Rashtreeya Sikshana Samithi Trust

R. V. COLLEGE OF ENGINEERING

(Autonomous Institution Affiliated to VTU, Belgaum)

R. V. Vidyaniketan Post, Mysore Road

Bangalore – 560 059

Scheme & Syllabus

III & IV Semester B.E.

Industrial Engineering and

Management

(2012 Scheme)

R. V. College of Engineering, Bangalore – 59

(Autonomous Institution affiliated to VTU, Belgaum)

Department of Industrial Engineering and Management

RVCE Vision and Mission

Vision Statement

Leadership in, Quality Technical Education, Research & Innovation through Teamwork, with a Focus on Development of Sustainable and Inclusive Technology.

Mission Statement

- Deliver Quality Technical Education, with an equal emphasis on theoretical and practical aspects.
- To provide state of the art infrastructure for the students and faculty to upgrade their skills and knowledge.
- To produce quality engineers who are disciplined, ethical and socially concerned.
- To create an open and conducive environment for faculty and students to carryout research and excel in their field of specialization.
- To focus especially on Innovation and Development of Technologies those are sustainable and inclusive, and thus benefit all sections of the society.
- Establish a strong Industry Academic Collaboration for teaching and research, which could lead to entrepreneurship.
- To assist weaker section of the society by providing opportunity and resources for developing skills for employability or self help / entrepreneurship.

R.V. College of Engineering, Bangalore – 59

(Autonomous Institution affiliated to VTU, Belgaum)

Department of Industrial Engineering and Management

Department Vision and Mission

Vision

Imparting innovation and value based education in Industrial Engineering and Management for steering organizations to global standards with an emphasis on sustainable and inclusive development.

Mission

- To impart scientific knowledge, engineering and managerial skills for driving organizations to global excellence.
- To promote culture of training, consultancy, research and entrepreneurship interventions among the students & faculty.
- To institute collaborative academic and research exchange programs with National and globally renowned Universities, industries and other organizations.
- To establish and nurture Center of Excellence in the niche area of Industrial and Systems Engineering.

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(Autonomous Institution affiliated to VTU, Belgaum)

Department of Industrial Engineering and Management

Programme Educational Objectives (PEO's)

I. Conceive, design, implement and operate integrated man – machine systems, focus on appropriate measures of performance at strategic, tactical and operational levels.
II. Exhibit competency to adapt to changing roles for achieving organizational excellence.
III. Design and develop sustainable technologies and solutions for betterment of society, at large.
IV. Pursue entrepreneurial venture with a focus on creativity and innovation for developing newer products, processes and systems.

Programme Outcomes (PO's)

1. Exhibit knowledge of basic sciences and engineering and manufacturing processes.
2. Demonstrate the ability to accomplish the integration of systems using appropriate analytical, computational and application practices and procedures.
3. Demonstrate the ability to apply knowledge of probability and statistics, optimization techniques, simulation modeling, engineering economic analysis and cost control, and other technical sciences and specialties necessary in the field of industrial engineering and management.
4. Be able to identify, formulate, solve problems and implement solutions for engineering, managerial and societal requirements.
5. Possess skills related to design / re-design and conduct experiments, analyze and interpret data through systems thinking and modeling approaches
6. Exhibit knowledge of values and professional ethics in their areas of work.
7. Develop an ability to adapt and continuously learn to pursue successful careers in chosen professional field
8. Manage projects in various sectors of economy with a focus on conceptual, technical and human aspects

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Department of Industrial Engineering and Management

THIRD SEMESTER								
Sl. No	**Subject Code**	**Subject Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture	**Tutorials**	**Practical**	**Self study**	
1	12MA31	Applied Mathematics-III	Sc	3	1	0	0	4
2	12EM32	Engineering Materials	ME	3	0	0	0	3
3	12IM33/ CV33/ME33	Mechanics of Materials	Civil	3	0	1	1	5
4	12IM34	Manufacturing Process – I	IEM	3	0	1	1	5
5	12IM35	Design of Work Systems	IEM	3	0	1	1	5
6	12IM36	Basics of Thermodynamics & Fluid Mechanics	IEM	3	0	1	1	5
7	12DMA37	Bridge Course Mathematics – I	Sc					
								27
		No. Of Hrs.		**18**	**02**	**08**	**16**	**44**

FOURTH SEMESTER								
Sl. No	**Subject Code**	**Subject Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture	**Tutorials**	**Practical**	**Self study**	
1	12MA41	Statistics for Decision Making	IEM	3	1	0	0	4
2	12EB42	Environmental science and Biology for Engineers	Sc	3	0	0	1	4
3	12IM43/ME43	Metrology and Measurements	IEM	3	0	1	1	5
4	12IM44	Engineering Economy	IEM	3	1	0	0	4
5	12IM45	Manufacturing Process – II	IEM	3	0	1	1	5
6	12IM46	Applied Ergonomics	IEM	3	0	1	1	5
7	12HSS47	Innovation and Social skills	HSS	0	0	1	0	1
8	12DMA48	Bridge Course Mathematics - II	Sc					
								28
		No. Of Hrs.		**18**	**04**	**08**	**16**	**46**

* Audit Course 4 Hrs/Week

III Semester

APPLIED MATHEMATICS III
(Common to all Programs)

Course Code: 12MA31 | **CIE Marks: 100**
Hrs/Week: L:T:P:S : 3:2: 0:0 | **SEE Marks: 100**
Credits: 04 | **SEE : 3 Hrs**

Course Learning Objectives:
Students are expected to :
- Be able to analyze periodic phenomena using concept of Fourier series.
- Understand the basics of matrix theory and its applications for finding solution of system of linear equations.
- Finding the approximate solutions using numerical methods, for problems which do not have analytical solutions.
- Approximating functional values with different curves.
- Optimizing real functional with various applications.

Unit – I **08 Hrs**

Fourier series and Fourier Transforms
Introduction, periodic functions, Even and odd functions, properties. Special waveforms - Square wave, half wave rectifier, saw-tooth wave and triangular wave. Euler's formula for Fourier series, Fourier series for functions of period 2L (particular cases), Dirichlet's conditions - problems. Half Range Fourier series- Construction of Half range cosine and sine series, Complex form of Fourier series. Complex Fourier Transforms –Properties & simple problems.

Unit – II **07 Hrs**

Matrices and Linear Equations: Elementary transformation, rank of matrix by using Echelon form, consistency of system of linear equations and solutions, solution of system of linear equations using Gauss elimination method, Gauss Jordan method, Gauss Seidel method, Eigenvalues and Eigenvectors, finding largest eigenvalue by using Power method.

Unit – III **07 Hrs**

Curve Fitting and Interpolation: Method of Least squares - fitting of the curves of the form $y = ax + b$, $y = ae^{bx}$, $y = ax^b$ and $y = ax^2 + bx + c$, Correlation and Regression analysis. Finite differences-forward and backward differences, Interpolation-Newton's forward and backward interpolation formulae, Lagrange's interpolation formula.

Unit – IV **07 Hrs**

Numerical methods: Numerical integration – Simpson's rules, Weddle's rule and Gaussian quadrature (two point & three point formula). Numerical methods for first order ODE – Single step & Multistep methods-Taylor's series method, Runge-Kutta fourth order method, Adam-Bash forth's method, BVP for ODE – Shooting methods for second order ODE (All methods without proof).

Unit – V **07 Hrs**

Calculus of Variation
Introduction, Variation of functions and functional, extremal of a functional, variational problem, Euler's equation and special cases. Examples - Geodesics, Hanging cable, and Brachistochrome problem.

Course outcomes:

At the end of this course the student will be able to :

CO1. Apply knowledge of linear algebra for finding the solution of system of linear equations.
CO2. Analyze and interpret physical phenomena which are periodic in nature by applying Fourier series.
CO3. Solve Algebraic and transcendental equations using effective numerical methods.

Reference Books

1. B.S. Grewal - Higher Engineering Mathematics, Khanna Publishers, 40th Edition, 2007, ISBN: 81-7409-195-5, Chapters 2, 10, 24, 28, 29, 31, 34.
2. N.P Bali & Manish Goyal - A Text Book of Engineering Mathematics, Lakshmi Publications, 7th edition, 2010, ISBN: 978-81-7008-992-6, Chapters: 3(3.34-3.40,3.46, 3.47), 10 (10.1-10.7-10.10), 2 (2.24 -2.26).
3. Erwin Kreyszig - Advanced Engineering Mathematics, John Wiley & Sons, 9th Edition, 2007, ISBN: 978-81-265-3135-6, Chapters: 6, 7.1, 7.2,10(10.1-10.5,10.9-10.11),17, 18,19.
4. Murray R Spiegel - Theory & problems of Fourier Analysis with applications to Boundary Value problems, Schaum's Outline Series.

Scheme of Continuous Internal Evaluation:

CIE consists of Three Tests each for 45 marks (15 marks for Quiz + 30 marks for descriptive) out of which best of two will be considered. In addition there will be one seminar on new topics / model presentation etc. for 10 marks.

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions (descriptive, analytical, problems or/and design) carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Mapping of POs with CO's

Course Outcome	Program Outcomes
1.	1,4,5
2.	1,2,4
3.	1

ENGINEERING MATERIALS

(Common to all Programs)

Course Code	**:**	**12EM32**	**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 3:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**03**	**SEE Duration**	**:**	**03 Hrs**

Course Learning Objectives(CLO):

Students are expected to understand:

1. The versatile use of materials from biomedical applications to aerospace industries
2. The different properties of materials.
3. Different types of ferrous alloy its properties and applications.
4. Concept of phase transformation due to temperature in alloys.
5. Various heat treatment methods employed in the industry and its affect on the mechanical properties.
6. Importance of ceramics, polymers and composites, its types, applications.
7. Nano Materials synthesis, advantages over conventional materials.

Unit – I **06 Hrs**

INTRODUCTION

Classification of Materials - Metals, Ceramics, Polymers, composites, Advanced Materials-semiconductors, biomaterials, smart materials, nanostructured materials and their applications.

Material properties – Mechanical properties, thermal properties – Heat capacity, CTE, thermal conductivity, Electrical and Electronic conductivity, Magnetic properties – dia, para, ferro, ferri, antiferro, domains and hysteresis. Optical properties -Luminescence and photoconductivity.

Unit – II **10 Hrs**

Ferrous materials and Alloys - Binary phase diagrams, Phase Rule, Lever Rule, Solidification, Nucleation and Grain Growth.

Cast Iron, Chromium steels, Nickel steels, Silicon Steels, Tungsten and Molybdenum Steels & Stainless Steels; Tool Steels, structural steels, Corrosion and Heat Treatment.

Non-ferrous materials and alloys – Aluminium, Copper and Titanium, their alloys, properties and applications.

Unit – III **08 Hrs**

Overview of Flexible Electronics Technology

History of Flexible Electronics, Materials for Flexible Electronics , Fabrication Technology for Flexible Electronics Fabrication on Sheets by Batch Processing, Fabrication on Web by Roll-to-Roll Processing , Additive Printing, Low-temperature Amorphous and Nanocrystalline Silicon Materials, Low-temperature Dielectrics, Low-temperature Thin-film Transistor Devices.

Ceramic Materials - Definition, Classification of Ceramic Materials, Processing Methods, Properties and Industrial, Medical and Commercial Applications.

Unit – IV **06 Hrs**

COMPOSITES - Types of Matrix Materials and Reinforcements, Selection of Composites, Properties, Applications, Rule of Mixture for density, elastic modulus and tensile strength.

Nanomaterials - Definition, classification and synthesis – physical and chemical processes, Characterization of nanomaterials – Electron microscope, X-Ray Diffraction, particle size analyzer

Unit – V **06 Hrs**

Advanced materials for - Construction Applications, Biomedical applications, High temperature Applications, Sensors and Actuators - Shape Memory Alloys and Composites, Thin films and coatings.

Course Outcomes:

After successful completion of the course the students will be able to:

CO1. Classify materials based on properties
CO2. Compute the properties of composites based on the properties of the constituents
CO3. Draw Binary phase diagrams and identify the phases
CO4. Identify characterization techniques for nanomaterials, thin films, flexible electronics, biomedical applications, high temperature applications, sensors and actuators

Reference Books

William D. Callister; "Materials Science & Engineering- An Introduction"; Wiley India Pvt. Ltd.; 6th Edition; 2006; New Delhi; ISBN:9814-12-669-1:; 1,4,6,7,8,9

Fred W. Billmeyer, Jr; " Text Book Of Polymer Science"; Wiley-Interscience Publication; 2nd Edition; 1984; ISBN:0-471-82834-3; 8

Donald R. Askland, Pradeep P. Phule, "Essentials of Materials Science and Engineering", Thomas Canada Learning INDIA EDITION, ISBN:81-315-0233-3

William Smith,"Foundation of Materials Science and Engineering", 3rd Edition, McGraw Hill, 1997. ISBN:9780073529240

Flexible Electronics: Materials and Applications, William S. Wong and Alberto Salleo, eds. ISBN 978-0-387-74362-2, 2009

Scheme of Continuous Internal Evaluation:

CIE consists of Three Tests each for 45 marks (15marks for Quiz + 30 marks for descriptive) out of which best of two will be considered. In addition there will be one seminar on new topics / model presentation etc. for 10 marks.

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Mapping of POs with CO's

Course Outcome	Program Outcomes
1.	1
2.	1,4
3.	1
4.	1,2,4

MECHANICS OF MATERIALS

(Theory & Practice)

Course Code	**:**	**12IM33/CV33/ME33**	**CIE Marks**	**:**	**100 + 50**
Hrs/Week	**:**	**L:T:P:S 3:0:2:4**	**SEE Marks**	**:**	**100 + 50**
Credits	**:**	**05**	**SEE Duration**	**:**	**03 + 03 Hrs**

Course Learning Objectives:

Students are expected to:

- Understand mechanics of deformable bodies and apply them in analysis and design problems.
- Aanalyze a body subjected to two dimensional stress system.
- Understand the behavior of a structural member in flexure.
- Evaluate the slope and deflection in beams subjected to loading.
- Study the stability of columns and struts.
- Study the torsional behavior of structural members.

Unit – I **06 Hrs**

Elastic Constants: Volumetric strain, expression for volumetric strain, relationship among elastic constants, Thermal stresses and strains. Numerical problems.

Two Dimensional Stress System: Introduction, Stress components on inclined planes, Principal Stresses, principal planes, Mohr's circle of stress Numerical problems.

Unit – II **06 Hrs**

Bending stress and shear stress in beams: Introduction, Assumptions in simple bending theory, Derivation of Bernoulli's equation, modulus of rupture, section modulus, flexural rigidity, Beam of uniform strength, expression for horizontal shear stress in beam, shear stress diagram for simple rectangular and symmetrical I and T sections only. Numerical problems.

Unit – III **06 Hrs**

Deflection of determinate Beams: Introduction, Definitions of slope, deflection, Elastic curve –Derivation of differential equation of flexure, Sign convention, Slope and deflection using Macaulay's method for prismatic beams and overhanging beams subjected to point loads ,UDL and couple. Numerical problems.

Unit – IV **07Hrs**

Analysis of columns and struts: Introduction, Euler's theory on columns, effective length, slenderness ratio, short and long columns, radius of gyration, buckling load, assumptions, Derivation of Euler's Buckling load for different end conditions, Limitations of Euler's theory, Rankine's formula. Numerical problems.

Unit – V **06Hrs**

Torsion: Assumptions in theory of pure torsion, Torsion equations, Torsional rigidity and modulus of rupture, power transmitted, Comparison of solid and hollow circular shafts. Numerical problems.

Self Study:

Case study, Design and Emerging Technologies to be discussed pertaining to the course. **12 Hrs**
1 Credit: 4 Hrs / Week

Unit – VI (Laboratory Work)

1. Hardness Tests (Brinell, Rockwell,Vicker)
2. Tension test on Mild steel and HYSD bars
3. Compression test of Mild Steel, HYSD, Cast iron and Wood
4. Torsion test on Mild Steel circular sections
5. Bending Test on Wood Under two point loading
6. Shear Test on Mild steel
7. Impact test on Mild Steel (Charpy & Izod)

8. Demonstration of Strain gauges and Strain indicators
9. Demonstration of Non Destructive Testing Equipment.
10. Demonstration of Microstructural Analysis.

Course outcomes:

After going through this course the student will be able to:

CO1. Evaluate the behavior of a material under two dimensional stress system (Objective 1, syllabus 1)
CO2. Calculate the principle stresses and shear stresses analytically and graphically (Objective2, syllabus1)
CO3. Calculate the bending and shear stresses across the section of a beam.(Objective 3, syllabus 3)
CO4. Interpret the behavior of a material in shear and bending.(Objective 4 syllabus 3)
CO5. Calculate slope and deflection in beams(Objective 4 ,syllabus 4)
CO6. Calculate buckling load of columns (Objective 5,syllabus 5)
CO7. Determine Torsional strength of solid and hollow shafts (Objective 6, syllabus 6)

Reference Books

1. Timoshenko & Young "Elements of Strength of Materials", Affiliated East-West Press, 1976 Edition

2. F.P.Beer and R.Johnston,"Mechanics of Materials", McGraw-Hill Publishers, 2006 ISBN 9780073529387

3. S.Ramamrutham, R.Narayanan"Strength of Materials", DhanapathRai Publishing Company, New Delhi, 2012, ISBN 818743354X

4. S.S. Bhavikatti, "Strength of Materials", Vikas Publications House Pvt. Ltd. New Delhi, 2012 ISBN 9788125927914

5. LS.Srinath, Prakash Desai, N Srinivasa Murthy and S AnanthRamu; "Strength of Materials", MacMillan Publishers India Limited, New Delhi; -2010. ISBN-0333923928

Scheme of Continuous Internal Evaluation:

CIE consists of Three Tests each for 40 marks (15marks for Quiz + 25 marks for descriptive) out of which best of two will be considered. In addition 20 marks to be earned through self learning component on emerging topics.

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Scheme of Continuous Internal Evaluation(CIE) for Lab:

CIE consists of 50 marks out of which 40marks for maintaining record and 10 marks for internal test.

Scheme of Semester End Examination (SEE) for Lab:

2 Experiments of 20 Marks each	:	40 Marks
Viva Voce	:	10 Marks
Total	:	50 Marks

Mapping of POs with CO's

Course Outcome	Program Outcomes
1.	1
2.	1,4
3.	1,4
4.	1,2,4
5.	1,4
6.	1,4
7.	1,4

MANUFACTURING PROCESS – I

(Theory & Practice)

Course Code	**:**	**12IM34**	**CIE Marks**	**:**	**100 + 50**
Hrs/Week	**:**	**L:T:P:S 3:0:2:4**	**SEE Marks**	**:**	**100 + 50**
Credits	**:**	**05**	**SEE Duration**	**:**	**03 + 03 Hrs**

Course Learning Objectives (CLO):

Students are expected to:

- Develop the concepts related to forming & welding processes and practices.
- Explain the methodologies and stages involved in primary manufacturing processes.
- Incorporate the knowledge of producing a quality output through forming and welding processes.
- Develop a practice orientation to build skills in forming and welding technologies.

Unit – I **07 Hrs**

Introduction: - Production and assembly processes, classification of production processes, selection of a process for production. Recyclability issues, Maintenance of various equipments.

Metal Casting Process: Casting terminology, sand mould making procedure.

Pattern: Pattern allowances,core prints, pattern materials, types of patterns, pattern colour code.

Unit – II **07 Hrs**

Molding Materials & Core Making: Molding sand composition, testing sand properties, sand preparation, molding sand properties, fluidity, types of sand moulds, molding machines. Core sands, carbon dioxide molding, types of cores, core prints, chaplets, metalostatic forces.

Gating system Design: Elements of gating system, gates, pouring time, choke area, sprue, gating ratios, Caine's method for riser design.

Unit – III **06 Hrs**

Melting Practice: Cupola, charge calculations, reverberatory furnace, crucible furnace, induction furnace, ladles.

Product design for sand casting: Designing for economical molding, designing for eliminating defects, defects in casting. Analysis of impact of defects.

Unit – IV **07 Hrs**

Metal forming processes: Hot working & cold working, principle of rolling & applications, forging operations, smith forging, drop forging, press forging, principle of extrusion. Over view of Metal spinning and Hydro Forming techniques.

Metal fabrication Processes: Introduction, classification, principles of resistance welding, resistance spot welding, resistance seam welding, projection welding, upset welding, flash welding. Defects in welding.

Unit – V **07 Hrs**

Special Casting Processes: Shell molding, precision investment casting, permanent mould casting, die casting, centrifugal casting, and continuous casting.

Special Welding Processes: Thermit welding, electron beam welding, laser beam welding, forge welding, friction welding.

Self Study: Case Study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hours / Week **12 Hrs**

Unit – VI (Laboratory Work)

Part – I - Experiments on Sand Testing

1. Testing of Moulding sand and Core sand Preparation of specimen and conduction of the following tests:
    a) Compression/ Shear /Tensile tests
    b) Permeability test
    c) Grain fineness test
    d) Clay content test

Part – II - Experiments on Foundry & Forging

2. Preparation of moulds - two box method: using split pattern. Match plate pattern & Cores.
3. Preparing minimum three models involving upsetting, drawing and bending operations
4. Demonstration of arc and gas welding processes.
5. Demonstration of NDT Experiments.

Course Outcomes:

After the successful completion of the course the students will be able to:

CO1. Explain the basic principles and methodology of various manufacturing processes that are used for the production of mechanical parts and products.

CO2. Demonstrate basic operational skills in different manufacturing processes like forming, welding, casting, pattern making.

CO3. Compare and contrast the advantages and limitations of different manufacturing processes along with defects analysis.

CO4. Apply the design concept of various manufacturing processes when a specific product has to be manufactured

CO5. Evaluate the better way of manufacturing and construction of mechanical parts or products by means of various manufacturing processes along with basic computations

Reference Books:

1. P.N. Rao, Manufacturing Technology: Foundry Forming and Welding, TMH, 2nd Edition, 1998, ISBN: 0-07-463180-2.
2. Serope Kalpakjian, Steuen. R. Schmid, Manufacturing Technology, Pearson Education Asia, 4th Edition, 2000, ISBN: 0-07-463180-2.
3. R W Heine, C R Loper, P C Rosenthal, Principles of Metal Casting, Tata McGraw-Hill, Edition reprinted, ISBN-13:978-0-07-099378-8 & ISBN: 10:0-07-099348-3.
4. Amitabha Ghosh and A K. Mallik, Manufacturing Science, East West press, 4th Edition, ISBN: 0745800599.

Scheme of Continuous Internal Evaluation:

CIE consists of Three Tests each for 40 marks (15marks for Quiz + 25 marks for descriptive) out of which best of two will be considered. In addition 20 marks to be earned through self learning component on emerging topics.

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Scheme of Continuous Internal Evaluation(CIE) for Lab:

CIE consists of 50 marks out of which 40marks for maintaining record and 10marks for internal test.

Scheme of Semester End Examination (SEE) for Lab:

Experiment from Part – I	:	20 Marks
Experiment from Part – II	:	20 Marks
Viva Voce	:	10 Marks
Total	:	50 Marks

Mapping of POs with CO's

Course Outcome	Program Outcomes

1.	1
2.	1,4,5
3.	1,4
4.	1,2,4
5.	1,4

DESIGN OF WORK SYSTEMS

(Theory & Practice)

Course Code	**:**	**12IM35**	**CIE Marks**	**:**	**100 + 50**
Hrs/Week	**:**	**L:T:P:S 3:0:2:4**	**SEE Marks**	**:**	**100 + 50**
Credits	**:**	**05**	**SEE Duration**	**:**	**03 + 03 Hrs**

Course Learning Objectives (CLO):

Graduates shall be able to

- Develop concepts related to principles of productivity & work study as a tool for increasing the efficiency and effectiveness in organizational systems.
- Incorporate the concepts related to measuring work using principles of work analysis.
- Create the knowledge useful in designing work systems for productivity improvement.

Unit – I **07 Hrs**

Introduction: Definition of Industrial Engineering, Concept and Scope of Industrial Engineering, Evolution of Industrial Engineering approach. Productivity concepts, techniques for productivity improvement. Over view of Lean concepts and tools.

Work Study: Definition, objective and scope of work study. Human factors in work study. Influence of working conditions on work study.

Unit – II **07 Hrs**

Method Study: Definition, objective and scope of method study. Steps involved in Method study, Selection of activity, Activity recording.

Recording tools: Out Line Process Chart, Flow Process Chart, Flow diagram, String Diagram, Travel Chart, Multiple Activity Chart, Value Stream Mapping tools.

Unit – III **06 Hrs**

Principles of Motion Economy: Introduction, Classification of movements. Two- hand process chart, Micromotion study, SIMO Chart, therbligs, cyclegraph and chronocyclegraph.

Define, Install, and Maintain: Obtaining approval for the improved layout, defining and installing the improved method. Training and retraining operatives. Maintaining the new method.

Unit – IV **06 Hrs**

Work Measurement & Work sampling: Definition, objective and benefits of work measurement. Work measurement techniques. Work sampling, problems.

Time Study: Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information.

Unit – V **07 Hrs**

Performance Rating: Qualified worker, standard rating, standard performance, scales of rating. Systems of rating – Speed rating, Westing house system of rating, synthetic rating, objective rating. Factors affecting rate of working.

Standard Time Determination: Allowances and standard time determination. Time standards for man-machine systems. Standard data, Method time measurement (MTM), Time Study Software's, MOST, problems.

Self Study: Case Study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hours / Week **12 Hrs**

Unit – VI (Laboratory Work)

Part -I

1. Exercises on Recording Techniques**:**
   Outline process chart, Multiple Activity Chart, Flow process chart, Flow diagram, String diagram, Two handed process charts, Value stream mapping tools.
2. Exercises on conducting method study for assembling simple components and office work.

Part - II

3. Exercise on Timing Practice using element generator.
4. Exercices on Pace and Performance rating.
5. Determining the standard time for simple operations using stopwatch time study.
6. Exercises on estimating standard time using PMTS.

Course Outcomes:

After going through this course the student will be able to:

CO1. State the industrial engineering principles that influence the productivity improvement in organizations.

CO2. Apply the method study guidelines in the analysis and redesigning of processes.

CO3. Model work systems using standard tools for purposes of work system documentation, analysis, and design.

CO4. Determine the time required to do a job using the concepts of work measurement.

CO5. Demonstrate documentation and presentation skills pertinent to Work Systems design.

Reference Books:

1. George Kanawaty, Introduction to work study, ILO, 4th revised Edition, 1992, ISBN: 9221071081.
2. L. C. Jhamb, A Practical Guide to Work Study and Ergonomics, Everest Publishing House, 2nd Edition, 1990.
3. Ralph M Barnes, Motion and Time Study, John Wiley, 7th Edition, 1980, ISBN: 978-0-471-05 905-9.
4. M P Groover, Work Systems and the Methods, Measurement and Management of Work, Pearson Prentice Hall, 2007, ISBN: 0131406507
5. B. Niebel and Freivalds, Niebel's Methods Standards and Work Design, McGraw-Hill, 12th Edition, 2009, ISBN: 0071283226.

Scheme of Continuous Internal Evaluation:

CIE consists of Three Tests each for 40 marks (15marks for Quiz + 25 marks for descriptive) out of which best of two will be considered. In addition 20 marks to be earned through self learning component on emerging topics.

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Scheme of Continuous Internal Evaluation(CIE) for Lab:

CIE consists of 50 marks out of which 40marks for maintaining record and 10marks for internal test.

Scheme of Semester End Examination (SEE) for Lab:

Experiment from Part – I	:	20 Marks
Experiment from Part – II	:	20 Marks
Viva Voce	:	10 Marks
Total	:	50 Marks

Mapping of POs with CO's

Course Outcome	Program Outcomes

1.	1,2
2.	1,3,4
3.	1,2
4.	1,3
5.	4,5

BASICS OF THERMODYNAMICS AND FLUID MECHANICS

(Theory and Practice)

Course Code	**:**	**12IM36**	**CIE Marks**	**:**	**100 +50**
Hrs/Week	**:**	**L:T:P:S 3:0:2:4**	**SEE Marks**	**:**	**100+50**
Credits	**:**	**05**	**SEE Duration**	**:**	**03 + 03 Hrs**

Course Learning Objectives:

Students are expected to :

- Use the Bernoulli equation to solve flow problems.
- Apply the concepts of static, stagnation, dynamic and total pressures to design the systems.
- Incorporate the laws of thermodynamics in Engineering Design.
- Analyze the gas power cycles.

Unit – I	**07 Hrs**
Thermal Engineering: Definition, Thermodynamic approaches Thermodynamic systems, Thermodynamic properties, Thermodynamics processes, Thermodynamic equilibrium, Laws of thermodynamics.	
Unit – II	**06 Hrs**
Gas Power Cycles: Basic Consideration in the Analysis of Power cycles, The Carnot Cycle. Working Principle & application of Otto, Diesel and Dual combustion air cycles.	
Unit – III	**06 Hrs**
Fluid Mechanics: Properties of fluids, Pressure of fluid and buoyancy, Pascal' s law of pressure, pressure variation in a static fluid, Pressure head of liquid, Equation of continuity, Bernoulli's Theorem.	
Unit – IV	**06 Hrs**
Fluid flow Measurement Principles: Venturimeter, orifice meter, pitot tube and rectangular & V- notches.	
Principles of Flow through Pipes: Friction losses in pipes, Energy line and hydraulic gradient line, Darcy equations in pipes.	
Unit – V	**07 Hrs**
Hydraulics and Pneumatics: Elements of Hydraulics and Pneumatics systems, symbols. Control valves-Flow, direction & pressure valves. Logic circuit design for machine tool application.	
Self Study: Case Study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hours / Week	**12 Hrs**

Unit – VI (Laboratory Work)
Part – I

1.	Determination of Flash point and Fire point of lubricating oils using Abel pen sky and pen sky Martins Apparatus.
2.	Determination of Caloric value of solid/ liquid fuel.
3.	Valve Timing diagram of an I.C. Engine
4.	Performance Tests on IC Engines: a. Four stroke Diesel Engine b. Four stroke Petrol Engine

	c. Two stroke Petrol Engine d. Variable compression Ratio IC Engine e. Morse test
	Part – II
5.	Measurement of fluid discharge using Orifices, Venturimeter and Notches.
6.	Determination of Friction in Pipe.
7.	Simple Hydraulics and Pneumatics circuits design.
Note: A minimum of 10 experiments to be conducted covering the entire syllabus in Unit VI.	

Course Outcomes:
After going through this course the student will be able to:

CO1. Explain the need of thermodynamic systems in Mechanical Engineering applications.
CO2. Demonstrate the application of Bernoulli equation in designing various flow measuring devices.
CO3. Apply the laws of thermodynamics in Engineering Design.
CO4. Apply the concepts of static, stagnation, dynamic and total pressures in designing the systems.
CO5. Analyze the gas power cycles in designing the IC Engines.

Reference books:

1.	Yunus A Cencgal and Michael A. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill publications, 5th Edition, 2006, ISBN: 0072884959.
2.	Obert and Young, Thermodynamics and Heat Transfer, McGraw Hill, 2nd Edition, Digitized 7 May 2007
3.	Lewitt, Hydraulics and Fluid Mechanics, Pitman Publishing, ISBN 10: 0273417061, ISBN 13: 9780273417064
4.	Dr. R K. Bansal, A Text Book of Fluid Mechanics and Hydraulic Machines by Laxmi Publication (P) Ltd., New Delhi, 9th Edition, 2010, ISBN : 978-81-318-0815-3

Scheme of Continuous Internal Evaluation:
CIE consists of Three Tests each for 40 marks (15marks for Quiz + 25 marks for descriptive) out of which best of two will be considered. In addition 20 marks to be earned through self learning component on emerging topics.

Scheme of Semester End Examination:
The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Scheme of Continuous Internal Evaluation(CIE) for Lab:
CIE consists of 50 marks out of which 40 marks for maintaining record and 10 marks for internal test.

Scheme of Semester End Examination (SEE) for Lab:

Experiment from Part – I	:	20 Marks
Experiment from Part – II	:	20 Marks
Viva Voce	:	10 Marks
Total	:	50 Marks

Mapping of POs with CO's

Course Outcome	Program Outcomes
1.	1, 2
2.	1,2,4
3.	1,2,4,7
4.	1,2,4
5.	1,2,4

BRIDGE COURSE MATHEMATICS- I

Course Code: 12DMA37 **CIE Marks: 100**
Hrs/Week: L:T:P : 2:0:0 **SEE Marks:100**
Audit course **SEE : 03 Hrs**

Course Learning Objectives:

Students are expected to:

- Apply the knowledge of ordinary and partial differentiation in engineering and real life problems;
- Learn how to formulate and interpret a Taylor series approximation of a function.
- Make the student to learn the concepts of vector analysis.
- Recognize and model differential equations, apply analytic techniques to compute solution for engineering problems.

Unit – I **06 Hrs**

Differential Calculus

Successive differentiation, n^{th} derivatives of standard functions, Leibnitz's theorem. Taylor's series and Maclaurin's series for function of single variable (all results without proof).

Unit – II **06 Hrs**

Partial Differentiation

Introduction-partial derivatives, total derivative, differentiation of composite and implicit functions. Jacobians and problems.

Unit – III **06Hrs**

Ordinary differential equations

Solution of first order and first degree differential equations - variable separable methods homogeneous, linear, Bernoulli, exact equations (without integrating factor).

Unit – IV **06 Hrs**

Linear ordinary differential equations of second and higher order

Linear differential equations of higher order with constant coefficients. Solution by inverse differential operator method. Solution by method of variation of parameters.

Unit – V **06Hrs**

Vector Analysis

Vector Algebra - Vector addition, Multiplication (dot, cross & triple products),
Vector differentiation – velocity, acceleration of a vector point function.

Course Outcomes:

At the end of this course, the student will be able to:

CO1. Use the concept of functions of several variables and their partial derivatives for computing the areas, volumes using multiple integrals.

CO2. Ability to apply concept of differential equations to handle physical problems

Reference Books

1. B. S. GREWAL, “Higher Engineering Mathematics”, Khanna publications, 40th edition 2007.
2. N. P. BALI, MANISH GOYAL “A Text Book of Engineering Mathematics”, Laxmi publications, 7th edition, 2007.
3. B. V. RAMANA “Higher Engineering Mathematics”, Tata Mc Graw Hill publications, 2007.
4. E- KREYSZIG “Advanced Engineering Mathematics”, John Wiley & sons publications, 8th edition, 2007.

Scheme of Continuous Internal Evaluation:

CIE consists of Two Tests each for 50 marks (20 marks for Quiz + 30 marks for descriptive).

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions (descriptive, analytical, problems or/and design) carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Mapping of POs with CO’s

Course Outcome	Program Outcomes
1.	1,4
2.	1,4

IV Semester

STATISTICS FOR DECISION MAKING

Course Code	**:**	**12IM41**	**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 3:2:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**	**SEE Duration**	**:**	**03 Hrs**

Course Learning Objectives (CLO):

Students are expected to:

- Explain the concepts related to data summarization and data handling techniques for statistical processing.
- Develop the concepts of probability and various probability distributions and their applications
- Analyze problems using descriptive and inferential statistical processing of data.

Unit – I **07 Hrs**

Data Summary and Presentation: Tabular and Graphical display: Stem and Leaf diagrams, Histograms, Box plots, Radar diagrams.

Concepts of Probability and Random Variables: Sample spaces and Events, Interpretations of probability, Addition rules, Conditional probability, Multiplication and Total probability rules, Independence, Bayes' Theorem. Random Variables, Discrete and continuous random variables. Probability distributions and mass functions, Expectations of random variables, Numerical Problems

Unit – II **07 Hrs**

Discrete Probability Distributions: Discrete uniform distribution, Binominal distribution, Poisson distribution, Applications, Numerical Problems.

Continuous Probability Distributions: Continuous Uniform distribution, Normal distribution, Normal approximations, Exponential, Erlang, Gamma, Weibull distributions, Applications, Numerical Problems.

Unit – III **06 Hrs**

Joint Probability: Marginal probability distributions, Independence, Covariance and correlation, Numerical Problems.

Estimation Theory: Statistical Inference, Random sampling, Properties of Estimators, Method of Moments, Method of Maximum Likelihood, Sampling distribution, Central Limit Theorem, Sampling distribution of means, Numerical Problems.

Unit – IV **06 Hrs**

Simple Linear Regression and Correlation: Empirical models, Simple Linear Regression, Properties of Least square Estimators and Estimation of variances, Common abuses of regression, Prediction of new observations, Correlation, Numerical Problems.

Unit – V **06 Hrs**

Statistical Inference for a single sample: Hypothesis testing, Confidence intervals, Inference on the mean of a population (variance known and unknown), Inference on the variance of a normal population, Testing for Goodness of Fit, Numerical Problems.

Overview of two-sample Inference and Features of Statistical software.

Course Outcomes:

After going through this course the student will be able to:

CO1. Perform simple data analysis, graphical representation and interpretation to understand various phenomena in the fields of science and engineering.

CO2. Identify probability distributions encountered in real life situations and use the concepts of random variables to solve simple problems.

CO3. Apply appropriate statistical tools for analyzing a specific set of data to estimate population parameters and relationship between two variables

CO4. Conduct hypothesis tests and build confidence intervals to reach conclusions about population mean and standard deviation based on a single set of data

Reference Books:

1. Douglas C Montgomery, George C Runger, Applied statistics and Probability for Engineers, Wiley, Asia Student Edition, 4th Edition, 2007, ISBN: 978-81-265-2315-3.
2. Richard I Levin, David S Rubin, Statistics for Management, Prentice Hall India, 7th Edition, 1997, ISBN: 9780134762920.
3. Walpole, Myers, Myers, Ye, Probability and Statistics for Engineers and Scientists, Pearson Education Inc., 8th Edition, 2007, ISBN: 978-81-317-1552-9.
4. Purna Chandra Biswal, Probability and Statistics, PHI Learning Private Limited, Eastern Economy Edition, 2007, ISBN: 978-81-203-3140-2

Scheme of Continuous Internal Evaluation:

CIE consists of Three Tests each for 45 marks (15marks for Quiz + 30 marks for descriptive) out of which best of two will be considered. In addition there will be one seminar on new topics / model presentation etc. for 10 marks.

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Mapping of POs with CO's

Course Outcome	Program Outcomes
1.	1,2,4
2.	2,3,4
3.	2,3,4,7
4.	2,3,4,5

ENVIRONMENTAL SCIENCE and BIOLOGY for ENGINEERS

Course Code	**:**	**12EB42**	**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 3:0:0:4**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**	**SEE Duration**	**:**	**03 Hrs**

Course Learning Objectives (CLO):

- Students are expected to :
- Understand the changes happening in the environment over decades (to give statistics with causes)
- Role of human beings in the changes in environment and ways and means of controlling the changes through technology
- Sustainability issues in new technologies and its adaptation
- Innovation (case studies) to arrest degradation of environment
- To create awareness among all engineering graduates the need of biological study in engineering (biology related issues in each engineering profession with case studies and also application of biology in each program of engineering
- Various branches of biological sciences (this might contain discussion of basic human physiology, sensors and systems)
- Effect of environment on biological issues and think of solutions (case studies in industrial environment to be studied)

Unit – I **06 Hrs**

Ecosystems and environment

Principles of ecosystem, impact of human being on environment: pollution, resource depletion and global environmental issues, ecosystem health and environmental changes and human health. Procedure to assess ecosystem's health. Standards- ISO14000 and Environmental Impact Assessment – definition, objectives, and types. Rapid and Comprehensive Environmental Impact Assessment (EIA), Environmental Impact Statement (EIS) and Finding Of No Significant Impact (FONSI). Some EIA examples –Thermal Power Plant, Mining, Fertilizer, Construction Projects, Airport, Water and Wastewater Treatment Plants.

Unit – II **10 Hrs**

Strategies and Technology-based solutions for Improvement of Environment Quality:

Environment quality objectives and 'Waste challenge' in modern society - types of waste: municipal, agricultural, medicinal, E-waste, industrial. Engineering ethics, 3 R's – Reduce, Reuse & Recycle, and Sustainable waste management: Compacting, drying, dewatering, bio-drying, composting, bioremediation, biodegradation (chemicals and oil spillage). Waste to energy – energy recovery by incineration, bio-gasification, gasification and pyrolysis, bioconversion to clean energy (biofuels). Some examples: Upflow anaerobic sludge blanket (UASB) digestion for waste water treatment and biogas production. **Technology to reduce pollution**: SO_2/CO_2 reduction by smoke-scrubber in coal thermal plants, chlorofluorocarbon (CFC) and incandescent bulb replacement, Renewable energy sources–wind, solar, tidal waves and biomass. Emerging technologies: Geo-engineering - ocean iron fertilization, green cement, bioremediation by terminator insects and synthetic biology.

Unit – III **06 Hrs**

Design and Modeling for Development of Environment

Environmental Design: principles, benefits and motivation. Environmental design for manufactured products, building and for developmental planning. Systems Engineering – Analysis - Design – synthesis - applications to environmental Engineering Systems.

Environmental Modeling: introduction, forecast modeling and growth modeling, sensitivity

analysis. Application of remote-sensing and geographic information systems (GIS) in environmental modeling.

Unit – IV **06 Hrs**

Introduction to cell and organ systems

Cell Types: Structure of plant, animal and microbial cell and Specialized cells like stem cells and nerve cells. Biological macromolecules: Carbohydrates, proteins and nucleic acids and Special biomolecules – hormones, enzymes, vitamins and antibiotics. Introduction to organ systems for example digestive, respiratory, excretory nervous and circulatory. Nervous Control and coordination, sensory organs: Auditory, vision, olfactory, touch and taste.

Unit – V **08 Hrs**

Bio-Inspired engineering (BIE) or Bionics

Biological phenomena and innovative engineering. Introduction to Bioelectronics, Biocomputing, biophotonics and biomechatronics. Locomotion and Bio-inspired Robotics, Prosthesis and biomedical implants, Aerodynamics and flight muscle functioning (birds & Drosophila). **Signaling**: Enzymes and recognition receptors in biosensors; Neurotransmission and neural networks (artificial intelligence, signal processing and imaging); Bioelectric signals and cardiac generator. **Sound**: Ultrasonics in biology (echolocation in bats, sonar in whales & dolphins) and instrumentation (medical ultrasonography - ultrasound imaging). **Light**: Photosynthesis and photovoltaic cells

Self Study: Case Study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hours / Week **12 Hrs**

Reference Books:

1. Vijay Kulkarni and T. V. Ramachandra 2009. Environment Management. TERI Press; ISBN: 8179931846, 9788179931844
2. Gerald Kiely 1997. Environmental Engineering. McGraw-Hill; ISBN: 9780077091279
3. Sven Erik Jørgensen 2002. Integration of Ecosystem Theories: A Pattern Ecology & Environment; Edition 3, Springer; ISBN: 1402007558, 9781402007552
4. Linvil Gene Rich 2003. *Environmental Systems Engineering*, McGraw-Hill; ISBN: 9780070522503
5. Ni-Bin Chang: Systems Analysis for Sustainable Engineering: Theory and Applications (Green

Manufacturing & Systems Engineering). McGraw-Hill Professional, 2011, ISBN: 0071630058, 9780071630054

6. Larry Canter 1995. “Environmental Impact Assessment”, McGraw-Hill. ISBN: 0070097674

Scheme of Continuous Internal Evaluation:
CIE consists of Three Tests each for 40 marks (15marks for Quiz + 25 marks for descriptive) out of which best of two will be considered. In addition 20 marks to be earned through self learning component on emerging topics.

Scheme of Semester End Examination:
The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

METROLOGY AND MEASUREMENTS

(Theory & Practice)

Subject Code	**:**	**12IM43 / ME43**	**CIE Marks**	**:**	**100 + 50**
Hrs/Week	**:**	**L:T:P:S 3:0:2:4**	**SEE Marks**	**:**	**100 + 50**
Credits	**:**	**05**	**SEE Duration**	**:**	**03+03 Hrs**

Course Learning Objectives (CLO):
Students are expected to :

- Explain the concepts of measurement and gauging instruments.
- Define the relevance of various measurement systems & standards with regards to practical applications.
- Apply the principles of metrology and measurements in manufacturing industries.

Unit – I **07 Hrs**

Linear measurement: Introduction to metrology, Linear measuring instruments: Vernier micrometer, Standards of length – Line standard, End standard & wavelength standard, subdivision of standards, Slip gauges for linear measurement, Numerical problems on building of slip gauges.
Limits, fits and tolerances: Definition of tolerance, Principle of interchangeability and selective assembly, Indian standards, concept of limits of size and tolerances, definition of fits, types of fits, hole basis system, shaft basis system, classification of gauges, brief concept of design of gauges (Taylor’s principles), Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

Unit – II **07Hrs**

Form measurement: Measurement of screw threads- principles of floating carriage micrometer, tool maker's microscope: straightness & flatness measurement using autocollimator, measurement of surface roughnes and cylindricity.
Comparators: Introduction to comparators, Characteristics, Classification of comparators, Mechanical comparators: Johnson Mikrokator, Sigma comparators, Dial Indicator. Optical comparators: Principles, Zeiss Ultra Optimeter. Electric comparators: Principles, LVDT. Pneumatic comparators: Back Pressure Gauges, Solex comparator.
Interferometry- Principle, Optical flats. Angular Measurements – Sine bar, Sine centre, Bevel protractor

Unit – III **06 Hrs**

Laser and advances in metrology: Precision instruments based on laser-Principles, laser interferometry application in linear, angular measurements and machine tool metrology. **Visual Measuring Machine (VMM)** – Constructional features, types & applications. Digital devices, computer aided inspection.

Unit – IV **07 Hrs**

Concept of Measurements: Generalized measuring system and functional elements, units of measurement, static and dynamic performance characteristics of measurement devices. Errors in measurement, classification of errors,

Transducers: Characrteistics, transfer efficiency, primary and secondary transducers, electrical, mechanical transducers, Signal transmission and processing: Devices and systems. Signal Display & Recording Devices.

Unit – V **07 Hrs**

Measurement of pressure: working principle and applications of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.
Strain measurement: Types of strain gauges and their working principles, strain gauge circuits.
Temperature measurement: Resistance thermometers, thermocouple, law of thermo couple, materials used for construction, pyrometer, optical pyrometer.
Self Study: Case Study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hours / Week **12 Hrs**

Unit – VI (Laboratory Work)

Part – I

1. Calibration of Thermocouple using Thermometer.
2. Calibration of Linear Variable Differential Transducer.
3. Flatness testing of slip gauge using Optical Flat.
4. Calibration of Micrometer using slip gauges.
5. Calibration of Strain gauges.
6. Measurement of Taper angle using Sine Bar, Sine centre, Bevel Protractor.

Part – II

7. Measurement of Screw thread diameters using Floating Carriage Micrometer & Tool Maker's Microscope
8. Measurement of Roughness parameters using Dial Indicator & Perthometer / Surftester
9. Measurement of Straightness using Autocollimator.
10. Measurement of various parameters of simple machine components (Cam shaft, Crank shaft, etc.) using VMM
11. Measurement of cutting forces using Lathe tool dynamometer, Drilling tool dynamometer
12. Conduction of Static tests on lathe and shaping machine

Course Outcomes:

After going through this course the student will be able to:

CO1. Discuss the principles and practices of metrology in manufacturing environment and analyze uncertainty in an appropriate manner.

CO2. Describe the operating principles of range of widely used instrumentation techniques and illustrate how to use them in the design of measurement systems.

CO3. Compare the production process, the product function and the product design, and to select appropriate measurement quantities and tools for these purposes.

CO4. Evaluate and respond to the need for rigorous and formal metrology concepts in designing and using measurement systems

Reference Books:

1. Jain R.K., Engineering Metrology, Khanna Publishers, 1994,17th edition, ISBN: 71-7409-024-x
2. Beckwith T.G, and N. Lewis Buck, Mechanical Measurements, Addison Wesley, 1991,5th edition, ISBN: 81-7808-055-9
3. Morris Dr. Alan S, The Essence of Measurement, Prentice Hall of India, 1997, ISBN-81-203-1194-9
4. Tayal A.K, Instrumentation and Mechanical Measurements, Galgotia Publications, 2000,1st edition, ISBN: 81-7515-286-9
5. J. F. W. Galyer and C. R. Shotbolt, Metrology for engineers, Cassell publications, 1990, 5th Edition, ISBN: 030431734

Scheme of Continuous Internal Evaluation:

CIE consists of Three Tests each for 40 marks (15marks for Quiz + 25 marks for descriptive) out of which best of two will be considered. In addition 20 marks to be earned through self learning component on emerging topics.

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Scheme of Continuous Internal Evaluation(CIE) for Lab:

CIE consists of 50 marks out of which 40 marks for maintaining record and 10 marks for internal test.

Scheme of Semester End Examination (SEE) for Lab:

Experiment from Part – I	:	20 Marks
Experiment from Part – II	:	20 Marks
Viva Voce	:	10 Marks
Total	:	50 Marks

Mapping of POs with CO's

Course Outcome	Program Outcomes
1.	1,2,4
2.	1,2,4
3.	2,3,4
4.	3,4,5

ENGINEERING ECONOMY

Course Code	**:**	**12IM44**	**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S 3:2:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**	**SEE Duration**	**:**	**03 Hrs**

Course Learning Objectives (CLO):

Students are expected to

1. To inculcate an understanding of concept of money and its importance in the evaluation of projects.
2. Analyze the present worth of an asset.
3. Evaluate the alternatives based on the Equivalent Annual Worth.
4. Illustrate concept of money and its importance in evaluating the projects.

Unit – I **06 Hrs**

Introduction: Principles of Engineering Economy, Engineering Decision- Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy.

Interest and Interest Factors: Interest rate, Simple interest, Compound interest, Cash- flow diagrams, Exercises and Discussion.

Unit – II **07 Hrs**

Present worth comparison : Conditions for present worth comparisons, Basic Present worth comparisons, Present worth equivalence, Net Present worth, Assets with unequal lives, infinite lives, Future worth comparison, Pay – back comparison, Exercises, Discussions and problems.

Unit – III **07 Hrs**

Equivalent annual worth comparisons :Equivalent Annual Worth Comparison methods, Situations for Equivalent Annual Worth Comparison Consideration of asset life, Comparison of assets with equal and unequal lives, Use of sinking fund method, Exercises, Problems.

Unit – IV **06 Hrs**

Rate of return calculations: Rate of return, Minimum acceptable rate of return, IRR, IRR misconceptions, Problems.

Structural Analysis of Alternatives : Identifying and defining alternatives, IRR analysis of mutually exclusive alternatives, Capital budget view point, Ranking criteria, Problems.

Unit – V **06 Hrs**

Depreciation : Causes of Depreciation, Basic methods of computing depreciation charges, Problems.

Effects of Inflation: Causes, consequences and control of inflation. After tax actual cash flow comparisons, Lease / Buy decisions.

Course Outcomes:

After going through this course the student will be able to:

CO1. Define Engineering Economy
CO2. Discuss the time value of money, and how to sketch the cashflow diagram
CO3. Demonstrate to convert different cash flows into Present worth, Futureworth and Annual equivalent worth
CO4. Compare the alternatives using different compound interest factors
CO5. Select a feasible alternative based on the analysis.
CO6. Formulate a given problem for decision making

Reference Books:

1. Riggs J.L ., Engineering economy, Tata McGraw Hill, 5th Edition, ISBN 0-07-058670-5
2. T.R.Banga, S.C.Sharma, Mechanical Estimating & Costing, Khanna Publishers, 16th Edition, 2011, ISBN 8174091009

3. Sullivan, Bontadelli & Wick, Engineering economy, Prentice Hall, Eleventh Edition, 2nd Edition, ISBN 0-13-025402-9
4. R Panneerselvam, Engineering Economics, PHI, Eastern Economy Edition 2001, ISBN – 81-203-1743-2.

Scheme of Continuous Internal Evaluation:
CIE consists of Three Tests each for 40 marks (15marks for Quiz + 25 marks for descriptive) out of which best of two will be considered. In addition 20 marks to be earned through self learning component on emerging topics.

Scheme of Semester End Examination:
The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Mapping of POs with CO's

Course Outcome	Program Outcomes
1.	3
2.	3
3.	3,4
4.	2,3,4
5.	2,3,4,7
6.	2,3,4,5

Course Code	**:**	**12IM45**	**CIE Marks**	**:**	**100 + 50**
Hrs/Week	**:**	**L:T:P:S 3:0:2:4**	**SEE Marks**	**:**	**100 + 50**
Credits	**:**	**05**	**SEE Duration**	**:**	**03 + 03 Hrs**

Course Learning Objectives (CLO):

Students are expected to

- Explain the basic principles of metal cutting.
- Define cutting parameters influencing metal cutting.
- Explain the methodologies and stages involved in secondary manufacturing processes.
- Develop a practice orientation to build skills in machining.

Unit – I **07 Hrs**

Theory of metal cutting: Single point tool nomenclature, geometry, orthogonal & oblique cutting, mechanism of chip formation, types of chips, Merchants analysis, shear angle relationship. Tool wear & tool failure effects of cutting parameters, Tool life criteria, Taylor's tool life equation, problems on Merchants analysis & tool life evaluation.

Cutting tool materials: Desired properties, types of cutting tool materials- HSS carbides, coated carbides, ceramics. Cutting fluids- properties, types & selection. Machinability, factors affecting machinability.

Unit – II **07 Hrs**

Production lathes: Capstan & turret lathes-constructional features, tool & work holding devices, tool layout.

Drilling machines: Classification, constructional features. Types of drill, drill bit nomenclature, geometry of twist drill. Drilling & related operations. Problems on calculating the machining time.

Unit – III **07Hrs**

Shaping Machine: Classifications, constructional features, driving mechanisms, shaping operations. Tool & work holding devices. Problems on calculation of machining time.

Planing Machine: Classifications, constructional features, driving mechanisms, planing operations. Tool & work holding devices. Problems on calculation of machining time.

Unit – IV **07 Hrs**

Milling machines: Classification, constructional features. Milling cutters & nomenclatures. Milling operations - up milling & down milling concepts. Indexing: Purpose of indexing, indexing methods. Problems on indexing.

Grinding machines: Types of Abrasives, Bonding process, classification, constructional features of surface, cylindrical & centreless grinding machines & operations.

Unit – V **06 Hrs**

Numerical Control of Machine Tools: Introduction, numerical control, NC machine tools, part programming fundamentals, manual part programming methods, computer aided part programming (CAP) (Conceptual coverage only and no numerical problems).

Self Study: Case Study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hours / Week **12 Hrs**

Unit – VI (Laboratory work)

Part – I

1. Preparation of models involving the following lathe operations: Plain Turning, Taper Turning, Step Turning, Thread Cutting, Facing, Knurling, and Eccentric Turning.

Part – II

2. Cutting of gear teeth using milling machine.
3. Preparation of models involving Cutting of V-groove / Dovetail / Rectangular groove using shaping machine.
4. Demonstration of surface grinding.
5. Assembly and Disassembly of machine parts.

Course Outcome:

After going through this course the student will be able to:

CO1. Define various Machine tools used for metal removing operations, desired properties of cutting materials and cutting fluids.
CO2. Classify and describe the metal removal processes such as Lathe, Milling, and Drilling machines.
CO3. Solve the problems which arise during the machining process.
CO4. Analyze the cutting parameters affecting the tool wear and tool failure.
CO5. Compare among the manufacturing process and examine the suitability for specific operation.
CO6. Create physical components by using secondary manufacturing processes.

Reference Books:

1. HMT, Production Technology, Tata McGraw Hill, 2004, ISBN: 0-07-096443-2.
2. Amitabha Bhattacharyya, Metal Cutting – Theory & Practice, New Central Book Agency (P), Ltd, 2008, ISBN: 81-7381-228-4.
3. G. Boothroyd, Fundamentals of Metal Machining & Machine Tools, Mc Graw Hill, 2004, ISBN: 978-1-5-7442659 -3.
4. P.N.Rao, Manufacturing Technology and M/C tool & Metal Cutting, Tata Mc Graw Hill, 1998, ISBN: 978-0-07-008769-9.

Scheme of Continuous Internal Evaluation:

CIE consists of Three Tests each for 40 marks (15marks for Quiz + 25 marks for descriptive) out of which best of two will be considered. In addition 20 marks to be earned through self learning component on emerging topics

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily

Scheme of Continuous Internal Evaluation(CIE) for Lab:

CIE consists of 50 marks out of which 40marks for maintaining record and 10marks for internal test.

Scheme of Semester End Examination (SEE) for Lab:

Experiment from Part – I	:	20 Marks
Experiment from Part – II	:	20 Marks
Viva Voce	:	10 Marks
Total	:	50 Marks

Mapping of POs with CO's

Course Outcome	Program Outcomes
1.	1
2.	1
3.	1,4
4.	3,4
5.	1,2
6.	1,5

APPLIED ERGONOMICS

(Theory and Practice)

Course Code	**:**	**10IM46**	**CIE Marks**	**:**	**100 + 50**
Hrs/Week	**:**	**L:T:P:S 3:0:2:4**	**SEE Marks**	**:**	**100 + 50**
Credits	**:**	**05**	**SEE Duration**	**:**	**03 + 03 Hrs**

Course Learning Objectives (CLO):

Students are expected to

- Define the scope of ergonomics in work system design for productivity improvement.
- Express the role of cognitive ergonomics in problem solving and decision making.
- Compile basic anthropometric data for designing the man-machine systems for various applications.

Unit – I **07 Hrs**

Introduction: Description of human-machine systems, ergonomics and its area of application in the work system, history of ergonomics, modern ergonomics.

Anatomy, Posture, and Mechanics: Basic body mechanics, aspects of muscle functions, anatomy of the spine and pelvis related to posture, musculoskeletal problems in sitting and standing postures, behavioral aspects of posture.

Unit – II **07 Hrs**

Anthropometric Principles in Workspace and Equipment Design: Anthropometry and its use, types of anthropometric data, principles of applied anthropometry in ergonomics, application of anthropometry in product design, case studies.

Unit – III **06Hrs**

Workspace Design: Contribution of ergonomics to work station design, ergonomic approach to work station design, work surface design, visual display terminals, case studies.

Unit – IV **06 Hrs**

Cognitive Ergonomics: Problem solving and decision-making, cognitive control of systems, modeling of human operator control strategy, user models of interactive systems, the human operator as a decision maker, improving human decision making and problem solving.

Unit – V **06 Hrs**

Work Organization and Work System Design: Design of human-machine system, the systems approach, work organization, motivation and job satisfaction, sociotechnical systems theory, trends in work system design, legislative trends: standards, guidelines, intervention programs and NPC guidelines on work organization and work system design.

Self Study: Case Study, Design and Emerging Technologies to be discussed pertaining to the course. 1 Credit: 4 Hours / Week **12 Hrs**

Unit – VI (Laboratory Work)

Part – I

1. Measurement of effort using Walking Simulator and Ergo meter.
2. Study the effect of Noise, Light and Heat on human efficiency in work environments.
3. Measurements of anthropometric data in standing position.
4. Measurements of anthropometric data in sitting posture.

Part – II

5. Experiment on design of work station for standing posture.
6. Experiment on design of work station for sitting posture.

7. Experiments on cognitive ergonomics.
8. Ergonomics studies under various working conditions.

Course Outcome:

After going through this course the student will be able to:

CO1. Recognize the role of ergonomics and its areas of application in the work system.

CO2. Explain and apply the ergonomic concepts in the evaluation of existing systems and design of new systems.

CO3. Demonstrate an understanding of concepts of ergonomics and human body mechanics.

CO4. Analyze the relationship between work attributes and ergonomic risk factors.

CO5. Evaluate the effect of ergonomic risk factors on the physiological and bio-mechanical mechanisms of human worker.

CO6. Design, develop, conduct and analysis ergonomic related experiments.

Reference Books:

1. R S Bridger, Introduction to Ergonomics, Taylor & Francis, 2nd Edition, 2003, ISBN: 0415273781.
2. Mark S. Sanders and Ernest J McCormick; Human Factors in Engineering and Design; McGraw-Hill and Co. Singapore 1992. 7th Edition, ISBN 0-07-112826-3.
3. Gavriel. Salvendy-Editor, Handbook of Human Factors and Ergonomics, Wiley, Hoboken, New Jersey, USA, 2006, 3rd Edition, ISBN: 0471116904.

Scheme of Continuous Internal Evaluation:

CIE consists of Three Tests each for 40 marks (15marks for Quiz + 25 marks for descriptive) out of which best of two will be considered. In addition 20 marks to be earned through self learning component on emerging topics.

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Scheme of Continuous Internal Evaluation(CIE) for Lab:

CIE consists of 50 marks out of which 40marks for maintaining record and 10marks for internal test.

Scheme of Semester End Examination (SEE) for Lab:

Experiment from Part – I	:	20 Marks
Experiment from Part – II	:	20 Marks
Viva Voce	:	10 Marks
Total	:	50 Marks

Mapping of POs with CO's

Course Outcome	Program Outcomes
1.	2
2.	2,3,4
3.	2,3
4.	2,4
5.	2,4
6.	2,4,5

BRIDGE COURSE MATHEMATICS- II

Course Code: 12DMA48 **CIE Marks: 100**
Hrs/Week: L:T:P : 2:0:0 **SEE Marks:100**
Audit course **SEE : 3Hrs**

Course Learning Objectives:
Students are expected to

- Recognize partial differential equations and apply analytic techniques to compute solution for engineering problems.
- Apply the significance of vector differentiation and their theoretical importance in engineering problems.
- Apply the significance of Laplace transforms and inverse Laplace transforms and their theoretical importance in engineering problems.
- Identify and solve initial value problems, physically interpret the solutions using the Laplace transforms.

Unit – I **06 Hrs**

Laplace Transforms
Definition, transforms of elementary functions, properties, derivatives and integrals, unit step function.

Unit – II **06 Hrs**

Inverse Laplace Transforms
Inverse Laplace transforms- properties, convolution theorem (statement only) - problems. Solution of linear differential equations with constant coefficients.

Unit – III **06Hrs**

Integral Calculus
Multiple integrals - Double and Triple integrals. Area enclosed by plane curves, Volume of solids. Definition of beta and gamma functions and problems.

Unit – IV **06 Hrs**

Partial Differential Equations (PDE)
Formation of Partial differential equations by elimination of arbitrary constants/functions. Solution of Lagrange's linear PDE. Solution of PDE by the Method of separation of variables (first and second order equations).

Unit – V **06Hrs**

Vector Analysis
Vector Differentiation - Scalar and vector point functions, gradient, directional derivative, divergence and curl. Solenoidal and Irrotational fields, Vector identities.

Course Outcomes:

At the end of this course, the student will be able to:

CO1. Solve problems arising in signal processing and various systems using Laplace transforms techniques for problems arising in signals and systems.

CO2. apply vector integration to different Engineering applications.

Reference Books

1. B. S. GREWAL, "Higher Engineering Mathematics", Khanna Publications, 40th edition 2007.

2. N. P. BALI, MANISH GOYAL "A Text Book of Engineering Mathematics", Laxmi publications, 7th edition, 2007.

3. B. V. RAMANA "Higher Engineering Mathematics", Tata Mc Graw Hill publications, 2007.

4. E- KREYSZIG "Advanced Engineering Mathematics", John Wiley & sons publications, 8th edition, 2007.

Scheme of Continuous Internal Evaluation:

CIE consists of Two Tests each for 50 marks (20 marks for Quiz + 30 marks for descriptive).

Scheme of Semester End Examination:

The question paper consists of Part A and Part B. Part A will be for 20 marks covering the complete syllabus and is compulsory. Part B will be for 80 marks and shall consist of five questions (descriptive, analytical, problems or/and design) carrying 16 marks each. All five from Part B will have internal choice and one of the two have to be answered compulsorily.

Mapping of POs with CO's

Course Outcome	Program Outcomes
1.	1,4
2.	1,4