, *Entrepreneurship - Theory, process and practices*, Thomson Learning.
3. Kanungo R. N., *Entrepreneurship and Innovation*, Sage Publications.
4. Khanka S. S., *Entrepreneurial Development,* S. Chand & Co.
5. Vasant Desai, *Entrepreneurial Development – Volume I,* Himalaya Publishing House.
6. Norman Walzer, *Entrepreneurship and Local Economic Development,* Lexington Books.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as homework, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern: (Maximum Marks: 100)

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

***Note:** If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course outcome:

After the completion of this course, the student shall be able to get an idea of the entrepreneurship process and introduce them to various areas involved in new business ventures. The subject encourages students to take up new ventures in diverse fields.

13.706.2 TOTAL PRODUCTIVE MAINTENANCE (N) (Elective III)

Teaching Scheme: 3(L)-1(T)-0(P) **Credits**: 4

Course Objectives:

- *Should develop knowledge on principles and practices of Total Productive Maintenance.*
- *Should be able to use TPM tools for effective maintenance.*
- *Should acquire knowledge on autonomous maintenance and its implementation.*
- *Should be able to use equipment improvement techniques.*

Module – I

Overview of TPM implementation: TPM Basic Policy & Objectives, Maximize Equipment Effectiveness through Total Employee Involvement, Improvement, Improve Equipment Reliability, Maintainability &Productivity, Aim for Economical Life cycle costs, Enhance Equipment Expertise & skills, Create a vital, Enthusiastic work environment, Companywide TPM Goals, TPM Promotion Organization & management.

Module – II

Autonomous maintenance : Implementing Autonomous Maintenance Step, Initial cleaning, Addressing the causes of Dirty Equipment, Improving Access to hard-to-clean Areas, Standardizing Maintenance activities, General Inspection skills, Autonomous Inspection, Organizing & Managing the workplace, Autonomous Management. The manager's role in autonomous maintenance, Learning from Breakdowns, Time table of Autonomous Maintenance Activities, Results& Evaluation.

Module – III

Equipment improvement: Equipment Improvement objectives, Promoting Successful Equipment Improvements, Four levels of Equipment Improvement Activity, Effect of Equipment Improvements. Quality maintenance (QM): Relation between Quality Assurance & QM, conceptual approach QM, preconditions for promoting QM, techniques for developing QM, implementing QM. Education and training : Education & training system, studies in general inspection, studies in PM analysis, cultivating in-house maintenance techniques, training in equipment, diagnostic techniques using vibration using vibration measurements, results of TPM education and training.

Module – IV

Example of implementation programmes: From equipment to product Development and Design, From Equipment Development and Design to Product Development & Design, Establishing and Equipment Design, Preliminary Evaluation (Design), Step by step

management, Collecting and using maintenance prevention (MP) data, product set-up procedure & daily management. Overall effects of TPM implementation: Striving for overall equipment effectiveness, defects prevention systems, relationship between TPM and tero technology.

References:

1. Nahchi-Fujikoshi Corporation, *Training for TPM*, Japan Institute of Plant Maintenance, 1990.
2. Selichi Nakajima, *Introduction to TPM*, The Purtor Factory, Japan Institute of Plant Maintenance, 1986.
3. Myumon and Sciichi Nakjima, *TPM*, Japan Institute for Plant Maintenance, 1989.
4. Sciichi Nakjima, *TPM Maintenance Prevention Design*, Productivity Press Inc. First Indian Edition, 1993.
5. Unio K. Shirose, Y. Oshifumi Kimura and M. Itsugu Kaneda, *An Advanced Step in TPM Implementation*, Japan Institute of Plant Maintenance.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern: (Maximum Marks: 100)

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each.All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

***Note:** If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course outcome:

- *Understand the principles and practices of TPM.*
- *Understand the use of TPM tools for effective maintenance.*
- *Acquire knowledge on autonomous maintenance and its implementation.*
- *Able to use equipment improvement techniques.*

13.706.3 ADVANCED NUMERICAL METHODS (N) (Elective III)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

- *To develop numerical skills in the solution of mathematical equations of various scientific and engineering problems.*
- *To acquire knowledge in the data analysis and statistical interpretation of experimental results.*
- *To acquire knowledge on the various prediction methods based on the experimental data.*
- *To get idea on how to formulate a given physical problem in mathematical equations.*
- *To get knowledge on how to minimize the error growth in a particular solution procedure.*

Module - I

Solution of algebraic and transcendental equations-comparisons of various iterative methods, convergence-General Newton Raphson method for multiple roots, Higher order methods, Newton method for nonlinear systems. Solutions of simultaneous equations – Direct and Indirect methods-Gauss elimination, Gauss Seidel and Relaxation methods-Convergence, Eigen value problem-vector iteration method.

Module - II

Interpolation-Newton's divided difference, Lagrange, Aitken, Hermite and Spline techniques, Inverse interpolation, Error estimate, Double interpolation, Trigonometric interpolation. Numerical differential, Numerical integration-Newton Cotes integration formula, Gauss quadrature, Error estimate, Double integration.

Module - III

Curve fitting-method of least square-nonlinear relationship, correlation and regression-Linear correlation, Measures of correlation, Standard error of estimate, Coefficient of correlation-multiple linear regression. Solution of ordinary differential equations-single step and multi- step methods, Simultaneous first order differential equations, Higher order differential equations. Numerical solution of integral equations.

Module - IV

Partial differential equations-classifications. Finite difference methods. Forward difference, backward difference and central difference approximation. Discretised form and solution of Laplace equation,1D wave equation,1D steady and unsteady heat conduction equation. Relaxation methods. Stability and convergence of solution of partial differential equations.

References:

1. Jain.M. K., *Numerical Methods for Scientific and Engineering Computation*.
2. Gupta A. and S. C. Boss, *Introduction to Numerical Analysis*.
3. Hilderbrand F. B., *Introduction to Numerical Analysis*.
4. Kendall E. Atkinson, *An Introduction to Numerical Analysis*.
5. Murrey R. Spiegel, *Statistics*.
6. James B. Scarborough, *Numerical Mathematical Analysis*.
7. Gerald C. F. and P. O. Wheatley, *Applied Numerical* Analysis.
8. Sastry S. S., *Introductory Method of Numerical Analysis*.

Internal Continuous Assessment Pattern: *(Maximum Marks: 50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 3) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

***Note:** If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course Outcomes:

After the completion of this course, students will get necessary foundation on the following:

- *Various Numerical strategy and its comparisons in the solution of mathematical equations.*
- *How to build mathematical formulations of various physical problems.*
- *Statistical interpretation and data analysis of experimental results.*
- *How to choose a particular numerical scheme for solving a physical problem.*

13.706.4 CUSTOMER RELATIONSHIP MANAGEMENT (N) (Elective III)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

- *To learn the importance of customer relationship management and customer loyalty.*
- *To understand various concepts, cardinal principles, architectural and other related aspects of CRM*
- *To familiarize the students with overall process of building and maintaining profitable customer relationships by delivering superior customer value and satisfaction.*

Module – I

Industrial Conventional marketing approach – drawbacks – emerging challenges in the marketing front –relationship marketing – definition – concepts – relevance of relationship marketing approach –significance - introduction to CRM – new trends and concepts.

Module – II

Understanding buyers' expectations – building customer loyalty – types of loyalty – influencing factors – loyalty ladder – significance of loyal customer – impact of lost customers – computing cost of lost customers.

Module – III

Creating customer database – process and approaches to database marketing – application of data base marketing in relationship building. Concept of customer driven organizations – learning organizations – internal marketing. Customer satisfaction audit– developing relationship strategies for different types of business under competitive environment.

Module – IV

Information technology application in building customer relationship – emerging new trends. Integration of CRM with ERP system. Introduction to SRM and International Marketing.

References:

1. Paul Greenberg, *Customer Relationship Management at the Speed of Light.*
2. Bukowitz, *The Handbook of Key Customer Relationship Management,* Pearson Education

3. Dyche, *The CRM Handbook*, Pearson Education.
4. Peeru Mohamed H. and A. Sagadevan, *Customer Relationship Management,* Vikas Publishing.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as homework, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern: (Maximum Marks: 100)

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each.All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

***Note:** If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course outcome:

- *After the completion of this programme, students are expected to have knowledge about various methods that can be effectively employed for improving customer loyalty and application of these techniques in building better customer relationship.*

13.706.5 NON DESTRUCTIVE TESTING TECHNIQUES (N) (Elective III)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

- *To educate the students about the importance of inspection and testing of materials and equipments in the industrial and domestic sectors.*
- *This course will provide the basics of the most common methods and equipments in Non-Destructive Testing.*

Module – I

Introduction: Non Destructive Testing. Destructive testing- Visual Inspection - methods: Optical aids, In-situ metallography, holographic methods- Dye Penetrant Testing - Principles: Process: Florescent dye penetrant testing. Emulsifiers: cleaners – developers – methods of application - sensitivity: Advantages: Limitations: Applications.

Module – II

Radiography Testing - Principles of radiography: sources of Radiation - Ionizing radiation -X-rays sources, gamma-ray sources - Recording of radiation: Radiographic sensitivity: Film radiography and Real time radiography – Image Quality Indicators - Radiography testing of pipes -Radiation safety. Advantages – Limitations – applications. Ultrasonic testing - Generation of Ultrasonic waves, general characteristics of ultrasonic waves – different types of probes - Advantages, disadvantages, Applications

Module – III

Fundamentals of Magnetism - Magnetic Particle Inspection – Different methods of testing-equipments - : Advantages, Limitations, and Applications - Magnetic Hysteresis. Eddy current Testing – Basic principle - Instruments – types of probes – applications – advantages – limitations.

Module – IV

Acoustic Emission Test - Basic principle - Instruments – types of probes – applications – advantages – limitations. Leak detection – hydro testing and pneumatic testing – Ultrasonic leak detectors – leak detection using spectrometers. Thermal inspection – Thermography – Infra Red Camera - applications – advantages – limitations.

References:

1. Halmshaw P., *Non-Destructive Testing*
2. *Metals Handbook Vol.II, Nondestructive Inspection and Quality Control*
3. Warren J. Mcgomnagle, *Non-Destructive Testing*, McGraw Hill.
4. Baldev Raj *et. al*., *Non-Destructive Testing,* Narosa Publishing House.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern: (Maximum Marks: 100)

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten short answer questions of 2 marks each.All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

***Note:** If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course outcome:

After completion of this course the students will be conversant in understanding the fundamentals of Non Destructive Testing. They will be capable of interpreting the results of the common NDT techniques. They will be aware of the Timely intervention of inspection/ testing in industrial sectors and thereby they can avoid the premature failure of the components and save the life of the occupants.

13.706.6 VALUE ENGINEERING AND ANALYSIS (N) (Elective III)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

- *To understand the theory and fundamentals of value engineering.*
- *To know the methodology is to be applied for cost-improving decisions.*
- *To understand the use of techniques through case studies.*

Module – I

Value Engineering concepts: Origin and history of value engineering, SAVE and its role, Concept of Innovation and creativity, Innovation vs Invention, Relevance of value engineering in Indian scenario, Life cycle of a product.

Module – II

Value Engineering: Type of Value, Reasons for poor Value, How to build and add value, Value engineering Job Plan: Phases of Value engineering Job Plan – General phase, Information Phase, Function Phase – Function definition, Function classification, Function – cost analysis, and matrix, Creation phase, Evaluation phase, Investigation phase, Recommendation phase.

Module – III

Organizing the value engineering study – different industries, Value engineering and Quality, Selection of Projects – Methods used, selecting team members.

Module – IV

Use of advanced technique like FAST (Function Analysis System Technique): FAST diagramming, How, Why and When Logic, Ground rule for FAST diagram. Case studies in value engineering and analysis.

References:

1. Miles L. D., *Techniques of Value Analysis and Engineering,* McGraw Hill.
2. Mudge A. E., *Value Engineering* - A Systematic Approach.
3. Mittal H. S., *Value Engineering for Cost Reduction and Product Improvement.*
4. Iyer S. S., *Value Engineering*, New Age International.
5. Heller, *Value Management,* Addison Wesley.

6. Oughson, *Value Analysis and Value,* Pitman.
7. Burns T. and G.M., Stalker *The management of Innovations*, Tavistock Publications, London.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern: (Maximum Marks: 100)

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

***Note:** If use of tables and charts are permitted for the university examination for this course, proper direction of the same should be provided on the facing sheet of the question paper.*

Course outcome:

- *Acquire the knowledge of theory and fundamentals of value engineering and analysis.*
- *Understand the various phases of V. E. techniques*
- *Understand the techniques used to evaluate the value of a product.*

13.707 SYSTEM SIMULATION AND ENTERPRISE RESOURCE PLANNING LAB (N)

Teaching Scheme: 0(L) - 0(T) - 2(P) **Credits**: 2

Course Objectives:

- *Understandsimulationmodelbuildingandsimulationthroughsoftwarepackages.*
- *Understand how Enterprise Resource Planning software is used to optimize business processes.*
- *Acquire experience in using ERP software package.*

Simulation Lab:

1. Statistical distribution fitting using software package (Stat::Fit/ Excel/ EasyFit/ ExpertFit).
2. Queuing and Inventory modeling in C/C++/Java.
3. Modeling and simulation in Simio/ Arena/ AnyLogic/ Vensim (Training shall be given in at least two software packages mentioned).
4. Mini project.

Enterprise Resource Planning lab:

Students shall be given training in using at least two modules (Human Capital Management; Financial Management; Procurement and Inventory Management; Supplier Relationship Management; Production Planning and Execution; Supply Chain Planning; Sales and Service; Warehouse and Transport Management; Customer Relationship Management; Quality Management etc. in any ERP software package).

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Test (minimum 1)

40% - Lab performance (evaluation of models, rough record, fair record etc.)

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

Questions based on the list of exercises prescribed.

Question paper shall be with or without different parts/sections.

The evaluation should be based on appropriate spilt of marks suitable to the question.

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

The students who succeed this course:

- *Will be able to analyze input data, fit statistical distribution and conduct experiments using simulation model.*
- *Will be able to use a simulation software package to develop a simulation model to analyze systems.*
- *Will have the knowledge of functional modules of an ERP system and will have a working knowledge of some functional modules of an ERP software package.*

13.708 QUALITY CONTROL AND NON DESTRUCTIVE TESTING LAB (N)

Teaching Scheme: 0(L) - 0(T) - 2(P) **Credits**: 2

Course Objective :

- *Understand the proof of central limit theorem using different populations.*
- *Understand the construction and purpose of variable control charts & attribute control charts.*
- *Understand the construction of OC curve and design of various sampling plans.*
- *Acquire knowledge on various non-destructive evaluation (NDE) techniques.*
- *Understand the working of various non-destructive testing (NDT) equipments.*
- *Conduct non-destructive evaluation on different test specimens using various NDT equipments.*

Statistical Quality Control (SQC) Lab

For conducting statistical quality control (SQC) experiments data can be generated using implements like normal bowl, beads bowl, dotted sheet etc.

1. Experiments to verify central limit theorem using different distributions.
2. Experiments to verify central limit theorem using different distributions and Henry line.
3. Study and construction of variable control charts ($\bar{X}$ and R charts) for actual measurements.
4. Study and construction of attribute control charts (p, c, np, u, Q and D charts) for actual counts.
5. Study and construction of CUSUM chart and standardized control chart.
6. Experiment on OC curve, double sampling plan and multiple sampling plan.
7. Experiment on construction of OC curve for p chart.
8. Experiment on finished product inspection and certification procedures.
9. Experiments on performance testing and life testing.

Non Destructive Testing (NDT) lab

Study the working and conduct non destructive evaluation (NDE) on different test specimens (plates, pipe, T Joint etc.) using the following non destructive testing (NDT) equipments.

1. Dye penetration test.
2. Yoke type magnetic crack detector.
3. Portable magnetic crack detector.
4. Bench type magnetic crack detector.

5. Ultrasonic flaw detector.
6. Radiographic film viewer.
7. Eddy current sorter.
8. Acoustic emission.
9. Thermal camera.

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Test (minimum 1)

40% - Lab performance (continuous evaluation of rough record, fair record etc.)

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

Questions based on the list of exercises prescribed.

Question paper shall be with or without different parts/sections.

The evaluation should be based on appropriate spilt of marks suitable to the question.

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

The students who succeed this course will be able to:

- *Prove central limit theorem using different populations.*
- *Construct variable control charts & attribute control charts.*
- *Construct OC curve and design of various sampling plans.*
- *Understand the working of various non-destructive testing (NDT) equipments.*
- *Conduct non-destructive evaluation on different test specimens using various NDT equipments.*

13 .709 PROJECT AND PROJECT SEMINAR (MNPSU)

Teaching Scheme: 0(L) - 0(T) - 2(P) **Credits**: 2

Course Objective :

- *To identify a problem for the final-year project, outline a solution, and prepare a preliminary design for the solution.*
- *To do a detailed study on the selected topic based on current journals or published papers and present seminars*
- *To improve the ability to perform as an individual as well as a team member in completing a project work.*
- *The seminar based on the project provides students adequate exposure to presentations to improve their communication skills.*

The student shall do a project (project phase 1) in the seventh semester, which shall be continued in the eight semester. He/she shall submit an interim report at the end of the seventh semester and the final project report shall be submitted at the end of the eighth semester. The student shall present two seminars in the seventh semester on the work carried out during project phase 1. The first seminar should highlight the definition of problem, novelty of the project, literature survey and work plan/ methodology. The second seminar should include preliminary results. The students may be assessed individually/ and in groups.

Internal Continuous Assessment *(Maximum Marks-100)*

40% - Assessment by the Guide

40% - Assessment by the Committee.

20% - Regularity in the class

Course Outcome:

At the end of the course, the students would have acquired the basic skills to for performing literature survey and paper presentation. This course shall provide students better communication skills and improve their leadership quality as well as the ability to work in groups, and thus aid them in building a successful career as an engineer.