B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19

DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT

# Department of Industrial Engineering and Management

## *Scheme and Syllabus*

## III to VI Semester

## 2019 - 2020

## B. M. S. COLLEGE OF ENGINEERING, BENGALURU– 560019

***(Autonomous Institute, Affiliated to VTU)***

***BATCH -2018 ONWARDS***

## DEPARTMENT VISION

To emerge as an excellent center for imparting quality higher education and generating highly proficient technical manpower to adopt to the constantly changing global scenario with professional and ethical values.

## DEPARTMENT MISSION

- Providing excellent education in curricular, co- curricular and extra-curricular activities to students.
- Facilitating to continue their education through research activities
- Catering to the needs of the Industry and society.
- Nurturing and mentoring students to acceptance by stake holders

## PROGRAM OUTCOMES (POS): INDUSTRIAL ENGINEERING & MANAGEMENT

**Engineering Graduates will be able to:**

| | |
|---|---|
| **PO1** | **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. |
| **PO2** | **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. |
| **PO3** | **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. |
| **PO4** | **Conduct investigations of complex problems** : Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. |
| **PO5** | **Modern tool usage** : Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. |
| **PO6** | **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. |
| **PO7** | **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. |
| **PO8** | **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. |

| | |
|---|---|
| **PO9** | **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. |
| **PO10** | **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. |
| **PO11** | **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. |
| **PO12** | **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. |

## PROGRAMME SPECIFIC OUTCOMES (PSOs):

| | |
|---|---|
| **PSO1** | Analyze and solve complex industrial engineering problems using modern tools |
| **PSO2** | Provide solutions to complex managerial problems using latest management techniques |
| **PSO3** | Design and solve manufacturing and allied problems |

B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19

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## NOTATIONS

| | |
|---|---|
| **AY** | Academic Year |
| **AAT** | Alternative Assessment Tools |
| **BOE** | Board of Examiners |
| **BOS** | Board of Studies |
| **CBCS** | Choice Based Credit System |
| **CGPA** | Cumulative Grade Point Averages |
| **CIE** | Continuous Internal Evaluation |
| **DC** | Departmental Core |
| **GC** | Group Core |
| **HSS** | Humanity and Social Science Courses |
| **IC** | Institutional Core |
| **IE** | Institutional Elective |
| **IL** | Institutional Lab. |
| **LTPS** | Lecture – Tutorial-Practical-Self Study |
| **NFTE** | Not Fit for Technical Education |
| **PCC** | Professional Core Courses |
| **PEC** | Professional Elective Courses |
| **SEE** | Semester End Examination |
| **SGPA** | Semester Grade Point Average |
| **ST** | Studio |
| **SS** | Self-Study |
| **CO** | Course Outcome |
| **PO** | Program Outcome |
| **PEO** | Program Educational Objectives |

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## SCHEME OF INSTRUCTIONS FOR III SEMESTER

| Sl No | Course Code | Course Title | Teaching Dept. | Credits | | | | Contact Hrs/Wk | MARKS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Total | | CIE | SEE | TOTAL |
| 1 | 19MA3BSEM3 | ENGINEERING MATHEMATICS-3 | Maths | 3 | 1 | 0 | 4 | 5 | 50 | 50 | 100 |
| 2 | 19IM3DCMAP | MANUFACTURING PROCESS | IEM | 4 | 0 | 0 | 4 | 4 | 50 | 50 | 100 |
| 3 | 19IM3DCMOM | MECHANICS OF MATERIALS | IEM | 3 | 1 | 0 | 4 | 5 | 50 | 50 | 100 |
| 4 | 19IM3DCIME | INDUSTRIAL METROLOGY | IEM | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 5 | 19IM3DCEES | ELEMENTS OF ENERGY SYSTEMS | IEM | 4 | 0 | 0 | 4 | 4 | 50 | 50 | 100 |
| 6 | 19IM3DCCMD | COMPUTER AIDED MACHINE DRAWING | IEM | 1 | 0 | 2 | 3 | 6 | 50 | 50 | 100 |
| 7 | 19IM3DLMAP | MANUFACTURING PROCESS LAB | IEM | 0 | 0 | 1 | 1 | 3 | 50 | 50 | 100 |
| 8 | 19IM3DLIME | INDUSTRIAL METROLOGY LAB | IEM | 0 | 0 | 1 | 1 | 2 | 50 | 50 | 100 |
| 9 | 19IM3DCMP1 | MINI PROJECT-1 | IEM | 0 | 0 | 1 | 1 | 1 | 50 | 50 | 100 |
| | | | Total | | | | 25 | 33 | 450 | 450 | 900 |

**Lecture Hours/Week,1 Credit=1hour, P-Practical Hours/Week, 1 Credit=2Hours,**
**T-Tutorial Lecture Hours/Week, 1 Credit =2 hours,**
**CIE-Continuous Internal Evaluation, SEE-Semester End Examination (of 3 hours duration)**

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## SCHEME OF INSTRUCTIONS FOR IV SEMESTER

| Sl No | Course Code | Course Title | Teaching Dept. | Credits | | | | Contact Hrs/Wk | MARKS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Total | | CIE | SEE | TOTAL |
| 1 | 19IM4DCIEE | INDUSTRIAL ENGINEERING AND ERGONOMICS | IEM | 4 | 0 | 0 | 4 | 4 | 50 | 50 | 100 |
| 2 | 19IM4DCSFE | STATISTICS FOR ENGINEERS | IEM | 3 | 1 | 0 | 4 | 5 | 50 | 50 | 100 |
| 3 | 19IM4DCCIM | COMPUTERS IN MANUFACTURING | IEM | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 4 | 19IM4DCENE | ENGINEERING ECONOMY | IEM | 4 | 0 | 0 | 4 | 4 | 50 | 50 | 100 |
| 5 | 19IM4DCMCD | MACHINE DESIGN | IEM | 3 | 1 | 0 | 4 | 5 | 50 | 50 | 100 |
| 6 | 19IM4DCFPT | FUNDAMENTALS OF PROGRAMMING TOOLS | IEM | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 7 | 19IM4DLIEE | INDUSTRIAL ENGINEERING AND ERGONOMICS LAB | IEM | 0 | 0 | 1 | 1 | 2 | 50 | 50 | 100 |
| 8 | 19IM4DLCIM | COMPUTERS IN MANUFACTURING LAB | IEM | 0 | 0 | 1 | 1 | 2 | 50 | 50 | 100 |
| 9 | 19IM4DLMTL | MATERIAL TESTING LAB | IEM | 0 | 0 | 1 | 1 | 2 | 50 | 50 | 100 |
| 10 | 19IM4DCPDC | PERSONALITY DEVELOPMENT AND COMMUNICATION SKILLS | IEM | 0 | 0 | 0 | 0 | 0 | - | - | - |
| | | | Total | | | | 25 | 30 | 450 | 450 | 900 |

**Lecture Hours/Week,1 Credit=1hour, P-Practical Hours/Week, 1 Credit=2Hours,**
**T-Tutorial Lecture Hours/Week, 1 Credit =2 hours,**
**CIE-Continuous Internal Evaluation, SEE-Semester End Examination (of 3 hours duration)**

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## SCHEME OF INSTRUCTIONS FOR V SEMESTER

| Sl No | Course Code | Course Title | Teaching Dept. | Credits | | | | Contact Hrs/Wk | MARKS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Total | | CIE | SEE | TOTAL |
| 1 | 20IM5DCOPR | OPERATION RESEARCH | IEM | 3 | 1 | 0 | 4 | 5 | 50 | 50 | 100 |
| 2 | 20IM5DCQAR | QUALITY ASSURANCE AND RELIABILITY | IEM | 3 | 1 | 0 | 4 | 5 | 50 | 50 | 100 |
| 3 | 20IM5DCMAE | MANAGEMENT AND ENTREPRENEURSHIP | IEM | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 4 | 20IM5DCAIM | AUTOMATION IN MANUFACTURING | IEM | 4 | 0 | 0 | 4 | 4 | 50 | 50 | 100 |
| 5 | 20IM5DEEL1 | ELECTIVE-1 | IEM | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 6 | 20IM5DEEL2 | ELECTIVE-2 | IEM | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 7 | 20IC5HSCPH | CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND HUMAN RIGHTS | IEM | 1 | 0 | 0 | 1 | 1 | 50 | 50 | 100 |
| 8 | 20IM5DLQAR | QUALITY ASSURANCE AND RELIABILITY LAB | IEM | 0 | 0 | 1 | 1 | 2 | 50 | 50 | 100 |
| 9 | 20IM5DLDML | DECISION MODELLING LAB | IEM | 0 | 0 | 1 | 1 | 2 | 50 | 50 | 100 |
| 10 | 20IM5DCMP2 | MINI PROJECT-2 | IEM | 0 | 0 | 1 | 1 | 1 | 50 | 50 | 100 |
| | | | Total | | | | 25 | 29 | 500 | 500 | 1000 |

**L-Lecture Hours/Week,1 Credit=1hour, P-Practical Hours/Week, 1 Credit=2Hours,**
**T-Tutorial Lecture Hours/Week, 1 Credit =2 hours,**
**CIE-Continuous Internal Evaluation, SEE-Semester End Examination (of 3 hours duration)**

**ELECTIVE-1**

| | |
|---|---|
| 20IM5DEPDD | PRODUCT DESIGN & DEVELOPMENT |
| 20IM5DEOBE | ORGANIZATIONAL BEHAVIOR |
| 20IM5DEFPD | FACILITIES PLANNING AND DESIGN |
| 20IM5DERPR | RAPID PROTOTYPING |

**ELECTIVE-2**

| | |
|---|---|
| 20IM5DEVAE | VALUE ENGINEERING |
| 20IM5DETOC | THEORY OF CONSTRAINTS |
| 20IM5DETEM | TECHNOLOGY MANAGEMENT |
| 20IM5DEWCM | WORLD CLASS MANUFACTURING |

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## SCHEME OF INSTRUCTIONS FOR VI SEMESTER

| Sl No | Course Code | Course Title | Teaching Dept. | Credits | | | | Contact Hrs/Wk | MARKS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | Total | | CIE | SEE | TOTAL |
| 1 | 20IM6DCSMA | SIMULATION MODELING & ANALYSIS | IEM | 4 | 0 | 0 | 4 | 4 | 50 | 50 | 100 |
| 2 | 20IM6DCFAC | FINANCIAL ACCOUNTING & COSTING | IEM | 3 | 1 | 0 | 4 | 5 | 50 | 50 | 100 |
| 3 | 20IM6DCLOM | LEAN AND OPERATIONS MANAGEMENT | IEM | 3 | 1 | 0 | 4 | 5 | 50 | 50 | 100 |
| 4 | 20IM6DEEL3 | ELECTIVE-3 | IEM | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 5 | 20IM6DEEL4 | ELECTIVE-4 | IEM | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 6 | 20IM6IE1 | INSTITUTION ELECTIVE-1 | IEM | 3 | 0 | 0 | 3 | 3 | 50 | 50 | 100 |
| 7 | 20HS6PCEPC | ENVIRONMENTAL POLLUTION CONTROL | IEM | 2 | 0 | 0 | 2 | 2 | 50 | 50 | 100 |
| 8 | 20IM6DLSMA | SIMULATION MODELING & ANALYSIS LAB | IEM | 0 | 0 | 1 | 1 | 2 | 50 | 50 | 100 |
| 9 | 20IM6DLLNM | LEAN MANUFACTURING LAB | IEM | 0 | 0 | 1 | 1 | 2 | 50 | 50 | 100 |
| 10 | NC-2 | ENGLISH | - | - | - | - | - | - | - | - | - |
| | | | Total | | | | 25 | 29 | 450 | 450 | 900 |

**L-Lecture Hours/Week, 1 Credit=1hour, P-Practical Hours/Week, 1 Credit = 2Hours,**
**T- Tutorial Lecture Hours/Week, 1 Credit =2 hours,**
**CIE-Continuous Internal Evaluation, SEE-Semester End examination (of 3 hours duration)**

**ELECTIVE-3**

| | |
|---|---|
| 20IM6DEAOR | ADVANCED OPERATION RESEARCH |
| 20IM6DESCM | SUPPLY CHAIN AND LOGISTICS MANAGEMENT |
| 20IM6DEDFM | DESIGN FOR MANUFACTURABILITY |
| 20IM6DEIEX | INDUSTRIAL EXPERIMENTATION |

**ELECTIVE-4**

| | |
|---|---|
| 20IM6DEDBM | DATABASE MANAGEMENT SYSTEM |
| 20IM6DETQM | TOTAL QUALITY MANAGEMENT |
| 20IM6DEMKM | MARKETING MANAGEMENT |

**INSTITUTION ELECTIVE-1**

| | |
|---|---|
| 20IM6IEOPR | OPERATIONS RESEARCH |
| 20IM6IEMAE | MANAGEMENT AND ENTREPRENEURSHIP |
| 20IM6IESCM | SUPPLY CHAIN AND LOGISTICS MANAGEMENT |

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DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT

# Department of Industrial Engineering and Management

*Syllabus for*

# III Semester

## B. M. S. COLLEGE OF ENGINEERING, BENGALURU– 560019

***(Autonomous Institute, Affiliated to VTU)***

## III SEMESTER

| Course Name | Engineering Mathematics-3 | Course Code | 19MA3BSEM3 |
|---|---|---|---|
| Credits | 04 | L – T –P | 3-1-0 |

**Prerequisites:** Matrices, concepts of Trigonometry and Trigonometric formulas, methods of differentiation, methods of integration, partial derivatives, solution methods of ordinary differential equations.

**Course Outcomes**:

On completion of the course, the student will have the ability to:

CO 1 Compute solution of a system of algebraic equations
CO 2 Demonstrate an understanding to Fourier series and Fourier transforms.
CO 3 Formulate boundary value problems involving one dimensional heat and wave equation.
CO 4 Employ analytical techniques to solve partial differential equations with appropriate boundary conditions
CO 5 Apply Z- transforms techniques to solve difference equations
CO 6 Obtain the extremal of a functional.

### UNIT-1

**MATRICES** **[9 hours]**

Introduction: Elementary row transformations, Echelon form of a matrix, rank of a matrix by elementary row transformations. Consistency of system of linear equations and solution.

Solution of a system of non-homogenous equations: Gauss elimination method, LU decomposition method, Gauss-Seidel method. Eigen values and eigenvectors of matrices. Reduction of a matrix to diagonal form. **(7L + 2T)**

Suggested Reading: Inverse of a matrix using Gauss-Jordan method. Largest eigen value and corresponding eigenvector using Rayleigh power method.

### UNIT-2

**FOURIER SERIES** **[9 hours]**

Introduction: Periodic function, Dirchlet's conditions, statement of Fourier Theorem, Fourier series of a periodic function of period 2*l*, Fourier series of functions having points of discontinuity.

Applications: Fourier series of typical waveforms -saw toothed waveform, triangular waveform, square waveform, half-wave rectifier, full wave rectifier and modified saw tooth waveform. Practical harmonic analysis. **(7L + 2T)**

Suggested Reading: Half range Fourier series, Fourier series of discrete functions, Complex Fourier series.

## UNIT-3

**FOURIER TRANSFORMS** **[10 hours]**

Infinite Fourier transform, Fourier Sine and Cosine transforms, properties, Inverse transforms, Fourier transforms of derivatives. **(7L + 3T)**
Suggested Reading: Convolution theorem, Parseval's identities and physical significance of Parseval's identities.

## UNIT-4

**PARTIAL DIFFERENTIAL EQUATIONS** **[10 hours]**

Formation of Partial differential equations-elimination of arbitrary constants, elimination of arbitrary functions.Equations of first order- The linear equation $P\ p + Q\ q = R$ **(**Lagrange's partial differential equation).
Applications: One-dimensional heat equation and wave equation (without proof), various possible solutions of these by the method of separation of variables. **(7L + 3T)**

Suggested Reading: Direct integration method, method of separation of variables, D'Alembert's solution of wave equation.

## UNIT-5

**Z –TRANSFORMS AND CALCULUS OF VARIATIONS** **[10 hours]**

Z-transforms**:** Definition, Properties, Transforms of standard functions, Inverse transforms.
Applications:Solution of difference equations using Z- transforms.
Calculus of variations: Variation of a functional, Euler's equation, variational problems.
Applications: Hanging cable problem, Geodesics on a right circular cylinder, Brachistochrone problem. **(8L + 2T)**
Suggested Reading: Minimal surface of revolution, Geodesics of a right circular cone and sphere.

## Mathematics Lab

- Solution of system of algebraic equations using Gauss Seidel method
- LU decomposition of matrices.
- Eigenvalues and eigenvectors of matrices.
- Largest and smallest eigenvalue and corresponding eigenvector of a matrix.
- Diagonalisation of matrices
- Z-transforms

## Bibliography

### Text Books

1. "Advanced Engineering Mathematics", Erwin Kreyszig, 10th edition Vol.1 and Vol.2, 2014, Wiley-India.
2. "Advanced Engineering Mathematics", Dennis G. Zill and Cullen, 4th edition, 2011, Jones and Bartlett India Pvt. Ltd.

**Reference Books:**

1. "Higher Engineering Mathematics", B.V. Ramana, 6th edition, 2007, Tata McGraw Hill.
2. "Higher Engineering Mathematics", B.S. Grewal, 43rd edition, 2013, Khanna Publishers.

**E books and online course materials**

(1) Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001 http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.
(2) Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.

**Online Courses and Video Lectures:**

(1) http://ocw.mit.edu/courses/mathematics/ (online course material)
(2) http://nptel.ac.in/courses.php?disciplineId=111
(3) https://www.khanacademy.org/
(4) E-learning: www.vtu.ac.in
(5) https://www.class-central.com/subject/math (MOOCS)

On completion of the course students will be able to:

| Course Code | CO# | COURSE OUTCOME (CO) | PO | Bloom's level |
|---|---|---|---|---|
| | CO 1 | Compute solution of a system of algebraic equations. | 2, 3 | 2, 3 |
| | CO 2 | Determine whether a given system is stable or unstable. | 2, 3 | 2, 3 |
| | CO 3 | Express given functions to form Fourier series. | 2, 3, 4 | 2, 3, 4 |
| | CO 4 | Demonstrate an understanding of Fourier transforms techniques | 2, 3, 4 | 2, 3, 4 |
| | CO 5 | Employ analytical techniques to solve partial differential equations with appropriate boundary conditions | 2, 3, 4 | 2, 3, 4 |
| | CO 6 | Apply Z- transforms techniques to solve difference equations. | 2, 3 | 2, 3 |
| | CO 7 | Use calculus of variations to find the extremal of a functional | 2, 3 | 2, 3 |

**Question Paper Pattern**

1. Each unit consists of one full question.
2. Each full question consists of three or four subdivisions.
3. Five full questions to be answered.
4. Internal choice in unit-3 and unit-5

**Assessment:**

- Each unit consists of one full question.
- Each full question consists of three or four subdivisions.

- Five full questions to be answered.
- To set one question from Units 1, 2, 5 and two questions from Unit 3 and Unit 4

Questions for CIE and SEE will be designed to evaluate the various educational components (Blooms taxonomy) such as:

- Remembering and understanding the course contents (weightage: 40%)
- Applying the knowledge acquired from the course (weightage: 35%)
- Analyzing various engineering problems (weightage: 15%)
- Understanding of various system models (weightage: 5%)

## III SEMESTER

| Course | MANUFACTURING PROCESS | Course Code | 19IM3DCMAP |
|---|---|---|---|
| Credits | 04 | L -T – P | 4-0-0 |

**PRE-REQUISITES:** Elements of Mechanical Engineering-lathe, milling machine, drilling machine: operations, principle and working, Arc welding, types, metal joining processes

### UNIT- 1

**THEORY OF METAL CUTTING**:

Single point cutting tool nomenclature, Merchants circle diagram and analysis, Ernst Merchant's solution, shear angle relationship, problems of Merchant's analysis, tool wear and tool failure, tool life, effects of cutting parameters on tool life, tool failure criteria, Taylor's tool life equation, Problems on metal cutting**.**

Types of cutting tool and properties of Cutting tool materials: HSS, carbides coated carbides, ceramics.

**CUTTING FLUIDS**:

Desired properties, types and selection, Heat generation in metal cutting, factors affecting heat generation, Heat distribution in tool and W/P, Measurement of tool tip temperature.

Machining Time calculation of Conventional Tools: lathe, Drilling machine and Milling Machine, Indexing methods in milling **14Hrs**

### UNIT -2

**NON-TRADITIONAL MACHINING PROCESSE**S:

Principle, need, equipment, operation: LBM, plasma arc machining, Electro chemical machining, ultrasonic machining, abrasive jet machining, water jet machining

**RAPID PROTOTYPING:**

Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems.

Stereo Lithography Systems, Selective Laser Sintering and Fusion Deposition Modeling: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application. **08Hrs**

### UNIT – 3

**CASTING PROCESS**: Introduction to the casting process, steps involved, the Foundry – types and classification; typical types of components produced by casting process.

**PATTERNS**: Definition, functions, materials used for pattern, classification of patterns, various pattern allowances and their importance, Method of molding using different patterns, orientation and parting.

**BINDER/ADDITIVES**: Definition, Types of binder used in molding sand, clay-water binding system –green compressibility, dry compression strength, flowability, Need, type of additives used, quantities.

**CASTING DESIGN**: Introduction, design consideration on pattern, the mould, the parting line, cast holes- cored holes, machined holes, identifying the possible parting line, casting requiring special sand cores, design to obviate sand cores, Problems – CI Bearing Bracket, Steel Forked Lever, Pedestal Housing, V-Belt Pulley.

**METAL MOULDS**: Basic Features of metal moulds, Pressure Die Casting – Low pressure Die casting process, High Pressure Die Casting Process – Cold Chamber and Hot

Chamber, Centrifugal Casting Process – Vertical and Horizontal Type, Centrifuge Casting, Squeeze Casting, Thixocasting, Continuous Casting Process

**SAND MOULDS**: Types of Sand Moulds, base sand ingredients - for different sand mixtures. Method used for sand moulding. **14Hrs**

## UNIT - 4

**ARC WELDING**: Principle, Metal Arc welding (MAW), Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding processes (AHW)

**GAS WELDING:** Principle, Oxy Acetylene welding, Reaction in Gas welding, Flame characteristics, Gas torch construction & working, forward and backward welding.

**SPECIAL TYPE OF WELDING**: Resistance welding - principles, Seam welding, Butt welding, Spot welding and projection welding, Friction welding, Explosive welding, Thermit welding, Laser welding, Electron beam welding. **08Hrs**

## UNIT - 5

**HEAT AFFECTED ZONE (HAZ):**Metallurgical aspect in welding and Casting, Formation of different zones during Casting and welding.

**NDT Inspection methods**: Methods used for inspection of casting & welding, visual Inspection, magnetic particle, Fluorescent Powder Inspection, Ultrasonic Inspection, Radiography – X-Ray and Gamma Ray, Eddy Current Testing, Acoustic Monitoring Testing and Holography methods of inspection. **08Hrs**

**TEXT BOOK**S:

1. **Workshop Technology**, Hazra Choudhry, Vol -II, Media Promoters & Publishers Pvt. Ltd. 2004, ISBN-81-85099-15-4
2. **Production Technology**, R.K. Jain, Khanna Publications, 2003.ISBN 8174090991, 9788174090997
3. **Stereo Lithographyand other RP & M Technologies** – Paul F. Jacobs – SME NY 1996.
4. **Manufacturing Process-I**, Dr K. Radhakrishna, Sapna Book House, 5th Ed, 2006.
5. **Manufacturing & Technology**: Foundry Forming and Welding, P.N. Rao 2nd Ed., Tata McGraw Hill, 2003

**REFERENCE BOOK**S:

1. **Production technology,** HMT, Tata McGraw Hill, 2001.ISBN-978-0-07-096443-3
2. **Fundamentals of Metal Machining and Machine Tools**,G. Boothroyd, McGraw Hill, 2000,ISBN-13-978-57444-659-3,
3. **Workshop Technology**, N.W.A.J. Chapman,Vol.II,, CBS Publications, 2005, ISBN-10:8123904010, ISBN-13:978-8123904016.
4. **Manufacturing Technology**, SwaroopKalpakjian, Steuen R Sechmid, Pearson Education Asia, 5th Ed. 2006.

5. **Process and Materials of Manufacturing**, Roy A Lindberg, 4th Ed. Pearson Education, 2006, ISBN - 8120306635, 9788120306639
6. **Modern Manufacturing Methods**, M. Grover, John Wiley & Sons, 4th Edition, 2010., ISBN – 978 – 0470 – 467-008 5.
7. **Metal casting: Computer Aided Design and Analysis**, B. Ravi PHI, 2005, ISBN-8120327268.
8. **Design for Manufacture**, Harry Peck, Pitman Publishing. 1983, ISBN-0273000071
9. **Product Design and Manufacturing**, A. K. Chitale and R. C. Guptha. Fifth Edition, 2013, ISBN-8120348737.

**ONLINE REFERENCE**:
1) http://nptel.ac.in/courses/112107077/ (Advanced Manufacturing Process)
2) http://nptel.ac.in/courses/112107089/ (Welding)

**MOOCS**
1. http://nptel.ac.in/courses/112105126/
2. http://nptel.ac.in/courses/112105127/
3.https://www.class-central.com/subject/
4.http://nptel.ac.in/courses/112107090/ (Welding)

**COURSE OUTCOMES:**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand the types of production of the products by conventional machining and comprehend the significance between conventional and non-conventional methods. | - | 1 |
| CO2 | Ability to apply theoretical knowledge to know the mechanism, calculate machining time, tools required and various operations performed in Machine tools. | PO1 | 2 |
| CO3 | Ability to analyze skills and capabilities in the areas of advanced manufacturing methods like Rapid Prototyping based on energy sources and mechanisms employed. | PO2 | 1 |
| CO4 | Ability to Design castings while considering parameters such as strength, weight, and number of cores. | PO3 | 2 |

**SCHEME OF EXAMINATION:** One question from unit 2, 4& 5 and two questions from Unit 1and 3.

**ASSESSMENT:**
**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.
**Semester End Examination(SEE)-**a written examination for theory course.
Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

**III SEMESTER**

| Course | MECHANICS OF MATERIALS | Course Code | 19IM3DCMOM |
|---|---|---|---|
| Credits | 04 | L-T-P | 3-1-0 |

**PRE-REQUISITES: Engineering Mechanics**

**UNIT – 1**

**SIMPLE STRESS AND STRAIN:** Introduction, stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation – behavior in Tension for Mild steel and nonferrous metals. Extension / Shortening of a bar, bars with cross sections varying in steps, Total elongation of tapering bars of circular cross section . Principle of super position, Elongations due to self-weight for constant cross section, simple shear stress, shear strain, elastic constants and their relations, volumetric strain.

**COMPOUND BARS:** General Introduction, plane stress, stresses on inclined sections, General two dimensional stress system, principal stresses and maximum shear stresses, Mohr's circle for plane stress. **12 Hrs**

**UNIT - 2**

**BENDING MOMENT AND SHEAR FORCE IN BEAMS:** Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load and couple for different types of beams. **06 Hrs**

**UNIT -3**

**BENDING AND SHEAR STRESSES IN BEAMS:** Introduction, theory of simple bending, assumptions in simple bending, relationship between bending stresses, radius of curvature and bending moment, moment carrying capacity of a section, Shear stress diagram for rectangular, symmetrical I and T section (composite / fletched beams not included). Derivation of Euler Bernoulli deflection equation only. **06 Hrs**

**UNIT - 4**

**SOLID SOLUTIONS AND PHASE DIAGRAMS**: Types of solids solutions, Rules of governing the formation of solid solutions and intermediate phases. Cooling curves, construction of phase diagrams, Phase diagrams of Eutectic systems Phase rules: Gibbs phase rule and Lever rule. Iron carbon equilibrium Diagram with all phase fields, TTT and CCT diagram, Effect of alloying elements on steels.

Heat treatment processes- Annealing, normalizing, hardening and hardenability, tempering, surface heat treatment ( Carburizing, Flame hardening, Nitriding), Ageing, Designation of Steels. **12 Hrs**

**UNIT- 5**

**COMPOSITE MATERIALS-** Definition, Classifications, properties and applications of MMC and FRP composites.

**NANO MATERIAL**: Nano powders, and nanomaterial, Relevance in industry, Applications advantages and disadvantages. **06 Hrs**

**TEXT BOOKS:**

1. **Mechanics of Materials,** J B K Das, & P L Srinivasa Murthy, Sapna Book House(P) Ltd Gandhinagar, Bangalore, 2013,ISBN978-81-280-0723-1
2. **Strength of Materials**, B.C Punmia, Ashok Jain, Arun Jain, Lakshmi Publications, New Delhi. 3rd Edition, 2002
3. **Elements of Strength of Materials**, Timoshenko and Young- Published by Affiliated East- West Press, 1962
4. **Strength of Materials**,Ramamrutham, DhanpathRai Publishers, 2008.
5. M**echanics of materials**, S.I. Units, Ferdinand Beer & Russell Johnson, TATA McGrawHill-2003
6. **Materials Science & Engineering-An Introduction**, William D. Callister Jr. Wiley India Pvt. Ltd. 6th Edition, New Delhi 2006.
7. **Foundation of Material Science and Engineering**, Smith, 3rd Edition McGraw Hill, 1997.

**REFERENCE BOOKS:**

1. **Mechanics of Solids**, Mubeen, Pearson Edu. India, 2002
2. **Strength of Materials**, W.A. Nash, Schaum's Outline Series, Fourth Edition-2007
3. **Strength of Materials**, L. S. Srinath, Prakash Desai &AnanthRamu TMH Publishers, Chennai, 2008.
4. **Introduction to Material Science for Engineering**, 6th edition James F. Shackelford, Pearson, Prentice Hall, New Jersey, 2006.
5. **Mechanical Metallurgy**, 3rdEdn. George. E. Dieter, McGraw Hill, 2001. ISBN-9351342727
6. **Basic Science and Emerging technique**, Mick Wilson ,KamaliKannangara, First Indian edition ,2005.
7. **Mechanical Metallurgy,** George E. Dieter, SI Metric Edition, McGraw –Hill Book Company.

**E-BOOKS:**

1. http://engineeringebookstore.blogspot.in/2013/07/som-strength-of-materials.html
2. http://free-onlineebooks.blogspot.in/2014/11/download-bc-punmia-strength-of_29.html

**MOOCS:**

1. http://nptel.ac.in/courses/Webcourse-contents/IIT-ROORKEE/strength%20of%20materials/homepage.htm
2. http://www.onesmartclick.com/engineering/strength-of-material.html
3. https://www.class-central.com/subject

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the fundamentals of Strength of materials | - | 1 |
| CO2 | Ability to apply the concepts to structural members to obtain the desired parameters | PO1 | 2 |
| CO3 | Ability to analyze complex engineering problems related to structural members based on a set of criteria. | PO2 | 2 |
| CO4 | Ability to design structural members considering appropriate materials based on mechanical properties to withstand the strength | PO3 | 2 |
| CO5 | Ability to analyze the micro structures and phase diagram & understand the basic terminologies associated with metallurgy to select metals and alloys for industrial applications | PO3 | 2 |

**SCHEME OF EXAMINATION:** One Question from Unit 2, 3, 5 & two questions from Unit 1 & 4.

**ASSESSMENT:**

**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

**Semester End Examination(SEE)-**a written examination for theory courses

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | INDUSTRIAL METROLOGY | Course Code | 19IM3DCIME |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**PRE-REQUISITES: NIL**

**UNIT 1**

**LINEAR MEASUREMENT:** Introduction to metrology, objectives, need of inspection, requirements of inspection tool, selection on instruments, classification of methods of measurements, International system of units, Measurement of Standards, 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. Problems.

**COMPARATORS:** Introduction, features, classification, applications, benefits & limitations, Mechanical comparators - sigma comparators, electrical and electronic comparators, Solex pneumatic gauge. **12 Hrs**

**UNIT 2**

**FORM MEASUREMENT:** Measurement of screw threads and gears: Measurement of various elements of threads, major, minor and effective diameter, Measurement of pitch, gear inspection, measurement of tooth thickness, gear tooth caliper, Parkinson's gear tester.

Angular measurement- Angle Gauges, Sine Bar and Sine Centre. **6 Hrs**

**UNIT 3**

**MEASUREMENT OF SURFACE FINISH:** Representation of surface finish as per BIS- methods of measuring surface finish: comparison method and direct instrument measurement- surface inspection by comparison methods: touch inspection, visual inspection, scratch inspection, microscopic inspection, and comparison with standard specimen, surface photographs-Direct instrument measurement: stylus probe instruments. **6 Hrs**

**UNIT 4**

**MEASUREMENT AND MEASUREMENT SYSTEM:** Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response time delay. Errors in measurements, classification of errors.

**TRANSDUCERS:** Introduction, primary and secondary transducers, classifications and applications.

**MEASUREMENT OF PRESSURE:** Introduction, types of equipment, working principle and applications of elastic members.

**TEMPERATURE MEASUREMENT:** Introduction, types of equipment, working principle and applications of Resistance thermometers, industrial thermometer, thermocouple, law of thermo couple, materials used for construction, pyrometer, optical pyrometer. **12 Hrs**

## UNIT- 5

**ADVANCEMENT IN METROLOGY:** Precision instruments based on laser-Principles- laser interferometer-application in linear, angular measurements, 3D Scanner and its applications.

**COORDINATE MEASURING MACHINE (CMM)** – Introduction, types, applications, Constructional features and benefits, description of parts, probing system. Sources of errors in CMM measurements **06 Hrs**

**TEXT BOOKS:**

1. **Mechanical measurements**, Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed, 2006.
2. **Engineering Metrology**, R.K.Jain, Khanna Publishers, 1994.
3. **A course in Mechanical Measurements and Instrumentation**, A K Sawhney, J.C Kapur Publishers, 3rd Ed., 1989.

**REFERENCE BOOKS:**

1. **Engineering Metrology**, I.C.Gupta, DhanpatRai Publications, Delhi
2. **Measurements Systems, Applications & Design**, Ernen O Dobeblein, 5TH ed.
3. **Industrial Instrumentation**, Alsutko, Jerry. D.Faulk, Thompson Asia Pvt. Ltd.2002.
4. **Mechanical Measurements**, R.S. Shirohi& H.C. Radhakrishna, 3rd Ed., New Age Intl. Pvt Ltd.

**MOOCS :**

1) www.nptel.ac.in/courses/112106138/
2) www.nptel.ac.in/courses/112106139/
3) https://www.class-central.com/subject/

**SCHEME OF EXAMINATION:** One question from unit 2,3& 5 and 2 questions from unit 1 & 4.

**COURSE OUTCOMES:**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the principles and practices of metrology in manufacturing environment | - | 1 |
| CO2 | Ability to apply the required formulae to calculate various parameters in the measurement systems. | PO1 | 2 |
| CO3 | Ability to analyze the measuring devices and instruments in varieties of applications | PO2 | 3 |
| CO4 | Ability to infer various physical quantities and surface measurement with the application of measuring instruments. | PO3 | 3 |

**ASSESSMENT:**

**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

**Semester End Examination(SEE)-**a written examination for theory courses. Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | ELEMENTS OF ENERGY SYSTEMS | Course Code | 19IM3DCEES |
|---|---|---|---|
| Credits | 04 | L -T – P | 4-0-0 |

**PRE-REQUISITES: NIL**

**UNIT-1**

**FUNDAMENTAL CONCEPTS &DEFINITIONS:**

Microscopic and Macroscopic approach, thermodynamics system and control volume, thermodynamic properties, process, and cycles. Quasistatic process, cyclic and non-cyclic processes, thermodynamic equilibrium, Zeroth law of thermodynamics, measurement of temperature.

**WORK &HEAT:**

Definition of work, examples, sign convention, displacement work; expressions for displacement work in various processes through p-v diagrams. Other types of work, Heat; definition, units, sign convention, and path function, **7 Hrs**

**UNIT-2**

**FIRST LAW OFTHERMODYNAMICS:**

Statement of the First law of thermodynamics, First law of thermodynamics for a closed system undergoing a cycle and change of state. Energy, energy as a property, forms of stored energy. Extension of the First law to control volume; steady state, steady flow energy equation, important applications, analysis of unsteady processes such as filling and evacuation of vessels with and without heat transfer. **7 Hrs**

**UNIT-3**

**SECOND LAWOFTHERMODYNAMICS:**

Introduction to second law, thermal energy reservoir, heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin-Planck statement of the second law of Thermodynamic: PMMI and PMM II. Clasius statement of Second law of Thermodynamic, equivalence of the two statements, Carnot cycle, Carnot principles.

**AIR STANDARDCYCLES:**

Air standard cycles; Carnot, Otto, Diesel, and Dual cycles, P-V and T-S diagrams, description, efficiencies and mean effective pressures, Comparison of Otto, Diesel and Dual cycles. **15 Hrs**

**UNIT-4**

**FLUID STATICS:**

The Basic Equation of Fluid Statics, The Standard Atmosphere, Pressure Variation in a Static Fluid, Hydraulic Systems: Hydrostatic Force on Submerged Surfaces, Hydrostatic Force on a Plane Submerged Surface, Hydrostatic Force on a Curved Submerged Surface, Buoyancy and Stability

**FLUID DYNAMICS:**

Introduction, equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, limitation of Bernoulli's equation, fluid flow measurements, veturimeter, orifice meter, pitot tube. **15 Hrs**

## UNIT-5

**FLOW THROUGH PIPES:** Frictional loss in pipe flow, Darcy's equation and Chezy's equation for loss of head due to friction in pipes, Minor Energy (Head) losses due to sudden enlargement, sudden contraction, entrance, exit, an obstruction, bend and pipe fittings. Flow through parallel pipes and branched pipes. **8 Hrs**

**TEXT BOOKS:**

1. **Basic & Applied Thermo Dynamics**, Nag P. K. Tata McGraw Hill Co. Ltd., India, 2010.
2. T**hermodynamics an Engineering Approach**, Yunus A Cengel, Michael A Boles, Tata McGraw- Hill Publishin Company Limited, 6th Edition, 2008.
3. **Fluid Mechanics,** Dr. R. K. Bansal, Lakshmi Publications.

**REFERENCE BOOKS:**

1. **Thermal Engineering**, Sarkar B. K, Tata McGraw Hill Co. Ltd., India, 2005.
2. **Fluid Mechanics and Hydraulic Machines**, Rajput R.K. S.Chand& Co., India 2008.
3. **Engineering Thermodynamics**, Nag P.K, Tata McGraw Hill Co. Ltd., India, 2005.
4. **Thermal Engineering** Rajput R.K, Laxmi Publications (P) Ltd., New Delhi, Edition. 2010.
5. **Fluid Mechanics and Fluid Power Engineering**, Kumar D.S, S.K.Kataria& Sons publishers, India, 6th Edition, 2003.

**MOOCS:**

1.www.edx.org/course/iitbombayx/iitbombayx-me209x-thermodynamics-1384#.U8aBL_mSx8E
2. www.coursera.org/course/introthermodynamics
3. www.coursera.org/course/thermodynamics
4.www.class-central.com/subject/

**COURSE OUTCOMES**

| .CO | Course Outcomes | PO | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the fundamental concepts of thermodynamics | - - | 1 |
| CO2 | Ability to Apply the Principles of thermodynamics to solve problems | PO1 | 2 |
| CO3 | Ability to analyze the performance of an IC engine and fluid flow systems | PO2 | 1 |
| CO4 | Ability to solve the problems related to Fluid Mechanics | PO3 | 1 |

**Scheme of Examination:** One question from each unit and two questions from Unit-3 and Unit-4.

**ASSESSMENT:**

**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project
and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

**Semester End Examination(SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | COMPUTER AIDED MACHINE DRAWING | Course Code | 19IM3DCCMD |
|---|---|---|---|
| Credits | 03 | L-T-P | 1-0-2 |

**PRE-REQUISITES: Engineering Drawing**

## PART-A

**3D MODELING FROM ORTHOGRAPHIC VIEWS**: Given the 2 or 3 views of a machine component, Generation of the object in 3D environment using software.
**SECTIONS OF SOLIDS**: Sectioning, Sectional view, Representation of section plane, Hatching, Sectioning of engineering objects like: Square, Pentagonal, Hexagonal prisms, Square, Hexagonal pyramids, Cylinder and Cone (Direct and indirect method). **10 Hrs**

**FASTENERS**: Thread terminology, sectional views of threads.ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread. Etc.
Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly), Proportions for square and hexagonal headed bolts & nuts, simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

**RIVETED JOINTS:** Introduction to riveted joints**,** Lap joint and Butt joint with single and double cover chain and Zig Zag joint. **10 Hrs**

## PART-B

**JOINTS**: Assembly of Socket and Spigot cotter joint, Pin or Knuckle joint, protected type flanged coupling, Universal coupling. **12 Hrs**

**ASSEMBLY DRAWINGS**: Screw jack, Machine vice, Plummer block, Tail stock, Steam stop valve, Ram's bottom safety valve, and Simple eccentric. **20 Hrs**

**TEXT BOOKS:**

1. **Computer Aided Machine Drawing ,** K.R. Gopalkrishna, A.S. Ravindra, Revised Edition, ISBN978-93-83214-81-5,2017
2. **Machine Drawing**, K.R. Gopalkrishna, 20th Edition, Subhas Publications, 2007.

**REFERENCE BOOK:**

1. **Machine Drawing with Auto CAD**. Goutam Pohit & Goutham Ghosh, 1st Indian print Pearson Education, 2005.
2. **Auto CAD 2006 for Engineers and Designers**. Sham Tickoo Dream tech 2005.
3. **Machine Drawing**, N.D.Bhat&V.M.Panchal, 42nd Edition, Charotar Publishing House, 2007
4. **Machine Drawing**, N. Siddeshwar, P. Kanniah, V.V.S. Sastri, published by Tata McGraw Hill, 2006

**MOOCS :**

1) www.nptel.ac.in/courses/112104172/1
2) www.class-central.com/subject/

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and visualize the concepts of detailed drawing of a given Machine Components. | - | 1 |
| CO2 | Ability to apply the formulae to calculate the required dimensions to draw the views of machine component. | PO1 | 2 |
| CO3 | Ability to analyze the detailed component drawings to assemble the mechanical system. | PO2 | 3 |
| CO4 | Ability to create 2D and 3D models using modern software tool. | PO5,PO9, PO10 | 2 |

**Scheme of Examination:**
Test 1 –questions from PART-A.
Test 2 - questions from PART-B

**SEE**: Two questions from PART-A for 40 marks
One question from PART-B for 60 marks

**ASSESSMENT:**
**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

**Semester End Examination (SEE)-**a written examination for theory course
Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | MANUFACTURING PROCESS LAB | Course Code | 19IM3DLMAP |
|---|---|---|---|
| Credits | 01 | L-T-P | 0-0-1 |

## MACHINE SHOP LAB

Preparation of one model on lathe involving: Facing, Plain turning, Taper turning, Step turning, Thread cutting, Knurling, Drilling, External Thread cutting and Eccentric turning. Cutting of Gear Teeth Using Milling Machine Demonstration on Grinding Machine.

| | Models | Operations | Machine Tool |
|---|---|---|---|
| **Machine Shop** | Model-1 | Turning, Step turning, Thread cutting operations, Taper Turning ( using Tailstock offset method) | Lathe |
| | Model-2 | Eccentric Turning | Lathe |
| | Model-3 | Milling -Spur gear / helical gear | Milling Machine |
| **Sand Testing Lab** | **Testing of Moulding sand and Core sand Preparation of sand specimens and Conduction of the following tests:**<br>1. Grain fineness number test (Sieve Analysis test)<br>2. Compression, Shear, bending and Tensile tests on Universal Sand Testing Machine.<br>3. Clay and Moisture content test.<br>4. Permeability test | | |
| **Foundry** | Model-1 | Round pattern- central hexagon | |
| | Model-2 | Square pattern-central square | |

**Continuous Internal Evaluation (CIE)**: 50 Marks
**Semester End Examination (SEE):**50 Marks

| Course | **INDUSTRIAL METROLOGY LAB** | **Course Code** | **19IM3DLIME** |
|---|---|---|---|
| Credits | **01** | **L -T – P** | **0-0-1** |

## LABORATORY
## PART- A - MECHANICAL MEASUREMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

## PART- B-METROLOGY

6. Measurements using Optical Projector / Toolmaker Microscope.
7. Measurements of angle using Sine Center / Sine bar.
8. Measurements of angle using bevel protractor
9. Measurements of cutting tool forces using
    a) Lathe tool Dynamometer
    b) Drill tool Dynamometer.

10. Measurements of Screw thread Parameters using two wire or three-wire methods. (Demo)
11. Measurements of Surface roughness. Using Tally surf/mechanical Comparator.
12. Measurements of gear tooth profile using gear tooth Vernier.
13. Calibration of micrometer using slip gauges
14. Demonstration of Co-ordinate Measuring Machine with an example.
15. 3D Scanner demonstration.

**Continuous Internal Evaluation (CIE)**: 50 Marks
**Semester End Examination (SEE):**50 Marks

| Course | MINI PROJECT-1 | Course Code | 19IM3DCMP1 |
|---|---|---|---|
| Credits | 01 | L -T – P | 0-0-1 |

**Rapid prototyping (Process Details)**:

Student group has to submit following assignments on Rapid Prototyping at the end of the course.

1. Creation of CAD model of component
2. Conversion of CAD model to STL format
3. Slicing the STL file into thin cross section layers
4. Construction of the model one layer at a time
5. Cleaning and finishing the model
6. Documentation and report submission

**Continuous Internal Evaluation (CIE)**: 50 Marks

**Semester End Examination (SEE):**50 Marks

# Lateral Entry: Mathematics for Diploma students

**THIRD SEMESTER B.E COURSE**
**(Common to all branches)**

| Course Title | Additional Mathematics-I | Course Code | 19MA3IMMAT |
|---|---|---|---|
| Credits | 00 | L – T – P | 3 – 1 – 0 |
| Contact hours | 48 hours (36L+12T) | III semester Lateral Entry students | |

**Prerequisites**: Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration.
**Course Objectives**: To provide students with a solid foundation in mathematical fundamentals such as differentiation, differential equations, vectors and orthogonal curvilinear coordinates for different branches of engineering.

## UNIT 1

**DIFFERENTIAL ANDINTEGRALCALCULUS [9Hours]**

List of standard derivatives including hyperbolic functions, rules of differentiation. Taylor's and Maclaurin's series expansion for functions of single variable. List of standard integrals, integration by parts. Definite integrals–problems **(7L+2T)**

## UNIT 2

**POLAR COORDINATES ANDPARTIALDERIVATIVES [10Hours]**

Polar curves: Polar ordinates, angle between radius vector and tangent, angle between two polar curves. Partial differentiation. Total differentiation-Composite and Implicit functions. Jacobians and their properties (without proof)–Problems. **(7L+3T)**

## UNIT 3

**VECTOR CALCULUS AND ORTHOGONAL CURVILINEAR COORDINATES [10 Hours]**

Recapitulation of scalars, vectors and operation on scalars and vectors. Scalar and vector point functions. Del operator, gradient-directional derivative, divergence, curl and Laplacian operator. Vector identities (without proof).Cylindrical and Spherical polar coordinate systems. Expressing a vector point function in cylindrical and spherical systems. Expressions for gradient, divergence, curl and Laplacian in orthogonal curvilinear coordinates. **(7L+3T)**

## UNIT 4

**FIRST ORDER ORDINARYDIFFERENTIALEQUATIONS [9Hours]**

Introduction to first order differential equations. Linear equation and its solution. Bernoulli's equation and its solution. Exact differential equation and its solution. Orthogonal Trajectories. **(7L+2T)**

## UNIT 5

## SECOND AND HIGHER ORDER ORDINARY DIFFERENTIAL EQUATIONS

**[10 Hours]**

Ordinary differential equations with constant coefficients: Homogeneous differential equations, non-homogeneous differential equations – Particular integral for functions of the type $f(x) = e^{ax}$, sin(ax), cos(ax), $x^n$, method of variation of parameters, Cauchy's and Legendre linear differential equations. **(8L+2T)**

On completion of the course, students will have the ability to:

| Course Code | CO# | COURSEOUTCOME(CO) | PO |
|---|---|---|---|
| 19MA3IMMAT | CO 1 | Understand the basic concepts of differentiation and integration. | 1 |
| | CO 2 | Apply the concepts of polar curves and multivariate calculus. | |
| | CO 3 | Apply analytical techniques to compute solutions of first and higher order ordinary differential equations. | |
| | CO 4 | Apply techniques of vector calculus to engineering problems. | |
| | CO 5 | Comprehend the generalization of vector calculus in curvilinear coordinate system. | |

**TEXT BOOK:**

1. Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers
2. Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. Zilland Cullen, Jones and Bartlett India Pvt. Ltd.

**REFERENCE BOOK:**

1. AdvancedEngineeringMathematics,ErwinKreyszig,WileyPreciseTextbookseries,Vol. 1 and Vol. 2, 10th edition, 2014, Wiley-India.
2. Higher Engineering Mathematics, B.V. Ramana, 2007, Tata Mc Graw Hill.

**E BOOKS AND ONLINE COURSE MATERIALS:**

1. Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001
2. http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL-xB8dEC&redir_esc=y.
3. Advanced Engineering Mathematics, P. V. O'Neil, 5th Indian reprint, 2009, Cengage learning India Pvt. Ltd.
4. http://ocw.mit.edu/courses/mathematics/ (online course material)

**ONLINE COURSES:**

1. https://www.khanacademy.org/Math
2. https://www.class-central.com/subject/math(MOOCS)

# Department of Industrial Engineering and Management

*Syllabus for*

# IV Semester

## B. M. S. COLLEGE OF ENGINEERING, BENGALURU– 560019

***(Autonomous Institute, Affiliated to VTU)***

## IV SEMESTER

| Course Title | INDUSTRIAL ENGINEERING AND ERGONOMICS | Course Code | 19IM4DCIEE |
|---|---|---|---|
| Credits | 04 | L – T – P | 4 – 0 – 0 |

**PRE-REQUISITES: NIL**

### UNIT- 1

**INDUSTRIAL ENGINEERING:** Meaning, Definition, Objective, Need, Scope and Evolution.
**PRODUCTIVITY:** Definition of productivity, individual enterprises, Productivity of materials, land, building, machine and power. Measurement of productivity, factors affecting the productivity, productivity improvement programs, wages and incentives (simple numerical problems). **08 Hrs**

### UNIT- 2

**WORK STUDY:** Definition, objective and scope of work study. Work study and management, work study and supervision, work study and worker.

**METHOD STUDY:** Definition, objective and scope of method study, activity recording and exam aids. Charts to record moments in shop operation – process charts, flow process charts, travel chart and multiple activity charts. (With simple problems.)

**MICRO AND MEMO MOTION STUDY:** Charts to record moment at work place – principles of motion economy, classification of movements, two handed process chart, SIMO chart, and micro-motion study. Development, definition and installation of the improved method, brief concept about synthetic motion studies. **08 Hrs**

### UNIT- 3

**WORK MEASUREMENT:** Definition, objective and benefit of work measurement. Work measurement techniques. Work sampling: need, confidence levels, sample size determinations, random observation, conducting study with the simple problems.

**TIME STUDY:** Time Study, Definition, time study equipment, selection of job, steps in time study. Breaking jobs into elements, recording information. Rating & standard Rating, standard performance, scale of rating, factors of affecting rate of working, allowances and standard time determination. Predetermined motion time study – Method time measurement (MTM).

**14 Hrs**

### UNIT- 4

**ERGONOMICS:** Introduction, areas of study under ergonomics, system approach to ergonomics model, man-machine system. Components of man-machine system and their functions – work capabilities of industrial worker, study of development of stress in human body and their consequences.

**DESIGN OF MAN-MACHINE SYSTEM:** Fatigue in industrial workers, Quantitative qualitative representation and alphanumeric displays, Controls and their design criteria, control

types, relation between controls and displays, layouts of panels and machines. Design of work places.

**ERGONOMICS AND ENVIRONMENTAL FACTORS:** Introduction, ergonomics and thermal conditions, effect of noise and vibration on human health and job performance, effect of light and illumination on workers efficiency, effect of hazardous working condition on workers efficiency.

**ANTHROPOMETRIC DATA DEVELOPMENT AND APPLICATIONS:** Introduction historical background and applications, status of anthropometric data in India, development of anthropometric data, mobility of human body movements around joints. **14 Hrs**

**UNIT- 5**

**CURRENT TRENDS:** Introduction to Agile manufacturing, Lean and Six Sigma, Value Engineering, Just in time, Total quality management, Enterprise resource planning, Supply chain and logistics management. **08 Hrs**

**TEXT BOOKS:**

1. **Introduction to work study**, ILO, - III Revised Edition, 1981
2. **Motion and Time study** - Ralph M Barnes; John Wiley, 8th Edition, 1985.
3. **Engineered work Measurement** - Weldon, ELBS, Marvin E. Mundel- Motion and Time study, PHI, 1st edition, 1991.
4. **Industrial Engineering and Production Management**, Telsang, Marland, S. Chand Publisher, ISBN: 9788121917735, 8121917735

**REFERENCES BOOKS:**

1. **Human Factors in Engineering Design** - S Sanders and E J McCormick, 6th Edition, McGraw Hill, ISBN0071128263, 9780071128261
2. **Work Study and Ergonomics** - S Dalela and Sourabh, Chand Publishers, 3rd edition.
3. **Work study and Ergonomics**- K C Jain, P L Verma, NithinShrivastava, 1st edition, 2018, New Age International Pvt. Ltd. ISBN-978-93-86649-33-1

**MOOCS**

1) https://www.class-central.com/subject/

## COURSE OUTCOMES

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the Industrial Engineering concepts and to improve productivity of the resources. | - | 1 |
| CO2 | Ability to apply the Industrial Engineering tools and techniques to eliminate the unproductive activities. | PO1 | 2 |
| CO3 | Ability to analyze and measure work to improve productivity. | PO2 | 1 |
| CO4 | Ability to apply various conventional and modern IE tools and techniques to measure work content and improve methodology | PO3, PO5, PO9, PO12 | 2 |
| CO5 | Ability to create better work eco system using various IE tools and techniques | PO1, PO5 | 3 |

**SCHEME OF EXAMINATION:** One Question to be set from unit 1, 2, & 5 and Two Questions will be set from the unit 3 & 4each

**ASSESSMENT:**

**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini – project and other Alternate Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes.

**Semester End Examination (SEE):** A written examination for theory course.

| Course | STATISTICS FOR ENGINEERS | Course Code | 19IM4DCSFE |
|---|---|---|---|
| Credits | 04 | L -T – P | 3 -1-0 |

**PRE-REQUISITES: NIL**

**UNIT- 1**

**THE ROLE OF STATISTICS IN ENGINEERING (DATA SUMMARY AND PRESENTATION):** Statistical Thinking, Collecting data, Statistical Modeling Framework, measure of central tendency and variance, Importance of Data summary and Display, Practical problems solving through tools like Tabular and Graphical display, Pie charts, Constructions of Box Plots, S curves, Frequency polygon, Pareto Graph. **06 Hrs**

**UNIT-2**

**DISCRETE RANDOM VARIABLES AND PROBABILITYDISTRIBUTIONS**: Discrete Random variables, Probability distributions and Probability mass functions, Cumulative distribution functions, Mean and Variance of a discrete random variable, discrete uniform distribution, Binominal distribution, Hyper Geometric distribution with applications.

**CONTINUOUS RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS:** Continuous random variables, Probability distributions and probability density functions, cumulative distribution functions, Mean and Variance of a continuous random variable, uniform distribution, Normal distribution, Normal approximation to Binominal and Poisson distribution, Chi-square distributions, theoretical concepts of Exponential distribution Weibull distribution with applications **11 Hrs**

**UNIT-3**

**ESTIMATION THEORY:** Statistical Inference, Random sampling, Properties of Estimators, Sampling distribution, Sampling distribution of means, variance and proportion, Introduction to confidence intervals. **06 Hrs**

**UNIT-4**

**STATISTICAL INFERENCE FOR A SINGLE SAMPLE:** Hypothesis testing, Inference on the mean of a population (variance known and unknown), Inference on the variance of a normal population, Inference on a population proportion.

**STATISTICAL INFERENCE FOR TWO SAMPLES:** Testing for Goodness of Fit, Inference for a difference in Means, Variances known, Inference for a difference in means of two normal distributions, Variances unknown, Inference on the Variances of two normal populations, Inference on two population proportions. **11 Hrs**

**UNIT-5**

**REGRESSION & CORRELATION:** Simple Linear Regression, hypothesis testing of simple linear regression (t–test), confidence interval on slope and intercept, Coefficient of Correlation and Determination.

**MULTIPLE LINEAR REGRESSION MODEL:** Introduction, Least Square Estimation of parameters (confined to 2 independent variables)
**Design of Experiments:** Introduction, Single factor, multiple factor (Only to theory).
**DATA ANALYTICS:** Introduction to data analytics, definition, types of data analytics with applications. **08 Hrs**

**TEXTBOOKS:**

1. **Applied Statistics and Probability for Engineers**, Douglas C Montgomery, George C Runger, 3nd Edn, John Wiley and Sons, 2003, ISBN 0-471-20454-4.
2. **Statistics for Management**, - Richard I Levin, David S Rubin, 07th Edn, Pearson Education,2017, ISBN-10: 9332581185, ISBN-13: 978-9332581180
3. **Data Analytics**, Anil Maheshwari, Mcgraw Hill, 2017, ISBN: 9789352604180, 9352604180.

**REFERENCE BOOKS:**

1. **Probability and Statistics in Engineering**, - William W Hines, Douglas C Montgomery, 4th Edn, John Wiley & Sons, 2003,ISBN-10: 0471240877, ISBN-13: 978-0471240877
2. **Business Statistics for Management and Economics**, - Daniel, Terrell, 07th Edn, Cengage Learning, 2010, ISBN-10: 0395712319, ISBN-13: 978-0395712313
3. **Probability and Statistics**, - Walpole & Mayer, 9th Edn, Pearson, 2010, ISBN-10: 0321629116, ISBN-13: 978-0321629111.

**COURSE OUTCOMES:**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand the concepts of Statistics, probability theory, design of experiments and data analytics concepts. | - | 1 |
| CO2 | Ability to apply the probability distribution for the given situation. | PO1 | 2 |
| CO3 | Ability to analyze and interpret the given statistical data | PO2 | 3 |
| CO4 | Ability to create Regression and correlation model for a given data. | PO3 | 2 |

**SCHEME OF EXAMINATION:** One Question to be set from unit 1,3& 5 and Two Questions from unit 2 &4.

**ASSESSMENT:**
**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.
**Semester End Examination (SEE)-**a written examination for theory course.
Both CIE and SEE have equal (50:50) weights. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE

| Course | COMPUTERS IN MANUFACTURING | Course Code | 19IM4DCCIM |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Production Technology**

**UNIT-1**

**INTRODUCTION:** Role of computers in design and manufacturing. Influence of computers in manufacturing environment. Product cycle in conventional and computerized manufacturing environment, Introduction to CAD and CAM, Advantages and disadvantages of CAD and CAM Application of computers in design process. **06** Hrs

**UNIT- 2**

**COMPUTER GRAPHICS:** Software configuration of a graphic system, functions of a graphics package, construction of geometry, wire frame and solid modeling, geometric 2D homogeneous transformation with simple problems. **06** Hrs

**UNIT- 3**

**INTRODUCTION TO COMPUTER NUMERICAL CONTROL:** Fundamental concepts of Numerical control, Numerical control modes, Numerical control elements, open and closed loop systems, advantages and limitations.

Drives of CNC system: Hydraulic drives, DC Motors, Stepper motors. Adaptive control systems: ACO and ACC systems.

Turning tool geometry, modular tooling system, milling tooling systems, tool presetting, automatic tool changers (ATC), Tool magazines. **12** Hrs

**UNIT- 4**

**PROGRAMMING OF CNC MACHINE TOOLS:** Introduction to part programming, co-ordinate systems, dimensioning, axes and motion nomenclature, structure of a part program, tool radius and length compensation, subroutines, canned cycles. Manual part programming, APT programming, writing programs using G& M codes, and by APT Language. **12** Hrs

**UNIT- 5**

**INTRODUCTION TO ROBOTICS:** Introduction, robot configuration, robot motions, Programming the robots, Robot programming methods, End effectors, work cell control and interlocks Robot sensors, Robot applications. **06** Hrs

**TEXT BOOKS:**

1) **Computer Control of Manufacturing Systems**, Yorem Koren ,McGraw Hill, 1983 ISBN-0-07-Y66379-3,
2) **CAD/CAM**, Mikell P. Grover, Emory, W. Zimmers Pearson Education Inc.,2003 ISBN-81-203-0402-0,
3) **CAD/CAM Principle and Applications**, PN Rao, Tata McGraw Hill, 7th Reprint, 2007, ISBN-0-07-058373-0,

**REFERENCES**:

1) **Principle of interactive Computer Graphics,** Newman and Sproull, TMH, 2nd Edition, 1978, ISBN13-978-0070463-387
2) **CAD/CAM**, Ibrahim Zeid, THM, 1991, ISBN-00707-28577,
3) **Numerical control and CAM,** Kundra, Rao and Tiwary, Tata McGraw Hill Publishing Co., NewDelhi, 1987, ISBN 13-978 00 745 17 406,
4) **Mechatronics** HMT – Tata McGraw Hill publishing company,ISBN 0-07-462127-5
5) **CAD/CAM/CIM** – P. Radhakrishnan, S. Subramanyan and Raju – New Age International Publishers, 2009 Edition, ISBN-13-978-8122422368

**ONLINE RESOURCE**: www.nptel.ac.in

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the basic concept of a CAD, NC and CNC system. | - | 1 |
| CO2 | Ability to develop manual and APT part programs for 2D complex profiles and test the programs through simulation. | PO1 | 2 |
| CO3 | Ability to analyse the error in the program and choose right G and M codes to optimize the program and construct the final geometry by running the simulation using the software. | PO2 | 2 |
| CO4 | Ability to program for robot to perform typical tasks including Pick &Place, Stacking and to develop program for CNC to machine various profiles. | PO2, PO9 | 2 |
| CO5 | Ability to create complex geometries of machine components using CAD software. Develop G and M codes for turning and milling components. Produce the part using CNC machine. | PO5 | 2 |

**SCHEME OF EXAMINATION:** One question from Units **1**, **2 & 5** and two questions each from Units **3& 4**.

**ASSESSMENT:**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | ENGINEERING ECONOMY | Course Code | 19IM4DCENE |
|---|---|---|---|
| Credits | 04 | L-T-P | 4-0-0 |

**Prerequisites: Nil**

**UNIT-1**

**INTRODUCTION:** Engineering Decision- Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy, Decision maze. Practical oriented decision making.

**INTEREST AND INTEREST FACTORS:** Interest rate, simple interest Compound interest, Cash- flow diagrams, Exercises and Discussion on time value of money. **12 Hrs**

**UNIT- 2**

**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. **08 Hrs**

**UNIT- 3**

**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, Annuity contract for guaranteed income, Exercises, Problems.

**RATE OF RETURN CALCULATIONS:** Rate of return, Minimum acceptable rate of return, IRR, IRR misconceptions, Cost of capital concepts.

**DEPRECIATION:** Causes of Depreciation, Basic methods of computing depreciation charges **12 Hrs**

**UNIT-4**

**REPLACEMENT ANALYSIS:** Deterioration, obsolescence, inadequacy, Economic life for cycle replacements

**STRUCTURAL ANALYSIS OF ALTERNATIVES:** Identifying and Defining alternatives, IRR analysis of mutually exclusive alternatives, Capital Budget view point, Rankine criteria. **10 Hrs**

**UNIT-5**

**ESTIMATING & COSTING:** Components of costs such as Direct Material Cost, Direct Labour Cost, Fixed, Over – Heads, Factory Costs, Administrative – Over Heads, First Cost, Marginal Cost, Selling price, Estimation for simple components

**EFFECTS OF INFLATION:** Causes, consequences and control of inflation. After tax actual cash flow comparisons, Lease/ Buy decisions **10 Hrs**

**TEXT BOOKS:**

1. **Engineering Economy**- Riggs J.L. McGraw Hill, 2002, ISBN 0-07912248-5.
2. **Engineering Economy** - Paul Degarmo, Macmillan Pub, Co. 2001, ISBN-00-232 86008.
3. **Engineering Economy** - Naidu, Babu and Rajendra –, New Age International Pvt. Ltd 2008, ISBN-13:4788122419092
4. **Engineering Economics-** R Panner Selvam – PHI Publishing Pvt Ltd, 2nd Edition, ISBN; 978-81-203-4837-0 2008

**REFERENCE BOOKS:**

1. **Industrial Engineering and Management**–O. P.Khanna, DhanpatRai& Sons 2000, ISBN-818992835X
2. **Financial Management** - I M Pandey, Vikas Publishing House 11th Edition, 2002, ISBN- 978932598229
3. **Engineering Economy** -Thuesenh.G. PHI, 9th Edition, 2002, ISBN-10:01 30281289

**ONLINE REFERENCE:** www.ntpel.com
**E BOOKS :** http://bookboon.com/en/search?q=enginnering%20economics&p=1

**COURSE OUTCOME**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain problem solving & decision making process in Engineering Economy | - | 1 |
| CO2 | Ability to apply Engineering Economy tools to compare alternative proposals | PO1 | 3 |
| CO3 | Ability to analyze alternative proposals usingEngineering Economy tools. | PO2 | 3 |
| CO4 | Ability to evaluate alternative proposals usingEngineering Economy tools | PO3 | 2 |

**SCHEME OF EXAMINATION:** One Question to be set from unit 2,4& 5and two Questions will be from the unit 1 & 3.

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course
Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | MACHINE DESIGN | Course Code | 19IM4DCMCD |
|---|---|---|---|
| Credits | 04 | L-T-P | 3-1-0 |

**PRE-REQUISITES : Strength of Materials**

**UNIT–1**

**DESIGN FOR STATIC STRENGTH:** Design considerations: Codes and Standards, Static strength; Static loads and factor of safety; Theories of failure -Maximum normal stress theory, maximum shear stress theory, Distortion energy theory; Failure of brittle materials, Failure of ductile materials. Stress concentration, Determination of Stress concentration factor. Combined Stress concentration factor.

**DESIGN FOR FATIGUE STRENGTH:** Introduction, S -N diagram, Low cycle fatigue, High cycle fatigue, and Endurance limit. Modifying factors -size effect, surface effect, Stress concentration effects; Fluctuating stresses, Fatigue strength under fluctuating stresses, Goodman and Soderberg relationship; Stresses due to combined loading. **12 Hrs**

**UNIT–2**

**JOINTS AND COUPLING:** Design of rigid flange coupling & Bushed pin type flexible coupling. Cotter and Knuckle joints.

**DESIGN OF SHAFTS:** Torsion of shafts, design for strength & rigidity, with steady loading, ASME & BIS codes for design of transmission shafting, shafts under fluctuating loads and combined loads **12 Hrs**

**UNIT- 3**

**DESIGN OF GEARS:** Introduction to Spur, Helical & Bevel gears, Design of spur gear, stresses in gear tooth, Lewis equation, form factor- dynamic and wear load. **06 Hrs**

**UNIT- 4**

**MECHANICAL JOINTS:** Riveted Joints -Types, rivet materials, Failures of Riveted joints, Efficiency, Welded Joints -Types, Strength of butt and fillet welds. **06 Hrs**

**UNIT -5**

**LUBRICATION AND BEARINGS:** Mechanisms of Lubrication -Viscosity, bearing modulus, coefficient of friction, minimum oil film thickness-Heat Generated, Heat dissipated, bearing materials, lubricants and properties. Examples of journal bearing and thrust bearing design.

**06 Hrs**

**TEXT BOOKS:**

1. **Design of Machine Elements**Vol-1 and 2**,** J B K Das and P L Srinivasa Murthy, -Sapna Book House,Bangalore, 2015, ISSN-978-81-280-0306-6
2. **Mechanical Engineering Design,** Joseph Edward Shigley, Tata McGraw Hill, New Delhi 1986.
3. **Machine Design,** V.L. Maleev& Hartman, CBS Publishers &Distribution, Delhi, 1983.
4 **Machine Design,** R.S Khurmi and J.K. Gupta, Eurasia Publishing house (P) Ltd., New Delhi, ISBN-8121925371, 9788121925372
5. **Design Data Hand Book:**Vol .l & Vol.2 -Dr. K. Lingaiah, Suma Publications, Bangalore.

**REFERENCE BOOKS:**

1. **Machine Design,** Robert .L , Norton -Pearson Education Asia, New Delhi, 2001
2. **Theory and Problems of Machine Design**, -Hall, Holowinko, Laughlin, - Schaums Outline Series, 2002.
3. **Elements of Machine Design**, N. C. Pandey& C. S. Shah, - Chorotar Publishing House, 2002.
4. **Design of Machine Elements**, V.B.Bahandri, Tata McGraw Hill Publishing Co. Ltd., New-Delhi
5. **Machine Component & Design**, William Orthwan, Jaico Publishing Co.
6. **Fundamentals of Design** -Benerad J Hamrock, Bo -Jacobson & Steven R. Schmid, ISBN-13-978-1-4822-4750-3.
7. **Fundamentals of Machine Design Component**, Robert C. Juvinall and Kurt M. Marshek, John Wiley &sons,ISBN - 1119342813, 9781119342816
8. **Machine Design,** R. K. Jain,Khanna Publications, New Delhi.

**ONLINE REFERENCES:**

1) http://nptel.ac.in/courses/112105124/
2) http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Machine%20design1/New_index1.html
3) http://nptel.ac.in/courses/IIT-MADRAS/Machine_Design_II/

**E-BOOKS**

1) http://www.faadooengineers.com/threads/2060687-Machine-design-by-shigley-ebook-download-pdf
2) http://www.free4ebook.com/mec.html

**COURSE OUTCOME**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the concepts of Static & fatigue strength in the design of mechanical components | - | 1 |
| CO2 | Ability to apply and design procedural principles of machine elements to withstand loads and deformations. | PO1, PO4 | 3 |
| CO3 | Ability to analyze and evaluate designed components against the constraints set. | PO2 | 2 |

**MOOCS**

1) https://www.class-central.com/subject/

**SCHEME OF EXAMINATION:** 2 questions from units 1 & 2 and one question from units 3,4 &5.

**ASSESSMENT:**

**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

**Semester End Examination(SEE)-**a written examination for theory course.
Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | FUNDAMENTALS OF PROGRAMMING TOOLS | Course. Code | 19IM4DCFPT |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**UNIT 1**

**INTRODUCTION TO PROGRAMMING TOOLS**

Introduction to program tools in Industrial Engineering, applications of solutions engineering, solutions architecture, solutions v/s software engineering. Sensors and senses | definition, applications in Industrial Engineering, |Sight, Hearing, Touch, Smell and Taste| IR Sensor, Humidity Sensor, Sound Sensor, Voltage Sensor, Heart rate pulse sensor and others. **08 Hrs**

**UNIT-2**

**BASICS OF THE ARDUINO BOARD**

Arduino board basics, IDE Architecture, Digital Input, Output and Pulse-Width Modulation, Reading Analog Sensors, Programming Interfaces, Industrial Applications. **06 Hrs**

**UNIT-3**

**INTRODUCTION TO RASBERRY PI**

Introduction, Basic structure of a credit card PC (architecture), Hardware and software, Types of OS, Types of Firmware, Sensors and Applications. **06 Hrs**

**UNIT-4**

**MATLAB PROGRAMMING**

Introduction, Features of Matlab, Manually solve and write solutions to numerical method problems like Bisection Method, False positions method, Simpsons 1/3 rule, Simpsons 3/8 rule, Newton's forward difference and Lagrange's Interpolation methods. **12 Hrs**

**UNIT-5**

**INTRODUCTION TO PYTHON PROGRAMMING**

Introduction, Features of Python, Programming, advantages and disadvantages of Python, Programming development environment. **06 Hrs**

**TEXT BOOKS:**

1.**ExploringArduino – Tools and Techniques for Engineering,** Wizardry, Jeremy Blum, John Wiley & Sons, Inc., 2013

2. **Raspberry Pi Cookbook – Software and Hardware Solutions**, Simon Monk, O'Reilly Media, 2014

**REFERENCE BOOKS:**

1. **Introduction To Matlab For Engineering Students**, David Houcque, Northwestern University, USA 2005
2. **Python: The Ultimate Beginners' Guide**, Andrew Johansen, 2016

MOOCS :

1. https://www.coursera.org/learn/arduino-platform
2. https://www.coursera.org/learn/raspberry-pi-platform
3. https://www.coursera.org/learn/python
4. https://www.edx.org/learn/matlab

**COURSE OUTCOMES**

| CO | Course Outcomes | PO | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the fundamental concepts of Programming for Industrial Engineering | - - | 1 |
| CO2 | Ability to Analyze and Apply the Arduino Board for a given task | PO1 | 2 |
| CO3 | Ability to Analyze and Apply the Raspberry Pi Circuit for a given Application | PO1 | 2 |
| CO4 | Ability to create a MATLAB program to solve Numerical Methods problems | PO3 | 2 |

**SCHEME OF EXAMINATION:** One question from each unit and choice in Unit-1 and Unit-4

**ASSESSMENT:**

**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

**Semester End Examination(SEE)-**a written examination for theory course.
Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | INDUSTRIAL ENGINEERING AND ERGONOMICS LAB | Course Code | 19IM4DLIEE |
|---|---|---|---|
| Credits | 01 | L-T-P | 0-0-1 |

## I. METHOD STUDY

1) Recording Techniques using charts.
   i) Outline process chart.
   ii) Flow process chart.
   iii) Multiple Activity Chart.
2) Recording Techniques using diagrams.
   i) Flow diagram.
   ii) String diagram.
3) Application of principle of motion economy:
   i) Two handed process chart.
4) Assembling simple components.
   i) Peg board assembly.

## II. WORK MEASUREMENT

1) Rating practice using:
   i) Walking simulator.
   ii) Pin board assembly
   iii) Dealing a deck of cards.
   iv) Marble collection activity
2) Determining the standard time using:
   i) Simple operations using stopwatch time study.
   ii) Predetermined Method Time Study (PMTS).

## III. ERGONOMICS (6 Experiments)

1) Measurement of heart beat rate, calorie consumption parameters using:
   i) Walking simulator.
   ii) Cycle Ergo-meter.
2) Effect of human efficiency in work environments:
   i) Noise.
   ii) Light

**Continuous Internal Evaluation (CIE)**: 50 Marks
**Semester End Examination (SEE):**50 Marks

| Course | COMPUTER IN MANUFACTURING LAB | Course Code | 19IM4DLCIM |
|---|---|---|---|
| Credits | 01 | L-T-P | 0-0-1 |

**LABORATORY EXPERIMENTS:**

1) CNC Turning: Writing and simulation of manual part program using G & M codes for Simple parts including turning, taper turning, and shoulder turning and cutting. Use of radius compensation, canned cycles. (4 programs) Demonstration of one CNC program
2) CNC Milling- Writing and simulation of manual part program using G & M codes for simple parts including Surface milling, Edge milling, Contour milling, Drilling, and pocket milling. Tool length compensation, use of canned cycles.(4 programs). Demonstration of one CNC program
3) Programming of Robots by lead through and off line methods. Use of robot to pick and place, stacking of objects in increasing or decreasing order. (4 programs)

**Continuous Internal Evaluation (CIE)**: 50 Marks
**Semester End Examination (SEE):**50 Marks

| Course | MATERIAL TESTING LAB | Course Code | 19IM4DLMTL |
|---|---|---|---|
| Credits | 01 | L-T-P | 0-0-1 |

## LAB EXPERIMENTS

Tensile, shear and compression tests of metallic specimens using a Universal Testing Machine, Torsion tests, Bending Test on metallic specimen, Izod and Charpy tests on M S Specimen Brinell, Rockwell and Vickers Hardness test.

1. Examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, Grey C.I, SG iron, Brass, Bronze & composites. (Preparation of specimen demo)
2. Heat treatment: Annealing, normalizing, hardening and tempering of steel Hardness studies of heat-treated Samples (Demo).
3. To study the wear characteristics of ferrous, and non-ferrous materials
4. Demo on Non-destructive test experiments like,
   (a). Magnetic particle testing
   (b). Dye penetration testingto study the defects of Cast and Welded specimens

**EXPERIMENTS**

1. Impact Test by Izod Machine
2. Impact Test by Charpy Machine
3. Tensile test by Universal Testing Machine
4. Compression test by Universal Testing Machine
5. Shear test by Universal Testing Machine
6. Bending test by Universal Testing Machine
7. Torsion test
8. Hardness test by Brinell Hardness Machine
9. Hardness test by Vickers Hardness Machine
10. Hardness test by Rockwell Hardness Machine
11. Wear Test by Abrasive Belt Machine
12. Wear Test by Pin on Disc Machine
13. Microstructure testing by Metallurgical Microscope
14. Demonstration on Heat treatment

**Continuous Internal Evaluation (CIE)**: 50 Marks
**Semester End Examination (SEE):**50 Marks

**FOURTH SEMESTER B.E COURSE**
**(Common to All Branches)**

| | | | |
|---|---|---|---|
| **Course Title** | **Additional Mathematics-II** | **Course Code** | **19MA4IMMAT** |
| **Credits** | **00** | **L – T – P** | **3 – 1 – 0** |
| **Contact hours** | **48 hours (36L+12T)** | **IV semester Lateral Entry students** | |

**Prerequisites:** Basic concepts of Trigonometry, Trigonometric formulas, concept of differentiation, concept of integration.

**Course Objectives:** To provide students with a solid foundation in mathematical fundamentals such as Laplace Transforms, Solution of ordinary differential equations using Laplace Transforms, vector integration, computation of area and volume using double and triple integrals respectively.

**UNIT 1**

**LAPLACE TRANSFORMS** **[ 9Hours]**

Laplace transforms of standard functions. Properties and problems. Laplace Transform of Periodic functions with plotting, unit step function and dirac-delta function. **(7L+2T)**

**UNIT 2**

**INVERSE LAPLACE TRANSFORMS** **[10Hours]**

Inverse Laplace transforms of standard functions. Properties and problems. Solution of ODE-Initial and Boundary value Problems. **(7L+3T)**

**UNIT 3**

**DOUBLE INTEGRALS** **[11Hours]**

Evaluation of double integral. Change of order of integration. Change of variables to polar coordinates. Application: Area. **(8L+3T)**

**UNIT 4**

**TRIPLE INTEGRALS AND IMPROPER INTEGRALS** **[9Hours]**

Evaluation of triple integral. Application: Volume. Beta and Gamma functions-definition, relation between Beta and Gamma functions, properties and problems. **(7L+2T)**

**UNIT 5**

**VECTOR INTEGRATION** **[9Hours]**

Line integral, Green's theorem, Stokes' theorem and Gauss divergence theorem. **(7L+2T)**

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On completion of the course, students will have the ability to:

| Course Code | CO# | COURSEOUTCOME(CO) | PO |
|---|---|---|---|
| 19MA4IMMAT | CO 1 | Use Laplace transforms to solve differential equations. | 1 |
| | CO 2 | Apply multiple integrals of plane figures to compute areas and volume. | |
| | CO 3 | Use Gamma and Beta functions to evaluate integrals. | |
| | CO 4 | Ability to understand the use of integral calculus in scalar and vector fields. | |

**TEXT BOOK:**

1. Higher Engineering Mathematics, B.S. Grewal, 43rd edition, 2014, Khanna Publishers.
2. Higher Engineering Mathematics, B.V. Ramana, 2007, Tata McGrawHill.

**REFERENCE BOOK:**

1. Advanced Engineering Mathematics, Erwin Kreyszig, Wiley Precise Textbookseries, Vol. 1 and Vol. 2, 10th edition, 2014, Wiley-India.
2. Advanced Engineering Mathematics, 4th edition, 2011, by Dennis G. ZillandCullen, Jones and Bartlett India Pvt.Ltd

## E books and online course materials

1. Engineering Mathematics, K. A. Stroud, Dexter J. Booth, Industrial Press, 2001 http://books.google.co.in/books/about/Engineering_Mathematics.html?id=FZncL- xB8dEC&redir_esc=y.
2. Advanced Engineering Mathematics, P. V. O'Neil, 5thIndian reprint, 2009, Cengage learning India Pvt. Ltd.
3. http://ocw.mit.edu/courses/mathematics/ (online coursematerial)

## Online Courses:

1. https://www.khanacademy.org/Math
2. https:// www.class-central.com/subject/math(MOOCS)
3. E-learning:www.vtu.ac.in

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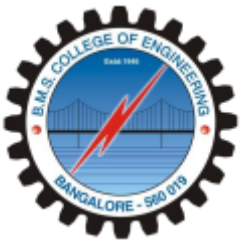
# Department of Industrial Engineering and Management


## *Syllabus for*

# V Semester




## B. M. S. COLLEGE OF ENGINEERING, BENGALURU– 560019

***(Autonomous Institute, Affiliated to VTU)***

| Course | OPERATIONS RESEARCH | Course Code | 20IM5DCOPR |
|---|---|---|---|
| Credits | 04 | L-T-P | 3-1-0 |

**Prerequisites: Nil**

**UNIT-1**

**INTRODUCTION:** OR definition, scope, phases, limitations, models, applications and advantages of OR

**LINEAR PROGRAMMING:** Definition, mathematical formulation, standard form, graphical method: feasible, infeasible, multiple solution, unbounded solution and simplex method: feasible, infeasible, multiple solution, unbounded solution, Duality in LPP, Dual Simplex method. **11 Hrs**

**UNIT - 2**

**TRANSPORTATION PROBLEM:** Formulation of transportation model, basic feasible solution using different methods, optimal solutions, degeneracy in transportation problems, unbalanced transportation problem

**ASSIGNMENT PROBLEM:** Formulation, balanced, unbalanced and maximization assignment problem, travelling salesman problem using Hungarian method **10 Hrs**

**UNIT - 3**

**QUEUING THEORY:** Queuing system and their characteristics, analysis of Markovian queues, M/M/1, M/M/K queuing system **06 Hrs**

**UNIT - 4**

**PROJECT MANAGEMENT USING NETWORK ANALYSIS:** Network construction, determination of critical path and duration, floats using CPM. PERT-Estimation of project duration, Variance and crashing of projects **07 Hrs**

**UNIT - 5**

**GAME THEORY:** Two persons - zero sum game, games with and without saddle point, graphical solution, dominance property **06 Hrs**

**TEXT BOOKS:**

1) **Operations Research and Introduction**, Taha H A, Pearson Education, 9th Edition, 2014
2) **Introduction to Operation Research**, F K Hiller and Liberman, McGraw hill Education Pvt. Ltd, 9th Edition, 2011
3) **Operations Research –Principles and practice**, Philips Ravindaran and Soleberg, Wiley Publication, 2nd Edition, 2007

**REFERENCE BOOKS:**

1) **Operations Research**, S D Sharma, KedarNath, Ram Nath Publication, 2014
2) **Operations Research**, Kanthiswarup and others, Sultan Chand and sons, 2014
3) **Operations Research Problems and Solutions**, J K Sharma, McMillan Publishers, 3rd Edition, 2009.
4) **Operations Research**, P K Gupta and Hira, S Chand Publications, 2007.

**ONLINE REFERENCE**: www.nptel.ac.in

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand the concepts, approaches and optimization in Operation Research Techniques. | - | 1 |
| CO2 | Ability to apply and develop the mathematical skills related to Operation Research Techniques. | PO2 | 3 |
| CO3 | Ability to analyze and solve network models arising from a wide range of applications | PO3 | 3 |
| CO4 | Ability to evaluate real world problems using Operation Research Techniques. | PO4 | 2 |

**SCHEME OF EXAMINATION: One Q**uestion from unit 3,4& 5 and two questions from **unit-1**& 2

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | QUALITY ASSURANCE AND RELIABILITY | Course Code | 20IM5DCQAR |
|---|---|---|---|
| Credits | 04 | L-T-P | 3-1-0 |

**Prerequisites: Probability and Statistics**

**UNIT-1**

**INTRODUCTION TO QUALITY:** Definition of Quality, Quality function, Dimensions of Quality, Quality Engineering terminology, Brief history of quality methodology, statistical methods for quality improvement, Quality costs – four categories costs and hidden costs. Brief discussion on sporadic and chronic quality problems, Introduction to Quality function deployment. **06 Hrs**

**UNIT- 2**

**QUALITY ASSURANCE:** Definition and concept of quality assurance, departmental assurance activities. Quality audit concept, audit approach etc. structuring the audit program, planning and performing audit activities, audit reporting, ingredients of a quality program.ISO 9000 series of standard, ISO 9001 clauses, Registration process, Benefits of ISO.

**STATISTICAL PROCESS CONTROL:** Introduction to statistical process control–chance and assignable cause's variation. Basic principles of control charts, choice of control limits, sample size and sampling frequency, rational subgroups. Analysis of patterns of control charts. Case Studieson application of SPC, Process capability–Basic definition and six sigma concept of process capability, Seven QC tools. **11 Hrs**

**UNIT- 3**

**CONTROL CHARTS FOR VARIABLES:** Controls charts for X bar and Range statistical basis of the charts, development and use of X bar and R charts, interpretation of charts. Control charts for X bar and standard deviation(S), development and use of X bar and S chart. Control charts for individual measurements**.** Gauge R and R and MSA.

**CONTROL CHARTS FOR ATTRIBUTES:** Controls chart for fraction non- conforming (defectives) development and operation of control chart, brief discussion on variables sample size.

**CONTROL CHART FOR NON-CONFORMITIES (DEFECTS)** – Development and operation of control chart for constant sample size and variable sample size. Choice between variables and attributes control charts. Guidelines for implementing control charts. **11 Hrs**

**UNIT-4**

**SAMPLING INSPECTION:** Concept of accepting sampling, economics of inspection, Acceptance plans–single, double sampling. Operating characteristic curves–construction and use.Determinations of average outgoing quality, average outgoing quality level, average total inspection, producer risk and consumer risk, published sampling plans. **06 Hrs**

## UNIT-5

**RELIABILITY AND LIFE TESTING:** Failure models of components, definition of reliability, MTBF, Failure rate, common failure rate curve, types of failure, reliability evaluation in simple cases of exponential failures in series, paralleled and series-parallel device configurations, Redundancy and improvement factors evaluations , Optimization in reliability, Product design – Product analysis – Product development – Product life cycles. **06 Hrs**

**TEXT BOOKS**

1. **Introduction to statistical Quality Control-** DC Montgomery, John Wiley and Sons, 7th edition ISBN : 978-1-118-32416-5
2. **Quality Planning &Analysis** - J M Juran, Frank M Gryna; Tata McGrawHill, 4th edition, ISBN-13: 978-0070393684

**REFERENCE BOOKS**

1) **Statistical Quality Control** - Grant and Leavenworth, McGraw Hill,7thEdition ISBN-13: 978-0078443541
2) **Total Quality Management** – NVR Naidu, KM BabuandG. Rajendra –New Age International Pvt.Ltd–2006
3) **Fundamentals of quality control and improvement**, AmitavaMitra, Wiley Blackwell 4th edition 2016 ISBN-**13:** 978-1118705148

**ONLINE REFERENCE:** www.nptel.com
**E-BOOKS :**http://bookboon.com/en/quality-management-ebook

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand the underlying reasons for modern quality methodologies, acceptance sampling plans and basic reliability concepts. | - | 1 |
| CO2 | Ability to apply the knowledge of control charts, sampling plans and reliability to real world engineering problems | PO1, PO4 | 3 |
| CO3 | Ability to analyze and interpret the process data generated overtime for variable and attribute control charts. | PO2 | 2 |
| CO4 | Ability to conduct experiments using control charts, sampling plans and modern tool like Minitab to solve problems for given application. | PO5, PO9 | 3 |

**SCHEME FOR EXAMINATION**: One question from unit 1, 4 & 5 and two questions from u**nit 2**&**3**

## ASSESSMENT

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course.

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | MANAGEMENT AND ENTREPRENEURSHIP | Course Code | 20IM5DCMAE |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

**UNIT- 1**

**MANAGEMENT** : Introduction- Historical evolution of management, Thought and its Development, Scope and Functional areas of management, Management as a science, art of profession Management and Administration Roles of Management, Levels of Management, functions of Management **06 Hrs**

**UNIT- 2**

**PLANNING AND ORGANIZING:** Nature, importance and purpose of planning process Objectives Types of plans Importance of planning steps in planning and planning premises Hierarchy of plans.

Introduction of organization-Principles of organization Types of organization, centralization Vs decentralization of authority and responsibility Span of control, MBO and MBE. **06 Hrs**

**UNIT- 3**

**STAFFING, DIRECTING & CONTROLLING:** Purpose and importance of staffing-selection process and recruitment, appraisal, Meaning and purpose of Directing Leadership styles, motivation theories, communication and Coordination. Techniques of Co-ordination, Meaning and steps in controlling- essentials of a sound control system-methods of establishing control **11 Hrs**

**UNIT- 4**

**ENTREPRENEURSHIP:** Meaning of Entrepreneur, evolution of the concept, functions of an entrepreneur, types of an entrepreneur, Concept of Entrepreneurship, stages in entrepreneurial process; role of entrepreneurs in economic development, Entrepreneurship in India, barriers for entrepreneurship.

**SMALL SCALE INDUSTRIES** : Definition, characteristics; scope and role of SSI in economic development, advantages of SSI, steps to start and SSI changes in government policy towards SSI in the past 4 decades, Impact of Liberalization, Privatization, Globalization on SSI, Effect of WTO/GATT on SSI, Ancillary industry and tiny industry **11 Hrs**

**UNIT- 5**

**INSTITUTIONAL SUPPORT** : Government agencies supporting industrial activities, schemes; TECKSOK, KIADB, KSSIDC, KSIMC,DIC Single window agency, SISI; NSIC, SIDBI, KSFC.-Industrial Finance

**PREPARATION OF PROJECT**: Meaning of project; Project identification; Project selection; project report; need and significance of report; Contents: Network analysis; Errors of Project report: project appraisal, identification of business opportunities; Market Feasibility study technical feasibility study, financial feasibility study and social feasibility study. **06 Hrs**

**TEXT BOOKS:**

1. **Management and Entrepreneurship**- NVR Naidu& T. Krishna Rao, I K Publishing, 2008 ISBN 978-81-906757-8-9
2. **Dynamics of Entrepreneurial Development & Management-**Vasant Desai, Himalaya Publishing House. Himalaya Publishing House, 2009,ISBN8178669870, 9788178669878
3. **Entrepreneurship Developmen**t,- Poornima M. Charantimath, Small Business Enterprises Pearson Education 2006, ISBN-978-81-7758-260-4(For Unit-2 & 4).

**REFERENCE BOOKS:**

1. **Essentials of Management** Harold Koontz, Heinz Weihrich, RamachandraAryasri, Tata McGraw Hill, 2010.
2. **Principles of Management**, P.C.Tripathi,P.N.Reddy Tata McGraw Hill. 2004 ISBN1259050572, 9781259050572
3. **Management Fundamentals Concepts, Application, Skill Development**- Roberts LusierThomson/South-Western, 2003, ISBN 032411754X, 9780324117547
4. **Entrepreneurship Development**- S. S. Khanka S. Chand & Co.,1999, ISBN-81-219-1801-4
5. **Management** Stephen Robbins Pearson Education/PHI 17th Edition, 2003.

**ONLINE REFERENCE:** http://nptel.ac.in/courses.php
**MOOCS:**https://www.class-central.com/subject/

**COURSE OUTCOMES:**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand the basic principles and concepts of management and Entrepreneurship | | |
| CO2 | Ability to apply the principles of management and entrepreneurship. | PO1 | 1 |
| CO3 | Ability to analyze Management issues to solve the problem to facilitate decision making. | PO2 | 3 |
| CO4 | Ability to formulate and evaluate the feasibility of the project report | PO3 | 3 |

**SCHEME OF EXAMINATION:** One question from units 1, 2 & 3 and two questions from units 4& 5.

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | AUTOMATION IN MANUFACTURING | Course Code | 20IM5DCAIM |
|---|---|---|---|
| Credits | 04 | L-T-P | 4-0-0 |

**Prerequisites: Nil**

**UNIT - 1**

**INTRODUCTION:** Introduction to automation, definition, types of automation, reasons for automating, arguments for and against automation.

**PRODUCTIVITY CONCEPTS AND MATHEMATICAL MODELS:**
Introduction, manufacturing lead-time, components of operating time, production rate, plant capacity, utilization and availability, work-in-process, automation strategies. (Problems) **08 Hrs**

**UNIT - 2**

**HIGH VOLUME PRODUCTION SYSTEM:** Introduction to automated flow lines, Configuration of flow lines, Methods of work-part transport systems, Performance analysis of automated flow lines, analysis of automated transfer lines without buffer, automated flow lines with storage buffer, analysis of a two-stage line. Line balancing.(Problems on line balancing only). **14 Hrs**

**UNIT - 3**

**GROUP TECHNOLOGY:** Part families, part classification and coding systems, Production Flow Analysis, machine cell design, Benefits of group technology.

**COMPUTERIZED MANUFACTURING PLANNING SYSTEMS:** Introduction, computer aided process planning, retrieval and generative type of process planning, benefits of computer aided process planning. **8 Hrs**

**UNIT – 4**

**FLEXIBLE MANUFACTURING SYSTEMS:** Introduction to FMS, components of FMS, types of FMS, Layout configurations, computer control system, application and benefits of FMS. FMS planning and implementation issues.

**COMPUTER NETWORKS FOR MANUFACTURING:** Introduction, hierarchy of computers in manufacturing, local area networks, manufacturing automation control. **8 Hrs**

**UNIT - 5**

**INTRODUCTION TO MATERIAL HANDLING:** Overview of Material Handling Equipments, Considerations in Material Handling System Design, Ten Principles of Material Handling.

**MATERIALTRANSPORTSYSTEMS:** Industrial Trucks, Automated Guided Vehicle Systems, Monorails and Other Rail Guided Vehicles, Conveyor Systems, Crane and Hoists.

**AUTOMATED INSPECTION AND TESTING:** Introduction, contact and non-contact inspection techniques, Types of coordinate measuring machines, applications and benefits, machine vision.

**THE FUTURE AUTOMATED FACTORY:** Introduction, trends in manufacturing, the future automated factory, the social impact of automated systems, Industry 4.0 **14 Hrs**

**TEXT BOOKS:**

1. **Automation, Production Systems and Computer Integrated Manufacturing** - Mikell P. Groover, Pearson – Education, New Delhi
2. **Computer control of manufacturing systems. -** YoremCoren

**REFERENCE BOOKS:**

1. **Automation, Production Systems and Computer Integrated Manufacturing** - Mikell P. Groover, PHI, New Delhi
2. **CAD/CAM**, Mikell P. Groover and Emory W.Zimmers, PHI, New Delhi
3. **Numerical Control and Computer aided Manufacture**, Pressman and Williams PHI
4. **An Introduction to Automated Process Planning System** – TiessChieu Chang and Richard A Wysk PHI

ONLINE: www.nptel.ac.in

## COURSE OUTCOMES

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the concepts of automation and its different types and production concepts. Is able to understand the concept of computerized measuring systems, types of equipment used in the automated systems. Is also able to acquire the knowledge of trends in manufacturing, and the future automated factory. Is able to acquire the knowledge of Flexible manufacturing systems, Layout configurations, and implementation of FMS. Is able to understand about computer networks for production automation, hierarchy, network topology, manufacturing automation protocol. | - | 2 |
| CO2 | Ability to apply the knowledge of automated flow line, storage buffer line (with and without) to solve line balancing problems and to find solutions to the implications of the global factors in the market. | PO1 | 3 |
| CO3 | Ability to analyze material handling and transport systems, different types of automated guided vehicles, vehicle guidance and routing, and system management. | PO2 | 2 |
| CO4 | Ability to develop part families by the of Group technology concepts, and apply knowledge of CAPP and manage product data. Is able to develop the concept of computerized measuring systems, types of equipment used in the automated measuring systems. | PO3 | 2 |

**SCHEME OF EXAMINATION:**
**To set two questions from units 2&5 and one question from units 1, 3&4.**

**ASSESSMENT**
**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.
**Semester End Examination (SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

## ELECTIVE – I

| Course | PRODUCT DESIGN & DEVELOPMENT | Course Code | 20IM5DEPDD |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

### UNIT-1

**INTRODUCTION:** Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development.

**DEVELOPMENT PROCESSES AND ORGANIZATIONS:** A generic development process, concept development: the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMF organization.

**PRODUCT PLANNING:** The product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process. **11 Hrs**

### UNIT-2

**IDENTIFYING CUSTOMER NEEDS:** Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.

**PRODUCT SPECIFICATIONS:** What are specifications, when are specifications established, establishing target specifications, setting the final specifications.

**CONCEPT GENERATION:** The activity of concept generation clarifies the problem, search externally, search internally, explore systematically, and reflect on the results and the process. **06 Hrs**

### UNIT-3

**CONCEPT SELECTION:** Overview of methodology, concept screening, and concept scoring,

**CONCEPT TESTING:** Define the purpose of concept test, choose a survey population, choose a survey format, communicate the concept, measure customer response, interpret the result, and reflect on the results and the process.

**PRODUCT ARCHITECTURE**: What is product architecture, implications of the architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. **11 Hrs**

## UNIT- 4

**INDUSTRIAL DESIGN:** Assessing the need for industrial design, the impact of industrial design, industrial design process, managing the industrial design process, assesses the quality of industrial design.

**DESIGN FOR MANUFACTURING:** Definition, estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors.

**PROTOTYPING**: Prototyping basics, principles of prototyping, technologies, planning for prototypes **06 Hrs**

## UNIT-5

**INTELLECTUAL PROPERTY RIGHTS:** Basic principles of IP laws: Introduction, Concept of property, Need for a holistic approach, Basis for protection, Invention, Criteria for patentability, Non – patentable inventions. Patents: Introduction, principles underlying the patent law in India, patentable invention. Procedure for obtaining patent. **06 Hrs**

**TEXT BOOKS:**

1) **Product Design & Development** - Karl Ulrich , Steven Eppinger, Maria C. Yang, Tata McGraw Hill, 7th Edition, 2019

**REFERENCE BOOKS:**

1) **Product Design and Manufacturing** by A.K. Chitale and R.C. Gupta, PHI. 6th Edition 2015
2) **Basic principles and acquisition of Intellectual Property Rights**", Dr. T Ramakrishna, CIPRA, NSLIU -2005.
3) **Intellectual Property Law Handbook**, Dr.B.L.Wadehhra, Universal Law Publishing Co. Ltd., 2002.
4) **New Product Development** by Tim Jones, Butterworth Heinr1ann, Oxford, UIC 1997.
5) **New Product Development**: Design & 'Analysis by Roland Enene, Kinetovicz, John Wiley and Sons Inc., N. Y. 1990.
6) **Product Design for Manufacture and Assembly** by Geoffrey Boothroyd, Peter Dewhurst and Winston Knight, Taylor & Francis group, 3rd Edition, 2011
7) **Successful Product Design** by Jill Hollins, Stout Pugh, Butterworth, London 1990.

**ONLINE LINKS:**

http://nptel.ac.in/courses.php

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| **CO1** | Ability to understand and explain the Product design and development process. | - | 1 |
| **CO2** | Ability to apply the concepts of Product design and development process to develop engineering products. | PO1 | 3 |
| **CO3** | Ability to analyze the existing products and develop new products using Product design and development concepts. | PO2 | 2 |
| **CO4** | Ability to listen and comprehend audio/video lectures related to product design and development. | PO10 PO12 | 2 |

**SCHEME FOR EXAMINATION:** One questions from unit 2,4& 5 and two questions from **Unit 1** and **3**

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course.

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | ORGANIZATIONAL BEHAVIOR | Course Code | 20IM5DEOBE |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

**UNIT - 1**

**INTRODUCTION:** Definition of Organization Behavior and Historical development, Environmental context (Information Technology and Globalization, Diversity and Ethics, Design and Cultural, Reward Systems.

**THE INDIVIDUAL:** Foundation of individual behavior, Ability.

**LEARNING:** Definition, Theories of Learning, Individual Decision Making, classical conditioning, operant conditioning, social Making, learning theory, continuous and intermittent reinforcement. **06 Hrs**

**UNIT - 2**

**PERCEPTION:** Definition, Factors influencing perception, attribution theory, selective perception, projection, stereotyping, Halo effect.

**VALUES AND ATTITUDES:** Definitions, values, Attitudes: Types of values, job satisfaction, job involvement, Professional Ethics, Organizational commitment, cognitive dissonance. **11 Hrs**

**UNIT – 3**

**MOTIVATION:** Maslow's Hierarchy of Needs, Mc. Gregor's theory X and Y, Herzberg's motivation Hygiene theory, David Mc Cleland three needs theory, Victor vroom's expectancy theory of motivation.

**THE GROUP:** Definition and classification of groups, Factors affecting group formation, stages of group development, Norms, Hawthorne studies, group processes, group tasks, group decision making.

**CONFLICT MANAGEMENT:** Definition of conflict, functional and dysfunctional conflict, stages of conflict process. **11 Hrs**

**UNIT – 4**

**LEADER SHIP:** Definition, Behavioral theories – Blake and Mounton managerial grid, Contingency theories, Hersey - Blanchard's situational theory, Leadership styles, characteristics, Transactional, transformation leaders. **06 Hrs**

**UNIT - 5**

**THE ORGANIZATION:** Mechanistic and Organic structures, Minitberg's basic elements of organization, Organizational Designing and Employee behaviour, organization development, quality of work life (QWL), Team building. **06 Hrs**

**TEXT BOOKS:**

1. **Organizational Behavior**, Stephen P Robbins, 9th Edn, Pearson Education Publications, ISBN–81–7808–561-5, 2002
2. **Organizational Behavior** – Fred Luthans, 9th Edn, McGraw Hill International Edition, ISBN–0–07– 20412–1, 2011

**REFERENCE BOOKS:**

1. **Organization Behavior** – Hellriegel, Srocum and woodman, Thompson Learning, 9th Edition, PHI, 2001
2. **Organizational Behavior** – Aswathappa – Himalaya Publishers. 2001.
3. **Organizational Behavior** – VSP Rao and others, Konark Publishers 2002.
4. **Organizational Behavior** (Human behaviour at work) 9th Edition John Newstron / Keith Davis. 2002.
5. **Management of Organizational Behavior**, Paul Henry and Kenneth H. Blanchard, Prentice Hall of India, 1996.

**ON LINE REFERENCE:** organizational-behavior-15e-stephen-p-robbins-timothy-a-judge-pdf

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| **CO1** | Ability to understand and explain the concept of organizational behavioural theories | - | - |
| **CO2** | Ability to apply organizational behaviour concepts, models and theories to real life management situations through case analysis | PO1 | 2 |
| **CO3** | Ability to analyze the behaviour of individuals and groups in organizations in terms of organizational behavior theories, models and concepts | PO2 | 2 |
| **CO4** | Ability to demonstrate and communicate effectively in oral and written forms about organizational behavior theories and their application using appropriate concepts, logic and rhetorical conventions. | PO9 | 3 |

**SCHEME OF EXAMINATION:** One question to be set from units 1, 4 & 5 and two questions from **unit 2 & 3**.

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | FACILITIES PLANNING AND DESIGN | Course Code | 20IM5DEFPD |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

**UNIT - 1**

**PLANT LOCATION:** Factors influencing plant location, Theories of plant location and Locational Economics.

**PLANT LAYOUT:** Objectives, Principles of plant layout, types – Merits and Demerits.

**MATERIAL HANDLING:** Objectives and Principles of Material handling, Unit load concept, Classification of material handling equipment. **06 Hrs**

**UNIT - 2**

**SPACE DETERMINATION IN A PLANT LAYOUT & AREA ALLOCATION:** Factors for consideration in space planning, receiving, storage, production, shipping, tool room and tool crib, other auxiliary service actions. Establishing total space requirement. The Area Allocation Procedure, the plot plan.

**DESIGN OF PLANT LAYOUTS:** Earlier Procedures: Immer's Basic Steps, Nadler's Ideal system's Approach, Apple's Plant Layout Procedure and Reed's procedure.

Flow Analysis, Quantitative and Qualitative Flow Measurement, Activity Relationship Chart, Relationship Diagram, Space Relationship Diagram. Muther's Systematic Layout Procedure **11 Hrs**

**UNIT – 3**

**COMPUTERIZED LAYOUT PLANNING:** Classification of Layout Algorithms–Distance-based Vs. Adjacency-based Approaches, Pair-wise Exchange Method
CRAFT, CORELAP, ALDEP – Input requirements and procedure
Introduction to Simulated Annealing and Genetic Algorithm in Layout design.

**CONSTRUCTING THE LAYOUT:** Methods of constructing the layout, Evaluation of layout, efficiency indices, presenting layout to management. **11 Hrs**

**UNIT - 4**

**QUANTITATIVE APPROACHES TO LOCATION MODELS: F**acility location models -

Single and Multi-facility, Location allocation Models and numerical problems.

**OTHER Related MODELS:** –Warehouse layout models. Machine Layout Models, Conventional Storage models, AS & RS. **06 Hrs**

## UNIT – 5

**QUADRATIC ASSIGNMENT PROBLEM**: Simple Problems.
**DECISION MAKING PROCESS:** Introduction to MCDM, MADM approaches-AHP, TOPSIS

**06 Hrs**

**TEXT BOOKS:**

1. **Facilities Planning** –James A.Tomkins, John A.White, YavuzA.Bozer, J M.A.Tanchoco, John Wiley and Sons.
2. **Plant Layout and Material handling -** James M Apple,, John, Wiely and Sons,2nd Edition
3. **Facility layout and Location** - Francies, R.L. and White, J.A., McGraw Hill 2nd edition

**REFERENCE BOOKS:**

1. **Practical layout** - Muther Richard, McGraw Hill-1955.
2. **Facilities Design** –SundereshHeragu, PWS Publishing Company, ISBN-0-534-95183.
3. **Plant Layout Design -** James M Moore, Mc Milan Co.1962 LCCCN61- 5204.

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain various factors influencing the decision regarding Facilities Planning using traditional and computerized techniques. | - | 1 |
| CO2 | Ability to apply Facilities Planning and design tools to solve numerical problems to plan and design facilities layout. | PO1 | 3 |
| CO3 | Ability to analyze Facilities Planning problems and improve existing layouts for different product lines using modern tools. | PO2, PO5 | 3 |
| CO4 | Ability to create and evaluate single facility and multiple facility location situations using MCDM techniques and enabling creative application of AHP methods. | PO3, PO5 | 2 |

**SCHEME OF EXAMINATION:**
Five Questions to be set with one question from each unit carrying 20 marks each. **Unit-2**&**Unit-3** units will have an internal choice.

**ASSESSMENT**
**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or AlternativeAssessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.
**Semester End Examination (SEE)-**a written examination for theory courses andpractical/design examination with built-in-oral part (Viva voce)
Both CIE and SEE have equal (50:50) weightages. The students performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | RAPID PROTOTYPING | Course Code | 20IM5DERPR |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

**UNIT-1**

**INTRODUCTION & HISTORY OF RAPID PROTOTYPING:** Need for the compression in Product development Growth of RP Industry, Classification of RP, Stereo lithography(SLA) system & principle, Process parameter, process details of SLA, Data preparation, data files of SLA, Machine details & Application of SLA. **11 Hrs**

**UNIT- 2**

**SELECTIVE LASER SINTERING (SLS)**- Introduction, SLS Machine Type – Details, SLS principle of operation, Process parameters of SLS, Data preparation for SLS, Fused Deposition Modeling (FDM) – Introduction, FDM Principles, Process Parameters, Path generation & Application of FDM, Solid Ground curing (SGC) - Principle of operation, SGC machine details & application. **11 Hrs**

**UNIT- 3**

**LAMINATE OBJECT MANUFACTURING (LOM)**- Principle of operation, LOM materials, LOM Process details & Application, Concepts modelers – Principle, Thermal Jet Printer, Sander model maker – Explanation, 3-D Printer, Genesis Printer & HP Systems, Object Qudra system. **06 Hrs**

**UNIT- 4**

**RAPID TOOLING**-Indirect rapid tooling, Silicon Robber tooling, Aluminium filling epoxy tooling, Spray metal tooling, Direct rapid tooling, Quick cast process, copper Polyamide, DMILS – explanation, Prometals, sand casting tooling, Soft tooling & hard tooling**.** **06 Hrs**

**UNIT- 5**

**STL FILES**: Solid View, Magics, Imics, Magic communicator, Internet based software,
Rapid Manufacturing – Introduction, Factors influencing accuracy, Data preparation errors, Part building errors, Errors in finishing, Influence of build orientation. **06 Hrs**

**TEXT BOOK(S):**

1. Stereo lithography and other RP & M Technologies, Paul F. Jacobs: SME, NY 1996.
2. Rapid Manufacturing, Flham D. T &DinjoyS.S. Verlog London 2001.
3. Rapid automated, Lament wood. Indus press New York

**REFERENCES:**

1. Wohler's Report 2000, Terry Wohlers "" Wohler's Association 2000.
2. Rapid prototyping materials, Gurumurthi, IISc Bangalore.

## COURSE OUTCOMES

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Understand Theory behind RP process. | - | 1 |
| CO2 | Learn the Process parameters of different machine. | PO1 | 2 |
| CO3 | Learn different types of Rapid tooling. | PO2 | 3 |
| CO4 | Understand the industrial standards; learn how to prepare manufacturing DATA. | PO1 | 2 |
| CO5 | Understand basics concept of different software used in RP system. | PO1 | |

**SCHEME OF EXAMINATION:** Five Questions to be set with one question from each unit carrying 20 marks each. **Unit-1**&**2** will have an internal choice

**ASSESSMENT:**
**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.
**Semester End Examination (SEE)-**a written examination for theory courses and practical/design examination with built-in-oral part (Viva voice)
Both CIE and SEE have equal (50:50) weightages. The students performance in a course shall be judged individually and together based on the results of CIE and SEE.

## ELECTIVE-2

| Course | VALUE ENGINEERING | Course Code | 20IM5DEVAE |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

### UNIT – 1

**INTRODUCTION TO VALUE ANALYSIS**: Definition of Value, Value Analysis, Value Engineering, Value management, Value Analysis versus Value Engineering, uses, applications, advantages and limitations of Value analysis. Symptoms to apply value analysis. Types of values, Reasons for poor value & unnecessary cost of product, Peeling cost Onion concept, unsuspected areas responsible for higher cost, Value Analysis Zone, attractive features of value analysis. **11 Hrs**

### UNIT - 2

**VALUE ENGINEERING JOB PLAN:** Meaning and Importance of Value Engineering Job plan. Phases of job plan proposed by different value engineering experts, Information phase, Analysis phase, Creative phase, Judgment phase, Development planning phase, and case studies. Cost reduction programs, **06 Hrs**

### UNIT –3

**FUNCTIONAL COST AND ITS EVALUATION:** Meaning of Function and Functional cost, Rules for functional definition, Types of functions, primary and secondary functions using verb and Noun, Function evaluation process, Methods of function evaluation. Evaluation of function by comparison, Evaluation of Interacting functions, Evaluation of function from available data, matrix technique. **06 Hrs**

### UNIT - 4

**IMPLEMENTATION OF VE TECHNIQUES:** Guidelines for selecting VE projects, Guidelines for formation of VE teams, Application of VE for cost reduction and improving competitiveness – some examples, Relevance of VE for Materials Management. **06 Hrs**

### UNIT - 5

**INTRODUCTION TO SOME ADVANCED TECHNIQUES:** FAST diagramming, Life Cycle costing. VE and some new variants – BPR, Product Reengineering, QFD, Benchmarking. Value analysis of Management practice (VAMP): Steps involved in VAMP.

**Typical Case Studies –** Tapping device of transformer, front rings, conveyor rollers, speedometer of a motorcycle, oil pump etc. **11 Hrs**

**TEXT BOOKS:**

1. **Value Engineering for COST REDUCTION and PRODUCT IMPROVEMENT** – M.S.Vittal, Systems Consultancy ServicesEdn 1993.
2. **Achieving competitive edge through Value Engineering** – M.S. Vittal, Systems Consultancy Services Edn 1993.
3. **Value Engineering** - S.S Iyer,
4. **Value Engineering**- A Practical approach for Owners, Designers and Contractors – Larry Zimmerman, P.E., Glen Hart, CBS Publishers & Distributors, 1988.

**REFERENCE BOOKS:**

1. **Value Analysis for Better Management** – Warren J Ridge American Management Association Edn 1969
2. **Elementsof Production Planning and Control** – Samuel Eilon, Universal Book Corporation.Edn 1981
3. **Getting More at Less Cost (The Value Engineering Way)**–G.Jagannathan Tata McgrawHill Pub. Comp. Edn 1995
4. **Value Engineering** – ArtherEMudge McGraw Hill Book Comp. Edn 1981
5. **An Introduction to Operational Research** – C R Kothari Vikas Pub. House Pvt. Ltd. Edn. 1982.
6. **Value Management, Value Engineering and Cost Reduction** – Edward D Heller Addison Wesley Publishing Company 1971

**ONLINE RESOURCE**

www.nptel.com

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Ability to understand and explain concept of Value, value analysis, value engineering, function. | - | 1 |
| CO2 | Ability apply VE techniques to product, processes, systems, components, parts etc. | PO1 | 2 |
| CO3 | Ability to analyze value engineering techniques to the real world problems | PO2 | 3 |
| CO4 | Ability to design the value added products by value engineering | PO3 | 2 |

**SCHEME OF EXAMINATION:** One question from unit 2, 3 &4 and two questions from Unit 1 & 5

**ASSESSMENT**

Continuous Internal Evaluation (CIE) includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

Semester End Examination (SEE)-a written examination for theory course.

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | THEORY OF CONSTRAINTS | Course Code | 20IM5DETOC |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

**UNIT-1**

**INTRODUCTION**: Definition of constraint. The Five focusing steps. TOC Thinking Tools: Current Reality, Tree and core conflicts, conflict clouds, Negative branch reservations, prerequisite tree, Categories of legitimate reservation, layers of resistance. **11 Hrs**

**UNIT-2**

**THE PROCESS OF CHANGE:** How to Improve Effect-Cause-Effect, How to invent Simple solutions-Evaporating clouds. The set-up cost, Carrying cost and optimum size.

**TOC APPLICATIONS IN PRODUCTION/OPERATIONS:** Concept of Drum, Buffer, Rope, Simplified Drum Buffer rope, Drum Buffer rope, Use of simulator to explain DBR. **11 Hrs**

**UNIT-3**

**LOW INVENTORY:** The key to more accurate Forecasts, The focusing Process and Improvement of process itself.

**TOC APPLICATION IN DISTRIBUTION**: Replenishment Model and case discussions. **06 Hrs**

**UNIT-4**

**HOW SHOULD IT BE IMPLEMENTED:** how to become a Jonals. The devastating Impact of the Organizations Philosophy.TOC in Throughput accounting and in finance. **06 Hrs**

**UNIT-5**

**REALIZING THE INITIAL CONSENSUS AND THE INITIAL STEP:** How to reach the top. What about existing new projects.

**TOC APPLICATIONS IN PROJECT MANAGEMENT:** Critical chain and case discussion. **06 Hrs**

**TEXT BOOKS**

1**. Goldratt's Theory of constraints: A Systems approach to Continuous Improvement**, H. William Dittmer, 1997, ISBN-087389-370-0.

2. **The Goal:** Eliyahu M. Goldratt and Jeff Cox, Third Edition, ISBN: 978-0-566-08665-6 published in 2016

**ONLINE RESOURCES**

www.nptel.ac.in

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| **CO1** | Ability to understand and explain concepts of theories of Constraints | - | 2 |
| **CO2** | Ability to apply various applications of theory of constraints on various sectors | PO1 | 3 |
| **CO3** | Ability to analyze different cases of Theory of constraints | PO2 | 1 |
| **CO4** | Ability to use of modern tools to resolve the issues of theory of constraints | PO5 | 2 |

**SCHEME OF EXAMINATION**: One question to be set from units 3,4& 5 and two questions from units 1 & 2

**ASSESSMENT**

Continuous Internal Evaluation (CIE) includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

Semester End Examination (SEE)-a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | TECHNOLOGY MANAGEMENT | Course Code | 20IM5DETEM |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

**UNIT-1**

**THE CONCEPT OF TECHNOLOGY**: Introduction, The nature of knowledge, Aspects of classification, Concept and Meaning of technology, the character of a specific technology, Scope of technology, Examples of classification of technology, Scale of technology information, Levels of technology, Technology portfolios, Technology as an environment.

**THE NATURE OF TECHNOLOGICAL CHANGE**: Introduction, Meaning of technological change, Concept of invention, Nature of innovation, Emergence of new technologies, Life cycle of a technology, Motivation for technological change, Nature of technological progress, Nature of mature technology, Nature of diffusion, Technological convergence. **11 Hrs**

**UNIT-2**

**THE ECONOMICS OF TECHNOLOGY**: Introduction, Meaning of technological economics, Examples of technological economics, Scope of technological economics, Engineering economics, Production economics, Concept of economy of scale, Concept of optimum size, Technology as a commodity, Technology at the macro-economic level.

**CORPORATE TECHNOLOGY STRATEGY**: Introduction, The business mission, Where is the business? Concept of business strategy, Capability for strategic planning, Corporate technology strategy, Competitive technology, Focus of strategy, Technological alliances, Realization of strategy, Technology crisis. **11 Hrs**

**UNIT-3**

**ANALYSIS FOR TECHNOLOGY STRATEGY:** Introduction, Technology assessment, Technology forecasting, Main techniques of technology forecasting, Technology forecasting system, Yield of technology forecasting. **06 Hrs**

**UNIT-4**

**THE REALIZATION OF NEW TECHNOLOGY**: Introduction, Concept of R&D, R&D policy, Stimuli for innovation, Sources of innovation, Intelligence function of R&D, Management of R&D, R&D team, Effectiveness of R&D, Marketing aspects of R&D, Finance for R&D, Design, Development, Manufacture and Marketing, Reduction of development lead time, Patterns for new technology development, Remaining a going concern.

**THE ADOPTION OF NEW MANUFACTURING TECHNOLOGY**: Introduction, Manufacturing strategy, Introduction of new technology, Challenges of factory automation, Stages of factory automation,

Manufacturing cells, FMS, CIM, CAD/CAM, Intelligent manufacturing systems, Operation of new technology, Change management, People and technology at work, Work structures. **06 Hrs**

## UNIT-5

**TECHNOLOGY- AN INSTRUMENT OF COMPETITION**: Introduction, Securing competitive advantage, Technological competition analysis, Technological leadership, Adoption of new technology, marketing a new technology product, Retention of competitive advantage. **06 Hrs**

**TEXT BOOK:**

1. The Management of Technology Paul Lowe,: Perceptions and Opportunities, Chapman and Hall, London, 1995.

**REFERENCE BOOKS:**

1 Strategic Management of Technology Frederick Betz, , McGraw-Hill Inc, 1993.
2 Management of Technology and Innovation: Competing Through Technological Excellence, Rastogi, P.N., , Sage Publications, 1995

**SCHEME FOR EXAMINATION:** One question from Units 3,4& 5 and two questions from Units 1 &2

**ONLINE LINKS:**

http://ocw.mit.edu/courses/sloan-school-of-management/15-912-technology-strategy-fall-2008/

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | PSOs |
|---|---|---|---|
| **CO1** | Ability to understand and explain the concepts of Technology Management | - | 1 |
| **CO2** | Ability to apply various drivers of Technological Invention and Innovation | PO1 | 3 |
| **CO3** | Ability to analyze product / process for industrial applications , and is patentability | PO2 | 3 |
| **CO4** | Ability to evaluate the cases of the Industry with respect to competitive ability (TCA) | PO3 | 2 |

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | WORLD CLASS MANUFACTURING | Course Code | 20IM5DEWCM |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

## UNIT-1

**INTRODUCTION TO WORLD CLASS MANUFACTURING:** Manufacturing Excellence and Competitiveness, What is World-Class Manufacturing? - Hall's Framework of Value-added Engineering, Schonerger's Framework of World-Class Manufacturing (WCM), Gunn's Model of World-Class Manufacturing, Mask ell's Model of World-Class Manufacturing, America's Best Plants Model of World Class Manufacturing. The Philosophy of World-Class Manufacturing - The Evolution of World-Class Manufacturing, The First Principles of World-Class Manufacturing, The Practices of World Class Manufacturing The customer Interface, The Supplier Interface, World-Class Practices in the Factory, Quality in World Class Manufacturing - Deming's Approach to Quality Management, Shingo's Approach to Quality Management, Assessing the Two Basic Approaches to Quality, Conclusion - The Culmination of World-Class Manufacturing. **11 Hrs**

## UNIT- 2

**BENCHMARKING:** Definition, mission and objectives, managing benchmarking process, training and code of conduct, future scope and benchmarking process.

**WHAT TO BENCHMARK:** Concept of step zero, priorities, business processes - linking to goals etc., investigation, documentation, performance measures, improving business processes.
**WHOM TO BENCHMARK:** Developing candidate list, systematic search, refining the initial list. Data Collection and Analyzing the Performance Gap: Data collection plan, research - internal, public domain sources, outside experts' etc. original research, site visits, and code of conduct.
**ANALYZING THE GAP:** Tools, displaying data, deciding and combining best work practices, validation, recommendations etc. **11 Hrs**

## UNIT- 3

**REENGINEERING:** Definition of reengineering, importance of 3Cs - customers takes charge, competition intensifies, and change becomes constant. Detailed definition of reengineering – fundamental rethinking, radical redesign, and dramatic improvement.

**REENGINEERING:** Rethinking business process, new world of work, and enabling role of information technology. **06 Hrs**

## UNIT- 4

**SIX SIGMA:** The Basics, The core of Six Sigma (DMAIC), Design for Six Sigma, DFSS and the customer, Quality time & the Bottom line, Core of DFSS - IDOV method, DFSS Metrics, DFSS Infrastructure - People & Resources, Implementing DFSS. **06 Hrs**

## UNIT- 5

**ACTIVITY BASED MANAGEMENT (ABM):** Introduction, Traditional Cost Systems, Activity Based Costing, Activity Based Management, ABM Implementation, and Case Study.

**TOTAL PRODUCTIVE MAINTENANCE:** Introduction, the plan, learning the new philosophy, promoting the philosophy, training, improvement needs, goals, developing plans, autonomous work groups, summary, examples. **06 Hrs**

**TEXT BOOKS:**

1. **World Class Manufacturing** Sahay B S. Saxena K.B., C.Ashish Kumar, - A Strategic Perspective; MacMillan India Ltd., ISBN 0333-93-4741
2. **Business Process Benchmarking:. Finding and Implementing Best Practices**, Champ, Robert C. Vision Books, New Delhi, 1995.
3. **Reengineering the Corporation A Manifesto for Business Revolution**, Hammer, Michael and James Champy. Nicholas Brealey Publishing, London, ISBN-0-06-662112-7
4. **Design for Six Sigma,** Gerg Brue, TMH 2003, ISBN 0-07-058120
5. **Six Sigma for Managers,** Greg Brue, TMH 2002; ISBN - 0-07-048639-5

**REFERENCE BOOKS:**

1. **Design for Six Sigma in Technology and Product Development** Creveling, Pearson Education.
2. **Total Quality Management** Dale H. Besterfield, Carol Besterfield- Minchna, Glen H Besterfield& Mary BesterfieldSacre, 3rd edn, Pearson Education, ISBN 81-297-0260-6

**ONLINE REFERENCES:**

https://www.youtube.com/playlist?list=PL1AF592F3CDD31C86

**EBOOKS**

http://bookboon.com/en/how-to-improve-your-production-part-i-ebook

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the concepts of World Class Manufacturing Practices, re-engineering, benchmarking etc. | - | 2 |
| CO2 | Ability to analyze effective implementation of World-Class manufacturing practices, re-engineering, benchmarking etc . | PO2 | 2 |
| CO3 | Ability to listen, comprehend and communicate audio/video lectures related to WCM | PO9,PO10 , PO12 | 1 |

**SCHEME FOR EXAMINATION:**One question from unit 3, 4 & 5 and two questions from **Unit 1 & 2**

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND HUMAN RIGHTS | Course Code | 20IC5HSCPH |
|---|---|---|---|
| Credits | 01 | L-T-P | 1-0-0 |

**TOTAL HOURS: 12**

**COURSE OBJECTIVES:**

1. To educate students about the Supreme Law of the Land.
2. To value human dignity and to save the liberties of the people against discriminations.
3. To raise awareness and consciousness of the issues related to the profession and discuss the issue of liability of risks and safety at work place.

## UNIT-1

**[03 hours]**

### INTRODUCTION TO INDIAN CONSTITUTION

Historical Background of the Indian Constitution. Framing of the Indian constitution: Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India, Fundamental Rights and its limitations. Fundamental Duties and their significance. Directive Principles of State Policy: Importance and its relevance. Case Studies.

## UNIT -2

**[02 hours]**

### UNION EXECUTIVE AND STATE EXECUTIVE

The Union Executive – The President and the Vice President, The Prime Minister and The Council of Ministers. The Union Parliament –Lok Sabha & Rajya Sabha.

The Supreme Court of India.

State Executive – The Governors, the Chief Ministers and The Council of Ministers. The State Legislature – Legislative Assembly and Legislative Council. State High Courts.

## UNIT -3

**[02 hours]**

### ELECTION COMMISSION OF INDIA, AMENDMENTS AND EMERGENCY PROVISIONS

Election Commission of India – Powers & Functions – Electoral Process in India.

Methods of Constitutional Amendments and their Limitations.

Important Constitutional Amendments – 42$^{nd}$, 44$^{th}$, 61$^{st}$, 74$^{th}$, 76$^{th}$, 77$^{th}$, 86$^{th}$ and 91$^{st}$. Emergency Provisions. Case Studies.

## UNIT-4

**[02 hours]**

### SPECIAL CONSTITUTIONAL PROVISIONS/ HUMAN RIGHTS

Special Constitutional Provisions for Schedule Castes, Schedule Tribes & Other Backward Classes. Women & Children. Case Studies.

Human Rights/values – Meaning and Definitions, Legislative Specific Themes in Human Rights and Functions/ Roles of National Human Rights Commission of India. Human Rights (Amendment Act) 2006.

## UNIT-5

**[03 hours]**

### PROFESSIONAL ETHICS

Scope and Aims of Engineering Ethics, Responsibilities of Engineers and impediments to responsibilities. Honesty, Integrity and Reliability; Risks – Safety and Liability in Engineering. Case Studies.

### TEXT BOOKS:

1. "An Introduction to Constitution of India and Professional Ethics" by Merunandan K.B. and B.R. Venkatesh, Meragu Publications, 3rd edition, 2011.
2. "Constitution of India &Professional Ethics& Human Rights" by Phaneesh K. R., Sudha Publications, 10th edition, 2016.

### REFERENCE BOOKS:

1. "V.N. Shukla's Constitution of India" by Prof (Dr.) Mahendra Pal Singh (Revised), Eastern Book Company, Edition: 13th Edition, 2017, Reprint 2019.
2. "Ethics in Engineering" by Martin, W. Mike.,Schinzinger, Roland., McGraw-Hill Education; 4thedition (February 6, 2004).

### E-BOOK:

1. https://books.google.co.in/books/about/Constitution_of_India_and_Professional_E.html?id=VcvuVt-d88QC Constitution of India and Professional Ethics, by G.B. Reddy and MohdSuhaib, I.K. International Publishing House Pvt. Ltd., 2006.
2. http://www.scribd.com/doc/82372282/Indian-Constitution-M-Raja-Ram-2009#scribd Indian Constitution, by M. Raja Ram, New Age International Pvt. Limited, 2009.

## COURSE OUTCOMES:

**Students will:**

1: Understand and explain the significance of Indian Constitution as the Fundamental Law of the Land.

2: Analyze the concepts and ideas of Human Rights.

3: Apply the practice of ethical responsibilities and duties to protect the welfare and safety of the public.

**At the end of the course, the student will have the ability to**

| | | |
|---|---|---|
| **CO1** | Understand and explain the significance of Indian Constitution as the Fundamental Law of the Land. | **Remember** |
| **CO2** | Analyze the concepts and ideas of Human Rights | **Analyze** |
| **CO3** | Apply the practice of ethical responsibilities and duties to protect the welfare and safety of the public. | **Application** |

| Course | QUALITY ASSURANCE AND RELIABILITY LAB | Course Code | 20IM5DLQAR |
|---|---|---|---|
| Credits | 01 | L-T-P | 0-0-1 |

1. To test the Goodness of fit for the given quality characteristic using Uniform distribution
2. To test the Goodness of fit for the given quality characteristic using Binomial distribution
3. To test the Goodness of fit for the given quality characteristic using Poisson distribution
4. To test the Goodness of fit for the given quality characteristic using Normal distribution
5. Conduction of Repeatability and Reproducibility studies
6. Assessing ProcessCapabilityofthegivenmanufacturingprocessusing NormalProbability Paper method and process capability indices.
7. Construction of control chart for attribute equality characteristic.
8. Construction of control charts using Minitab Software.
9. Attribute sampling Plans–Single, Double sampling plans.
10. Experiments on correlation and Simple line regressions.
11. Conduction of Design of Experiments Full Factorial approach for the given quality characteristic for machining operations/ catapult/Golf experiment.
12. Exercises to demonstrate Taguchi's Orthogonal Array technique through DOE software.

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**Continuous Internal Evaluation (CIE):** 50 Marks
**Semester End Examination (SEE):**50 Marks

| Course | DECISION MODELLING LAB | Course Code | 20IM5DLDML |
|---|---|---|---|
| Credits | 01 | L-T-P | 0-0-1 |

## UNIT-1
## OPERATION RESEARCH

1. Solving& sensitivity analysis of LPP models
2. Solving& sensitivity analysis of transportation models
3. Solving of assignment models
4. Solving of Travelling Sales men models,
5. Determination of Critical path for CPM model
6. Crashing of activities using CPM model
7. Determination of Critical path for PERT model and its estimation
8. Determination of steady state condition using Markov models
9. Multi-criteria decision making problems

## UNIT-2
## STATISTICS

10. Data Presentation in tables & charts
11. Sampling distributions of mean & Proportions
12. Chi-square test for different between two proportions
13. Nonparametric analysis for two independent populations
14. t Test of Hypothesis for mean (σ unknown)
15. Z Test of Hypothesis for Proportions
16. Introduction to Big data Analytics.

**SUGGESTED SOFTWARE PACKAGES**

1. OR Packages : Lindo / Lingo / What s Best/Mat Lab/ Ciplex/MS Excel
2. Statistical Packages : MINITAB / SPSS/'R' Software/MS Excel

**REFERENCE BOOKS:**

1) **Operation Research an Introduction**, Hamdy A Taha, Pearson Education; 9 edition (2014), ISBN- 13: 978-9332518223.
2) **Introduction to Optimization techniques (Operations Research)**, Pant J.C. -, Jain Brothers, 6th Edition,(2005)
3) **Applied statistics and Probability for Engineers** - Douglas C Montgomery, George C Runger, 2nd Edn, John Wiley and Sons, ISBN-0-471-17027-5
4) **Probability and Statistics** - Walpole & Mayer, MacMillan Publishing Co.,

**ONLINE REFERENCE:**

1. http://people.brunel.ac.uk/~mastjjb/jeb/or/contents.html

**SCHEME OF EXAMINATION**: Student will appear for Examination and will conduct 2 Exercises choosing Unit-1 and Unit-2 suggested by the Examiners.

| Course | MINIPROJECT-2 | Course Code | 20IM5DCMP2 |
|---|---|---|---|
| Credits | 01 | L-T-P | 0-0-1 |

- **Projects based on the application of techniques of learned courses.**

# Department of Industrial Engineering and Management

*Syllabus for*

# VI Semester

## B. M. S. COLLEGE OF ENGINEERING, BENGALURU– 560019

***(Autonomous Institute, Affiliated to VTU)***

| Course | SIMULATION MODELING AND ANALYSIS | Course Code | 20IM6DCSMA |
|---|---|---|---|
| Credits | 04 | L-T-P | 4-0-0 |

**Prerequisites: Probability and Statistics**

## UNIT-1

**INTRODUCTION TO SIMULATION:** Definition, When simulation is the appropriate tool and when is not appropriate tool. Advantages and Disadvantages of simulation. Areas of application. Systems and System environment, components of a system, Model of a system, types of models, Discrete- Event system Simulation steps in a simulation study**.**
**SIMULATION EXAMPLES:** Simulation of Queuing systems, Single channel Queue and numerical on it. Simulation of Inventory System, Simulation of Project Management and Other simulation examples. **14 Hrs**

## UNIT - 2

**GENERAL PRINCIPLES:** Concepts in discrete - events simulation, event scheduling/Time advance algorithm, World View, Manual Simulation using Event Scheduling. Advanced techniques of simulation. Useful statistical model, Empirical Distributions.
**RANDOM NUMBERS:** Properties, Generation of Pseudo-Random Numbers, Random number Generation Techniques, Tests for Random number- Frequency test, Runs test, Autocorrelation test, Gap test, Poker test. **14 Hrs**

## UNIT –3

**RANDOM VARIATE GENERATION:** Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, Empirical continuous distribution. Direct transformation for Normal and log normal Distributions, Acceptance - Rejection Techniques – Poisson distribution and Gamma distributions. **08 Hrs**

## UNIT - 4

**ANALYSIS OF SIMULATION DATA:** Input Modeling: Data collection, Identification and distribution with data, Parameter Estimation, Goodness of fit tests, Selection of input models without data.
**Verification and Validation of Model**- Model Building, Verification, and Validation. Verification of Simulation models. Calibration and Validation of Simulation Models.
**08 Hrs**

## UNIT - 5

**Simulation of Manufacturing and Material Handling Systems:** Manufacturing and Material Handling Simulations-Models of Manufacturing systems, models of material handling, common material handling equipment's. Goals and performance measures, Issues in Manufacturing and material handling simulations.Case studies. **08 Hrs**

**TEXT BOOKS:**

1) **Discrete Event system Simulation** - Jerry Banks, John S Carson, II Berry L Nelson, Prentice Hall, 1996
2) **Discrete-event System Simulation**, David M Nicol, 5th Edition, Pearson Education, Asia, 2010
3) **Systems Simulation with Digital Computer**, Narsingh Deo, PHI Publication (EEE), 1978
4) **Simulation Modeling & Analysis** Averill, M Law, W David Kelton, - McGraw Hill, International Editions – Industrial Engineering series, 1991
5) **Systems Simulation**,Gordan. G. "", Prentice Hall India Ltd, 1991.

**REFERENCE BOOKS:**

1) **Simulation -- Business & Economics** Sheldon M. Ross, Academic Press, 31-Dec-2012
2) **Simulation Modeling and Analysis with Arena,** TayfurAltiok, Benjamin Melamed, 2010

**ONLINE COURSES**

1. http://nptel.ac.in/courses.php?disciplineId=110
2. http://informs-sim.org/
3. E-learning: http://vtu.ac.in
4. http://ocw.mit.edu/
5. http:// youtube.com/ Discrete Event simulation

**SOFTWARE PACKAGES**

1. Simulation Packages: Arena, Quest, Witness,
2. M S Excel, Minitab

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the fundamental concepts of Simulation and Modeling for Industrial Engineering stream. | - | 1 |
| CO2 | Ability to apply the concepts and techniques of Simulation to formulate and solve Industrial Engineering problems | PO1 | 2 |
| CO3 | Ability to analyze Industrial Engineering Problems and interpret and validate | PO2 | 3 |
| CO4 | Ability to model and Simulate using software packages to find the solution to complex Engineering problems | PO3 | 2 |
| CO5 | Ability to create Statistical model using simulation package like Arena / Witness and to performSensitivity analysis / Post optimal analysis for the generated model | PO5, PO9, PO10 | 2 |

**SCHEME OF EXAMINATION**: One question to be set from **units 3, 4 & 5** and two questions from **unit-1**&**2.**

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course.

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | FINANCIAL ACCOUNTING AND COSTING | Course Code | 20IM6DCFAC |
|---|---|---|---|
| Credits | 04 | L-T-P | 3-1-0 |

**Prerequisites: Nil**

**UNIT - 1**

**FINANCIAL ACCOUNTING:** Definition of financial accounting, Introduction to Book keeping: double-entry accounting, journal & ledger posting.

**FINANCIAL STATEMENTS & ANALYSIS**: Trial balance, preparation of Trading and Profit & Loss account, and Balance sheet. **11 Hrs**

**UNIT - 2**

**RATIO ANALYSIS:** Balance sheet ratio's, profit – loss account ratio's, and combined ratio's. **06 Hrs**

**UNIT - 3**

**COSTING:** Definition of costing, objectives of costing, elements of costing, methods of costing. Preparation of cost sheet. Job cost sheet, Process costing. Differences between Job & Process costing, problems.

**STANDARD COSTING**: Material, labor, overhead cost variance. **11 Hrs**

**UNIT - 4**

**WORKING CAPITAL MANAGEMENT:** Factors influencing working capital requirement, determination of operating cycle and working capital. **06 Hrs**

**UNIT - 5**

**BUDGETING AND BUDGETING CONTROL:** Sales budget, production budget, raw materials purchasing budget, selling and administrative expense budget, cash budget, Flexible Budget, Master budget. **06 Hrs**

**TEXT BOOKS:**

1) **Cost Accounting** - Khan M Y and Jain P K, Tata McGraw-Hill, 4thEdition, 2004
2) **Financial Management -** Prasanna Chandra; Tata McGraw-Hill,4th Edition. 1998.
3) **Management Accounting & Costing -** Prasad .N.K
4) **Financial Management and Policy -** James. C Vanhorne, Pearson education, 12th edition, 2002

**REFERENCE BOOKS:**

1) **Elements of Accountancy** - B.S Raman
2) **Practical Costing** - Ahuja, Pandey, Khanna and Arora, S. Chand& Co. Ltd 2005
3) **Financial Management & Costing –** Khan & Jain, TMH - 2000

## COURSE OUTCOMES

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the concepts of Financial accounting and Costing | - | 1 |
| CO2 | Ability to apply the financial concepts and techniques to solve Financial accounting and costing problems in an industry. | PO1 | 2 |
| CO3 | Ability to analyze and evaluate the financial aspects of accounting, costing and budgeting. | PO2 | 2 |
| CO4 | Ability to create the Journal transactions, trial balance, trading account, profit and loss account and balance sheet. | PO4, PO11 | 3 |

**SCHEME OF EXAMINATION :**One question to be set from **units 2, 4 & 5** and Two questions from **unit 1 & 3**.

**E BOOKS:**

http://www.zums.ac.ir/files/research/site/ebooks/accounting/managerial-and-cost-accounting.pdf
http://ebooks.narotama.ac.id/files/A%20Textbook%20of%20Financial%20Cost%20&%20Management%20Accounting%

**ASSESSMENT**

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**Semester End Examination (SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | LEAN AND OPERATIONS MANAGEMENT | Course Code | 20IM6DCLOM |
|---|---|---|---|
| Credits | 04 | L-T-P | 3-1-0 |

**Prerequisites: Nil**

**UNIT – 1**

**OPERATIONS MANAGEMENT CONCEPTS:** Introduction, Historical development, The trend: Information and Non -manufacturing systems, Operations management, Factors affecting productivity, International dimensions of productivity, the environment of operations, Production systems decisions- a look ahead. **06 Hrs**

**UNIT – 2**

**FORECASTING DEMAND:** Forecasting objectives and uses, Forecasting variables, Opinion and Judgmental methods, Time series methods, Exponential smoothing

**AGGREGATE PLANNING AND MASTER SCHEDULING:** Introduction- planning and scheduling. Aggregate planning methods, Master scheduling methods.

**MATERIAL AND CAPACITY REQUIREMENTS PLANNING:** Overview: MRP and CRP, MRP: Underlying concepts, System parameters, MRP logic, Capacity management, CRP activities. **12 Hrs**

**UNIT – 3**

**SCHEDULING AND CONTROLLING PRODUCTION ACTIVITIES:** Introduction, PAC, Objectives and Data requirements, Scheduling strategy and guide lines

**SINGLE MACHINE SCHEDULING:** Concept, measures of performance, SPT rule, Weighted SPT rule, EDD rule, minimizing the number of tardy jobs .

**FLOW –SHOP SCHEDULING**: Introduction, Johnson's rule for 'n' jobs on 2 and 3 Machines, CDS heuristic.

**JOB-SHOP SCHEDULING**: Types of schedules, Heuristic procedure, scheduling 2 jobs on 'm' Machines. **12 Hrs**

**UNIT –4**

**LEAN SYSTEMS:** Characteristics of Just-in-Time operations, Pull method of materials flow, Consistently high quality, small lot sizes, Uniform workstation loads, Standardized components and work methods, close supplier Ties, Flexible workforce, Line flows, Automated production, Prevention maintenance, continuous improvement **04** Hrs

**UNIT –5**

**LEAN MANUFACTURING TOOLS AND METHODOLOGIES:**

Standard work-communication of standard work employees- standard work and flexibility-visual control –quality at the source- 5S principles- preventive maintenance – total quality management -total productive maintenance- changeover/setup time-batch size reduction-production leveling

**VALUE STREAM MAPPING:** The as-is diagram-the future state map-application to the factory simulation scenario-line balancing- Poke Yoke- Kanban- Overall equipment effectiveness. **06 Hrs**

**TEXT BOOKS:**

1) **Operations Management**, William J. Stevenson McGraw-Hill Higher Education; 10th Revised Edition, April 1, 2010, ISBN-10007-802-4102.
2) **Operations Management**, Monks, J.G McGraw-Hill International Editions, 3rd Edition, 1987, ISBN- 0070427275
3) **Production and Operations Management** PannerSelvam. R, PHI. 2nd Edition, 2006,
4) ISBN-10:8120327675
5) **Productions &Operations Management** by Adam & Ebert, 5th Edition,
6) ISBN: 978-81-203-0838-1
7) **A Study of the Toyota Production System,** Shigeo Shingo , Andrew P. Dillon, Productivity Press,1989, ISBN 9780915299-17-8 ,
8) **The Machine that changed the World**, James P. Womack, Daniel T. Jones and Daniel Roos Free press, Simon and Schuster Inc., New York, 2007, ISBN SBN 10: 0743249275 ISBN 13: 9780743249270

**REFERENCE BOOKS:**

1) **Modern Production/Operations Management,** Buffa, Wiley Eastern Ltd., 8th Edition, 2007, ISBN-10:812-651-3721
2) **Production and Operations Management,** Chary, S.N, Tata-McGraw Hill., 2004
3) **Operations management** by James Dilworth, South Western Educational Publishing, 1999
4) **Operations Management – Strategy and Analysis** Lee J Karjewski and Larry P Ritzman, 6thEdition
5) **Design and Analysis of Lean Production Systems,** Askin R G and Goldberg J B, John Wiley and Sons Inc., 2003, ISBN 9812-53-027-4
6) **What is lean Six Sigma,** Micheal, L George, David T Rowlands, Bill Kastle, McGraw Hill, New York, 2004.
7) **Lean Tools; A Pocket Guide to Implement Lean Practices, Productivity And Quality** Micheal Wader, Publishing Pvt Ltd, 2002.
8) **One-piece Flow,** Productivity Press Kenichi Sekine, Portland Oregon, 1992.
9) **Continuous Improvement in Operations,** Alan Robinson, Productivity Press, Portland Oregon, 1991.
10) **Juran Institute's Six Sigma break Through and Beyond,** Joseph A De Feo, William W Bearnard, Juran Institute's Six Sigma break Through and Beyond, Tata McGraw hill Edition, New Dehli, 2004.
11) **Operations, Management for Competitive Advantage,** Richard B Chase F Robert Jacobs and Nicholas J Aquilano, McGraw Hill/Irwin: Tenth Edition, 2003

**ONLINE RESOURCE:** http://nptel.ac.in/syllabus/110102015/
**E BOOKS:** http://bookboon.com/en/operations-management-ebook

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | PSOs |
|---|---|---|---|
| CO1 | Ability to understand and explain the concepts and principles of Operations Management and Lean | - | 1 |
| CO2 | Ability to apply concepts and principles of Operations Management and Lean to solve Engineering and management Problems | PO1 | 3 |
| CO3 | Ability to analyze Engineering and management Problems and to propose optimal solutions | PO2 | 3 |
| CO4 | Ability to design aggregate plans and master schedules, MRP & CRP and Value Stream mapping solutions to Industrial Engineering problems | PO3 | 2 |

**SCHEME OF EXAMINATION**

One question to be set from units 1, 4& 5 and two questions from unit 2 &3

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course

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**ELECTIVE-3**

| Course | ADVANCED OPERATIONS RESEARCH | Course Code | 20IM6DEAOR |
|---|---|---|---|

| Credits | 03 | L-T-P | 3-0-0 |
|---|---|---|---|

**Prerequisites: Operation Research**

**UNIT – 1**

**ADVANCED LINEAR PROGRAMMING:** Two phase simplex techniques, Revised simplex techniques. Sensitivity analysis **10 Hrs**

**UNIT – 2**

**INTEGER PROGRAMMING:** Gomory's Algorithm, Branch & Board Technique, Solution of Assignment & Travelling salesman Problem

**GOAL PROGRAMMING:** Introduction and simple Problem formulation. **07 Hrs**

**UNIT – 3**

**NON-LINEAR PROGRAMMING:** Introduction, Lagrange and Kuhn – Tucker conditions for constrained problems

**QUEING THEORY:** M/M/C**,** M/Ek/1, M/D/1 and M/G/1 **10 Hrs**

**UNIT - 4**

**DYNAMIC PROGRAMMING:** Characteristics and DP model, Computational procedure (no problem solving, only formulation)

**ADVANCED CPM TECHNIQUES:** Advanced CPM Techniques: Resource leveling network techniques, scheduling activities to level the demands on key resources, time cost of trade off aspects in network techniques. Determination of least cost schedule. **07 Hrs**

**UNIT - 5**

**MARKOV CHAINS:** Discrete Stochastic Process, Markovian process, Stationary Markovchains, Markov diagrams, Ergodic and Absorbing Markov chains, Steady State probabilities, stochastic matrix, transition m, matrix and their applications. **06 Hrs**

**TEXTS BOOKS:**

1. **Operation Research**, **Taha H A,** Pearson Education, 10th Edition, 2019
2. **Operations Research: Principles and Applications** G. Srinivasan, PHI Learning, 3rd Edition, 2017
3. **Introduction to Operations Research**, Frederick S. and Lieberman, McGraw Hill Education, 10th Edition, 2017.

**REFERENCES BOOKS:**

1 **Operations Research: Applications and Algorithms**, Wayne L. Winston, Brooks/Cole, 4th Edition, 2003.
2. **Introductory Operations Research:** Theory and Applications, Kasana and Kumar, Springer, 2004.
3. **Operations Research—Introduction to Management Science**, Kanti Swarup, Sultan Chand and Sons, 2014.

**ONLINE REFERENCE:**

1. http://people.brunel.ac.uk/~mastjjb/jeb/or/contents.html

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| **CO1** | Understand the fundamentals of Optimization models and their application in Engineering | - | 1 |
| **CO2** | Explain the formulation processes considering Optimization methods. . | PO2 | 3 |
| **CO3** | Develop real world problems by adopting optimization tools and techniques. | PO3 | 3 |
| **CO4** | Analyze solutions derived from optimization techniques. | PO4 | 2 |
| **CO5** | Create viable scenarios for solving engineering problems using optimization methodologies | PO3 | 2 |

**SCHEME OF EXAMINATION:** One question from units 2,4&5 and two questions from Units 1& 3

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | SUPPLY CHAIN AND LOGISTICS MANAGEMENT | Course Code | 20IM6DESCM |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

## UNIT-1

**INTRODUCTION TO SUPPLY CHAIN**: Understanding Supply Chain - Objectives- importance Decision phases – Process view of a supply chain – Examples of supply chains – Supply chain performance - An overview: Competitive and supply chain strategies- Achieving strategic fit- Expanding strategic scope. Drivers of Supply Chain Performance: Framework for structuring drivers: Facilities, Inventory, Transportation, Information, Sourcing, Pricing, obstacles to achieving fit. **06 Hrs**

## UNIT-2

**DESIGNING THE SUPPLY CHAIN NETWORK:** The Role of Distribution in the Supply Chains, Factors influencing distribution Network design, Design Options for a Distribution Network, e-Business and the Distribution network, Distribution Networks in practice. Factors influencing network design decisions, Framework for Network design decisions, Models for Facility location and Capacity allocation, The role of IT in Network design. The impact of uncertainty on network design, Discounted cash flow analysis, Representations of Uncertainty, Evaluating Network Design Decisions Using Decisions Trees, Risk Management and Network Design. Problems to be discussed. **06 Hrs**

## UNIT-3

**INVENTORY MANAGEMENT IN SUPPLY CHAIN:** Definition of Inventory, inventory classification: P-System, Q-System, ABC system, VED, FSND and XYZ analysis. Classification of Inventory Models, Derivation and problems considering EOQ model for a single product with and without shortage. Economies of Scale to Exploit Quantity Discounts, Short-Term Discounting, Trade Promotions. The Role of Safety Inventory in a Supply Chain, Determining appropriate level of Safety inventory, Impact of supply Uncertainty on Safety inventory, Impact of aggregation on safety inventory, impact of replenishment policies on safety inventory. The Role of IT in inventory management. Problems to be discussed. **11 Hrs**

## UNIT-4

**DESIGNING AND PLANNING TRANSPORTATION NETWORKS:** The role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Transportation infrastructure and policies, Design options for a transportation network, Trade-offs in transportation design, Tailored transportation, The role of IT in transportation. Problems to be discussed.

Managing Cross-Functional Drivers In A Supply Chain: The role of sourcing in a supply chain, in-house or outsource, Third-and Fourth-party logistics providers, Supplier scoring and assessment, Supplier selection-Auctions and Negotiations, Contracts and supply chain performance, Design Collaboration, The procurement process, sourcing planning and analysis, the role of IT in sourcing. **11 Hrs**

## UNIT-5

**CURRENT TRENDS IN SUPPLY CHAIN & LOGISTIC MANAGEMENT:** Over view on e-SRM, e-LRM, e-SCM and block chain in SCM. Introduction to Supply Analytics: Descriptive Analytics, Prescriptive Analytics and Predictive Analytics. The role of sustainability in a Supply Chain, Key Metrics for sustainability and its drivers. Introduction to Reverse logistics, Closed Loop Supply Chains, Lean and Agile supply chains. **06 Hrs**

**TEXT BOOKS:**

1. **Supply Chain Management**, Chopra, S., Meindi, P. and Kalra, D.V., 7th Edition, Pearson, 2018.

2. **Designing And Managing the Supply Chain** David SimchiLevi , Edith Simchi Levi , Ravi Shankar and Philip Kaminsky, : Concepts, Strategies and Case studies, 3rd Edition, McGraw-Hill, 2019.
3. **Materials Management:** Procedures, Text and Cases, A K Datta, 2nd Edition, Prentice Hall India Learning Private Limited, 1998.
4. **Introduction to Materials Management** Chapman, Gatewood, Arnold and Clive, , 8th Edition, Pearson Education India, 2016.

**REFERENCE BOOKS:**

1. **Supply Chain Logistics Management** Bowersox, McGraw Hill Education, 4th Edition, 2018.
2. **Supply Chain Management: A Logistics Perspective ,**John J. Coyle, Jr. C. John Langley, Robert A. Novack and Brian J. Gibson, 10th Edition, 2019

3. **Principles of Supply Chain Management (Resource Management)**Richard E. Crandall, William R. Crandall, Charlie C. Chen, , 2nd Edition, 2014.
4. **Introduction to Materials Management,** Stephen N. Chapman, Tony K. Arnold, Ann K. Gatewood, Lloyd Clive, 8th Edition, Pearson, 2016

**ONLINE RESOURCE:** www.nptel.ac.in

**COURSE OUTCOME**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Understand supply chain basics, Role of SCM as systemic and strategic nature in dealing with global competitive environment | - | 1 |
| CO2 | Evaluate supply chain alternatives and distribution network structures applying Operation Research models. | PO1, PO6 | 3 |
| CO3 | Develop optimum sourcing and inventory policies in the supply chain context. | PO2 | 3 |
| CO4 | Select and incorporate latest practices for managing supply chain processes | PO4 | 2 |

**SCHEME OF EXAMINATION:** One Question to be set from **unit 1,2& 5** and Two Questions from **unit 3 &4.**

**ASSESSMENT:**

**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

**Semester End Examination (SEE)-**a written examination for theory course. Both CIE and SEE have equal (50:50) weights. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE

| Course | DESIGN FOR MANUFACTURABILITY | Course Code | 20IM6DEDFM |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

## UNIT-1

**MATERIAL AND PROCESS SELECTION**– Introduction, Advantages of applying DFMA, General requirements of early materials and process selection, Selection of Manufacturing processes, Process capabilities, Selection of materials, Primary process/ materials selection, Systematic selection of processes and materials. **06 Hrs**

## UNIT-2

**ENGINEERING DESIGN FEATURES**. – Dimensioning, Tolerances, General Tolerance, Geometric Tolerances, Assembly limits, achieving larger machining tolerances. Screw threads, Ground surfaces, holes. Examples

**Datum features** – Functional datum, machining sequence, manufacturing datum, changing the datum. Examples **06 Hrs**

## UNIT-3

**Component design – Machining Considerations** – Drills, Milling cutters, Drilling, Keyways, Dowels, Screws, Reduction in machining areas, Simplification by separation and amalgamation, work piece holding, surface grinding, Component surface design, Examples.

**Component design – Casting Considerations** – Pattern, Mould, parting line, cast holes, machined holes, identifying parting line, special sand cores, designing to obviate sand cores, Examples **11 Hrs**

## UNIT-4

**DESIGN FOR INJECTION MOLDING AND SHEET METAL WORKING** – Injection molding materials, Molding cycle, Systems, molds, machine size, cycle time, Cost estimation, Insert molding, Design guidelines, Introduction to sheet metalworking, Dedicated Dies and Press working, Press selections, Design Rules, Over Molding, Design of Undercuts, Collapsible cores.

**DESIGN FOR DIE CASTING AND POWDER METAL PROCESSING** – Die casting alloys, cycle, machines, dies, finishing, Assembly techniques, Design principles, Powder metallurgy processing, stages, compaction characteristics, Tooling, Sintering, Design guidelines, Surface definition, Example **11 Hrs**

## UNIT-5

**GEOMETRIC TOLERANCE** – Symbols, Three datum concept of dimensioning, Straightness, concentricity, Run-out, Location Tolerance, Assembly of parts having concentric cylinders, Control of feature location by true position, Body of revolution, Roundness, Profile dimensioning, Tapers, Shaft of two diameters. Examples. **06 Hrs**

**TEXT BOOKS**:

1. **Designing for Manufacturing** - Harry Peck, Pitman Publications, 1983. ISBN10-0273000071
2. **Machine Design** - Dieter, McGraw hill Publications for topic 1.Metrology - R.K. Jain Khanna, Publication for topic 6.
3. **Product design for manufacture and assembly** - Geoffrey Booth Royd, peter Dewhurst, Winston Knight, Mercel Dekker. Inc. New York, CRC press, Taylor and Francis group, 2011
   **ISBN**:-13-978142008928-8
4. **Material selection and Design**, - ASM Hand book,Vol. 20

**REFERENCE BOOKS:**

1. **Product Design for Manufacture and Assembly**, Geoffrey Booth Royd - Peter Dewhurst Winston Knight – Marcel Dekker,Inc.– New York -Second Revision, 1994, ISBN 0-8247-0584-X.
2. **Designing for Manufacturing** – Harry Peck - Pitman Publications – 1983.
3. **Dimensioning and Tolerance for Quantity Production**,Merhyle F Spotts –Inc. Englewood Cliffs - New Jersey - Prentice Hall, 5th edition.Publisher Prentice Hall, 1982, ISBN-13:9780132146845

**ONLINE REFERENCE:**

**http://nptel.ac.in/courses/112101005/**

**COURSE OUTCOMES:**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the various principles of Design For Manufacturability | - | 1 |
| CO2 | Ability to apply different Manufacturability techniques for different applications. | PO1 | 2 |
| CO3 | Ability to analyze various products for their underlying manufacturing techniques, and suggest improvements if required. | PO2 | 2 |
| CO4 | Ability to design casting specimens considering manufacturing cost, minimize the number of cores and retain casting strength. | PO3 | 3 |

**SCHEME OF EXAMINATION**: One Question to be set from units 1,2& 5 and Two Questions from the unit 3 & 4.

**ASSESSMENT**

Continuous Internal Evaluation (CIE) includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.Semester End Examination (SEE)-a written examination for theory course.

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| Course | INDUSTRIAL EXPERIMENTATION | Course Code | 20IM6DEIEX |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

**UNIT- 1**

**INTRODUCTION:** History of quality engineering: Japan versus U.S. track records. Taguchi Approach to Quality: Definition of quality, Loss function, Off-line and On-line quality control, Taguchi's quality philosophy. ANOVA, Test of hypothesis. **06 Hrs**

**UNIT - 2**

**BASIC DESIGNS:** Completely Randomized Design, Randomized Block Design, Latin Square Designs, one way analysis of variance and two way analysis of variance.

**FACTORIAL EXPERIMENTATION - TWO LEVELS:** Full Factorial Designs: Experimentation as a learning process. Traditional scientific experiments, Two factor design, Four-factor design, replicating experiments, Factor interactions. Fractional factorial designs based on eight-run experiments. **11 Hrs**

**UNIT -3**

**TAGUCHI TECHNIQUES:**

**CONSTRUCTING ORTHOGONAL ARRAYS:** Counting degrees of freedom, selecting a standard orthogonal array, dummy level technique and compound factor method, Linear graphs and interaction assignment, Modification of linear graphs, column merging method, branching design, Strategy for constructing an orthogonal array, Comparison with the classical statistical experiment design. **11 Hrs**

**UNIT 4**

**STEPS IN ROBUST DESIGN:** Case study discussion, Noise factors and testing conditions, Quality characteristics and objective functions, Control factors and their levels, Matrix experiment and data analysis plan, Conducting the matrix experiment, data analysis, verification experiment and future plan. **06 Hrs**

**UNIT - 5**

**SIGNAL-TO-NOISE RATIO FOR STATIC PROBLEMS:** Evaluation of sensitivity to noise, S/N ratios for Smaller-the-better, Larger-the-better, Nominal-the-best and Asymmetric Cases.

**SHAININ TECHNIQUE:** Introduction, salient features, case studies in sequential DOE tools to solve chronic problems. **06 Hrs**

**TEXTBOOKS:**

1. **Quality Engineering Using Robust Design** - Madhav S. Phadke, Prentice Hall PTR, Englewood Cliffs, New Jersey 07632.
2. **Design of Experiments** - D.C. Montgomery, John Wiley and Sons, 2002.
3. **World Class Quality using DOE to make it happen**, Keki R. Bhote, American Management Association publications, 2nd Ed. 2000

**REFERENCE BOOK:**

1. Designing for Quality - Robert H. Lochner and Joseph E. Matar, - an Introduction Best of Taguchi and Western Methods or Statistical Experimental Design", Chapman and Hall Madras, 2nd edition.

**ONLINE REFERENCE:**

http://www.nptel.ac.in/syllabus/110104020/
http://www.eformacion.com.
http://www.sas.com/storefront/aux/en/spdesignanlysisjmp/66584_excerpt.pdf

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strengths |
|---|---|---|---|
| **CO1** | Ability to understand and explain the principles of analysis of variance and experimental designs | - | 1 |
| **CO2** | Ability to apply & construct the appropriate experimental design for a particular problem. | PO1, PO3 | 3 |
| **CO3** | Ability to analyze the data & interpret the experimental results | PO2 | 2 |

**SCHEME FOR EXAMINATION: One** questions to be set from units1,4& 5 and two questions from Units 2& 3.

**ASSESSMENT**

Continuous Internal Evaluation (CIE) includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

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B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
DEPARTMENT OF INDUSTRIAL ENGINEERING & MANAGEMENT

## ELECTIVE -4

| Course | DATA BASE MANAGEMENT SYSTEM | Course Code | 20IM6DEDBM |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

### UNIT - 1

**DATABASES AND DATABASE USERS:** Introduction, characteristics of data base approach, intended use of a DBMS, advantages and implication of database approach.

**DATABASE SYSTEMS CONCEPTS AND ARCHITECTURE**: Data models, Schemas and instances' DBMS architecture and data independence, database languages and interfaces, database system environment, classification of data base management Systems.

**DATA MODELING:** High level conceptual data models for database design. Entity types, entity. Sets, attributes, and keys. Relationships, relationship types, roles, and Structural constraints, Weak entity types. ER Diagrams **11 Hrs**

### UNIT - 2

**RECORD STORAGE AND PRIMARY FILE ORGANIZATIONS**: Secondary storage devices, buffering of blocks, placing fi1l records on disk, operations on files, heap files a sorted files, hashing techniques.

**INDEX STRUCTURE OF FILES:** Single-level and multilevel ordered indexes, dynamic multi-level indexes using B-trees and B+trees. **06 Hrs**

### UNIT - 3

**RELATIONAL DATA MODE ANQ RELATIONAL ALGEBRA:** Brief' discussion on Codd rules, relational model concepts, constraints, and schemas. Update operation on relations, basic and additional relational algebra operations, and queries in relational algebra.

**Structured Query Language (SQL):** Data definition etc. in SQL2.Basic and complex queries in SQL. Insert, delete, update statements, and views in SQL, embedded SQL. **11 Hrs**

### UNIT - 4

**DATABASE DESIGN**: Design guidelines for relational schemes, functional Dependencies, normalization -1st, 2nd, 3'd, 4 , and 5th normal forms. Database design process, factors influencing physic I database design guidelines, and guidelines for relational systems. **06 Hrs**

## UNIT - 5

**SYSTEM IMPLEMENTATION:** System catalog for RDBMSs, transaction processing and system concepts, properties of transactions, brief discussion on concurrency, control and recovery techniques, database security and authorization.

**BRIEF DISCUSSION ON:** Distributed databases, objected oriented databases, next generation databases, and interfacing with other technologies. **06 Hrs**

**TEXTBOOKS:**

1. **Fundamentals of database systems**"-RamezElmasri and Shamkanth B. Navathe, Addison Wesley Publishing Company, 6th Edition,
2. **"Database Management System**", -Raghu Ramakrishnan and Johanne's Gehrke, TATA McGraw Hill, 3'd Edition, ISBN 0-071231511 I

**REFERENCE BOOKS:**

1. **Modern Data base management**: McLfadden, hoffer, Prescott
2. **Database Management Design** Gary W. Hansen and James V. Hansen, PHI Pvt . Ltd, 2nd Edition

**ONLINE REFERENCE:**

http://nptel.ac.in/video.php?subjectId=106106093

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand DBMS architecture, languages, interfaces, data modeling | - | 2 |
| CO2 | Ability to apply relational model concepts, schemas to business functions, Hashing | PO1 | 1 |
| CO3 | Ability to evaluate models, ER Diagrams, system implementation, SQL queries and DBMs systems | PO3, PO4 | 2 |
| CO4 | Ability to create complex SQL queries, stored procedures | PO3,PO4 | 3 |

**SCHEME OF EXAMINATION:** One Question to be set from units2,4&5 and Two Questions be set from the Units 1 & 3.

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for theory course

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | TOTAL QUALITY MANAGEMENT | Course Code | 20IM6DETQM |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

## UNIT - 1

### INTRODUCTION: BUSINESS EVOLUTION

The Evolution of the Customer Satisfaction Concept: Evolution of Customer Satisfaction Methods, Evolution of Company Integration, Continuing Evolution.

Survival in a Rapidly Changing World: Practice Systematic Development of Skill, Treat Management as a Coherent System, Focus on People and Their Purposes, Integrate Best Practices, Financial Benefit

Developing a Unique Organizational Capability: Four Practical Revolutions in Management, Evolution of our Understanding, Four Levels of Practice

### THE FIRST REVOLUTION: CUSTOMER FOCUS

Change in the Work Concept: Market-in, Customers, Philosophy-in and Philosophy-out Evolution of Customer Focus and Its Challenges: Three Stages of Customer Focus, Customer Concerns, Integration of Concerns, Individualizing Customers **06 Hrs**

## UNIT –2

### THE SECOND REVOLUTION: CONTINUOUS IMPROVEMENT

Improvement as a Problem-Solving Process: Management by Process, WV Model of Continuous Improvement, Continuous Improvement of Processes for All Types of Work, Continuous Improvement and the Scientific Method

### MANAGING EXISTING PROCESSES

Process Discovery and Management: Thinking In Terms of Process, Process Discovery

Process Control and Variation: A Typical Example of (Mishandling) Variation, Making the Most of Variation, Process Control and Process Improvement

Reactive Improvement and the 7 Steps Method; Identifying the Problem, Standard Steps and Tools. The 7 Steps: A Case Study, The 7 QC Tools

Management Diagnosis of the 7 Steps of Reactive Improvement: General Guidelines for Managers

Diagnosing a QI Story , Step-by-Step Guidelines for Managers Diagnosing a QI Story , Case Study for Diagnosis of the 7 Steps, Run PDCA and Develop Skill

Process Management Mobilization Case Study: Introduction to the Teradyne Mobilization story Introduction of the 7 Steps, Experience Using the 7 Steps, Improving Mobilization, Process Discovery and Process Control

Planning Projects or Tasks: The 9 Steps Compared with the 7 Steps, The 9 Steps Mobilization at Teradyne, A Teradyne Illustration of the 9 Steps Use, Relationship of the 9 Steps to Other Methods **11 Hrs**

## UNIT - 3

**PROACTIVE IMPROVEMENT**: Collecting Data for Proactive Improvement, Language Data and Use of Semantics, Toward Standard Tools and Steps for Proactive Improvement, Customer Visitation as a Method of Collecting Proactive Improvement Data

Applying Proactive Improvement to Develop New Products; Develop Understanding of Customers' Needs and Environment, Convert Understanding into Requirements, Operationally Define Requirements for Downstream Development, Generating Concepts and Selecting the Concept, Expanding View of WV Model and Proactive Improvement **06 Hrs**

## UNIT -4

## THE THIRD REVOLUTION: TOTAL PARTICIPATION

Engagement and Alignment of Organization Members: Engaged Employees for a Rapidly Changing World, Explicit Joining of Improvement and Routine Work , Processes and People, Coordinating Behavior; Societal Networking Case Study of the CQM Study Group on Conversation, Expansion of the Principles of Semantics, Some Types and Models of Conversations

Leading Change: Technical Skill, Human Skill, Conceptual Skill

Self-Development: Lessons from the Non-business World, Local Improvement in Absence of a Supportive Environment, the Bottom Line

Team Skill Development: Teamwork Skill, Some Fundamentals, Some Types of Teams substantially, Models for Team Development

Initiation Strategies; CEO Involvement, Case Study: Teradyne Strategy for Introduction

Infrastructure for Mobilization: Create Explicit Structures for Mobilization, A General Model for Mobilization: The 7 Infrastructures

Phase-In: Orientation Phase, Empowerment Phase, Alignment Phase, Evolution of the Parallel Organization, Common Patterns of Phase-In

U.S. Focused Strategies for Phase-In: Benchmarking, Six Sigma, Cycle-Time Reduction.**11 Hrs**

## UNIT –5

**HOSHIN MANAGEMENT**: Hoshin Management and Its Parts, Management by Objectives and Conventional Business Planning, Hoshin Management at Analog Devices

Leading Process Improvement: Modeling Personal Improvement, Employee Development at NIMS, Company Strategies, Individual Practice of CAPD by Managers,' Case studies

The Practice of Breakthrough; Process versus Business Breakthrough, Case Studies and a Model of Business Breakthrough, Biggest Obstacle to Business Breakthrough, Integration of Ideas

## THE FOURTH REVOLUTION: SOCIETAL NETWORKING

Networking and Societal Diffusion: Regional and National Networking the Japanese Model, Taking a Lesson from Japan—CQM, Comparison of National Methods, Use of Indirect Influence

Ongoing Integration of Methods: Applying Idealized Design to Hoshin Management, Structural Process Improvement Case Study, SerVend Case Study **06 Hrs**

**TEXT BOOK:**

1.**Four Practical Revolutions in Management: Systems for Creating Unique Organizational Capability** -Shoji Shiba and David Walden,– Productivity Press & Center for Quality Management, (USA) , 2012, ISBN-9781563273889

**REFERENCE BOOKS:**

1 .**Management for Total Quality** -N Logothetis- Prentice Hall of India, New Delhi, 2003, ISBN-81-203-1137-X

2.**Total Quality Management**- Besterfield, Pearson Education, 2011. ISBN, 817758412X, 9788177584127.

**ONLINE LINKS:**

1. http://nptel.ac.in/syllabus/110101010/

**COURSE OUTCOMES:**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the quality concepts and the practical evolution in management, revolution in total quality management | - | 2 |
| CO2 | Ability to apply the quality tools and methods in the manufacturing and service processes | PO1 | 2 |
| CO3 | Ability to analyze the TQM related cases and quality improvement process | PO2 | 1 |

**SCHEME OF EXAMINATION**: One Question to be set from units 1,3& 5and Two Questions will be set from the unit 2 & 4.

**ASSESSMENT**

Continuous Internal Evaluation (CIE) includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

Semester End Examination (SEE)-a written examination for theory course.

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE.

| Course | MARKETING MANAGEMENT | Course Code | 20IM6DEMKM |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

## UNIT - 1

**INTRODUCTION:** Evolution of marketing management, Definition of Marketing, Drivers of Marketing Management, Micro and Macro Environment, importance of marketing in the India Socio – economic system.
**MARKETING RESEARCH**: Components, benefits & uses, marketing research procedure, measurement of market demand. Types of markets, Marketing Vs. MIS, Marketing Mix. **11 Hrs**

## UNIT - 2

**PRODUCT PLANNING AND DEVELOPMENT:** The concept of a product, features of a product, classification of products, product policies – product planning and development, product line, product mix – factors influencing change in product mix, product mix strategies, meaning of New – product; major stages in new – product development, product life cycle.
**CONSUMER MARKETS AND BUYING BEHAVIOUR**: Characteristics affecting Consumer behavior, Types of buying decisions, buying decision process, Classification of consumer products, Market Segmentation.
**MARKETING OF INDUSTRIAL PRODUCTS:** Introduction, types and strategies. **11 Hrs**

## UNIT - 3

**BRANDING:** Branding, Reasons for branding, functions of branding, features and types of brands, kinds of brand name, branding failures.
**LABELING:** Types, functions, advantages and disadvantages
**PACKAGING:** Meaning, growth of packaging, function of packaging, kinds of packaging, packaging failures
**LEGAL CONCERNS:** Introduction, legal provisions pertaining to branding, labeling and packaging. **06 Hrs**

## UNIT - 4

**ADVERTISING AND SALES PROMOTION:** Objectives of advertisement function of advertising, classification of advertisement copy, advertisement media – Ethical Code, kinds of media, advantages of advertising, Advt. Standards Council of India – Role and Responsibilities. Objectives of sales promotion, advantages of sales promotion.
**DIGITAL MARKETING:** Introduction, Trends, viral marketing **06 Hrs**

## UNIT-5

**PERSONAL SELLING:** Objectives of personal selling, establishing the Sales force objectives, sales force strategy, sales force structure and size, salesmanship, qualities of good salesman, types of salesman.

**PRICING:** Problems in Pricing, methods in pricing, pricing strategies.

**MARKETING & SOCIAL MEDIA:** Introduction, challenges, strategies.
**TYPICAL CASE STUDIES** – Examples from MNCs and Indian Companies penalized for wrong advertisement practices and promotion methods. **06 Hrs**

**TEXT BOOKS:**

1) **Modern Marketing – Principles and Practices –** RSN Pillai&Bhagavathi – S.Chand and Co. Ltd, New Delhi.,2001
2) **Marketing Management – Planning, Implementation and Control** – The Indian Context - V S Ramaswamy, S Namakumari, Mac Millan India Ltd, 1990.
3) **Principles of Marketing** - Philip Kotler& K Gary Amstrong , Prentice – Hall. 11th Edn., 2008
4) **Marketing Management** - Philip Kotler , Prentice – Hall. 12th Edn.2009.
5) **Marketing Management** - Michael R Czinkota, , 2nd Edition, Vikas Publishing House.
6) **Case Studies in Marketing**: The Indian Context – R. Srinivasan, 7th Edition 2018 – ISBN978-93-87472-31-0.

**REFERENCE BOOKS:**

1) **Marketing Management** – ICFAI Centre for Management Research, Hyderabad., 1st Edition, 2004,
2) **Fundamentals of Marketing -**William J Stanton, McGraw Hill, 1994
3) **Marketing Management**– Russel, S.Winar, Pearson education series, 3rd Edition,2009
4) **Marketing Management Text &Cases,** Rajagopal - Vikas Publishing House, 2006

## COURSE OUTCOMES

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand and explain the concepts, principles and functions of Marketing. | - | 1 |
| CO2 | Ability to apply marketing concepts and principles to solve business/corporate marketing problems. | PO1, PO2 | 2 |
| CO3 | Ability to analyze strategies which enable decision making process. | PO2 | 2 |
| CO4 | Ability to use appropriate models and techniques to the study ever-changing environment. | PO5 | 2 |
| CO5 | Ability to create the idea into a viable marketing plan. | PO5 | 2 |

**SCHEME OF EXAMINATION: One** question from unit 3, 4 & 5 and two questions from **units 1 & 2**

## ASSESSMENT

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for the theory course.

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## INSTITUTION ELECTIVE-1

| Course | OPERATIONS RESEARCH | Course Code | 20IM6IEOPR |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: NIL**

### UNIT-1

**INTRODUCTION:** Evolution, definition, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, Linear Programming Problems (LPP) - Formulation of LPP-Graphical solution. Use of slack, surplus and artificial variables, Canonical and Standard forms, Solution of LPPs using Simplex method, Big- M method. **11 Hrs**

### UNIT-2

**TRANSPORTATION PROBLEM:** Formulation of transportation problem, types, initial basic feasible solution using North-West Corner method, least cost method, Vogel approximation method, Degeneracy in transportation problems, optimal solutions by MODI method. **06 Hrs**

### UNIT-3

**ASSIGNMENT PROBLEM**- Formulation, types, Hungarian method for assignment problem, Unbalanced assignment problem, application to maximization cases and travelling salesmen problem **06 Hrs**

### UNIT-4

**PERT-CPM TECHNIQUES:** Introduction, network construction-AON & AOA diagrams, Fulkerson's rule for numbering the events, Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project. Predicting the completion time of project; crashing of projects. **11 Hrs**

### UNIT-5

**GAME THEORY:** Formulation of games, types, solution of games with saddle point, Solution of games without saddle point, 2x2 games without saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **06 Hrs**

**TEXT BOOK:**

1. S.D. Sharma-Operations Research, Kedarnath Ramanath & Co. 2002
2. R. Panneerselvam-Operations Research, second edition, PHI Learning Private Limited 2011.
3. Richard Bronson, Govindasami Naadimuthu:Schaumn Outline series-second edition, Tata McGraw Hill edition 2004, Eleventh reprint 2011.

**REFERENCE BOOKS:**

1. Hiller and Liberman -Introduction to Operations Research, Ninth edition McGraw Hill Publications.
2. Hamdy ATaha H A- Operations Research, eighth edition, Pearson Prentice Hall.
3. KantiSwarup, P K Gupta, Man Mohan, Operations Research, Sultan Chand & Sons, 2010.

**E-LEARNING:**

1. **https://books.google.co.in/books?isbn=8131711048, Taha-2008**
2. **https://books.google.co.in/books?isbn=8121902819D S Hira-2008**
3. **https://books.google.co.in/books?isbn=8131700003, A. M. Natarajan, PBalasubramani-2006**

**Question Paper Pattern:**

1. Each unit consists of one full question.
2. Each full question consists of two, three or four subdivisions.
3. Five full questions to be answered.
4. Internal choice in Unit 1 and Unit 4.

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand the concepts, approaches and optimization in Operation Research Techniques. | - | 1 |
| CO2 | Ability to apply and develop the mathematical skills related to Operation Research Techniques. | PO2 | 3 |
| CO3 | Ability to analyze and solve network models arising from a wide range of applications | PO3 | 3 |
| CO4 | Ability to evaluate real world problems using Operation Research Techniques. | PO4 | 2 |

## ASSESSMENT

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**Semester End Examination (SEE)-**a written examination for theory course

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| Course | MANAGEMENT AND ENTREPRENEURSHIP | Course Code | 20IM6IEMAE |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

**UNIT- 1**

**MANAGEMENT** : Introduction- Historical evolution of management, Thought and its Development, Scope and Functional areas of management, Management as a science, art of profession Management and Administration Roles of Management, Levels of Management, functions of Management **06 Hrs**

**UNIT- 2**

**PLANNING AND ORGANIZING:** Nature, importance and purpose of planning process Objectives Types of plans Importance of planning steps in planning and planning premises Hierarchy of plans.

Introduction of organization-Principles of organization Types of organization, centralization Vs decentralization of authority and responsibility Span of control, MBO and MBE. **06 Hrs**

**UNIT- 3**

**STAFFING, DIRECTING & CONTROLLING:** Purpose and importance of staffing-selection process and recruitment, appraisal, Meaning and purpose of Directing Leadership styles, motivation theories, communication and Coordination. Techniques of Co-ordination, Meaning and steps in controlling- essentials of a sound control system-methods of establishing control **06 Hrs**

**UNIT- 4**

**ENTREPRENEURSHIP:** Meaning of Entrepreneur, evolution of the concept, functions of an entrepreneur, types of an entrepreneur, Concept of Entrepreneurship, stages in entrepreneurial process; role of entrepreneurs in economic development, Entrepreneurship in India, barriers for entrepreneurship.

**SMALL SCALE INDUSTRIES** : Definition, characteristics; scope and role of SSI in economic development, advantages of SSI, steps to start and SSI changes in government policy towards SSI in the past 4 decades, Impact of Liberalization, Privatization, Globalization on SSI, Effect of WTO/GATT on SSI, Ancillary industry and tiny industry **11 Hrs**

**UNIT- 5**

**INSTITUTIONAL SUPPORT** : Government agencies supporting industrial activities, schemes; TECKSOK, KIADB, KSSIDC, KSIMC,DIC Single window agency, SISI; NSIC, SIDBI, KSFC.-Industrial Finance

**PREPARATION OF PROJECT**: Meaning of project; Project identification; Project selection; project report; need and significance of report; Contents: Network analysis; Errors of Project report: project appraisal, identification of business opportunities; Market Feasibility study technical feasibility study, financial feasibility study and social feasibility study. **11 Hrs**

**TEXT BOOKS:**

4. **Management and Entrepreneurship**- NVR Naidu& T. Krishna Rao, I K Publishing, 2008 ISBN 978-81-906757-8-9
5. **Dynamics of Entrepreneurial Development & Management-**Vasant Desai, Himalaya Publishing House.Himalaya Publishing House, 2009,ISBN8178669870, 9788178669878
6. **Entrepreneurship Developmen**t -Poornima M. Charantimath, Small Business Enterprises Pearson Education 2006, ISBN-978-81-7758-260-4(For Unit-2 & 4).

**REFERENCE BOOKS:**

1. **Essentials of Management** Harold Koontz, Heinz Weihrich, RamachandraAryasri, Tata McGraw Hill, 2010.
2. **Principles of Management**, P.C.Tripathi,P.N.Reddy Tata McGraw Hill. 2004 ISBN1259050572, 9781259050572
3. **Management Fundamentals Concepts, Application, Skill Development**- Roberts LusierThomson/South-Western, 2003, ISBN 032411754X, 9780324117547
4. **Entrepreneurship Development**- S. S. Khanka S. Chand & Co.,1999, ISBN-81-219-1801-4
5. **Management** Stephen Robbins Pearson Education/PHI 17th Edition, 2003.

**ONLINE REFERENCE:** http://nptel.ac.in/courses.php

**MOOCS:**https://www.class-central.com/subject/

**COURSE OUTCOMES:**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Ability to understand the basic principles and concepts of management and Entrepreneurship | - | 1 |
| CO2 | Ability to apply the principles of management and entrepreneurship. | PO1 | 1 |
| CO3 | Ability to analyze Management issues to solve the problem to facilitate decision making. | PO2 | 3 |
| CO4 | Ability to formulate and evaluate the feasibility of the project report | PO3 | 3 |

**SCHEME OF EXAMINATION:** One question from units 1, 2 & 3 and two questions from units 4& 5.

**ASSESSMENT:**

**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

**Semester End Examination(SEE)-**a written examination for theory course Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE

B.M.S. COLLEGE OF ENGINEERING (Autonomous), BENGALURU-19
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| Course | SUPPLY CHAIN AND LOGISTICS MANAGEMENT | Course Code | 20IM6IESCM |
|---|---|---|---|
| Credits | 03 | L-T-P | 3-0-0 |

**Prerequisites: Nil**

## UNIT-1

**INTRODUCTION TO SUPPLY CHAIN**: Understanding Supply Chain - Objectives-importance Decision phases – Process view of a supply chain – Examples of supply chains – Supply chain performance - An overview: Competitive and supply chain strategies- Achieving strategic fit- Expanding strategic scope. Drivers of Supply Chain Performance: Framework for structuring drivers: Facilities, Inventory, Transportation, Information, Sourcing, Pricing, obstacles to achieving fit. **06 Hrs**

## UNIT-2

**DESIGNING THE SUPPLY CHAIN NETWORK:** The Role of Distribution in the Supply Chains, Factors influencing distribution Network design, Design Options for a Distribution Network, e-Business and the Distribution network, Distribution Networks in practice. Factors influencing network design decisions, Framework for Network design decisions, Models for Facility location and Capacity allocation, The role of IT in Network design. The impact of uncertainty on network design, Discounted cash flow analysis, Representations of Uncertainty, Evaluating Network Design Decisions Using Decisions Trees, Risk Management and Network Design. Problems to be discussed. **06 Hrs**

## UNIT-3

**INVENTORY MANAGEMENT IN SUPPLY CHAIN:** Definition of Inventory, inventory classification: P-System, Q-System, ABC system, VED, FSND and XYZ analysis. Classification of Inventory Models, Derivation and problems considering EOQ model for a single product with and without shortage. Economies of Scale to Exploit Quantity Discounts, Short-Term Discounting, Trade Promotions. The Role of Safety Inventory in a Supply Chain, Determining appropriate level of Safety inventory, Impact of supply Uncertainty on Safety inventory, Impact of aggregation on safety inventory, impact of replenishment policies on safety inventory. The Role of IT in inventory management. Problems to be discussed. **11 Hrs**

## UNIT-4

**DESIGNING AND PLANNING TRANSPORTATION NETWORKS:** The role of transportation in a Supply chain, Modes of transportation and their performance characteristics, Transportation infrastructure and policies, Design options for a transportation network, Trade-offs in transportation design, Tailored transportation, The role of IT in transportation. Problems to be discussed.

Managing Cross-Functional Drivers In A Supply Chain: The role of sourcing in a supply chain, in-house or outsource, Third-and Fourth-party logistics providers, Supplier scoring and assessment, Supplier selection-Auctions and Negotiations,Contracts and supply chain performance, Design Collaboration, The procurement process, sourcing planning and analysis, the role of IT in sourcing. **11 Hrs**

## UNIT-5

**CURRENT TRENDS IN SUPPLY CHAIN & LOGISTIC MANAGEMENT:**Over view on e-SRM, e-LRM, e-SCM and block chain in SCM. Introduction to Supply Analytics: Descriptive Analytics, Prescriptive Analytics and Predictive Analytics. The role of sustainability in a Supply Chain, Key Metrics for sustainability and its drivers. Introduction to Reverse logistics, Closed Loop Supply Chains, Lean and Agile supply chains. **06 Hrs**

**TEXT BOOKS:**

5. **Supply Chain Management**, Chopra, S., Meindi, P. and Kalra, D.V., 7th Edition, Pearson, 2018.

6. **Designing And Managing the Supply Chain** David SimchiLevi , Edith Simchi Levi , Ravi Shankar and Philip Kaminsky, : Concepts, Strategies and Case studies, 3rd Edition, McGraw-Hill, 2019.
7. **Materials Management:** Procedures, Text and Cases, A K Datta, 2nd Edition, Prentice Hall India Learning Private Limited, 1998.
8. **Introduction to Materials Management** Chapman, Gatewood, Arnold and Clive, , 8th Edition, Pearson Education India, 2016.

**REFERENCE BOOKS:**

5. **Supply Chain Logistics Management** Bowersox, McGraw Hill Education, 4th Edition, 2018.
6. **Supply Chain Management: A Logistics Perspective,**John J. Coyle, Jr. C. John Langley, Robert A. Novack and Brian J. Gibson, 10th Edition, 2019
7. **Principles of Supply Chain Management (Resource Management)**Richard E. Crandall, William R. Crandall, Charlie C. Chen, , 2nd Edition, 2014.
8. **Introduction to Materials Management,** Stephen N. Chapman, Tony K. Arnold, Ann K. Gatewood, Lloyd Clive, 8th Edition, Pearson, 2016

**ONLINE RESOURCE:** www.nptel.ac.in

**COURSE OUTCOME**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| CO1 | Understand supply chain basics, Role of SCM as systemic and strategic nature in dealing with global competitive environment | - | 1 |
| CO2 | Evaluate supply chain alternatives and distribution network structures applying Operation Research models. | PO1, PO6 | 3 |
| CO3 | Develop optimum sourcing and inventory policies in the supply chain context. | PO2 | 3 |
| CO4 | Select and incorporate latest practices for managing supply chain processes | PO4 | 2 |

**SCHEME OF EXAMINATION:** One Question to be set from **unit 1,2 & 5** and Two Questions from **unit 3 &4.**

**ASSESSMENT:**

**Continuous Internal Evaluation (CIE)** includes mid-term tests, weekly/fortnightly class test, homework assignments, problem solving, group discussions quiz, seminar, mini-project and other Alternate Assessment Tools (AAT)prescribed by the faculty handling a course prior to beginning of the classes.

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| Course | ENVIRONMENTAL POLLUTION CONTROL | Course Code | 20HS6PCEPC |
|---|---|---|---|
| Credits | 02 | L-T-P | 2-0-0 |

**UNIT- 1**

**POLLUTION AND ITS MEASUREMENTS INTRODUCTION:** Man and Environment, types of pollution, pollution control aspects-Preventive and Curative approaches

**INDUSTRIAL POLLUTION LEGISLATIONS**: Water Act, 1974, Air Act, 1981, Water quality management in India **04 Hrs**

**UNIT-2**

**ANALYSIS OF POLLUTANTS** Introduction, Industrial Waste Water Analysis, Industrial Gaseous Effluents' Analysis

**POLLUTION CONTROL ASPECTS REGARDING FEW SPECIFIC POLLUTANTS:** BOD, Chromium, Mercury, Ammonia/urea, Phenolic effluents - Sources, Measurements, Removal Systems. **04 Hrs**

**UNIT- 3**

**PARTICULATE MATTER:** Separation of particulate matter from effluent gases - **METHODS OF SEPARATION: C**yclone Separators, Aerodynamic Separation, Fabric filters, Liquid scrubbers, Electrostatic Precipitators.

**TREATMENT OF GASEOUS EFFLUENTS** Removal of: Sulphur-di-oxide, Oxides of Nitrogen, Organic Vapours - Analysis, Harmful effects, ISI standards, Control Measures.

**07 Hrs**

**UNIT- 4**

**POLLUTION CONTROL IN SELECTED PROCESS IN INDUSTRIES** General considerations of Pollution Control in Fertilizer Industries, Petrochemical Refineries, Treatment of E-wastes, Radioactive Wastes. **04 Hrs**

**UNIT- 5**

**CASE STUDIES** and Details of Industrial disasters and their impact on Human Habitation - Bhopal gas tragedy, nuclear disasters - Chernobyl, US, Fukushima Daichi, Heavy Metal Contamination. .

**INTRODUCTION TO POLLUTION PREVENTION**: Definition, Drivers of Pollution Prevention, Incentives for Pollution Prevention - Case Studies

**POLLUTION CONTROL CONSULTANCY** – Identification and Evaluation of PC Consultants. **07 Hrs**

**TEXT BOOKS:**

1) **Pollution control in process industries**, S.P.Mahajan, IIT Bombay, Tata-McGraw Hill Publishing Co., New Delhi, 1985.
2) **Pollution Prevention** – Methodology, Technologies & Practice, Kenneth L. Mulholland, James A. Dyer, American Institute of Chemical Engineers, New York, 1999.

**REFERENCE BOOKS:**

1) **Industrial Pollution and Management**, Arvind Kumar, APH Publishing Corp., New Delhi, 2004.
2) **Environmental Planning – Machinery and Management**, V.S.Mahajan, Deep & Deep Publishing, 1991
3) **Industrial Air Pollution Engineering,** Edited by Vincent Cavaseno& Staff of Chemical Engg., McGraw Hill Publishing Co., New York, 1980

**COURSE OUTCOMES**

| CO# | Course Outcomes | POs | Strength |
|---|---|---|---|
| **CO1** | Ability to understand and explain the fundamentals of Industrial pollution Control | **-** | **1** |
| **CO2** | Ability to apply the Industrial pollution Control concepts to solve individual cases of Industrial Pollution | **1** | **2** |
| **CO3** | Ability to analyze the efficacy of Industrial pollution Control concepts. | **2** | **2** |
| **CO4** | Ability to design Industrial pollution Control strategies. | **3** | **2** |

**SCHEME OF EXAMINATION:** One question to be set from Units 1,2&4 and two questions from Unit 3 and Unit 5.

**ASSESSMENT**

**Continuous Internal Evaluation (CIE)** includes periodic class tests, quizzes or Alternative Assessment Tools (AAT) prescribed by the faculty handling a course prior to beginning of the classes like assignments, problem solving, case studies, group discussion, seminar, mini-project etc.

**Semester End Examination (SEE)-**a written examination for the theory course.

Both CIE and SEE have equal (50:50) weightages. The student's performance in a course shall be judged individually and together based on the results of CIE and SEE

| Course | SIMULATION MODELING AND ANALYSIS LAB | Course Code | 20IM6DLSMA |
|---|---|---|---|
| Credits | 01 | L-T-P | 0-0-1 |

Development of simulation models using the simulation language / packages studied for systems Such as, Queuing systems, Production systems, Inventory systems, Maintenance and Replacement systems, Investment analysis and Networks.

1. Solving Monte Carlo simulation problems using MS Excel (minimum 4 exercise)
2. Input analysis of Simulation data by statistical tools
3. Simulation of Service system considering Breaks, Schedules and resource failure etc
4. Activity based costing in Simulation
5. Simulation of Manufacturing system with multiple servers and failures
6. Simulation of Transport system considering Forklift and conveyor
7. Supply chain simulation
8. Network simulation.
9. Statistical Analysis of Simulation models ( output analysis)
10. Simulation of Bank Queue model
11. Simulation of Project Execution
12. Simulation of Inventory Management

**Continuous Internal Evaluation (CIE):** 50 Marks
**Semester End Examination (SEE):**50 Marks

| Course | LEAN MANUFACTURING LAB | Course Code | 20IM6DLLNM |
|---|---|---|---|
| Credits | 01 | L-T-P | 0-0-1 |

**1. To demonstrate the importance of 5s techniques in an industrial assembly scenario using a Torch assembly kit.**

**2. Assembly exercises:**

i) Piston assembly
ii) Single plate clutch assembly
iii) Carburetor
iv) ABS module
v) Disc brake caliper

**3. Hands–on and Simulation activity**

**i)Flow Production Simulation Kit**: This game is designed in such a way that trainer can set up a production line and allow participants to work in the production line and see how deployment of Lean improves the KPIs (Lead Time, Productivity, WIP, Space Utilization) of the production line.

Key learnings,

- Batch vs. Single piece flow
- Push vs. Pull, Kanban Signal
- Takt Time vs. Cycle Time
- Line Balancing

**ii)Poka Yoke Simulation Kit :** This game is designed in such a way that trainer can set up a production line and allow participants to work in the production line and see how defects passthrough undetected Set up a perfect case for learning to design various detection ideas and mechanisms

**iii) Mapping the value stream – VSM software / Arena**

**iv) Establishing a pull system (**relies on mobility and synchronization)

4. **Lean manufacturing: an approach for waste elimination**

5. **Single-Minute Exchange of Dies-SMED**

**Continuous Internal Evaluation (CIE):** 50 Marks
**Semester End Examination (SEE):**50 Marks