# UNIVERSITY OF KERALA

## B. TECH. DEGREE COURSE

## (2013 SCHEME)

**SYLLABUS FOR**

**V SEMESTER**

**MECHANICAL - STREAM - INDUSTRIAL ENGINEERING**

## SCHEME -2013

## V 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 | | | | |
| 13.501 | Introduction to Stochastic Models (N) | 4 | 3 | 1 | - | 50 | 3 | 100 | 150 |
| 13.502 | Operations Research (N) | 4 | 3 | 1 | - | 50 | 3 | 100 | 150 |
| 13.503 | Work Study and Ergonomics (N) | 4 | 3 | 1 | - | 50 | 3 | 100 | 150 |
| 13.504 | Object Oriented Programming and Numerical Methods (N) | 4 | 3 | - | 1 | 50 | 3 | 100 | 150 |
| 13.505 | Machine Tools (MN) | 4 | 3 | 1 | - | 50 | 3 | 100 | 150 |
| 13.506 | ELECTIVE - I | 4 | 3 | 1 | - | 50 | 3 | 100 | 150 |
| 13.507 | Machine Tools Lab (N) | 3 | - | - | 3 | 50 | 3 | 100 | 150 |
| 13.508 | Work Study and Ergonomics Lab (N) | 2 | - | - | 2 | 50 | 3 | 100 | 150 |
| | **Total** | **29** | **18** | **5** | **6** | **400** | | **800** | **1200** |

**13. 506 Elective I**

| | |
|---|---|
| 13.506.1 | Management of Projects (N) |
| 13.506.2 | Organisational Behaviour (N) |
| 13.506.3 | Advanced Mechanics of Solids (N) |
| 13.506.4 | Computer Aided Design (N) |
| 13.506.5 | Energy Management (N) |

## 13.501 INTRODUCTION TO STOCHASTIC MODELS (N)

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

**Course Objective:**

- *To develop knowledge on probability theory.*
- *To be able to use limit theorems and Markov chains.*
- *To acquire knowledge on Brownian motion and Stationary Processes.*

**Prerequisites:**

*Familiarity with basic notions of probability theory (finite sample spaces), concept of independence, Bayes theorem and law of total probability.*

**Module – I**

Random variables - discrete and continuous. Probability distributions - probability density (mass) functions and cumulative distribution functions. Expectation of random variables and their functions - mean and variance. Markov and Chebychev Inequality. Special discrete random variables - Bernoulli, Binomial, Poisson and Geometric (properties, basic probability computations and mean & variance).

**Module – II**

Special continuous random variables - Uniform, Exponential, Normal, Gamma and Weibull (properties, basic probability computations and mean & variance). Multiple random variables-joint probability distributions, independence of random variables, expected values, correlation and covariance. Expectation and variance of sums of random variables. Central limit theorem.

**Module – III**

Stochastic process - definition, classification and examples. Markov chains - transition probability matrix, Chapman-Kolmogorov theorem (without proof), steady-state probabilities, classification of states. Poisson process - definition based on independent increments property and stationarity, distribution of inter arrival times, reproductive property.

**Module – IV**

Birth-death processes- steady state probability distributions. M/M/1 queuing system as a birth - death process - computation of steady state parameters. Brownian motion - as a limit of random walk, simple transformations, hitting times and maximum values, Brownian motion with drift, Geometric Brownian motion (definition, basic properties and computation of probabilities only).

**References:**


1. Ross S. M., *Introduction to Probability Models*, Elsevier, 2014.
2. Ghahramani S., *Fundamentals of Probability with Stochastic Processes*, Pearson Education, 2012.
3. Ross S. M., *Stochastic Processes*, Wiley, 1996.
4. Hines W. W., D. C. Montgomery, D. M. Goldsman and C. M. Borror, *Probability and Statistics in Engineering*, Wiley, 2002.
5. Grimmett G. R. and D. R. Stirzaker, *Probability and Random Processes*, Oxford University Press, 2001.
6. Feller W., *An Introduction to Probability Theory and its Applications*, Vol.1 & 2, John Wiley, 1970.
7. Cinlar E., *Introduction to Stochastic Processes*, Prentice Hall Inc., 1975.
8. Kulkarni V. G., *Modeling and Analysis of Stochastic Systems*, Chapman and Hall, 1995.


**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:**

*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.*

**Course Outcome:**

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

- *Understand various probability theories and limit theorems.*
- *Understand the use of different types of Markov chains.*
- *Acquire knowledge on Brownian motion and Stationary Processes.*

## 13. 502 OPERATIONS RESEARCH (N)

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

**Course Objectives:**

- *To develop the ability to formulate mathematical models for quantitative analysis of managerial problems in industry.*
- *To have skills in the use of Operations Research approaches in solving real life problems in industry.*

**Module – I**

Operations research - Definitions, History, Applications, Models and Methods for solving Operations Research Models. Linear Programming models - General formulation, Graphical solutions, Simplex method - Two Phase method, Big M method, Duality theory – Interpretation of dual variables - Primal Dual Relationships - Sensitivity Analysis, Dual Simplex Method, Bounded Variables LP Problem.

**Module – II**

Transportation Problems - General Concepts, Formulations, Balanced/Unbalanced transportation problems. Solution Methods - North West Corner Method, Least Cost Method, Vogel‘s Approximation Method. Optimality Tests - Stepping Stone Method and Modified Distribution method, Sensitivity analysis in Transportation problem, Degeneracy, Transshipment problem. Assignment Problems - General Concepts, Assumptions & Limitations, Formulation and solution of assignment problem, Special Issues, Restricted routes/Multiple Optimal Solutions. Generalized Transportation Problem, Generalized Assignment Problem, Multi-objective Transportation Problem.

**Module – III**

Queuing theory - Taxonomy of waiting line models, Probability distributions of inter arrival times and service times. Basic Queuing Models - Single Server Infinite Queue Length Model, Single Server Finite Queue Length Model, Multiple Server Infinite Queue Length Model, Multiple Server Finite Queue Length Model. Birth and Death Process. Decision theory - Types of decision making environment - Decision making under uncertainty and under risk – Decision tree analysis.

**Module – IV**

Deterministic Dynamic Programming - stage and state, characteristics of DP problems, recursive relationship, Bellman’s principle of optimality - computational procedure for Shortest Route problem, Reliability Problem, Equipment Replacement Problem, Linear Programming Problem, Manpower Planning problem, Oil Exploration Problem etc.

Probabilistic Dynamic Programming - computational procedure for Inventory Control, Equipment Replacement, Distribution and Sales Forecasting Problems. Game theory - Practical application of game theory, Two – person Zero - Sum games, Solution with / without Saddle point, Rules of Dominance, Different Solution Methods like Algebraic, Arithmetic, Matrix, Graphical and Linear Programming. Case studies illustrating above models in Industries, introduction to software packages for decision making.

**References**


1. Srinivasan G., *Operations Research*, PHI, 2010.
2. Sharma J.K., Operations Research, Macmillan, 2009.
3. Hillier F. S. and G. J. Lieberman, Introduction to Operations Research, Tata McGraw Hill, 2005.
4. Taha H. A., Introduction to Operations Research, 9/e, PHI, 2010.
5. Wagner H.M., Principles of Operations Research with Applications to Managerial Decisions, PHI, 1975.
6. Vohra N. D., Quantitative Methods in Management, TMH, 2006.
7. Taylor, Introduction to Management Science, Pearson Education, 2013.
8. Winston W. L., Operations Research: Applications and Algorithms, Thomson Business Press, 2008.
9. Kalavathi S., Operations Research, Vikas Publishing House, 2002.
10. Swarupet K., P. K. Gupta and M. Mohan, Operations Research, S. Chand and Sons, 1978.
11. Gupta P. K. and D. S. Hira, Operations Research, S. Chand and Sons, 2008.
12. Rardin R. L., Optimization in Operations Research, Pearson Education, 2013.


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

*50% - Tests (minimum 2)*

*30% - Assignments (minimum 2) such as home work, problem solving, 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:**

*Upon completion of the subject, students will:*

- *Understand the importance and value of operations research and mathematical modeling in solving practical problems in industry.*
- *Understand the characteristics of different types of decision-making environments and will apply appropriate decision making approaches and tools to be used in each type.*

## 13.503 WORK STUDY AND ERGONOMICS (N)

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

**Course Objectives:**

- *To explain / use the tools and techniques of work study (Charts/diagrams, micro-motion studies & Principles of Motion economy).*
- *To explain /use the tools and techniques of work measurement (WM). (Basic concept of WM and various Techniques of WM).*
- *To design, perform and analyze the studies/experiments related to work study (eg. Process analysis, operation analysis, time study, Pre-determined motion time system (PMTS), Standard data and work sampling with statistical analysis).*

*To develop knowledge to apply methods engineering and ergonomics or human factors design principles to the analysis and redesign of an existing work station, work task, piece of equipment, work environment etc..*

**Module – I**

Introduction, definition, concept, objectives and need for work study. Work study and productivity. Method study - Definition, steps in method study, process analysis, process chart, process chart symbols, outline process chart, flow process charts, multiple activity charts, two handed process charts, flow diagram, string diagram and travel chart. Micro motion analysis - THERBLIGS - SIMO chart, memo motion analysis. Operation Analysis – basic procedure.

**Module – II**

Work Measurement - Definition, Objectives and concept of work measurement, work measurement technique, Stop watch time study, Time study equipments, selecting the job to be timed, selection of workers for time study, performance Rating, Systems of Rating, Predetermined motion time systems, Work factor systems – Mento - Factor System, Methods

Time Measurement (MTM), MTM systems, Use of MTM Tables, Maynard Operation Sequence Technique (MOST), Types of MOST, Use of Basic MOST Data-card, Work sampling, Use of control chart (P-chart) in work sampling, applications of work measurement techniques.

**Module – III**

Principles of motion economy, Ergonomics - definition and applications, Human-Machine system, Anthropometry and its uses in ergonomics – Types of anthropometric data,

Principles of applied anthropometry in ergonomics, Ergonomic approach to work station design – design for standing workers and design for seated workers, Design of Computer Work Stations, Design of manual handling tasks - NIOSH lifting equation - NIOSH approach to the design and evaluation of lifting tasks, Speed Accuracy Operating Characteristic (SAOC) - Fitts' Law - Fitts' and Peterson's experiment - Zellers' Model.

**Module – IV**

Work Capacity - Physical work capacity - Maximum oxygen uptake, Energy expenditure and work load guidelines, Applied physiology in the workplace - Calculation of rest periods in manual work – Murrell's empirical formula, Stress and Fatigue - Fatigue allowance determination, Heat stress - Heat stress Index (HSI) and Wet Bulb Global Temperature, heat stress control, Lighting design considerations, Design of the acoustic environment - Industrial noise control, Principles for the design of visual and auditory displays.

Design of controls in work place - Design principles for controls - control-response ratio (C/R – ratio) – control error statistics – calculation of control error - Partial means. Learning curves – Power form learning curves, Discrete Exponential Learning curves, Applications of learning curve. Case studies in work study and ergonomics.

**References:**


1. Ralph B. M., Motion and Time Study: Design and Measurement of Work, John Wiley & Sons, 1980.
2. Kanawaty G., Introduction to Work Study, ILO, 1992.
3. Phillips C. A., Human Factors Engineering, John Wiley and Sons, 2000.
4. Bridger R. S., Introduction to Ergonomics, Taylor and Francis, 2003.
5. Lehto M. R., S. J. Landry, and J. Buck., Introduction to Human Factors and Ergonomics for Engineers, CRC Press, 2007.
6. Hansen B. L., Work Sampling: For Modern Management, Prentice Hall, 1960.
7. Mundell M. E. and D. L. Danner, Motion and Time Study, Prentice Hall, 1993.
8. Niebel B. W. and A. Freivalds, Methods, Standards and Work Design, McGraw Hill, 1998.
9. Maynard H. and K. Zandin, Industrial Engineering Handbook, McGraw Hill, 2001.


**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:**

*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 question 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:**

*The students who succeed this course will be able to:*

- *understand the reasons and logic behind work station design.*
- *model work systems using standard techniques, such as flow diagrams, process charts, operation charts, activities charts, and block diagrams, for purposes of work system documentation, analysis, and design.*
- *apply a structured engineering process (analysis/requirements development, design, implementation, operation, evaluation) to work system development.*
- *determine the time required to do a job using standard data, activity sampling, time study and predetermined time systems.*
- *recognize and constructively address ethical, social, and environmental issues that arise in a work systems engineering project.*
- *recognize the human indicators of fatigue and stress.*

## 13.504 OBJECT ORIENTED PROGRAMMING & NUMERICAL METHODS (N)

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

**Course Objective:**

- *To bring together mathematical modeling and modern programming methodology.*
- *To get the overview of OOP paradigm, its methodology and its applications in the field of software design for computer-based numerical analysis for natural science problems.*
- *To get the ideas of the object-oriented programming vs. procedure-oriented programming.*
- *To study the fundamental concepts of OOP: abstraction, encapsulation, modularity and data hierarchy through inheritance.*
- *To draw attention to polymorphism and typing, parallelism, stability and other significant concepts and features of OOP methodology.*
- *To deal with methods, techniques; tricks and receipts for practical programming and program coding in C++.*

**Module – I**

Role of programming methodology, programming technology and programming languages facilities. Comparison the concepts of procedure-oriented programming (POP) and object-oriented programming (OOP). Fundamental concepts of object-oriented programming OOP) -abstraction, encapsulation, modularity, data hierarchy through inheritance, polymorphism and typing, parallelism and stability. Classes in C++. Encapsulation and modularity – methods and properties in classes. Example – class "String". Polymorphism in C++. Five ways to implement polymorphic code. The functions overloading and default values for functions' parameters in C++.

**Module – II**

Interface as a data type definition. Operators overloading in C++.Class methods and class friends in C++. Inline functions. Concept of 'lvalue' in C++. Pointer and reference data types in C++. Constants in C++: objects, pointers, references, methods. Techniques; tricks and receipts for practical programming and program coding in C++ with pointers, references and constants. Concept of encapsulation and its implementation in C++. Default rules vs. encapsulation in C++. Initialization and assignment for objects. Constructors and destructor in C++ classes environmental. Type conversion (type casting) rules in C++. How to control typecasting by constructors and typecasting operation. Typecasting for variables, pointers and references.

**Module – III**

Heap-based (dynamic) memory control in C++ classes. Techniques - tricks and receipts for practical programming and program coding in C++ with heap-based memory control. Classes hierarchy-inclusion relations and inheritance. Inheritance implementation for polymorphism and for strong typing. Dynamic (late) binding and name (early) binding. Three inheritance schemes: for behaviour and realization; only for realization; only for behaviour. Abstract classes and abstract base classes in C++. Multiple inheritances in C++. Virtual inheritance and virtual base classes. Techniques - tricks and receipts for practical programming and program coding in C++ with multiple inheritances. Exception handling system in C++. Techniques; tricks and receipts for practical programming and program coding in C++ with exception handling implementation. Templates in C++, standard template library (STL). Techniques - tricks and receipts for practical programming and program coding in C++ with STL.

**Module – IV**

Errors - Concepts, types of errors. Finding roots of an equation by Bisection algorithm, Regular-falsi method, Secant and Newton - Raphson method, Problems and its graphical significances. Solution of Differential Equation-Euler Method, Taylor Method, Runge-Kutta second and fourth order method for solving differential equations. Interpolation-Newton Forward and Backward interpolation, Lagrange interpolation. Integration-Mathematical Foundation for Trapezoidal and Simpson's 1/3$^{rd}$ Rules and its Composite forms.

**References:**


1. Stroustrup B., *The C++ Programming Language*, Addison Wesley, 2013.
2. Sutter H., *Exceptional C++ Style*, Addison-Wesley, 2000.
3. Becker P., *The C++ Standard Library Extensions: A Tutorial and Reference*, Pearson, 2006.
4. Booch G., *Object-Oriented Analysis and Design with Applications*, Pearson, 2009.
5. Jain M. K., S. R. K. Iyengar and R. K. Jain, *Numerical Methods for Scientific and Engineering Computation*, New Age international, 2003.
6. Lippman S. B., J. Lajoie, B. E. Moo, *C++ Primer*, 4/e, Pearson Education, 2005.


**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 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 completing the course, the students are expected to be able to:*

- *compare the programming languages and their facilities for object-oriented programming.*
- *define a set of abstract concepts as a knowledge domain environment.*
- *design a hierarchical set of data types (classes) on the base of inheritance;*
- *make out the classes hierarchy on the base of inclusion relations and on the base of private inheritance.*
- *choose and implement a suitable inheritance scheme: behaviour and realization; only realization; only behaviour.*
- *understand and utilize dynamic dispatch (dynamic binding or late binding or run-time linking) and static calls (fixed implementation or name binding or early binding or compilation-time linking) and utilize both in computer program code.*
- *understand the role of polymorphism and design polymorphic computer program code.*
- *present coherent arguments to answer questions both orally and in writing.*

## 13.505 MACHINE TOOLS (MN)

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

**Course Objectives:**

- *To impart the fundamental knowledge of mechanical machining processes that are now widely used in industries.*
- *To impart knowledge about various machine tools, machining processes, cutting tools, selection of these and the forces in these processes.*
- *To outline the widely used unconventional machining processes.*

### Module – I

**Fundamentals of Metal cutting**: Orthogonal and Oblique cutting – Chip formation, Types of chips – Tool Geometry – Tool Signature – Machinability – Tool wear, wear measurement – Factors affecting tool life. Analysis of orthogonal cutting – Cutting forces – Merchant's theory (simple problems). Economic of Machining.

**Cutting Tools**: Materials, Characteristics, Selection for different work piece materials and cutting speeds. Tool inserts – Specification. Cutting Fluids.

### Module – II

**Lathe**: Types, Working, Size specification. Feeding Mechanisms – Apron mechanism. Work piece holding in lathe – Lathe attachments. Machining operations with lathe. Measurement of cutting forces in lathe. Semi-automatic Machine Tools – Turret and Capstan Lathes. Automatic Lathe – Single spindle and Multi-spindle machines.

**Shaper**: Machine, Mechanism – Mechanical, hydraulic. Shaper operations – Cutting tools used – Calculation of cutting speed.

### Module – III

**Milling**: Types of machines – Principal parts – Types of milling cutters – Elements of plain milling cutters – Up milling, Down milling – Types of milling operations – Indexing – Simple Indexing, Differential indexing, Simple problems. Measurement of cutting forces in milling.

**Grinding**: Types of machines – Classification – Working. Features of Centreless and Tool post grinder. Grinding Operations. Grinding wheels – Fabrication, Specification, Selection – Glazing and Loading of Wheels – Dressing and Truing of Grinding wheels. Measurement of cutting forces in grinding.

### Module – IV

**Unconventional machining**: Features of processes and machines – EDM, Wire cut EDM, ECM, LBM, USM, AJM, AWJM, EBM and Chemical Machining.

**High energy rate forming**: Concept, Processes – Explosive forming, Hydro forming, Electromagnetic forming.

**Transfer machines**: Concept, Mechanisms.

**References:**


1. Kalpakjian S., *Manufacturing Engineering and Technology*, 6/e, Pearson Education, 2009.
2. DeGarmo E. P., J. T. Black and R. A. Kohser, *Materials and Processes in Manufacturing*, John Wiley and Sons, 2011.
3. Ghosh A. and A. K. Mallik, *Manufacturing Science*, Affiliated East West Press, 2002.
4. Rao P. N., *Manufacturing Technology*, - *Metal Cutting and Machine Tools*, Vol. 2, Tata McGraw Hill, 2009.
5. HMT, *Production Technology*, Tata McGraw-Hill, 2001.
6. Youssef H. A. and H. El-Hofy, *Machining Technology: Machine Tools and Operations*, CRC Press, 2008.


**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:**

*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.*

**Course Outcome:**

*After completing the studies of the content of this syllabus, students must be able to identify and select the machine, the machining process and the cutting tool when a particular product is to be manufactured*

## 13.506.1 MANAGEMENT OF PROJECTS (N)

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

**Course Objective**:

- *To develop skills in identification and formulation of new and organizational projects.*
- *To acquire idea about all the important phases of project and the various tools and techniques used in each phase.*
- *To acquire knowledge on the various project financing options for different types of projects.*
- *To get idea on project implementation tools such as CPM, PERT, GERT, MOST etc. and contract management.*
- *To get knowledge on project risk analysis and execution management.*

**Module – I**

General phases of projects - project identification, generation of project ideas, types of projects, new projects and BMRED (Balancing, Modernization, Replacement, Expansion and Diversification) projects. Screening of project ideas - macro parameters in project screening, SPACE approach, PRI, different considerations for projects under private, public and joint sectors. Project management life cycle - Project initiation, establishment of terms of reference / project charter, project planning, project execution and project closure. Project formulation and preparation of DPR (detailed project report).

**Module – II**

Project appraisal and analysis - different types of analysis and feasibility studies -market and demand, commercial, technical, economic, ecological and financial. Demand forecasting, technology transfer, environmental impact analysis. Estimation of project cost and cost of capital, weighted average cost of capital. Discounted cash flow and non-discounted cash flow methods, SCBA. Project selection based on appraisal and analysis. Inflation adjusted project selection. Simulation based project selection. Project financing - sources of finances, public loans, venture capital, consortium financing, foreign aids.

**Module – III**

Project implementation and administration - project organization, contract management, tenders and quotations, tendering procedures, e-tenders, appointment of contractors, contract laws. Project implementation planning - scheduling and network planning tools and techniques, use of Critical Path Method (CPM), PERT, GERT, MOST etc. Resource levelling and resource allocation techniques. Crashing and time-cost trade off, Post project evaluation. Multiple projects and constraints - method of ranking and LP models.

## Module – IV

Project risk analysis and execution management - Sources and measures of risk, sensitivity analysis, scenario analysis, break even analysis, simulation analysis and decision tree analysis. Management of time, cost, quality, change, issues, acceptance and communication related to projects. Project management softwares - Features of MS project, Yojana and Primavera. Project audit - post audit, common project failures and reasons for audit, abandonment analysis, determination of success criteria.

**References:-**


1. Chandra P. *Project Planning, Analysis, Selection, Financing, Implementation and Review*, Tata McGraw Hill, 2011.
2. Panneerselvam R. and P. Senthilkumar, *Project Management*, PHI Learning, 2009.
3. Larson E. W. and C. F. Gray, *Project Management - The Managerial Process*, McGraw Hill,2006.
4. Gopalakrishnan P. and V. E. Ramamoorthy, *A Text book of Project Management*, Macmillan, 1992.
5. Gido J. and J. P. Clements, *Successful Project Management*, Cengage Learning, 2014.
6. Koster K., *International Project Management*, Sage Publications, 2009.
7. Avison D. and G. Torkzadeh, *Information System Project Management*, Sage Publications, 2008.
8. Choudhury S., *Project Management*, TMH, 1988.
9. Maylor H., *Project Management*, Pearson Education, 2003.
10. Ghattas R. G. and S. L.McKee, *Practical Project Management*, Prentice Hall, 2001.


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

*40% - Tests (minimum 2)*
*40% - Class work.*
*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 completion of this course, students will get necessary foundation on the following:*

- *Identification and formulation of new and organizational projects.*
- *Important phases of project and the various tools and techniques used in each phase.*
- *Various project financing options for different types of projects.*
- *Project implementation tools and techniques, risk analysis and execution management.*

## 13.506.2 ORGANISATIONAL BEHAVIOUR (N)

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

**Course Objective**:

- *To acquire basic idea about individual and organizational behaviour.*
- *To acquire knowledge on values and attitudes.*
- *To get idea on group behaviour and organizational structures.*

**Module – I**

Definition of Organizational Behaviour (OB). Historical development of OB - Goals of OB - Challenges and opportunities. OB in a global context - The global economy - Facing the international challenge - Behaviour across cultures. Understanding and managing individual behaviour. Foundation of individual behaviour - Biographical characteristics - Ability - Learning - Implication for performance and satisfaction.

**Module – II**

Values and attitudes - Importance of values - Types of values - Types of attitude - Attitude and consistency. Job satisfaction - measuring job satisfaction - effect on employee performance. Personality and emotions - Personality determinants - Personality traits - Major personality attributes influencing OB. Emotional intelligence - Defining emotions - The six universal emotions - Emotions and national culture - OB applications. Perception - Defining perception and its importance - Factors influencing perception. Individual decision making - The rational decision making process - Improving creativity in decision making - Identifying problems - Ethics in decision making. Motivation - definition - contemporary theories of motivation.

**Module – III**

Group behaviour - defining and classifying groups - Formal group - Informal group - Command group - Task group - Interest group. Basic group concepts - Roles - Norms - Cohesiveness - Size - Composition - Status. Group decision making - Individual Vs group - Group decision making techniques. Understanding work teams - Team versus groups - Types of teams - Cross-functional teams - Creating effective teams. Conflict and inter-group behaviour - Definition of conflict - Transitions in conflict thought - The conflict process - Intergroup relations. Communication - functions - direction of communication - interpersonal, organisational - communication channel - barriers to effective communication. Leadership - trait theories - behavioural theories - contingency theories - issues in leadership.

## Module – IV

Organization system - structure - Organizational designs. Organizational culture - definition - functions. Human resource policies - training and development programs - performance evaluation - recruitment and selection. Organizational dynamics - organizational change - planned change - resistance to change - approaches to manage organizational change. Work stress and its management.

**References:-**


1. Robbins S. P., Organisational Behaviour, 7/e, Prentice-Hall of India, 2008.
2. Bhattacharyya D. and S. Bhattacharya, Industrial Psychology, Universities Press, 2013.
3. Khanka S. S., Organisational Behaviour, S. Chand Publishing, 2002.
4. Luthans F., Organisational behaviour, McGraw Hill, 1997.
5. Hellriegel D. and J. W. Slocum, Organisational Behaviour, Cengage Learning, 2010.


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

*40% - Tests (minimum 2)*
*40% - Class work.*
*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 completion of this course, students will get necessary foundation and complete understanding on individual and organizational behaviour, values and attitudes, group behaviour and organizational structures.*

## 13.506.3 ADVANCED MECHANICS OF SOLIDS (N)

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

**Course Objective**:

*This course is concerned with the development of analytical methods for solving problems in mechanics of materials that are generally considered beyond the scope of basic course in the discipline. As such, the developments tend to evolve from fundamentals principles such as equilibrium and conservation of energy.*

**Module – I**

Analysis of strain in 3-Dimensions - introduction, deformation in neighbourhood of a point, change of length of linear element, state of strain at a point, principal axes of strain and principal strains, compatibility conditions, Stress strain relations for linearity elastic bodies, generalized Hooke's law.

**Module – II**

Analysis of stresses in 3-Dimensions - Body force, surface force and stress vectors, state of stress at a point, normal shear stress components, stress component on arbitrary plane, principal stresses for 3-Dimensions, Problems,

Stress invariants, decomposition of stress matrix into hydrostatic and pure shear states, Lame's stress ellipsoid, differential equations of equilibrium.

**Module – III**

Energy methods - Reciprocal relations - Maxwell-Betti-Rayleigh reciprocal theorem - Castigliano's I theorem - Fictitious load method.

Theorem of virtual work - Castigliano's II theorem – Engesser's theorem.

Bending of beams - Straight beams and asymmetrical bending - shear centre - shear stresses in thin walled open sections. Bending of curved bars (Winkler–Bach formula).

**Module – IV**

Torsion -Torsion of General prismatic bars - Torsion of circular, elliptic and equilateral triangular bars - Membrane analogy. Torsion of thin - walled tubes. Torsion of bars with narrow rectangular cross-section. Torsion of thin - walled multiple cell closed sections, Torsion of rolled sections, Centre of twist and flexure centre.

**References:-**


1. Sreenath L. S., *Advanced Mechanics of Solids*, Tata McGraw Hill, 2009.
2. Timoshenko S. P. and J. N. Goodier, *Theory of Elasticity*, McGraw Hill, 1951.
3. Kazimi S. M. A., *Solid Mechanics*, Tata McGraw Hill, 2001.


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

*40% - Tests (minimum 2)*
*40% - Class work.*
*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:**

*At the end of the course, students will understand 3D stress analysis and other advanced theories in mechanics.*

## 13.506.4 COMPUTER AIDED DESIGN (N)

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

**Course Objective**:

*The main objectives of this course are the understanding of the use of computers in design Procedures. It also helps to understand the mathematics behind CAD and Analysis of Engineering Problems.*

### Module – I

Computer Aided Design - Definition, Application of CAD/ features of latest software packages used in each stages of Design process - Features of Special purpose software packages used in design and analysis and their benefits, Requirement of a CAD workstation for various application.

Principles of various display techniques (Stroke writing and Raster scanning), Working Principles of various output devices like Flat panel display devices (LCD and Plasma), DLP and Organic LED display devices, 3D Display devices, Light valve display, Dot matrix printer, Inkjet printer and laser printer.

### Module – II

Graphic Input Devices - Alpha numeric inputs, Tablets, Optical mouse, wireless mouse, Light pen, valuator, Scanners, biometric scanners, bar cord readers, Optical mark reader, 3D mouse, Touch screen (capacitive and Resistive), Concepts on 3D range data acquisition and its application, Reverse Engineering , 3D scanning.

Introduction to Computer Graphics, Graphic standards, Requirement of a GUI window, Various coordinate system used to represent graphic entities, Methods of defining points, lines- arcs, Bresenham's algorithm for line and circle generation.

### Module – III

2D Transformations - translation, scaling, rotation, mirroring, concatenation of transformations. Use of homogeneous coordinate systems. Programming concepts or MATLAB coding to generate simple entities and their 2D Transformation. 3D Transformations, 3D modeling Techniques (Wireframe, surface and solid modeling), Database concepts on CAD modelling, Viewing Techniques, Window to Viewport mapping, Cohen Sutherland Clipping Algorithm, Simple problems on 3D Transformation and 3D Modeling.

**Module – IV**

Introduction to matrix problems solution techniques used in FEM, Introduction to finite element analysis - steps involved in FEM - Preprocessing phase - discretization - types of elements - selection of interpolation functions.

Formulation of stiffness matrix for 1D element, truss element and beam element - formulation of load vector - Simple problems with Axial element - beam element, CST element. Solution of 1D and 2D structural, Thermal, and Vibration related problems.

Programming concepts of 1D FEM problems in MATLAB or C++. Element Features in FEM packages like ANSYS.

**References:-**


1. Roger D. F. and J. A. Adams, *Mathematical Elements of CAD*, McGraw Hill, 1990.
2. Anand V. B., *Computer Graphics and Geometric Modeling for Engineers*, John Wiley, 1996.
3. Xiang Z.,and R. A. Plastock, *Computer Graphics*, McGraw Hill, 2000.
4. Rogers D. F., *Procedural Elements of Computer Graphics*, McGraw Hill, 1988.
5. Chandrupatla T. R. and A. D. Belagundu, *Introduction to Finite Element Analysis*, Prentice Hall, 2002.
6. Logan D., *A First Course in Finite Element Method*, Cengage Learning, 2011.
7. Senthil S., *Introduction to Finite Element Analysis*, Lakshmi Publications, 2010.
8. Bavikatti S. S., *Finite Element Analysis*, New Age International, 2005.
9. Hutton D. V, *Fundamentals of Finite Element Analysis*, Tata McGraw Hill, 2005.
10. Rao S. S., *The FEM in Engineering*, Butterworth Heinemann, 2011.
11. Reddy J. N., *Introduction to FEM*, McGraw Hill, 2006.
12. Kwon Y. W. and H. Bang, *The FEM using MATLAB*, CRC Press, 2000.
13. Madenci E. and I Guven, The *FEM and Applications in Engineering using ANSYS*, Springer, 2015.


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

*40% - Tests (minimum 2)*
*40% - Class work.*
*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 completion of the course the students will have the understanding of the use and application of computers in engineering design procedures. Also possess the knowledge on mathematics behind CAD and analysis of engineering problems.*

## 13.506.5 ENERGY MANAGEMENT (N)

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

**Course Objective**:

- *To impart necessary knowledge on energy management and its judicious usage.*
- *To develop knowledge on the need of conservation of energy.*
- *To remind students about the importance of energy management in domestic and industrial sectors.*

**Module – I**

Energy: definition - characteristics - energy an infrastructure - The basic conversion methods – Conventional: Thermal, Hydro, Nuclear fission. Non-conventional: Biomass, Fuel cells and Magneto Hydro dynamics. Energy from waste. Energy plantation.

**Module – II**

Energy storage: mechanical - electrical - chemical methods. Electrical energy generation and distribution infrastructure. Load curves: Base load, Intermediate load and peak load power plants. Energy Management: Definitions and significance, objectives, Energy Management program, Energy strategies and energy planning, Energy Audit: Types and Procedure, simple walkthrough, Intermediate and comprehensive audits.

**Module – III**

Optimum performance of existing facilities, Energy management control systems, Energy policy in India, Computer applications in energy management. Energy economics: simple payback period, Energy conservation: Principles, Energy conservation technologies, combined heat and power – cogeneration; Trigeneration.

**Module – IV**

Waste heat recovery: Recuperators, regenerators, Heat pipes, Heat pumps, Combined cycle power generation. Steam rate, heat rate, Pinch Technology. Energy Conservation Opportunities: Electrical ECOs, Thermodynamic ECOs in chemical process industry, ECOs in residential and commercial buildings, Energy Conservation Measures.

**References:-**

1. Eastop T. D. and D. R. Croft, *Energy Efficiency for Engineers & Technologists*, Longman, 1990.

2. Thumann A., T. Niehus and W. J. Younger, *Handbook of Energy Audits*, Fairmont Press, 2012.
3. Turner W. C., *Energy Management Handbook*, Fairmont Press, 2007.
4. Rao S. and B. B. Parulekar, *Energy Technology*, Khanna Publishers, 1999.
5. Rai G.D., *Non-conventional Energy Sources*, Khanna Publishers, 2000.

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

*40% - Tests (minimum 2)*
*40% - Class work.*
*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 completion of this course, students will get necessary foundation for a complete understanding of energy management, its judicious usage and the need of conservation of energy. It will remind them the importance of energy management in domestic and industrial sectors.*

## 13.507 MACHINE TOOLS LAB (N)

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

**Course Objective :**

- *To gain familiarity with physical use of machine tools.*
- *To develop and reinforce measurements skills.*
- *To develop and reinforce skills in documenting observations.*
- *To develop skills at writing laboratory reports.*

**List of Exercises:**

I. General study of Lathe and accessories, tools used for different operations.
Exercises involving plane turning, groove cutting, form turning, taper turning, facing and thread cutting.

II. Study of shaping, slotting and planing machines.
Exercises involving production of flat surfaces, grooves and keyways.

III. Study of Milling Machines and Milling Cutters.
Exercises on Milling machines - face milling, end milling - spur and Helical gear cutting - milling of keyways

**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. The evaluation should be based on appropriate spilt of marks suitable to the question or as noted below:*

*90% - Theory, Procedure and formula and tools required (10%);Work finish (20%)*
*Dimension Accuracy with permissible allowance (60%)*

*10% - Viva voce*

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

**Course Outcome:**

*At the end of this course,*

- *The students will get foundation in different machining operations.*
- *Proper understanding of Machines and machining operation performed on each machines.*
- *Developed skills to produce dimensionally accurate components.*

## 13.508 WORK STUDY AND ERGONOMICS LAB (N)

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

**Course Objective :**

- *To use the tools and techniques of work study (Charts/diagrams, micro-motion studies & Principles of Motion economy).*
- *To use the tools and techniques of work measurement (WM). (Basic concept of WM and various Techniques of WM)*
- *To design, perform and analyze the studies/experiments related to Work Study (e. g. Process analysis, operation analysis, time study, Pre-determined motion time system (PMTS), Standard data and work sampling with statistical analysis).*
- *To develop knowledge to apply methods engineering and ergonomics or human factors design principles to the analysis and redesign of an existing work station, work task, piece of equipment, work environment etc.*

**Experiments in Work Study and Ergonomics Lab:**

(1) Experiment to explain the principles of motion economy.
(2) Experiment to determine method improvement.
(3) Experiment to demonstrate learning effects (learning curve).
(4) Experiment to experience and practice of performance rating
(5) Experiment to determine standard times of different jobs by stop watch time study.
(6) Experiment to determine standard time by MTM.
(7) Experiment to determine standard time by MOST.
(8) Experiment to determine standard time by work sampling.
(9) Experiment to determine location for facilities by gravity method, etc.
(10) Experiment to determine physiological work for doing different tasks.
(11) Experiment to explain micro-motion analysis.
(12) Experiment to determine stress and fatigue for doing different tasks.
(13) Experiment to determine Mental Work Load (MWL) doing different tasks.
(14) Experiment on elements of work system by using design tools.
(15) Experiment using Ergonomic Software.

**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 experiments prescribed. The university exam question paper shall be prepared 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 understand the reasons and logic behind work station design.*
- *Will be able to model work systems using standard techniques, such as flow diagrams, process charts, operation charts, activities charts, and block diagrams, for purposes of work system documentation, analysis and design.*
- *Will be able to apply a structured engineering process (analysis/requirements development, design, implementation, operation, evaluation) to work system development.*
- *Will be able to determine the time required to do a job using standard data, activity sampling, time study, and predetermined time systems.*
- *Will be able to recognize and measure the human indicators of fatigue and stress.*