VINAYAKA MISSION'S RESEARCH FOUNDATION

(Deemed to be University under section 3 of the UGC Act 1956)

# Faculty of Engineering and Technology

## Programme : M.E – Manufacturing Engineering – FULL TIME

## CHOICE BASED CREDIT SYSTEM (CBCS)

## Curriculum & Syllabus

## (Semester I to IV)

## Regulations 2021

# VINAYAKA MISSION'S RESEARCH FOUNDATION, DEEMED TO BE UNIVERSITY, SALEM

## Department of Mechanical Engineering

### PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

| | |
|---|---|
| **PEO 1** | The graduates will execute their professional skills and knowledge acquired in the field of manufacturing engineering and management of the resources |
| **PEO 2** | The graduates will provide the innovative solutions to the problems arising in production to implement the green manufacturing |
| **PEO 3** | The graduate will execute the work with professional ethics, team work, develop quality products and will follow human values in their life. |
| **PEO 4** | The graduates will be able to develop innovative products and to become entrepreneur. |
| **PEO 5** | The graduates will involve in continuous learning and will be able to execute consultancy services. |

### PROGRAM SPECIFIC OUTCOMES (PSOs)

To achieve the mission of the program, Mechanical Engineering graduates will be able:

| | |
|---|---|
| **PSO.1** | To work independently as well as in team to formulate, design, execute solutions for engineering problems and also analyze, synthesize technical data for application to product, process, system design & development |
| **PSO.2** | To understand & contribute towards social, environmental issues, following professional ethics and codes of conduct and embrace lifelong learning for continuous improvement |
| **PSO.3** | To develop expertise towards use of modern engineering tools, careers in industries and research and demonstrate entrepreneurial skill |

# PROGRAMME OUTCOMES

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. |

# VINAYAKA MISSION'S RESEARCH FOUNDATION
## (DEEMED TO BE UNIVERSITY), SALEM

## CURRICULUM FOR REGULATION-2021

## Credit Requirement for the Course Categories

**M.E/M. Tech-Manufacturing Engineering**

| Sl. No. | Category of Courses | Types of Courses | Suggested Breakup of Credits (min-max) |
|---|---|---|---|
| 1. | **A. Foundation Courses** | Mathematics/Applied Mathematics | 3 |
| | | Research Methodology and IPR | 2 |
| 2. | **B. Program Core Courses** | Core Courses | 32 |
| 3. | **C. Elective Courses** | Program electives | 15 |
| | | Open electives (Courses on emerging areas..) | 3 |
| 4. | **D. Employability Enhancement Courses and courses for presentation of Technical skills related to the specialization** | Project work phase I | 6 |
| | | Project work phase II | 12 |
| | | Internship | 1 |
| | | Technical Seminar | 1 |
| 5. | **E. Mandatory Courses/Audit Courses** | Any two courses on:<br>1. English for Research Paper Writing<br>2. Disaster Mitigation and Management<br>3. Value Education<br>4. Constitution of India<br>5. Pedagogy Studies<br>6. Personality Development Through Life Enlighten Skills | Zero Credit |
| **Total credits to be earned for the award of M.E /M.Tech degree** | | | **75** |

## M.E/M.TECH-MANUFACTURING ENGINEERING-SEMESTER I TO IV

### A. Foundation Courses Credits-(5)

| SL. NO | COURSE CODE | COURSE | OFFERING DEPT. | CATEGORY | L | T | P | C | PREREQUISITE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 40221B01 | APPLIED PROBABILITY AND STATISTICS | MATH | FC-BS | 2 | 1 | 0 | 3 | NIL |
| 2 | 40221H01 | RESEARCH METHODOLOGY AND IPR | MECH | FC-HS | 2 | 0 | 0 | 2 | NIL |

### B. Programme Core Courses Credits-(32)

| SL. NO | COURSE CODE | COURSE | OFFERING DEPT. | CATEGORY | L | T | P | C | PREREQUISITE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 40221C01 | ADVANCES IN MANUFACTURING TECHNOLOGY | MECH | CC | 3 | 0 | 0 | 3 | NIL |
| 2 | 40221C04 | ADVANCED MATERIALS TECHNOLOGY | MECH | CC | 3 | 0 | 0 | 3 | NIL |
| 3 | 40221C83 | ADVANCED METALLURGY LAB | MECH | CC | 0 | 0 | 4 | 2 | NIL |
| 4 | 40221C03 | ADVANCES IN CASTING AND WELDING | MECH | CC | 3 | 0 | 0 | 3 | NIL |
| 5 | 40221C05 | ADVANCES IN METROLOGY AND INSPECTION | MECH | CC | 3 | 0 | 0 | 3 | NIL |
| 6 | 40221C84 | AUTOMATION AND METAL FORMINGLAB | MECH | CC | 0 | 0 | 4 | 2 | NIL |
| 7 | 40221C81 | CIM LAB | MECH | CC | 0 | 0 | 4 | 2 | NIL |
| 8 | 40221C02 | COMPUTER INTEGRATED MANUFACTURING SYSTEMS | MECH | CC | 3 | 0 | 0 | 3 | NIL |
| 9 | 40221C06 | METAL CUTTING THEORY AND PRACTICE | MECH | CC | 3 | 0 | 0 | 3 | NIL |
| 10 | 40221C07 | METAL FORMING PROCESSES | MECH | CC | 3 | 0 | 0 | 3 | NIL |
| 11 | 40221C82 | MODELLING AND ANALYSIS LAB | MECH | CC | 0 | 0 | 4 | 2 | NIL |
| 12 | 40221C08 | OPTIMIZATION TECHNIQUES IN MANUFACTURING | MECH | CC | 3 | 0 | 0 | 3 | NIL |

### C. Elective Courses Credits-(18)

### Program Electives Courses Credits – (15)

| SL. NO | COURSE CODE | COURSE | OFFERING DEPT. | CATEGORY | L | T | P | C | PREREQUISITE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 40221P09 | DESIGN FOR MANUFACTURE AND ASSEMBLY | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 2 | 40221P01 | FLUID POWER AUTOMATION | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3 | 40221P10 | MICRO MANUFACTURING | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 4 | 40221P11 | QUALITY AND RELIABILITY ENGINEERING | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 5 | 40221P12 | FINITE ELEMENT METHODS FOR MANUFACTURING ENGINEERING | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 6 | 40221P13 | INDUSTRIAL ERGONOMICS | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 7 | 40221P02 | LEAN MANUFACTURING | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 8 | 40221P14 | MATERIALS MANAGEMENT AND LOGISTICS | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 9 | 40221P04 | MEMS AND NANOTECHNOLOGY | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 10 | 40221P05 | NON-DESTRUCTIVE TESTING AND EVALUATION | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 11 | 40221P06 | ROBOT DESIGN & PROGRAMMING | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 12 | 40221P07 | ADDITIVE MANUFACTURING | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 13 | 40221P15 | COMPOSITE MATERIALS | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 14 | 40221P16 | COMPUTER AIDED PRODUCT DESIGN | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 15 | 40221P17 | EMERGING MATERIALS | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 16 | 40221P03 | MANUFACTURING MANAGEMENT | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 17 | 40221P18 | MANUFACTURING SYSTEM SIMULATION | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 18 | 40221P08 | MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 19 | 40221P19 | MECHATRONICS | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 20 | 40221P20 | NANO STRUCTURED MATERIALS AND APPLICATIONS | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 21 | 40221P21 | PROCESS PLANNING AND COST ESTIMATION | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 22 | 40221P22 | PRODUCT DESIGN AND DEVELOPMENT | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| 23 | 40221P23 | PRODUCT LIFECYCLE MANAGEMENT | MECH | EC-PS | 3 | 0 | 0 | 3 | NIL |
| **Open Electives (Courses on Emerging areas) Credits –(3)** | | | | | | | | | |

| SL. NO | COURSE CODE | COURSE | OFFERING DEPT. | CATEGORY | L | T | P | C | PREREQUISITE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 43421O01 | BIOMEDICAL PRODUCT DESIGN AND DEVELOPMENT | BME | OE-EA | 3 | 0 | 0 | 3 | NIL |
| 2 | 48121O02 | WASTE TO ENERGY | BTE | OE-EA | 3 | 0 | 0 | 3 | NIL |
| 3 | 41421O02 | SUSTAINABLE BUILT ENVIRONMENT | CIVIL | OE-EA | 3 | 0 | 0 | 3 | NIL |
| 4 | 45121O02 | ADVANCED CYBER SECURITY | CSE | OE-EA | 3 | 0 | 0 | 3 | NIL |
| 5 | 43321O01 | BIO MEMS | ECE | OE-EA | 3 | 0 | 0 | 3 | NIL |
| 6 | 44721O01 | SOLAR AND ENERGY STORAGE SYSTEMS | EEE | OE-EA | 3 | 0 | 0 | 3 | NIL |
| 7 | 44121O01 | OPERATIONS RESEARCH | MATH | OE-EA | 3 | 0 | 0 | 3 | NIL |
| 8 | 40221O01 | PROJECT MANAGEMENT FOR ENGINEERING BUSINESS AND TECHNOLOGY | MANAG | OE-EA | 3 | 0 | 0 | 3 | NIL |

**D. Employability Enhancement Courses and Courses for Presentation of Technical Skills Related to the Specialization Credits-(20)**

| SL. NO | COURSE CODE | COURSE | OFFERING DEPT. | CATEGORY | L | T | P | C | PREREQUISITE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 40221RP1 | PROJECT WORK PHASE I | MECH | EE-P | 0 | 0 | 12 | 6 | NIL |
| 2 | 40221RP2 | PROJECT WORK PHASE II | MECH | EE-P | 0 | 0 | 24 | 12 | NIL |
| 3 | 40221I81 | INTERNSHIP | MECH | EE-I | 3 WEEKS | | | 1 | NIL |
| 4 | 40221S81 | TECHNICAL SEMINAR | MECH | EE-S | 0 | 0 | 2 | 1 | NIL |

**E. Mandatory Courses/Audit Courses-(Zero Credits)**

| SL. NO | COURSE CODE | COURSE | OFFERING DEPT. | CATEGORY | L | T | P | C | PREREQUISITE |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 44121Z01 | ENGLISH FOR RESEARCH PAPER WRITING | ENG | AC | 0 | 0 | 2 | 0 | NIL |
| 2 | 44121Z02 | DISASTER MITIGATION AND MANAGEMENT | CIVIL | AC | 0 | 0 | 2 | 0 | NIL |
| 3 | 44121Z03 | VALUE EDUCATION | HS | AC | 0 | 0 | 2 | 0 | NIL |
| 4 | 44121Z04 | CONSTITUTION OF INDIA | LAW | AC | 0 | 0 | 2 | 0 | NIL |
| 5 | 44121Z05 | PEDAGOGY STUDIES | HS | AC | 0 | 0 | 2 | 0 | NIL |
| 6 | 44121Z06 | PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTEN SKILLS | ENG | AC | 0 | 0 | 2 | 0 | NIL |

# FOUNDATION COURSES

| 40221B01 | APPLIED PROBABILITY AND STATISTICS | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | | FC-BS | 2 | 1 | 0 | 3 |

**PREAMBLE**

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

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | To understand the basics of random variables with emphasis on the standard discrete and continuous distributions. |
| 2 | To introduce the concepts of sampling distributions and the test statistics. |
| 3 | To provide an understanding of the statistical methods and concepts by which real life problems are analyzed. |
| 4 | To train the students in design experiments and use these concepts for research. |
| 5 | To understand the basics of Multivariate Analysis. |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| **CO1.** Able to analyze the performance in terms of probabilities and distributions achieved by the determined solution. | Apply |
| **CO2.** Aware of various test statistics for the samples. | Apply |
| **CO3**. develop an ability to apply statistical tests in experiments as well as to analyze and interpret data. | Apply |
| **CO4**. use the concepts in design of experiments in real life problems. | Apply |
| **CO5**. Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality. | Apply |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| COS | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | M | L | -- | -- | -- | M | -- | -- | -- | M | -- | -- | -- |
| **CO2** | S | S | M | L | -- | -- | -- | M | -- | -- | -- | M | -- | -- | -- |
| **CO3** | S | S | M | L | -- | -- | -- | M | -- | -- | -- | M | -- | -- | -- |
| **CO4** | S | S | S | L | -- | -- | -- | M | -- | -- | -- | M | -- | -- | -- |
| **CO5** | S | S | M | M | L | -- | -- | M | -- | -- | -- | M | -- | -- | -- |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**RANDOM VARIABLES**

Random variables — Probability function - Standard Distributions - Binomial, Poisson, Geometric, Uniform, Exponential, Normal distributions and their applications.

**ESTIMATION THEORY**

Sampling distributions – Estimation of parameters (consistent and unbiased) – Point and interval estimates for population proportions, mean and variance - Maximum likelihood estimate method - Method of moments - Curve fitting by principle of least squares – Regression lines.

**TESTING OF HYPOTHESIS**

Hypothesis testing – Small samples/Large Samples – Tests concerning proportion, means, standard deviations – Tests based on chi square – Non-parametric test – Sign test, Wilcoxon signed rank test, Mann-Whitney test, Run test, Kolmogorov – Smirnov test, Spearman's and Kendall's test.

**DESIGN OF EXPERIMENT**: Experimental design – Analysis of variance – Methods for one, two factor models, – $2^k$ Factorial Design - Confounding in Factorial Design – Fractional Factorial Design - Response Surface Methods – Central Composite Design

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

**TEXT BOOKS:**


1. S.P. Gupta, "Statistical Methods", Sultan Chand & Sons, New Delhi, 45th Revised Edition (2017)
2. Douglas C. Montgomery and George C. Runger, "Applied Statistics and Probability for Engineers", 6th Edition, Wiley (2013).


**REFERENCES:**


1. S.C. Gupta and V.K. Kapoor, "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi(2015).
2. I.R. Miller, J.E. Freund and R. Johnson, "Probability and Statistics for Engineers", 8th Edition, (2015).


**COURSE DESIGNERS**


| S.No | Name of the Faculty | Designation | Department | Mail ID |
|---|---|---|---|---|
| 1 | Dr. P.Sasikala | Professor | Mathematics | sasikala@vmkvec.edu.in |
| 2. | Dr. M.Thamizhsudar | Asso. Professor | Mathematics | thamizhsudar@avit.ac.in |

| Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| 40221H01 | RESEARCH METHODOLOGY AND IPR | FC-HS | 2 | 0 | 0 | 2 |

Course Outcomes:

At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information.
3. Follow research ethics.
4. Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis, the need of information about Intellectual Property Right to be promoted among students in general & Engineering in particular.
6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

**UNIT I- RESEARCH PROBLEM AND SCOPE FOR SOLUTION**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

**UNIT II- FORMAT**

Effective literature studies approaches, analysis, Plagiarism, Research ethics. Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

**UNIT III- PROCESS AND DEVELOPMENT**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, patenting under PCT.

**UNIT IV- PATENT RIGHTS**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

**UNIT V- NEW DEVELOPMENTS IN IPR**

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

**TEXT BOOKS**

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students" Juta Publishers,1996.

2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction" , Juta Publishers,2004.

3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"

**REFERENCES**

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.

2. Mayall, "Industrial Design", McGraw Hill, 1992.

3. Niebel, "Product Design", McGraw Hill, 1974.

4. Asimov, "Introduction to Design", Prentice Hall, 1962.

5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.

6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

| **Course Designers** | | | | |
|---|---|---|---|---|
| **S.No** | **Faculty Name** | **Designation** | **Department/Name of the College** | **Email id** |
| **1** | | | | |
| **2** | | | | |

# PROGRAM CORE COURSES

| 40221C01 | ADVANCES IN MAUFACTURING TECHNOLOGY | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | | CC | 3 | 0 | 0 | 3 |

**Preamble**

To expose the students in the art of manufacturing new products due to the development of new materials.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To inform the students about the various alternative manufacturing processes available. |
| 2 | To develop an attitude to look for the unconventional manufacturing process to machine. |
| 3 | To make them to understand and appreciate the latest manufacturing process for micro fabrication and devices. |
| 4 | To produce useful research output in machining of various materials. |
| 5 | To introduce students the basics of /rapid prototyping and its applications in various fields. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | To understand the concepts and methods of various newer machining processes. | Understand |
| CO2 | To gain knowledge in the application of wire cut EDM and relative process. | Apply |
| CO3 | To analyze the laser beam machining process and to study its merits and demerits during application. | Analyze |
| CO4 | To be familiar with the various applications of surface modification and bulk machining. | Apply |
| CO5 | To develop knowledge in the application of micro fabrication technology. | Analyze |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | M | - | - | M | - | - | - | - | - | - | M | - | - |
| **CO2** | S | S | M | M | - | M | - | - | - | - | - | - | M | - | - |
| **CO3** | S | M | M | M | - | M | - | - | - | - | - | - | M | - | - |
| **CO4** | S | S | M | M | - | M | - | - | - | - | - | - | M | - | - |
| **CO5** | S | S | S | S | - | S | - | - | - | - | - | - | S | - | - |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**NEWER MACHINING PROCESSES - I**

(Non thermal energy) – Abrasive machining – water jet machining - ultrasonic machining – chemical machining – electro chemical machining – construction working principle – steps -types – process parameters – derivations – problems, merits, demerits and applications.

**NEWER MACHINING PROCESS – II**

Wire cut EDM - Electro chemical machining – ECG - Electric discharge machining – construction – principle – types – control - circuits – tool design – merits, demerits & applications.

**NEWER MACHINING PROCESS – III**

Laser beam machining – Electron beam machining – Plasma arc machining – Ion beam machining – construction working principle types – process parameter – derivations –problems, merits, demerits and applications.

**FABRICATION OF MICRO DEVICES**

Semiconductors – films and film depurification – Oxidation - diffusion – ion implantation –etching – metallization – bonding – surface and bulk machining – LIGA Process – Solidfree form fabrication

**MICROFABRICATION TECHNOLOGY**

Wafer preparation – monolithic processing – moulding – PCB board hybrid & mcmtechnology – programmable devices & ASIC – electronic material and processing–stereolithography SAW devices, Surface Mount Technology.

**Text Books**

1. Advanced Machining Processes by V. K. Jain, Allied Publications, 2007.
2. Manufacturing Engineering and Technology by Kalpakijian, Addison Wesley, 1995.

**Reference Books**

1.Serope kelpekijian & stevan r. schmid- manufacturing process engg material – 2003.
2. Micro senors Mems & smart devices- Julian W. Hardner, 2002.
3. Nario Taniguchi – Nano technology – Oxford University Press 1996.
4. Brahem T. Smith, Advanced machining I.F.S. UK 1989.
5. Jaeger R.C., Introduction to microelectronic fabrication Addison Wesley, 1988.
6. Pandey P.C. & Shan HS Modern Machining Processes, Standard Publishing Co.,1980.

**Course Designers**



| S.No | Faculty Name | Designation | Department/Name of the College | Email id |
|---|---|---|---|---|
| 1 | Dr.R.Jayaraman | Assoc. Prof. | MECH/VMKVEC | jayaramanr@vmkvec.edu.in |
| 2 | Mr.K.Surendra Babu | Assoc. Prof. | MECH /AVIT | surendrababu@avit.ac.in |

| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| 40221C04 | ADVANCED MATERIALS TECHNOLOGY | CC | 3 | 0 | 0 | 3 |

**Preamble**

This course to gives thorough knowledge on advanced concepts of material technologies of all engineering materials.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To impart knowledge on elastic, plastic and fractured behaviour of engineering materials. |
| 2 | To understand the behavior of materials under various loads. |
| 3 | To understand the selection of metallic and non-metallic materials for the various engineering applications. |
| 4 | Understand major types of special steels such as HSLA, TRIP, Dual and Tool steels and cast-irons. |
| 5 | To study the polymer behavior and develop polymer composites. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Understand the concepts of elastic, plastic behavior and strengthening Mechanism, also properties and applications of metallic and non metallic materials. | Understand |
| CO2 | Analyze the behavior of materials under various loading conditions. | Analyze |
| CO3 | Understand the important characteristics of materials and materials selection process. | Understand |
| CO4 | Understand the various ferrous alloys and their applications. | Understand |
| CO5 | Understand the behaviour and applications of smart materials, ceramics, glasses and non-metallic materials. | Understand |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | M | - | - | - | - | - | - | - | - | - | M | M | - | - |
| CO2 | S | M | M | - | - | - | - | - | - | - | - | S | S | - | M |
| CO3 | S | M | S | M | M | - | - | - | - | - | - | - | S | - | - |
| CO4 | S | M | M | M | L | - | - | - | - | - | - | - | M | - | - |
| CO5 | S | M | M | M | L | - | - | - | - | - | - | - | M | - | - |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**ELASTIC AND PLASTIC BEHAVIOR**

Elasticity in metals and polymers - Anelastic and visco-elastic behaviour – Mechanism of plastic deformation– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, precipitation hardening and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity. – Deformation of non-crystalline materials.

**FRACTURE BEHAVIOUR**

Griffith's theory, stress intensity factor and fracture toughness – Toughening mechanisms – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracturemechanism maps – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms. Effect of surface and metallurgical parameters on fatigue – Fracture of non-metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

**SELECTION OF MATERIALS**

Motivation for selection, cost basis and service requirements – Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero,auto, marine, machinery and nuclear applications – Computer aided materials selection.

**MODERN METALLIC MATERIALS**

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys –Metallic glass and nano crystalline materials.

**NONMETALLIC MATERIALS**

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics,WC, TIC, TaC, $Al_2O_3$, SiC, $Si_3N_4$, CBN and diamond – properties, processing and applications.

**Text Books**

1.Thomas H. Courtney, Mechanical Behavior of Materials, McGraw Hill, 2nd Edition, 2000.
2.George E. Dicter, Mechanical Metallurgy, McGraw Hill, 1998.

**Reference Books**

1. Ashby M.F., Material Selection in Mechanical Design, 3rd Edition, Butter Worth 2005.
2. ASM Hand book, Vol.11, Failure Analysis and Prevention, (10th Edition), ASM, 2002.
3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (3rd edition), Butterworth-Heiremann, 2001.
4. Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999.

**Course Designers**


| S.No | Faculty Name | Designation | Department/Name of the College | Email id |
|---|---|---|---|---|
| 1 | Dr.S.Arunkumar | Assistant Professor | MECH/VMKVEC | arunkumar@vmkvec.edu.in |
| 2 | Dr.D.Bubesh Kumar | Associate Professor | MECH/AVIT | bubeshkumar@avit.ac.in |

| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221C83** | **ADVANCED METALLURGY LAB** | **CC** | **0** | **0** | **4** | **2** |

**Preamble**

The purpose of this course is to study the microstructures of metals and alloys, Understand the type, and effect of heat treatment on properties.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To demonstrate an advanced and applied knowledge in Physical Metallurgy. |
| 2 | To study the microstructures of metals and alloys. |
| 3 | To understand the type, and effect of heat treatment on properties and hardness of materials. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Prepare the specimens and characterize the microstructures of different ferrous and non-ferrous metals. | Apply |
| CO2 | Evaluate the effect of heat treatment on properties of steel. | Evaluate |
| CO3 | To analyze metallurgical problems. | Analyze |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | L | L | L | - | - | - | - | - | - | - | L | - | - |
| **CO2** | S | M | L | L | L | - | - | - | - | - | - | - | L | - | - |
| **CO3** | S | M | L | L | L | - | - | - | - | - | - | - | L | - | - |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

1. Study and use of metallurgical microscope.
2. Study of muffle furnace.
3. Study of Recovery, Recrystallization and Grain growth of cold worked materials.
4. Metallographic specimen preparation, mechanical polishing, mounting, and etching.
5. Identification of Microstructure of different types of cast iron & steel specimens (Minimum 6) and use of specific etchants.
6. Identification of Microstructure of non-Ferrous specimens (Minimum 2) and use of specific etchants.
7. Heat treatment – Normalizing – comparison between annealed and un heat treated specimen.

**Text Books**

| | |
|---|---|
| **1** | **ADVANCED METALLURGY LAB MANUAL** |

**Reference Books**

| | |
|---|---|
| **1** | William D Callister "Material Science and Engineering", John Wiley and Sons 2005. |
| **2** | Sydney H.Avner "Introduction to Physical Metallurgy" McGraw Hill Book Company,1974. |

**Course Designers**

| S.No | Faculty Name | Designation | Department / Name of the College | Email id |
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| **2** | Dr.D.Bubesh | Associate | MECH/AVIT | bubeshkumar@avit.ac.in |

| | | | | |
|---|---|---|---|---|
| | Kumar | Professor | | |

| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221C03** | **ADVANCES IN CASTING AND WELDING** | **CC** | **3** | **0** | **0** | **3** |

**Preamble**

To make the students learn about need advance in casting and welding technology.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To study about solidification process of castings and design of gating and risering systems. |
| 2 | To study the metallurgical concepts and the suitability of various casting processes for a product. |
| 3 | To study about the recent casting techniques and about foundry layout. |
| 4 | To understand welding technique and technological aspects over welding design. |
| 5 | To understand the unique characteristics of welding. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Know about solidification process of castings and design of gating and risering. | Apply |
| CO2 | Know about the metallurgical concepts and suitability of various casting processes for a product. | Understand |
| CO3 | know about the recent casting techniques and about foundry layout. | Understand |
| CO4 | Ability to understand welding technique and technological aspects over welding design. | Understand |
| CO5 | Ability to understand the unique characteristics of welding. | Understand |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **S** | **S** | **S** | **M** | **L** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO2** | **S** | **M** | **S** | **M** | **L** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO3** | **S** | **M** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO4** | **S** | **M** | **M** | **M** | **L** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **M** | **-** | **-** |
| **CO5** | **S** | **M** | **M** | **M** | **L** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **M** | **-** | **-** |

**S- Strong; M-Medium; L-Low**

## SYLLABUS

**CASTING DESIGN**

Heat transfer between metal and mould — Design considerations in casting – Designing for directionalsolidification and minimum stresses - principles and design of gating and risering.

**CASTING METALLURGY**

Solidification of pure metal and alloys – shrinkage in cast metals – progressive and directional solidification —Degasification of the melt-casting defects – Castability of steel, Cast Iron, Al alloys, Babbit alloy and Cu alloy.

**RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT**

Shell moulding, precision investment casting, $CO_2$ moulding, centrifugal casting, Die casting, Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes. Layout of mechanized foundry – sand reclamation – material handling in foundry pollution control in foundry — Computer aided design of casting.

**WELDING METALLURGY AND DESIGN**

Heat affected Zone and its characteristics – Weldability of steels, cast iron, stainless steel, aluminum, Mg, Cu, Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control. Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment.

**RECENT TRENDS IN WELDING**

Friction welding, friction stir welding – explosive welding – diffusion bonding – high frequency induction welding – ultrasonic welding – electron beam welding – Laser beam welding –Plasma welding – Electroslag welding- narrow gap, hybrid twin wire active TIG – Tandem MIG- modern brazing and soldering techniques – induction, dip resistance, diffusion processes – Hot gas, wave and vapour phase soldering. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.

**Text Books**


1. Jain,P.L., "Principles of Foundry Technology", Tata McGraw Hill, 2003.
2. Parmar,R.S., "Welding Processes and Technology", Khanna Publishers, 1997.


**Reference Books**


1. ASM Handbook, Vol 15, Casting, 2004.
2. ASM Handbook vol.6, welding Brazing & Soldering, 2003.
3. Jain P.L., Principles of Foundry Technology, Tata McGraw Hill Publishers, 2003.
4. Carrry B., Modern Welding Technology, Prentice Hall Pvt Ltd., 2002.
5. Parmer R.S., Welding Engineering and Technology, Khanna Publishers,2002.
6. Srinivasan N.K., Welding Technology, Khanna Tech Publishers, 2002.
7. HEINELOPER & ROSENTHAL, Principles of Metal Casting, Tata McGraw Hill, 2000.
8. CORNU.J. Advanced welding systems – Volumes I, II and III, JAICO Publishers, 1994.
9. IOTROWSKI – Robotic welding – A guide to selection and application – Society of mechanical Engineers,1987.
10. SCHWARIZ, M.M. – Source book on innovative welding processes – American Society for Metals (OHIO),1981.
11. LANCASTER.J.F. – Metallurgy of welding – George Alien & Unwin Publishers, 1980.


**Course Designers**


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| | | | | | | |
|---|---|---|---|---|---|---|
| | **ADVANCES IN METROLOGY AND** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221C05** | **INSPECTION** | **CC** | **3** | **0** | **0** | **3** |

**Preamble**

To make the students capable of learning to operate and use advanced metrological devices with ease in industrial environments.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | Understand the various concepts of metrology and measurements. |
| 2 | Develop the knowledge on various measurement methods of surface roughness. |
| 3 | Understand the principles of light interference. |
| 4 | Study various measuring tools and laser gauges. |
| 5 | Understand the image processing for metrology. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Explain the various terminologies and measurement standards, errors and precisions of metrology. | Understand |
| CO2 | Analyze the materials surfaces and roughness by contact and non-contact methods. | Analyze |
| CO3 | Analyze the calibration of instruments and measurement of interferometers. | Analyze |
| CO4 | Apply the various inspection methods in laser techniques. | Apply |
| CO5 | Apply various image processing systems and image transformation in Metrology. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| **Cos** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | L | L | - | - | - | M | L | L | - | - | S | - | - |
| **CO2** | S | S | M | M | - | - | - | L | L | L | - | - | S | - | - |
| **CO3** | S | S | M | M | - | - | - | M | L | L | - | - | S | - | - |
| **CO4** | S | M | M | M | - | - | - | M | L | L | - | - | S | - | - |
| **CO5** | S | M | L | L | - | - | - | M | L | L | - | - | S | - | - |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

**CONCEPTS OF METROLOGY**

Terminologies – Standards of measurement – Errors in measurement – Interchangeability and Selective assembly – Accuracy and Precision – Calibration of instruments – Basics of Dimensional metrology and Form metrology.

**MEASUREMENT OF SURFACE ROUGHNESS**

Definitions – Types of Surface Texture: Surface Roughness Measurement Methods Comparison, Contact and Non-Contact type roughness measuring devices, 3D Surface Roughness Measurement, NanoLevel Surface Roughness Measurement – Instruments.

**INTERFEROMETRY**

Introduction, Principles of light interference – Interferometers – Measurement and Calibration – Laser Interferometry.

**MEASURING MACHINES AND LASER METROLOGY**

Tool Makers Microscope – Microhite – Coordinate Measuring Machines – Applications – Laser Micrometer, Laser Scanning gauge, Computer Aided Inspection techniques - In-process inspection,Machine Vision system- Applications.

**IMAGE PROCESSING FOR METROLOGY**

Overview, Computer imaging systems, Image Analysis, Preprocessing, Human vision system,Image model, Image enhancement, gray scale models, histogram models, Image Transforms – Examples.

**Text Books**


| | |
|---|---|
| **1** | Jain, R.K., "Engineering Metrology", Khanna Publishers, 2008. |
| **2** | Rajput, R.K., "Engineering Metrology and Instrumentations", Kataria & Sons Publishers, 2001. |
| **3** | Gupta, I.C., "A Text Book of engineering metrology", Dhanpat Rai and Sons, 1996. |


**Reference Books**


| | |
|---|---|
| **1** | Bewoor, A.K. and Kulkarni, V.A., "Metrology and Measurement", Tata Mc Graw-Hill, 2009. |
| **2** | Sonka, M., Hlavac, V. and Boyle. R., "Image Processing, Analysis, and Machine Vision", Cengage Engineering, 2007. |
| **3** | Whitehouse, D.J., "Surface and their measurement", Hermes Penton Ltd, 2004. |
| **4** | Smith, G.T., "Industrial Metrology", Springer, 2002 |
| **5** | "ASTE Handbook of Industries Metrology", Prentice Hall of India Ltd., 1992. |
| **6** | Galyer, F.W. and Shot bolt, C.R., "Metrology for engineers", ELBS, 1990. |


**Course Designers**


| S.No | Faculty Name | Designation | Department /College | Email id |
|---|---|---|---|---|
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| **2** | Mr.T.Raja | Asso.Prof | MECH/ VMKVEC | rajat@vmkvec.edu.in |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **AUTOMATION AND METAL FORMING** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221C84** | **LAB** | **CC** | **0** | **0** | **4** | **2** |

**Preamble**

To train the students to have an hands on having the basic concepts of metal forming processes and to determine some metal forming parameters for a given shape.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To impart the knowledge of various metal forming processes and manufacturing process. |
| 2 | To determine some metal forming parameters for a given shape powder metallurgy. |
| 3 | To understand the concept of automation. |
| 4 | To impart the knowledge of hydraulics and pneumatics circuits with PLC. |
| 5 | To learn the automation systems using fluid power control systems. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | To impart practical knowledge on bulk metal forming and sheet metal forming processes. | Apply |
| CO2 | Illustrate the characteristics of the forming and shaping processes. | Apply |
| CO3 | Apply the concepts of various metal forming process. | Apply |
| CO4 | Develop PLC for modern manufacturing applications using standard procedures. | Apply |
| CO5 | Identify the possibilities of automation and develop a suitable system to automate the processes. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | L | - | - | - | - | - | L | - | - | S | - | - |
| **CO2** | S | M | S | M | - | - | - | - | - | L | - | - | S | - | - |
| **CO3** | S | S | M | M | - | - | - | - | - | M | - | - | S | - | - |
| **CO4** | S | S | S | M | - | - | - | - | - | M | - | - | S | - | - |
| **CO5** | S | S | S | M | - | - | - | - | - | L | - | - | S | - | - |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

1. Determination of strain hardening exponent
2. Construction of formability limit diagram
3. Determination of efficiency in water hammer forming
4. Determination of extrusion load
5. Study on two high rolling process
6. Simulation of Hydraulic circuits
7. Simulation of electro pneumatic circuits
8. Simulation of electro hydraulic circuits
9. Simulation of PLC circuits
10. Software simulation of fluid power circuits using Automation studio

**Text Books**

| | |
|---|---|
| **1** | **AUTOMATION AND METAL FORMING LAB Manual** |

**Course Designers**

| **S.No** | **Faculty Name** | **Designation** | **Department/ College** | **Email id** |
|---|---|---|---|---|
| **1** | Mr.K.Vijayakumar | Assistant Professor | MECH/AVIT | vijayakumar@avit.ac.in |
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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221C81** | **CIM LAB** | **CC** | **0** | **0** | **4** | **2** |

**Preamble**

This course provides the in-depth knowledge about CNC machine, CNC programming and modeling software.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To discuss the basics of manual part programming for turning and milling. |
| 2 | To practice the methodologies for writing the CNC program using canned cycles and subroutines. |
| 3 | To learn and write the program using mirroring, left / right hand radius compensationconcept, rectangular and circular pocketing. |
| 4 | To study about various sensors, transducers and PLC. |
| 5 | To design 2D and 3D modelling of mechanical components. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | To study about various sensors, transducers and PLC. | Understand |
| CO2 | To learn the basic knowledge about G and M codes and Apply the programming knowledge to write the program for linear and circular interpolation. | Apply |
| CO3 | Apply the knowledge of mirroring and subroutine concepts to write the CNC program. | Apply |
| CO4 | Apply the knowledge of Left hand and right-hand radius compensation, the different types of canned cycles including turning, facing, grooving, drilling, boring and threading etc. | Apply |
| CO5 | Design and analyze 2D and 3D modeling of various mechanical components. | Analyze |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO1 2 | PSO 1 | PS O2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | L | L | L | L | - | - | - | - | - | - | - | L | L | L | L |
| **CO2** | S | S | M | S | - | - | - | - | M | - | - | M | L | L | L |
| **CO3** | S | S | S | S | - | - | - | - | M | - | - | M | S | M | M |
| **CO4** | S | S | S | S | - | - | - | - | M | - | - | M | S | M | M |
| **CO5** | S | S | S | S | - | - | - | - | S | | - | S | S | M | S |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**LIST OF EXPERIMENTS:**

**CAM LABORATORY**

1. Exercise on CNC Lathe: Plain Turning, Step turning, Taper turning, Threading, Grooving & canned cycle

2. Exercise on CNC Milling Machine: Profile Milling, Mirroring, Scaling & canned cycle

3. Study of Sensors, Transducers & PLC: Hall-effect sensor, Pressure sensors, Straingauge, PLC, LVDT, Load cell, Angular potentiometer, Torque, Temperature & Optical Transducers.

**CAD LABORATORY**

2D modeling and 3D modeling of components such as

1. Bearing
2. Couplings
3. Gears
4. Sheet metal components
5. Jigs, Fixtures and Die assemblies

**Text Books**

| | |
|---|---|
| **1** | **CIM LAB Manual** |

**Course Designers**

| S.No | Faculty Name | Designation | Department/ College | Email id |
|---|---|---|---|---|
| **1** | Dr.M.Saravanan | Asst. Professor | MECH / VMKVEC | saravanan@vmkvec.edu.in |
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| | | | | | | |
|---|---|---|---|---|---|---|
| | **COMPUTER INTEGRATED MANUFACTURING** | **Category** | L | T | **P** | **Credit** |
| **40221C02** | **SYSTEMS** | **CC** | **3** | **0** | **0** | **3** |

**Preamble**

The students completing this course are expected to understand the nature and role of computers in manufacturing. The course includes computer aided design, Automatic Manufacturing Systems, Group Technology and FMS, computer aided process planning techniques, shop floor control, types of process control and automatic data capture systems. It exposes the students to various current trends followed in the industries.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To understand the importance of CAD and CAM. |
| 2 | To enable student to learn about Automated Manufacturing Systems. |
| 3 | To understand about the Group Technology and FMS. |
| 4 | To gain knowledge about Process Planning. |
| 5 | To enable students to learn about types of process control and automatic data capture. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Explain the basic concepts of Computer Aided Design andManufacturing. | Understand |
| CO2 | Explain the basics, working principles of various components of Automated Manufacturing Systems. | Understand |
| CO3 | Apply the concepts of Group technology and FMS. | Apply |
| CO4 | Apply the concepts of process planning techniques. | Apply |
| CO5 | Analyze the functions of various types of process control and automatic data capture. | Analyze |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO 1 | PO2 | PO3 | PO4 | PO5 | PO 6 | PO7 | PO 8 | PO9 | PO 10 | PO 11 | PO12 | PSO 1 | PSO 2 | PS O3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | L | - | - | - | - | - | - | - | - | - | - | - | - | - |
| **CO2** | S | M | L | - | - | - | - | - | - | - | - | - | L | - | L |
| **CO3** | S | M | L | - | - | - | - | - | - | - | - | - | M | - | M |
| **CO4** | S | S | M | L | - | - | - | - | - | M | - | - | M | - | M |
| **CO5** | S | S | S | M | - | - | - | - | - | M | - | - | L | - | L |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION**

Introduction to CAD, CAM, CAD/CAM and CIM - Evolution of CIM – CIM wheel and cycle – Production concepts and mathematical models – Simple problems in production models – CIM hardware and software – Major elements of CIM system – Three step process for implementation of CIM – Computers in CIM – Computer networks for manufacturing – The future automated factory – Management of CIM – Impact of CIM on personnel – CIM status.

**AUTOMATED MANUFACTURING SYSTEMS**

Automated production line – system configurations, work part transfer mechanisms – Fundamentals of Automated assembly system – System configuration, Part delivery at workstations – Design for automated assembly – Overview of material handling equipments – Consideration in material handling system design – The 10 principles of Material handling. Conveyor systems – Types of conveyors – Operations and features.

Automated Guided Vehicle system – Types of vehicles and AGVs applications – Vehicle guidance technology – Vehicle management and safety.

Storage system performance – storage location strategies – Conventional storage methods and equipments – Automated storage/Retrieval system and Carousel storage system

Deadlocks in Automated manufacturing systems – Petrinet models – Applications in Dead lock avoidance.

**GROUP TECHNOLOGY AND FMS**

Part families – Visual – Parts classification and coding – Production flow analysis – Grouping of parts and Machines by rank order clustering method – Benefits of GT – Case studies.

FMS – Components – workstations – FMS layout configurations – Computer control systems – FMS planning and implementation issues – Architecture of FMS – flow chart showing various operations in FMS – Machine cell design – Composite part concept, Holier method, Key machine concept – Quantitative analysis of FMS – Bottleneck model – Simple and complicated problems – Extended Bottleneck model - sizing the FMS ─ FMS applications, Benefits.

**PROCESS PLANNING**

Process planning – Activities in process planning, Informations required. From design to process planning – classification of manufacturing processes – Selection of primary manufacturing processes – selecting among casting process, forming process and machining process. Sequencing of operations according to Anteriorities – various examples – forming of Matrix of Anteriorities – case study.

Typical process sheet – case studies in Manual process planning.

Computer Aided Process Planning – Process planning module and data base – Variant process planning– Two stages in VPP – Generative process planning – Flow chart showing various activities in generative PP – Semi generative process planning.

**TYPES OF PROCESS CONTROL AND AUTOMATIC DATA CAPTURE**

Introduction to process model formulation – linear feedback control systems – Optimal control –Adaptive control –Sequence control and PLC. Computer process control – Computer process interface
– Interface hardware – Computer process monitoring – Direct digital control and Supervisory computercontrol.

**Text Books**

| | |
|---|---|
| **1** | Mikell. P. Groover "Automation, Production Systems and Computer Integratedmanufacturing", Pearson Education 2001. |
| **2** | Radhakrishnan P, Subramanyan. S. and Raju V., "CAD/CAM/CIM", 2nd Edition New AgeInternational (P) Ltd., New Delhi, 2000. |

**Reference Books**

| | |
|---|---|
| **1** | Alavudeen and Venkateshwaran, "Computer Integrated Manufacturing", PHI Learning Pvt. Ltd., New Delhi, 2008. |
| **2** | Kant Vajpayee, S., "Computer Integrated Manufacturing", Prentice Hall of India,New Delhi, 2007. |
| **3** | James A. Retrg, Herry W. Kraebber, "Computer Integrated Manufacturing", PearsonEducation, Asia, 2001. |
| **4** | Viswanathan, N., and Narahari, Y., "Performance Modeling and Automated Manufacturing Systems", Prentice Hall of India Pvt. Ltd., 2000. |
| **5** | Gideon Halevi and Ronald D. Weill, "Principles of Process Planning", Chapman Hall,1995. |

**Course Designers**

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| 40221C06 | METAL CUTTING THEORYAND PRACTICE | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | | CC | 3 | 0 | 0 | 3 |

**Preamble**

To make the students to familiar with the basic principles of metal cutting.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To study the various design considerations for tooling. |
| 2 | To enable students, understand their knowledge on Tooling for Metal removal process. |
| 3 | To assess various Metal forming Process and its applications. |
| 4 | To gain knowledge Inspection and Gauging in Engineering applications. |
| 5 | Develop knowledge in tooling and work holding devices. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | To assess various types of Tooling in Manufacturing andInspection. | Understand |
| CO2 | To Design Jigs and Fixtures by using given parameters related to Engineering Applications. | Apply |
| CO3 | To apply the concepts of Metal casting and Metal Joining Processin an engineering problem using standard values. | Apply |
| CO4 | To apply the concepts of Inspection and Gauging by using CMM. | Apply |
| CO5 | Design and Develop tooling for Flexible Manufacturing. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO12 | PSO 1 | PS O 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | L | L | L | - | - | - | S | S | S | - | - | S | - | - |
| **CO2** | S | M | M | L | - | - | - | S | S | S | - | - | S | - | - |
| **CO3** | S | M | M | L | - | - | - | S | S | S | - | - | S | - | - |
| **CO4** | S | M | M | L | - | - | - | S | S | S | - | - | S | - | - |
| **CO5** | S | M | M | M | - | - | - | S | S | S | - | - | S | - | - |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

## INTRODUCTION

Manufacturing Processes-objectives of manufacturing processes-classification of manufacturing process-Objectives of Tool design-tool design process- Nature and scope of Tool engineering principles of economy for tooling-problems of economy in tooling-planning and tooling for economy
Manufacturing principles applicable to process and tool planning-tool control-tool maintenance-tool materials and its selection.

## TOOLING FOR METAL REMOVAL PROCESSES

Traditional machining processes -work and tool holding devices-tool nomenclatures Mechanism of machining-force temperature and tool life of single point tool-multipoint tools -tool design-tool wear special processes-capstan and turret lathe-tooling layout of automats-tooling in NC and CNC machines-tooling for machining centres-CAD in tool design- Jigs and fixtures-design-Non-traditional material removal processes mechanical, electrical thermal and chemical energy processes-principles operation equipment-tooling parameters- Advantages, disadvantages and Applications.

## TOOLING FOR METAL FORMING PROCESSES

Classification of Forming processes- Types of presses-design of -blanking and piercing dies-simple, compound, combination and progressive dies- Drawing dies - Bending dies-forging dies-plastic moulding dies. Applications of dies.

## TOOLING FOR METAL CASTING AND METALJOINING PROCESSES

Tools and Equipment for moulding-patterns– pattern allowances – pattern construction-die casting tools-mechanization of foundries. Tooling for Physical joining processes Design of welding fixtures –Arc welding, Gas welding, Resistance welding, laser welding fixtures- Tooling for Soldering and Brazing Tooling for Mechanical joining processes.

## TOOLING FOR INSPECTION AND GAUGING

Survey of linear and angular measurements-standards of measurement-design and manufacturing of gauges- measurement of form- Inspection bench centre-co-ordinate measuring machine-tooling in CMM. Applications of CMM.

**Text Books**


1. Bhattacharya.A., Metal Cutting Theory and practice, Central Book Publishers, India,2012.
2. Hoffman E.G Fundamentals of tool design SME, 2003.


**Reference Books**


1. B L Juneja and G S Sekhon., Fundamentals of Metal Cutting and Machine Tools, 2017.
2. Shaw.M.C.Metal cutting principles, Oxford Clare don press, 2012.
3. Boothroid D.G. & Knight W.A., Fundamentals of machining and machine tools, Marcel Dekker, Newyork, 2005.


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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| 40221C07 | METAL FORMING PROCESSES | CC | 3 | 0 | 0 | 3 |

**Preamble**

In this course the students are expected to upgrade their knowledge on various metal forming techniques and formability.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To apply the theory of plasticity for various types of metal forming process. |
| 2 | To learn the effect of friction and lubrication in Metal forming. |
| 3 | Selection of suitable metal forming techniques. |
| 4 | Calculation of force in metal forming process. |
| 5 | Evaluation of different methods and techniques for metal forming applications. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Demonstrate the concepts of theory of plasticity mechanics, stress and temperature distribution and friction in metal forming processes. | Understand |
| CO2 | Apply forging load calculations to evaluate the impact in the process. | Apply |
| CO3 | Analyze various forces and geometrical relationships that occur in a rolling process. | Analyze |
| CO4 | Analyze the extrusion and drawing processes in terms of deformation, lubrication and defects for various applications. | Analyze |
| CO5 | Analyze the various newer methods and techniques in metal forming process for newer applications. | Analyze |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 1 | PO 1 | PO 1 | PS O | PS O | PS O 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | M | S | - | - | - | - | - | - | - | - | - | M | - | - |
| CO2 | S | M | S | - | - | - | - | - | - | - | - | - | M | - | - |
| CO3 | S | M | S | - | - | - | - | - | - | - | - | - | M | - | - |
| CO4 | S | L | S | L | - | - | - | - | - | - | - | M | M | - | - |
| CO5 | S | L | S | L | - | - | - | - | - | - | - | M | M | - | - |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**FUNDAMENTALS OF METAL WORKING**

Classification of Forming Process, Mechanics of Metal working, Flow Stress determination, Temperature in Metalworking, influence of Friction and Lubrication.

**FORGING**

Classification of Forging process, Forging equipments, open and closed die forging, Calculation of forging loads, Forging defects.

**ROLLING**

Classification of Rolling process, Rolling mills, Hot-Rolling, Cold-Rolling, Forces and Geometrical Relationship in rolling, Rolling defects.

**EXTRUSION AND DRAWING**

Classification, Process parameters, equipment used, Lubrication and Defects in extrusion process, Analysis of the extrusion process, Hydrostatic extrusion, extrusion of tubing– Defects– applications. Rod and wire drawing, Analysis of wire drawing, Applications.

**ADVANCEMENTS IN METAL FORMING**

Forming Methods, Shearing and blanking, Bending, Stretch forming, Deep drawing, Forming Limit Criteria, Defects, Explosive forming, Electro hydraulic forming, magnetic pulse forming, super plastic forming, electro forming – fine blanking HERF- LASER beam forming- Application of powder metallurgy in forming.

**Text Books**


| | |
|---|---|
| **1** | Surender Kumar, Technology of Metal Forming Processes, Prentice Hall India Publishers, 2010. |
| **2** | Nagpal G.R. "Metal forming processes", Khanna publishers, New Delhi, 2004. |


**Reference Books**


| | |
|---|---|
| **1** | Marciniak,Z., Duncan J.L., Hu S.J., 'Mechanics of Sheet Metal Forming', Butterworth-Heinemann An Imprint of Elesevier, 2006. |
| **2** | Heinz Tschaetsch, (2005), Metal Forming Practise, Springer Berlin Heidelberg New York. |
| **3** | ASM Hand book, Forming and Forging, Ninth edition, Vol – 14, 2003. |
| **4** | ALTAN.T, SOO-IK-oh, GEGEL, HL – Metal forming, fundamentals and Applications, American Society of Metals, Metals Park, Ohio, 1995. |
| **5** | Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 1988. |


**Course Designers**


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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221C82** | **MODELLING AND ANALYSIS LAB** | **CC** | **0** | **0** | **4** | **2** |

**Preamble**

To provide hands-on experience to the students in analysis software.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | Learn basic procedure of finite element analysis. |
| 2 | Use computer as a tool in analysis. |
| 3 | Analysis of modeled parts. |
| 4 | Analysis of one and two-dimensional problems using software. |
| 5 | To model multi-dimensional heat transfer problems using ANSYS. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Apply the basic concepts to stress and strain problems for differentmaterials. | Understand |
| CO2 | Solve the finite element problems to trusses, beams and frames. | Apply |
| CO3 | Apply the buckling analysis, Stress analysis of axi-symmetry vessels. | Apply |
| CO4 | Apply Transient thermal conduction and Conductive heat transferanalysis. | Apply |
| CO5 | Solve linear, non-linear and Harmonic analysis problems. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | L | L | L | L | L | - | - | - | - | - | L | M | S | M |
| **CO2** | **S** | S | M | L | S | M | - | - | - | L | - | M | M | M | S |
| **CO3** | **S** | S | S | S | S | M | - | - | M | L | - | L | M | M | S |
| **CO4** | S | S | S | M | S | M | - | - | M | L | - | L | M | M | S |
| **CO5** | S | S | S | S | S | L | - | - | - | L | - | L | M | M | S |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

1. Study of analysis and its benefits
2. Stress analysis of cantilever and simply supported beam
3. Application of distributed loads
4. Nonlinear analysis of cantilever beam
5. Buckling analysis
6. Stress analysis of axi-symmetry vessels
7. Static analysis of two-dimensional truss
8. Transient thermal conduction
9. Conductive heat transfer analysis
10. Plane stress bracket
11. Modal analysis of simply supported beam
12. Harmonic analysis of a cantilever beam

**Text Books**

| | |
|---|---|
| **1** | **MODELLING AND ANALYSIS LAB MANUAL** |

**Reference Books**

| | |
|---|---|
| **1** | Hutton, D.V., "Fundamentals of Finite Element Analysis", McGraw Hill, International Edition, 2004. |
| **2** | Chandrupatla, T.R., Belegundu, A.D., "Introduction to Finite Elements in Engineering", Prentice Hall of India, 2002. |

**Course Designers**

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| | | | | | | |
|---|---|---|---|---|---|---|
| | **OPTIMIZATION TECHNIQUES IN** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221C08** | **MANUFACTURING** | **CC** | **2** | **1** | **0** | **3** |

**Preamble**

Optimization Techniques is one of the most advanced fields of computer science which involves use of Mathematics, Statistics, Management, Information Technology and Information Sciences in discovering new information and knowledge from large databases and optimize Human effort overall in Decision making process.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To learn basic principles of optimization. |
| 2 | To Study the methods of minimization. |
| 3 | To apply the constrained optimization techniques. |
| 4 | To analyze the unconstrained optimization techniques. |
| 5 | To learn the application of heuristics in optimization. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | To understand the formulation and classification of optimization techniques. | Understand |
| CO2 | Solve the problems using the minimization techniques. | Apply |
| CO3 | Apply the direct and indirect methods in optimization techniques. | Apply |
| CO4 | Solve the multi variable unconstrained optimization techniques. | Apply |
| CO5 | Understand the application of heuristics in optimization. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | L | L | L | L | - | - | - | - | - | - | - | M | S | M |
| **CO2** | S | S | S | M | M | - | - | - | - | - | - | - | M | M | S |
| **CO3** | S | S | S | S | M | - | L | - | M | L | - | - | M | M | S |
| **CO4** | S | S | S | S | S | - | L | - | M | L | - | - | M | M | S |
| **CO5** | S | S | S | S | M | - | L | - | M | L | - | - | M | M | S |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION TO OPTIMIZATION**

Formulation of an optimization problem- Classification of optimization problem – optimization techniques-Classical optimization technique – Single variable optimization – Multi variable optimization algorithms.

**MINIMIZATION METHODS**

One dimensional minimization method: unimodal function – elimination methods: unrestricted search, exhaustive search, Dichotomous search, Fibonacci methods, Golden section methods, Interpolation methods: Quadratic and cubic interpolation methods.

**CONSTRAINED OPTIMIZATION TECHNIQUES**

Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - separable programming and Geometric programming.

**UNCONSTRAINED OPTIMIZATION TECHNIQUES**

Multi variable unconstrained optimization techniques: Direct search methods: Random search method, univariate method, pattern search method, steepest descent method and Conjugate gradient method.

**APPLICATIONS OF HEURISTICS IN OPTIMIZATION**

Heuristics-Introduction-Multi objective optimization: Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

**Text Books**


| | |
|---|---|
| **1** | Rao, Singaresu, S., "Engineering Optimization – Theory & Practice", New Age International (P) Limited, New Delhi, 2000. |
| **2** | Kalyanamoy Deb, "Optimization for Engineering design algorithms and Examples", Prentice Hall of India Pvt. 1995. |


**Reference Books**


| | |
|---|---|
| **1** | Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 1990. |

| | |
|---|---|
| **2** | Goldberg, D.E., “Genetic algorithms in search, optimization and machine”, Barnen, Addison-Wesley, New York, 1989. |

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# PROGRAM ELECTIVE COURSES

| 40221P09 | DESIGN FOR MANUFACTURE AND ASSEMBLY | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | | EC-PS | 3 | 0 | 0 | 3 |

**Preamble**

To make the students learn about product development, design process, principles of assembly and reliability.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To understand the product development cycle. |
| 2 | To know the manufacturing issues that must be considered in the mechanical engineering design process. |
| 3 | To know the principles of assembly to minimize the assembly time. |
| 4 | To know the effect of manufacturing process and assembly operations on the cost of product. |
| 5 | To be familiar with tools and methods to facilitate development of manufactural mechanical designs. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Recognize the various product development cycle. | Apply |
| CO2 | Analyzing the manufacturing issues that must be considered in the mechanical engineering design process. | Analyze |
| CO3 | Analyzing the principles of assembly to minimize the assembly time. | Analyze |
| CO4 | Analyzing the effect of manufacturing process and assembly operations on the cost of product. | Analyze |
| CO5 | Recognize familiar with tools and methods to facilitate development of manufactural mechanical designs. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | M | M | L | L | - | - | - | - | - | - | - | S | - | - |
| CO2 | S | S | S | M | M | - | - | - | - | - | - | - | S | - | - |
| CO3 | S | S | S | M | M | - | - | - | - | - | - | - | S | - | - |
| CO4 | S | S | S | M | M | - | - | - | - | - | - | - | S | - | - |
| CO5 | S | S | S | M | M | - | - | - | - | - | - | - | S | - | - |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION**

Introduction Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design, Selection of Materials and Shapes.

**PROPERTIES OF MATERIALS**

Properties of Engineering Materials, Selection of Materials – I, Selection of Materials – II, Case Studies – I, Selection of Shapes, Co-selection of Materials and Shapes, Case Studies – II.

**MANUFACTURING PROCESSES**

Selection of Manufacturing Processes, Review of Manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes, Design for Machining, Design for Powder Metallurgy, Design for Polymer Processing, Co selection of Materials and Processes, Case-Studies – III

**ASSEMBLY**

Design for Assembly, Review of Assembly Processes, Design for Welding – I, Design for Welding – II, Design for Brazing and Soldering, Design for Adhesive Bonding, Design for Joining of Polymers, Design for Heat Treatment, Case-Studies - IV

**RELIABILITY**

Design for Reliability, Failure Mode and Effect Analysis and Quality, Design for Quality, Design for Reliability, Approach to Robust Design, Design for Optimization.

**Text Books**


1. M F Ashby and K Johnson, Materials and Design - the art and science of material selection in product design, Butterworth-Heinemann, 2003.
2. G Dieter, Engineering Design - a materials and processing approach, McGraw Hill, NY, 2000.
3. M F Ashby, Material Selection in Mechanical Design, Butterworth-Heinemann, 1999.
4. K G Swift and J D Booker, Process selection: from design to manufacture, London: Arnold, 1997.


**Reference Books**


1. James G Bralla, Handbook for Product Design for Manufacture, McGraw Hill, NY, 1998.
2. S S Rao, Engineering Optimization: theory and practice, John Wiley, NY, 1996.
3. G Boothroyd, P Dewhurst and W Knight, Product design for manufacture and assembly, John Wiley, NY: Marcel Dekkar, 1994.
4. Houldcroft, Which Process – an introduction to welding and related processes and guide to their selection, Cambridge, Abington Pub., 1990.


**Course Designers**


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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221P01** | **FLUID POWER AUTOMATION** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

To make the students learn about need for automation, fluid power generating, utilization, controls,regulation elements, hydraulic circuits design and electrical control circuits.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | Understand the need for automation. |
| 2 | To know the fluid power generating and utilizing elements. |
| 3 | To know the principles of control and regulation elements. |
| 4 | To know the typical industrial hydraulic circuits design. |
| 5 | To be familiar with electrical control of pneumatic and hydraulic circuits. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Recognize the various need for automation. | Apply |
| CO2 | Analyzing the fluid power generating and utilizing elements. | Analyze |
| CO3 | Analyzing the principles of control and regulation elements | Analyze |
| CO4 | Analyzing the typical industrial hydraulic circuits design. | Analyze |
| CO5 | Recognize familiar with electrical control of pneumatic and hydraulic circuits. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **S** | **M** | **M** | **L** | **L** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO2** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO3** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO4** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO5** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION**

Need for Automation, Hydraulic & Pneumatic Comparison – ISO symbols for fluid power elements, Hydraulic, pneumatics – Selection criteria.

**FLUID POWER GENERATING/UTILIZING ELEMENTS**

Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and Specification-Drive characteristics – Linear actuator – Types, mounting details, cushioning – power packs – construction. Reservoir capacity, heat dissipation, accumulators – standard circuit symbols, circuit (flow) analysis.

**CONTROL AND REGULATION ELEMENTS**

Direction flow and pressure control Valves-Methods of actuation, types, sizing of ports-pressure and temperature compensation, overlapped and underlapped spool valves-operating characteristics-electro hydraulic servo valves-Different types-characteristics and performance.

**CIRCUIT DESIGN**

Typical industrial hydraulic circuits-Design methodology – Ladder diagram-cascade, method-truth table-Karnaugh map method-sequencing circuits-combinational and logic circuit.

**ELECTRO PNEUMATICS & ELECTRONIC CONTROL OF HYDRAULIC AND PNEUMATIC CIRCUITS**

Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits. Electronic drive circuits for various Motors.

**Text Books**


1. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2003.
2. Antony Esposito, Fluid Power Systems and control Prentice-Hall, 1988.

3. Herbert R. Merritt, Hydraulic control systems, John Wiley & Sons, Newyork, 1967.

**Reference Books**

1. Peter Rohner, Fluid Power logic circuit design. Mcmelan Prem, 1994.
2. E.C.Fitch and J.B.Suryaatmadyn. Introduction to fluid logic, McGraw Hill, 1978.
3. Dudbey. A. Peace, Basic Fluid Power, Prentice Hall Inc, 1967.

**Course Designers**



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| | | | | | | |
|---|---|---|---|---|---|---|
| | **MICRO** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221P10** | **MANUFACTURING** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

To present the basics of micro machining technology and its applications.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To learn about the fundamental as well as advanced knowledge of Micro machining Technology. |
| 2 | To explain the basic principles and mechanism of Traditional Micro machining and its applications. |
| 3 | To illustrate the basic principles and applications of Advanced Micro Machining. |
| 4 | To demonstrate the basic principles and applications of different Abrasive based Micro Machining. |
| 5 | To illustrate the fundaments of MEMS and its techniques. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Explain the basic need of Micro Nano Manufacturing in different industries | Understand |
| CO2 | Summarize the traditional Micro Nano Manufacturing techniques. | Understand |
| CO3 | Demonstrate and Understand different mechanisms in Advanced Micro Nano Manufacturing. | Apply |
| CO4 | Utilize the importance of Abrasives in Micro Nano Nano Manufacturing | Apply |
| CO5 | Identify the need of MEMS in Micro Nano Machining. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| **COs** | **PO1** | **PO 2** | **PO 3** | **PO 4** | **PO 5** | **PO 6** | **PO** | **PO 8** | **PO 9** | **PO1 0** | **PO1 1** | **PO1 2** | **PS O** | **PS O** | **PSO 3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | L | - | - | - | - | - | - | - | - | - | - | S | - | - |
| **CO2** | S | L | - | - | - | - | - | - | - | - | - | - | S | - | - |
| **CO3** | S | M | L | - | - | - | - | - | - | - | - | - | S | - | - |
| **CO4** | S | M | L | - | - | - | - | - | - | - | - | - | S | - | - |
| **CO5** | S | M | L | - | - | - | - | - | - | - | - | - | S | - | - |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION TO MICRO MACHINING**

Need-evolution- fundamentals and trends in micro technologies- Consequences of the technology and society - challenges to manufacturing technology- evolution of precision in manufacturing, tooling and current scenario - Micro materials, fabrication tools, requirements and applications.

**TRADITIONAL MACHINING**

Theory of micro machining – Chip formation – Size effect in micro machining – Micro turning - Micro milling - Micro drilling - Micro machining tool design – Precision Grinding – Partial ductile mode grinding – Ultra precision grinding.

**ADVANCED MICRO MACHINING**

Introduction-Classification - Mechanical Micromachining (AJM, USM)- Thermal Micromachining (EDM, LBM, EBM)-Electrochemical and Chemical Micromachining-Ion Beam Machining-Photochemical Etching.

**ABRASIVE BASED MICRO MACHINING**

Abrasive Flow Finishing (AFF) -Magnetic Abrasive Finishing (MAF)- Magnetorheological Finishing - Magnetorheological Abrasive Flow Finishing- Elastic Emission Machining (EEM) and Magnetic Float Polishing.

**MEMS**

Introduction to MEMS, Definitions and classifications-History – applications - MEMSMarket - Bulk Micro machining - Wet and Dry Etching - Surface Micromachining – Chemical – Vapor Deposition – Lithography - Wafer Bonding.

**Text Books**

| | |
|---|---|
| **1** | Jain V.K., 'Introduction to Micro machining' Narosa Publishing House, 2011 |
| **2** | Bandyopadhyay. A.K., Nano Materials, New age international publishers, New Delhi, 2008, ISBN:8122422578. |

**Reference Books**

| | |
|---|---|
| **1** | Jain V. K., Micro Manufacturing Processes, CRC Press, Taylor & Francis Group, 2012. |
| **2** | Bharat Bhushan, Handbook of nanotechnology, springer, Germany, 2010. |
| **3** | Mcgeoug.J.A., Micromachining of Engineering Materials, CRC press 2001, ISBN10:0824706447 |

**Course Designers**

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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221P11** | **QUALITY AND RELIABILITY ENGINEERING** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

To expose the students to the various quality control techniques and to understand the importance andconcept of reliability.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To understand the techniques of quality & process control. |
| 2 | To understand process control and acceptance sampling procedure and their application. |
| 3 | To study about the various design process and to learn about taguchi method. |
| 4 | To learn the concepts of Reliability. |
| 5 | To analyze the process involved in design for reliability. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Understand the various techniques of quality & process control | Understand |
| CO2 | Understand the process control and acceptance of sampling procedure and their application. | Understand |
| CO3 | Analyze the various design process and to learn about taguchi method. | Analyze |
| CO4 | Analyze the various concepts of reliability techniques. | Analyze |
| CO5 | Analyze the various process involved in design for reliability. | Analyze |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **S** | **M** | **M** | **L** | **L** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO2** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO3** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO4** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO5** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |

**S- Strong; M-Medium; L-Low**

## SYLLABUS

### QUALITY & STATISTICAL PROCESS CONTROL

Quality – Definition – Quality Assurance – Variation in process – Factors – process capability – control charts– variables X, R and X, - Attributes P, C and U-Chart tolerance design. Establishing and interpreting controlcharts – charts for variables – Quality rating – Short run SPC.

### ACCEPTANCE SAMPLING

Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling plans – OC curves – Producer's risk and consumer's risk. AQL, LTPD, AOQL, Concepts – standard sampling plans fo AQL and LTPD – use of standard sampling plans.

### EXPERIMENTAL DESIGN AND TAGUCHI METHOD

Fundamentals – factorial experiments – random design, Latin square design – Taguchi method – Loss function – experiments – S/N ratio and performance measure – Orthogonal array.

### CONCEPT OF RELIABILITY

Definition – reliability vs quality, reliability function – MTBF, MTTR, availability, bathtub curve – time dependent failure models – distributions – normal, weibull, lognormal – Reliability of system and models – serial, parallel and combined configuration – Markove analysis, load sharing systems, standby systems, covarient models, static models, dynamic models.

**DESIGN FOR RELIABILITY AND MAINTAINABILITY**

Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, design methods, parts and material selection, derating, stress-strength and analysis, failure analysis, identification determination of causes, assessments of effects, computation of criticality index, corrective action, system safety – analysis of down-time – the repair time distribution, stochastic point processes system repair time, reliability under preventive maintenance state dependent system with repair. MTTR – mean system down time, repair vs replacement, replacement models, proactive, preventive, predictive maintenance maintainability and availability, optimization techniques for system reliability with redundancy heuristic methods applied to optimal system reliability.

**Text Books**


1. Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield and Mary Besterfield-Sacre, "Total Quality Management", 3rd edition, Pearson Education, 2011.
2. B. L. Hanson and P. M. Ghare, "Quality Control & Application", Prentice Hall of India, 2009.
3. Srinath L. S., "Reliability Engineering", 4th edition, Affiliated East West Press, 2005.
4. Quality Assurance and Total Quality Management (ISO 9000, QS 9000 ISO 14000) by K C Jain and AK Chitale, 3rd edition, Khanna Publishers, 2003.


**Reference Books**


1. Dhillon, Engineering Maintainability – How to design for reliability and easy maintenance, PHI, 2008.
2. Amata Mitra "Fundamentals of Quality Control and improvement" Pearson Education, 2002.
3. Patrick D To' corner, Practical Reliability Engineering, John-Wiley and Sons Inc, 2002
4. David J Smith, Reliability, Maintainability and Risk: Practical Methods for Engineers, Butterworth 2002.
5. Charles E Ebling, An Introduction to Reliability and Maintability Engineering, Tata-McGraw Hill, 2000.
6. Bester field D.H., "Quality Control" Prentice Hall, 1993.


**Course Designers**


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| | | | | | | |
|---|---|---|---|---|---|---|
| | **FINITE ELEMENT METHODS FOR MANUFACTURING ENGINEERING** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221P12** | | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

This course provides to learn the basic concepts of finite element analysis (FEA) of solids, structures, fluids and its application in manufacturing.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | Understand finite element analysis fundamentals and formulations |
| 2 | Study the basics of element properties natural, Triangular & rectangular and one-dimensional analysis in solid mechanics and heat transfer. |
| 3 | Formulation of finite element methods for two dimensional solids. |
| 4 | Formulate the truss, beam and frame problems and Development of code for one dimensional analysis and validation. |
| 5 | Formulation of finite element methods for the analysis of heat transfer, effect of plasticity and fracture in solids, Finite Element analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency and welding. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | To understand the basic concepts of finite element analysis, node and node numbering methods. | Understand |
| CO2 | Derive the finite element equations for different mechanical elements. Natural, Triangular & rectangular elements. | Apply |
| CO3 | Formulate and solve problems in 2-D structural systems of solids and their structures. | Apply |
| CO4 | Identify the application and characteristics of FEA elements such as bars, beams, plane and iso parametric elements. | Apply |
| CO5 | To be able to conduct engineering analysis of basic heat conduction, structural mechanics problems use finite element methods. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | L | L | L | L | - | - | - | - | - | - | - | L | - | - |
| **CO2** | S | S | S | M | M | - | - | - | - | - | - | - | M | - | - |
| **CO3** | S | S | S | S | M | - | L | - | M | L | - | - | S | - | - |
| **CO4** | S | S | S | S | S | - | L | - | M | L | - | - | S | - | - |
| **CO5** | S | S | S | S | M | - | L | - | M | L | - | - | S | - | - |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION**

Fundamentals – Initial, boundary and eigen value problems – weighted residual, Galerkin and Raleigh Ritz methods - Integration by parts – Basics of variational formulation – Polynomial and Nodal approximation.

**ONE DIMENSIONAL ANALYSIS**

Steps in FEM – Discretization. Interpolation, derivation of elements characteristic matrix, shape function, assembly and imposition of boundary conditions-solution and post processing- One dimensional analysis in solid mechanics and heat transfer.

**SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS**

Shape functions for one and two dimensional elements- Three nodded triangular and four nodded quadrilateral element Global and natural co-ordinates—Nonlinear analysis – Isoparametric elements –Jacobian matrices and transformations – Basics of two-dimensional, plane stress, plane strain andaxisymmetric analysis.

**COMPUTER IMPLEMENTATION**

Pre-Processing, mesh generation, elements connecting, boundary conditions, input of material and processing characteristics – Solution and post processing – Overview of application packages –Development of code for one dimensional analysis and validation.

**ANALYSIS OF PRODUCTION PROCESSES**

FE analysis of metal casting – special considerations, latent heat incorporation, gap element – Timestepping procedures – Crank – Nicholson algorithm – Prediction of grain structure – Basic concepts ofplasticity and fracture – Solid and flow formulation – small incremental deformation formulation – Fracture criteria – FE analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency – FE analysis of welding.

**Text Books**


| | |
|---|---|
| **1** | Hutton, D.V., –Fundamentals of Finite Element Analysis, McGraw Hill, International Edition, 2004. |
| **2** | Seshu P., Textbook of Finite Element Analysis, PHI Learning Pvt. Ltd, 2004. |


**Reference Books**


| | |
|---|---|
| **1** | Zienkiewicz, O.C., ―Finite Elements and Approximation, Dover International, 2006. |
| **2** | Rao, S.S., Finite Element method in engineering, Pergammon press, 2005. |
| **3** | Reddy, J.N. An Introduction to the Finite Element Method, McGraw Hill,2005. |
| **4** | Lewis R.W. Morgan, K, Thomas, H.R. and Seetharaman, K.N. The Finite Element Method in Heat Transfer Analysis, John Wiley, 1994. |
| **5** | Bathe, K.J., Finite Element procedures in Engineering Analysis, 1990 |
| **6** | Kobayashi, S, Soo-ik-Oh and Altan, T, Metal Forming and the Finite Element Methods, Oxford University Press, 1989. |
| **7** | Segerlind, L.J., –Applied Finite Element Analysis‖, John Wiley & Sons, 1984. |


**Course Designers**

| S.No | Faculty Name | Designation | Department /College | Email id |
|---|---|---|---|---|

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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221P13** | **INDUSTRIAL ERGONOMICS** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

Adapting the requirements of a job to the physical needs of the humans who perform it**.**

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To optimize the integration of man and machine in order to increase productivity with accuracy. |
| 2 | To enhance human performance, control fatigue and prevent accidents. |
| 3 | To increase the safety, comfort and performance of a product or an environment, such as an office. |
| 4 | To understand the environmental ergonomics includes which lighting, noise and vibration,heating and ventilation, platform motion. |
| 5 | To take into account metabolic cost, measurement and prevention of work strain, and other ergonomicfactors in the design of tasks and workplaces. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Understand ergonomics with human comfort point of view. | Understand |
| CO2 | Analyze the degree of protection against dangerous exposures, whether chronicor acute. | Analyze |
| CO3 | Apply the concept of ergonomics design in equipment. | Apply |
| CO4 | Understand environmental ergonomic factors Room temperature, illumination,noise, indoor air quality, relative humidity. | Understand |
| CO5 | Apply work measurement and work improvement techniques like stop watchtime study, work sampling, method study. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **S** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **M** | **M** | **-** | **-** |
| **CO2** | **S** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **M** | **-** | **M** |
| **CO3** | **S** | **S** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **M** | **-** | **M** |
| **CO4** | **S** | **S** | **-** | **-** | **-** | **S** | **-** | **S** | **-** | **-** | **-** | **S** | **M** | **-** | **M** |
| **CO5** | **S** | **S** | **-** | **-** | **S** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **M** | **-** | **M** |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION**

Concepts of human factors engineering and ergonomics – Man – machine system and design philosophy – Physical work – Heat stress – manual lifting – work posture – repetitive motion.

**ANTHROPOMETRY**

Physical dimensions of the human body as a working machine – Motion size relationships – Static and dynamic anthropometry – Anthropometric aids – Design principles – Using anthropometric measures for industrial design – Procedure for anthropometric design.

**DESIGN OF SYSTEMS**

Displays – Controls – Workplace – Seating – Work process – Duration and rest periods – Hand tool design – Design of visual displays – Design for shift work.

**ENVIRONMENTAL FACTORS IN DESIGN**

Temperature – Humidity – Noise – Illumination –Vibration – Measurement of illumination and contrast – use of photometers – Recommended illumination levels. The ageing eye – Use of indirect (reflected) lighting – cost efficiency of illumination – special purpose lighting for inspection and quality control – Measurement of sound – Noise exposure and hearing loss – Hearing protectors – analysis and reduction of noise – Effects of Noise on performance – annoyance of noise and interference with communication – sources of vibration discomfort.

**WORK PHYSIOLOGY**

Provision of energy for muscular work – Role of oxygen physical exertion – Measurement of energy expenditure Respiration – Pulse rate and blood pressure during physical work – Physical work capacity and its evaluation.

**Text Books**

1.E.J. Mccormic, Human factors in engineering design, McGraw Hill 1976.

**Reference Books**

1.Martin Helander, A guide to the ergonomics of manufacturing, East West press, 1996.
2.R.S. Bridger Introduction to Ergonomics, McGraw Hill, 1995.

**Course Designers**



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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221P02** | **LEAN MANUFACTURING** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

This course provides a technological knowledge for elimination or reduction of waste during manufacturingprocess, thereby saving materials and also contribute for a green environment.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To provide knowledge of manufacturing processes with special attention to reduction of waste. |
| 2 | To make the students understand the difference between mass production and lean production. |
| 3 | To develop skills for handling mechanical tools, testers and equipments. |
| 4 | To develop skills in handling work sequence in different machines. |
| 5 | To develop skills in elimination of waste using 5S techniques. |

**Course Outcomes: On successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | To know about mechanical manufacturing processes using powered machines. | Remember |
| CO2 | To differentiate between mass production and lean production. | Understand |
| CO3 | To describe working on machines using optimum conditions. | Apply |
| CO4 | To demonstrate processes used for value creation on finished products. | Apply |
| CO5 | To demonstrate procedures used for avoiding errors and mistakes. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | - | - | - | S | S | - | - | - | - | - | S | S | S |
| **CO2** | S | S | - | - | - | S | S | S | - | - | - | - | S | S | S |
| **CO3** | S | S | S | - | - | S | S | S | - | - | S | - | S | S | S |
| **CO4** | S | S | - | - | S | S | S | S | - | - | S | - | S | S | S |
| **CO5** | S | S | - | - | - | S | S | S | - | - | S | - | S | S | S |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**CONCEPTS OF LEAN MANUFACTURING**

Lean process, 3M concept, Key principles and implications of lean manufacturing, Traditional vs Lean manufacturing characteristics, Roadmap for Lean implementation and Lean benefits, Study of Ford and Toyota production system, JIT manufacturing, Lean building blocks.

**ADDING VALUE AND REDUCTION OF WASTE**

Value creation and waste elimination, Types of waste, Pull production and different models, The Kanban system, Continuous flow and Continuous improvement process, Kaizen - Worker involvement, Design of Kanban quantities, Leveled production, Tools for continuous improvement.

**JIT, COMPOSITE PART AND CASE STUDIES**

JIT with cell manufacturing, Part families, Production flow analysis, Composite part concept, Machine cell design, Quantitative analysis, Case studies, Single piece flow.

**VALUE STREAMING AND SIX SIGMA**

The value stream – Benefits and Mapping process. The Current state map– Mapping icons, Mapping steps, VSM exercises, TAKT time calculations. Six Sigma – Definition, Statistical considerations, Variability reduction, Design of experiments, Six Sigma implementation.

**WORK SEQUENCE, MISTAKE PROOFING AND WASTE ELIMINATION**

Standardized work – Standard work sequence, Timing and working progress. Quality at source – Automation / JIDOKA, Visual management system, Mistake proofing / Poka-Yoke. 5S technique – Elements and waste elimination through 5S, Advantages and Benefits, 5S Audit. Visual control aids for improvement, Flexible work force.

**Text Books**

| | |
|---|---|
| **1** | Value Stream Mapping: How to Visualize Work and Align Leadership for Organizational Transformation Paperback – 2016 by Karen Martin, Mike Osterling. |
| **2** | Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy, Second EditionHardcover – 2012 by Masaaki Imai. |
| **3** | Rother, M., and Shook, J.,' Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA", Lean Enterprise Institute, 1999. |
| **4** | James P Womack, Daniel T Jones, and Daniel Roos, The Machine that changed the World. The Storyof Lean Production -Harper Perennial edition published 1991. |
| **5** | Ohno, T.," Toyota Production System: Beyond Large-Scale Production", Taylor & Francis, Inc., 1988. |

**Reference Books**

| | |
|---|---|
| **1** | Dennis P.," Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System", (Second edition), Productivity Press, New York, 2007. |
| **2** | Liker, J., "The Toyota Way: Fourteen Management Principles from the World's Greatest Manufacturer", McGraw Hill, 2004. |
| **3** | Michael, L.G., "Lean Six SIGMA: Combining Six SIGMA Quality with Lean Production Speed", McGraw Hill, 2002. |

**Course Designers**

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| | | | | | | |
|---|---|---|---|---|---|---|
| | **MATERIALS MANAGEMENT** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221P14** | **AND LOGISTICS** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

This course provides to understand how material management should be considered for profitability and tolearn the need and importance of logistics in product flow.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To ensure understanding of the growth of the organization. |
| 2 | To gain application knowledge of the surplus capacity of the organization, such as physical facility, man power, etc. |
| 3 | To apply knowledge of application in the utilization of surplus fund of the organization. |
| 4 | To gain applicability knowledge in new requirement of the customers. |
| 5 | To analyze ways to increase company's market share and to target new market segment. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Understand the scope of operations function in industrial and business organizations and various elements of it from its management point of view. | Understand |
| CO2 | Understand the scope of Purchasing policies, procedures and Seller relationship. | Understand |
| CO3 | Understand the Stores function, Materials handling and Network analysis point of view. | Understand |
| CO4 | Apply demand forecasting, Material Requirement Planning (MRP) & managing materials levels. | Apply |
| CO5 | Apply specific type of inventory system and Aggregate Planning system for the given product category and type. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **S** | **M** | **M** | **L** | **L** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO2** | **S** | **S** | **M** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO3** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO4** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |
| **CO5** | **S** | **S** | **S** | **M** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **-** | **-** |

**S- Strong; M-Medium; L-Low**

## SYLLABUS

## INTRODUCTION

Introduction to materials management – Objectives – Functions – Operating Cycle – Value analysis – Make or buy decisions.

## MANAGEMENT OF PURCHASE

Purchasing policies and procedures – Selection of sources of supply – Vendor development – Vendor evaluation and rating – Methods of purchasing – Imports – Buyer – Seller relationship – Negotiations.

**MANAGEMENT OF STORES AND LOGISTICS**

Stores function – Location – Layout – Stock taking – Materials handling – Transportation – Insurance – Codification – Inventory pricing – stores management – safety – warehousing – Distribution linearprogramming – Traveling Salesman problems – Network analysis – Logistics Management.

**MATERIALS PLANNING**

Forecasting – Materials requirements planning – Quantity – Periodic – Deterministic models – Finite production.

**INVENTORY MANAGEMENT**

ABC analysis – Aggregate planning – Lot size under constraints – Just in Time (JIT) system.

**Text Books**


1. Dr.R. Kesavan, C.Elanchezian and B.Vijaya Ramnath, Production Planning and Control, Anuratha Publications, Chennai, 2008.
2. G. Reghuram, N. Rangaraj, Logistics and supply chain management – cases and concepts, Macmillan India Ltd., 2006.
3. Gopalakrishnan.P, Handbook of Materials Management, Prentice Hall of India, 2005.


**Reference Books**


1. Guptha P.K. and Heera, Operations Research, Suttan Chand & Sons, 2007.
2. Lamer Lee and Donald W.Dobler, Purchasing and Material Management, Text and cases, Tata McGraw Hill, 2006.
3. Dr. R. Kesavan, C.Elanchezian and T.SundarSelwyn, Engineering Management – Eswar Press – 2005.


**Course Designers**


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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221P04** | **MEMS AND NANOTECHNOLOGY** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

This course to gives thorough knowledge about the trends in latest manufacturing technologies of MicroElectro Mechanical Systems and also measuring systems to nano scale in Nano Technology. The fabrication processes for development of MEMS devices and systems, also to impart knowledge to thestudents about nano materials and various nano measurements techniques.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To understand the broad knowledge of the history, over view, applications and future directions of MEMS. |
| 2 | To understand the various materials and fabrication techniques about MEMS. |
| 3 | Identify the suitable applications for sensors and actuators in MEMS. |
| 4 | Develop the thorough knowledge of the Nano structures and fabrication process in Nano Technology. |
| 5 | To understand the advanced characterization techniques of Nano materials in Nano Technology. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Understand the concepts of MEMS, over view, applications and Future directions of MEMS. | Understand |
| CO2 | Select suitable materials and fabrication process for MEMS technology. | Apply |
| CO3 | Select for suitable applications in sensors and actuators in MEMS. | Apply |
| CO4 | Understand the Nano materials and structures in Nano Technology. | Understand |
| CO5 | Select the suitable characterizations techniques of Nano materials and Nano Technology. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | **S** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **M** | **M** | **-** | **-** |
| **CO2** | **S** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **M** | **-** | **M** |
| **CO3** | **S** | **S** | **M** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **M** | **-** | **M** |
| **CO4** | **S** | **S** | **-** | **-** | **-** | **S** | **-** | **S** | **-** | **-** | **-** | **S** | **M** | **-** | **M** |
| **CO5** | **S** | **S** | **-** | **-** | **S** | **-** | **-** | **-** | **-** | **-** | **-** | **S** | **M** | **-** | **M** |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION OF MEMS AND MICROSYSTEMS**

Unique characteristics of MEMS, Microsystems Technology- An Overview, typical MEMS and Microsystem Products. Scaling laws in miniaturization- Application of MEMS and Microsystems- Future Directions of MEMS.

**MATERIALS AND FABRICATION PROCESSES**

Structure of silicon and other materials, - Mechanical properties of Si, Silicon Compounds silicon piezo resistors, Galium arsenide, quartz, polymers for MEMS. Silicon wafer processing - Bulk micromachining and Surface micromachining, Wafer-bonding. Thin-film deposition, Lithography, wet etching and dry etching. LIGA and other moulding techniques- Soft lithography and polymer processing- Thick-film processing; Low temperature co-fired ceramic processing- Smart material processing.

**MICRO SENSORS AND MICRO-ACTUATORS**

Micro sensors - Basic principles and working of micro sensors- Acoustic wave micro sensors. Bio- medical micro sensors- Bio-sensors- Chemical micro sensors – Optical Sensors – Pressure micro sensors- Thermal micro sensors-acceleration micro sensors; Micro actuators - Basic principles and working of micro actuators- Electrostatic micro actuators- Piezoelectric micro actuators- Thermal micro actuators- SMA micro actuators- Electromagnetic micro actuators, micro valves, micro pumps.

**SCIENCE OF NANO MATERIALS**

Classification of nano structures – effect of the nanometer length scale effects of nano scale dimensions on various properties – structural, thermal, chemical, mechanical, magnetic, optical and electronic properties – effect of nanoscale dimensions on biological systems. Fabrication methods – Nanoparticles, Sol-Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon nano tubes – Solid carbon source-based production techniques – Gaseous carbon source-based production techniques. Top down processes – bottom up process.

**CHARACTERIZATION OF NANO MATERIALS**

Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

**Text Books**

1. Fahrner W.R., Nanotechnology and Nanoelectronics, Springer (India) Private Ltd., 2011.
2. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi, 2002.
3. Mohamed Gad-el-Hak, MEMS Handbook, CRC press, 2006, ISBN: 8493-9138-5

**Reference Books**

1.Yang Leng, Materials Characterization: Introduction to Microscopic and SpectroscopicMethods, John Wiley & Sons, 2013.
2. Guozhong Cao, “Nanostructures and Nanomaterials: Synthesis, Properties, and Applications”,World Scientific Publishing Private, Ltd., 2011.
3. Carl. C Koch, “Nanostructured Materials: Processing, Properties and Potential Applications”, William Andrew Publishing Norwich, 2006.
4. Zhong Lin Wang, “Characterization of Nanophase Materials”, Wiley-VCH, 2004.
5. Charles P Poole, Frank J Owens, Introduction to Nano technology, John Wiley and Sons, 2003.
6. Norio Taniguchi, Nano Technology, Oxford University Press, New York, 2003.
7. Mark Madou, Fundamentals of Microfabrication, CRC Press, New York, 1997.
8. Julian W. Hardner Micro Sensors, Principles and Applications, CRC Press 1993.

**Course Designers**


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| | | | | | | |
|---|---|---|---|---|---|---|
| | **NON-DESTRUCTIVE TESTING** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221P05** | **AND EVALUATION** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

To stress the importance of NDT in engineering.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To impart knowledge on visual inspection & liquid penetrant testing. |
| 2 | To understand the behavior of eddy current testing & acoustic emission. |
| 3 | To understand the selection of magnetic particle testing & thermography. |
| 4 | Develop the thorough knowledge of ultrasonic testing & radiography. |
| 5 | To understand the case studies, comparison and selection of NDT methods. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Understand the concepts of elastic, visual inspection & Liquid Penetrant Testing. | Understand |
| CO2 | Analyze the behavior of eddy current testing & acoustic emission. | Analyze |
| CO3 | Select for suitable applications in magnetic particle testing & thermography. | Apply |
| CO4 | Understand the ultrasonic testing & radiography. | Understand |
| CO5 | Select case studies, comparison and selection of NDT methods. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | M | - | - | - | - | - | - | - | - | - | M | M | - | - |
| CO2 | S | M | - | - | - | - | - | - | - | - | - | S | M | - | M |
| CO3 | S | S | M | - | - | - | - | - | - | - | - | S | M | - | M |
| CO4 | S | S | - | - | - | S | - | S | - | - | - | S | M | - | M |
| CO5 | S | S | - | - | S | - | - | - | - | - | - | S | M | - | M |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**NON-DESTRUCTIVE TESTING: AN INTRODUCTION, VISUAL INSPECTION & LIQUID PENETRANT TESTING**

Introduction to various non-destructive methods, Comparison of Destructive and Nondestructive Tests, Visual Inspection, Optical aids used for visual inspection, Applications. Physical principles, procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods-water washable, Post – Emulsification methods, Applications.

**EDDY CURRENT TESTING & ACOUSTIC EMISSION**

Principles, Instrumentation for ECT, Absolute, differential probes, Techniques – High sensitivity techniques, Multi frequency, Phased array ECT, Applications.Principle of AET, Instrumentation, Applications - testing of metal pressure vessels, Fatigue crack detection in aerospace structures.

**MAGNETIC PARTICLE TESTING & THERMOGRAPHY**

Principle of MPT, procedure used for testing a component, Equipment used for MPT, Magnetizing techniques, Applications. Principle of Thermography, Infrared Radiometry, Active thermography measurements, Applications – Imaging entrapped water under an epoxy coating, Detection of carbon fiber contaminants.

**ULTRASONIC TESTING & RADIOGRAPHY**

Principle, Ultrasonic transducers, Ultrasonic Flaw Detection Equipment, Modes of display A- scan, B-Scan, C-Scan, Applications, Inspection Methods - Normal Incident Pulse-Echo Inspection, Normal Incident Through-transmission Testing, Angle Beam Pulse-Echo testing, Applications of Normal Beam Inspection in detecting fatigue cracks, Inclusions, Slag, Porosity and Intergranular cracks. Principle of Radiography, Effect of radiation on Film, Radiographic imaging, Inspection Techniques- Single wall single image, Double wall Penetration, Multiwall Penetration technique, Real Time Radiography.

**CASE STUDIES, COMPARISON AND SELECTION OF NDT METHODS**

Case studies on defects in cast, rolled, extruded, welded and heat- treated components. Comparison and selection of various NDT techniques. Codes, standards, specification and procedures.

**Text Books**

1. Baldev Raj, Jeyakumar,T., Thavasimuthu,M., "Practical Non Destructive Testing" Narosa publishing house, New Delhi, 2002

**Reference Books**

1. Peter J. Shull "Non-Destructive Evaluation: Theory, Techniques and Application" Marcel Dekker, Inc.,New York, 2002.
2. Krautkramer. J., "Ultra Sonic Testing of Materials", 1st Edition, Springer – Verlag Publication, New York, 1996.
3. www.ndt.net

**Course Designers**


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| 40221P06 | ROBOT DESIGN & PROGRAMMING | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | | EC-PS | 3 | 0 | 0 | 3 |

**Preamble**

This course provides and creates a base for the students to develop concepts of Robotics.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To understand importance and anatomy of the robot. |
| 2 | To provide an in-depth study of robot kinematics and dynamics. |
| 3 | To develop skills for robot programming. |
| 4 | To develop criticizing skills for robot programming and AI. |
| 5 | To analysis sensors and actuators in robotic applications. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | To get knowledge of the mechanical structures of robots and grippers also will learn about basic terminology of the robots. | Remember |
| CO2 | To understand the kinematic and dynamic characteristics of the robot. | Understand |
| CO3 | Able to programming the robots using different techniques | Apply |
| CO4 | To apply the programming with the robots. | Apply |
| CO5 | To analysis the different actuators and sensors for the robotic applications. | Analyze |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | M | M | L | L | - | - | - | - | - | - | - | S | - | - |
| CO2 | S | S | S | M | M | - | - | - | - | - | - | - | S | - | - |
| CO3 | S | S | S | M | M | - | - | - | - | - | - | - | S | - | - |
| CO4 | S | S | S | M | M | - | - | - | - | - | - | - | S | - | - |
| CO5 | S | S | S | M | M | - | - | - | - | - | - | - | S | - | - |

**S- Strong; M-Medium; L-Low**

## SYLLABUS

## INTRODUCTION

History of robots, Classification of robots, Present status and future trends. Basic components of robotic system. Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom. Mechanisms and transmission, End effectors, Grippers-different methods of gripping, Mechanical grippers-Slider crank mechanism, Screw type, Cam type gripper, Magnetic grippers, Vacuum grippers, Air operated grippers; Specifications of robot.

## KINEMATICS AND DYNAMICS OF ROBOTS

2D, 3D Transformation, Scaling, Rotation, Translation, and Homogeneous coordinates, multiple transformations, Simple problems. Matrix representation, Forward and Reverse Kinematics of Three Degree of Freedom, Homogeneous Transformations, Inverse kinematics of Robot, Robot Arm dynamics, D-H representation of robots, Basics of Trajectory Planning.

## ROBOT PROGRAMMING

Robot Programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands.

## VAL LANGUAGE

Robot Languages-Classifications, Structures- VAL language commands motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications. VAL-II programming-basic commands, applications- Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot**.**

## ROBOT SENSORS AND ACTUATORS

Design of Robots – characteristics of actuating systems, comparison, microprocessors control of electric motors, magnetostrictive actuators, shape memory type metals, sensors, position, velocity, force, temperature,pressure sensors – Contact and non-contact sensors, infrared sensors, RCC, vision sensors.

**Text Books**


1. Groover, M.P., Weiss, M., Nagel, R.N., Odrey, N.G. and Dutta, A., 2012. Industrial robotics:technology, programming, and applications. McGraw-Hill.
2. Fu, K.S., Gonzalez, R. and Lee, C.G., 1987. Robotics: Control Sensing. Vis. Tata McGraw-Hill Education.


**Reference Books**


1. Siciliano, B., Khatib, O. and Kröger, T. eds., 2008. Springer handbook of robotics (Vol. 200). Berlin: springer.
2. Saeed.B.Niku, 'Introduction to Robotics, Analysis, system, Applications', Pearson educations, 2002.
3. Wesley E Snyder R, 'Industrial Robots, Computer Interfacing and Control', Prentice Hall International Edition, 1988.
4. Gordon Mair, 'Industrial Robotics', Prentice Hall (U.K.) 1988.


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| | | | | | | |
|---|---|---|---|---|---|---|
| | **ADDITIVE** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221P07** | **MANUFACTURING** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

To educate students with fundamental and advanced knowledge in the field of additive manufacturing technology and the various industrial applications.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | Understand the principles, methods, areas of usage, possibilities and limitations and the environmental effects of the additive manufacturing technologies. |
| 2 | Develop a comprehensive understanding of fundamental additive manufacturing. |
| 3 | Identify some of the important research challenges associated with AM and its data processing tools. |
| 4 | Select a design for-additive manufacturing skillset for CAD and CAM methodologies to produce successful 3D prints. |
| 5 | Fabricate 3D mechanical objects using a variety of 3D printing technologies. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Understand the operating principles, capabilities and limitations of liquid and solid based additive manufacturing system including fused deposition modelling and Stereo lithography. | Understand |
| CO2 | Understand the operating principles, capabilities and limitations of powder based additive manufacturing system including 3d printing and laser sintering. | Understand |
| CO3 | Describe the differences and the application of a range of additive manufacturing process. | Apply |
| CO4 | Selection and utilization of correct CAD formats in the manufacture of a 3d printed part. | Apply |
| CO5 | Describe the important process parameters and suitable additive technique for other manufacturing systems. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | - | - | - | M | - | M | - | - | - | - | L | L | - | - |
| **CO2** | M | - | - | - | M | - | M | - | - | - | - | L | L | - | - |
| **CO3** | M | - | - | - | M | - | M | - | - | - | - | L | L | - | - |
| **CO4** | M | - | - | - | M | - | M | - | - | - | - | L | L | - | - |
| **CO5** | M | - | - | - | M | - | M | - | - | - | - | L | L | - | - |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

**Introduction**

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits- Applications

**Reverse Engineering and CAD modelling**

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modelling techniques: Wire frame, surface and solid modelling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

**Liquid based and solid based Additive Manufacturing systems**

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications.
Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modelling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies

**Powder based Additive Manufacturing systems**

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

**Other Additive Manufacturing systems**

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

**Text Books**


| | |
|---|---|
| **1** | Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011. |
| **2** | Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005. |


**Reference Books**


| | |
|---|---|
| **1** | Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010. |

| | |
|---|---|
| **2** | Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010. |
| **3** | Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. |
| **4** | Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003. |

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| 40221P15 | COMPOSITE MATERIALS | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| | | EC-PS | 3 | 0 | 0 | 3 |

**PREAMBLE**

This course reviews the various composite materials their processing techniques and their behaviors, and to develop models and their applications in aerospace, automotive and medical fields.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | To study about fiber reinforced plastics. |
| 2 | To study the manufacturing processes of the composite materials. |
| 3 | To study about macro mechanical behavior of FRP. |
| 4 | To study about micromechanical behavior of composite materials. |
| 5 | To study about material models of composites. |

**COURSE OUTCOMES**

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

| | | |
|---|---|---|
| CO1 | Know the types of reinforcements and fibers used in composite materials. | Understand |
| CO2 | Know the various manufacturing techniques in composite manufacturing. | Understand |
| CO3 | Ability to test the macro mechanical behavior of fiber reinforced plastics. | Analyze |
| CO4 | Ability to test the Micro mechanical behavior of fiber reinforced plastics. | Analyze |
| CO5 | To make models for solving the composite material manufacturing. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COS | PO 1 | PO 2 | PO 3 | PO4 | PO5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO1 2 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | - | L | - | - | M | S | - | - | - | - | - | L | - | - |
| **CO2** | S | - | L | - | - | L | S | - | - | - | - | - | L | - | - |
| **CO3** | S | S | S | S | L | L | S | - | - | - | - | - | L | - | - |
| **CO4** | S | S | S | S | L | L | S | - | - | - | - | - | L | - | - |
| **CO5** | S | S | S | S | S | L | - | - | - | - | - | - | L | - | - |

**S- Strong M-Medium L- Low**

**SYLLABUS**

**FIBRE REINFORCED PLASTICS (FRP)**

Definition; Types; General properties and characteristics; Reinforcing materials – particles, fibers,

whiskers; Properties of reinforcing materials; Matrix materials; Additives; Properties of FRP materials; Applications.

**MANUFACTURING PROCESSES**

Open mold processes – Hand layup, Spray up, Vacuum bag, Pressure bag & autoclave, Centrifugal casting, Filament winding; Closed mold processes – Compression molding, Resin transfer molding (RTM), Injection molding, Pultrusion; SMC & DMC products, etc.

**MACROMECHANICAL BEHAVIOR OF FIBRE REINFORCED PLASTICS**

Design variables; Selection of fiber-matrix and manufacturing process; Effects of mechanical, thermal, electrical and environmental properties, Fiber orientation, Symmetric and asymmetric structure; Effects of unidirectional continuous and short fibers; Lamination theory; Failure theories.

**MICROMECHANICAL BEHAVIOR OF FIBRE REINFORCED PLASTICS**

Strengthening methods, Elasticity of fibre composites, Plasticity and fracture of composites, Crack propagation in fibre composites, Failure under compressive loads.

**MATERIAL MODELS**

Law of Mixtures, Shear lag model, Laminated plate model, Eshelby's models, Other models.

**Text Books**


1. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012, ISBN:978-0-387-74364-6.
2. Mallick, P.K. and Newman. S., Composite Materials Technology, Hanser Publishers, 2003.


**Reference Books**


1. Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010, ISBN:0849342058.
2. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers, 2002.
3. Seamour, E.B. Modern Plastics Technology, Prentice Hall, 2002.


**Course Designers**


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| 40221P16 | COMPUTER AIDED PRODUCT DESIGN | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | | EC-PS | 3 | 0 | 0 | 3 |

**Preamble**

To introduce the computer aided modeling and various concepts of product design.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To Know about computer aided modelling & software. |
| 2 | To Understand various computer graphics and model. |
| 3 | To Know about computer product design and management. |
| 4 | To understand design tools and techniques. |
| 5 | Understand the concept of product development & design techniques. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Describe the new engineering design and various phases involved. | Understand |
| CO2 | Learn various wireframe and surface modeling techniques used for generating computer models. | Understand |
| CO3 | Have knowledge about product design and design management. | Apply |
| CO4 | Have knowledge about various product models and different metric used | Apply |
| CO5 | Understand contemporary issues and their impact on provided solution. And use of Design technique | Understand |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | L | - | - | - | M | L | L | - | - | S | - | - |
| **CO2** | S | S | S | M | - | - | - | M | L | L | - | - | L | - | - |
| **CO3** | S | S | L | L | - | - | - | M | L | L | - | - | S | - | - |
| **CO4** | L | S | S | M | - | - | - | M | L | L | - | - | L | - | - |
| **CO5** | S | L | L | M | - | - | - | M | L | L | - | - | S | - | - |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION**

Introduction to Engineering Design – Various phases of systematic design – sequential engineering and concurrent engineering – Computer hardware & Peripherals – software packages for design and drafting. Concept of CAD as drafting and designing facility, desirable featuresof CAD package, drawing.

**COMPUTER GRAPHICS AND IT'S APPLICATIONS**

Computer graphics – applications – principals of interactive computer graphics – 2D 3D transformations – projections – curves - Geometric Modeling – types, Graphics standards –assembly modeling – use of software packages.

**PRODUCT DESIGN CONCEPTS AND PRODUCT DATA MANAGEMENT**

Understanding customer needs – Product function modeling – Function trees and function structures– Product tear down methods – Bench marking – Product portfolio – concept generation and selection – Product Data Management – concepts – Collaborative product design– manufacturing planning factor – Customization factor – Product life cycle Management.

**PRODUCT DESIGN TOOLS & TECHNIQUES**

Product modeling – types of product models; product development process tools – TRIZ – Altshuller's inventive principles – Modeling of product metrics – Design for reliability – design for manufacturability– machining, casting, and metal forming – design for assembly and disassembly.

**PRODUCT ARCHITECTURE AND DESIGN TECHNIQUES**

Product development management - establishing the architecture - creation - clustering - geometric layout development - Fundamental and incidental interactions. DOE-Taguchi method of DOE – Quality loss functions – Design for product life cycle.

**Text Books**


| | |
|---|---|
| **1** | Biren Prasad, "Concurrent Engineering Fundamentals Vol.11", Prentice Hall, 1997. |
| **2** | Ibrahim Zeid, "CAD/CAM theory and Practice", Tata McGraw Hill, 1991. |


**Reference Books**


| | |
|---|---|
| **1** | Kevin Otto, Kristin Wood, "Product Design", Pearson Education, 2000. |
| **2** | James G.Bralla, "Handbook of Product Design for Manufacturing", McGraw Hill, 1994 |
| **3** | David F.Rogers.J, Alan Adams, "Mathematical Elements for Computer Graphics", McGraw Hill,1990. |

| Course Designers | | | | |
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| 40221P17 | EMERGING MATERIALS | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | | EC-PS | 3 | 0 | 0 | 3 |

**Preamble**

The aim of the subject is to make students understand the properties, processing, manufacturing ofvarious emerging materials and their applications.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To understand the classification of engineering materials and their relevant applications. |
| 2 | To understand the powder metallurgy concepts, process techniques, applications. |
| 3 | To understand the basics in composites, fabrication methods, types and applications. |
| 4 | To understand the various forms of smart Materials, applications. |
| 5 | To understand the various types of Nano-material's, production & applications. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | |
|---|---|
| CO1 | To understand classification of Materials and its applications. |
| CO2 | Know the concepts of powder Metallurgy and its techniques. |
| CO3 | To know the different types of composites. |
| CO4 | To understand the concepts of smart materials. |
| CO5 | To obtain the knowledge of Nano Materials and its applications. |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | L | L | L | M | M | - | - | - | - | - | - | L | - | - |
| **CO2** | S | L | L | L | M | M | - | - | - | - | - | - | L | - | - |
| **CO3** | S | L | M | M | M | L | - | - | - | - | - | - | L | - | - |
| **CO4** | S | L | M | L | M | M | - | - | - | - | - | - | L | - | - |
| **CO5** | S | L | S | M | M | M | - | - | - | - | - | - | L | - | - |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**ENGINEERING MATERIALS – CONVENTIONAL**

Classification of engineering materials- Metallic materials-ferrous materials-steel & cast iron and non-ferrous materials – aluminium and copper. Non-Metallic materials – glasses, ceramics, Polymer and plastics – their characteristics and unique properties- Material for structural applications - Lightweight structural materials for automobiles and aero plane applications.

**POWDER METALLURGY – POWDER SYNTHESIS**

Powder Metallurgy – Near net shaping process methods and principles - chemical methods – electro-chemical methods - atomization – mechanical alloying – rapid solidification – processing – Nano size powders. Powder physical and chemical characterization – process characteristics - applications.

**COMPOSITE MATERIALS**

Composites – Types of composites - Naturally occurring, synthetic & engineered composites - MMC – CMC – PMC - Fibre and whisker reinforced composites (continuous and discontinuous) - particulate composites layered or sheet composites, composite coating or thin fibre, inter metallic composites - properties and characteristics of composites.

**SMART MATERIALS**

Introduction to intelligent/smart materials, shape memory alloys-types, Nitinol-origin, properties, martensitic transformation, Memorization process- applications-medical, satellite.

**NANO MATERIALS**

Nanomaterials-Definition, Classification of Nanostructured materials, causes of interest in nanomaterials, applications of nanomaterials. Processes for producing ultrafine powders-mechanical grinding, wet chemical synthesis of nanomaterials. Gas phase synthesis of Nano materials, gas condensation processes, chemical vapour condensation, laser ablation.

**Text Books**


1. Budinski, Kenneth G, Budinski, Michael K, Engineering Materials: Properties and Selection, 9th Edition, 2009.
2. A.K.Bandhopadyay, Nanomaterials-New Age International (P) Ltd., Publishers, 2009.
3. M.V.Gandhi., Thomson - Smart Materials and Structures, Chapman and Hall, United Kingdom, 1992.


**Reference Books**


1. Srinivasan.K, Composite Materials: Production, Properties, Testing and Applications, Narosa Publishing House, New Delhi, 2018.
2. Ramesh K.T, Nanomaterials: Mechanics and Mechanisms, Springer Verlag, EPZ, Paperback edition, 2010.
3. Angelo P.C., Subramanian R., Powder Metallurgy, Science, Technology and Applications,Prentice Hall of India, New Delhi 2008.


**Course Designers**


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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221P03** | **MANUFACTURING MANAGEMENT** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

To introduce the concepts of manufacturing management and various manufacturing management functions to the students.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To select the plant location, material handling system and construct the plant layout. |
| 2 | To make use of the work study and work measurement. |
| 3 | To develop an ability to forecast the demand and to create work sheet. |
| 4 | To identify the Project network analysis. |
| 5 | Apply the principles of marketing management. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Select the plant layout and Identify the appropriate material handling system. | Apply |
| CO2 | Illustrate method study and value analysis. | Understand |
| CO3 | Demonstrate market research and sales promotion techniques. | Understand |
| CO4 | Apply the knowledge to develop Process planning, scheduling and project management. | Apply |
| CO5 | Apply the skills in develop project network and construct critical path. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| Cos | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | M | M | L | - | - | - | S | L | L | - | M | - | L |
| **CO2** | S | S | S | S | L | - | - | - | M | L | L | - | M | - | L |
| **CO3** | S | S | M | S | L | - | - | - | S | M | M | - | M | - | L |
| **CO4** | S | S | M | S | L | - | - | - | M | L | L | - | M | - | L |
| **CO5** | S | S | S | S | L | - | - | - | M | L | L | - | M | - | L |

**S-Strong; M-Medium; L-Low**

**Syllabus**

**PLANT ENGINEERING AND FACILITY PLANNING**

Plant location – Factors affecting plant location – Techniques – Plant layout - principles - Types – Comparison of layouts – Materials handling – Principles – Factors affecting selection of Materials handling system – Types of materials handling systems – Techniques. Facility planning – Factors affecting selection of plant location, Factor rating analysis: Break event, Load distance model, closeness ratings.

| |
|---|
| **WORK STUDY** |
| Method study – Principles of motion economy – steps in method study – Tool and Techniques – Work measurement – Purpose – stop watch time study – Production studies – work sampling – Ergonomics – Value analysis. |
| **PROCESS PLANNING AND FORECASTING** |
| Process planning – Aims of process planning – steps to prepare the detailed work sheets for manufacturing a given component – Break even analysis – Forecasting – Purpose of forecasting – Methods of forecasting – Time series – Regression and Correlation – Exponential smoothing – Forecast errors. |
| **PRODUCTION PLANNING & CONTROL, SCHEDULING AND PROJECT MANAGEMENT** |
| Steps in PPC process mapping, preparation of process mapping and feedback control for effective monitoring. Aggregate production planning, production planning strategies, Disaggregating the aggregate plan, Materials Requirement Planning (MRP), MRP-II, Supply chain management, Operation scheduling, prioritization. Scheduling – Priority rules scheduling – sequencing – Johnson's algorithm for job sequencing – n job M machine problems – Project Network analysis – PERT/CPM – Critical path –Floats – Resource leveling – Queuing analysis. |
| **PERSONNEL AND MARKETING MANAGEMENT** |
| Principles of Management – Functions of personnel management – Recruitment – Training – Motivation – Communication – conflicts – Industrial relations – Trade Union – Functions of marketing – Sales promotionmethods – Advertising – Product packaging – Distribution channels – Market research and techniques. |

**Text Books**

| | |
|---|---|
| **1** | Pannererselvam, R "Production and Operations Management", 3rd Edition, PHI, 2012. |
| **2** | Dr. R. Kesavan, C. Elanchezian and B. Vijayaramnath, Production Planning and Control, Anuratha Publications, Chennai – 2008. |
| **3** | Martand T. Telsang, Production Management, S.Chand & Co., 2007. |

**Reference Books**

| | |
|---|---|
| **1** | Chary, SN, "Production and Operations Management", 4th Edition, SIE, TMH, 2009. |
| **2** | KanishkaBedi, "Production and Operations Management", 2nd Edition, Oxford Higher Education, 2007. |
| **3** | Lee. J. Krajewski, L. P. Ritzman, & M. K. Malhothra, "Operations Management – Process and Value Chains", 8th Edition, PHI/Pearson Education, 2007. |
| **4** | Chase. RB, N. J. Aquilano, & F. R. Jacobs, "Operations Management – For Competitive Advantage", 11th Edition, SIE, TMH, 2007. |

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| 40221P18 | MANUFACTURING SYSTEM SIMULATION | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | | EC-PS | 3 | 0 | 0 | 3 |

**Preamble**

To train the students various random number generation techniques, its use in simulation.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | Define the basics of simulation modeling and replicating the practical situations in organizations. |
| 2 | Generate random numbers and random variates using different techniques. |
| 3 | Design and develop simulation model using heuristic methods. |
| 4 | Analysis of Simulation models using input analyzer, and output analyzer. |
| 5 | Explain verification and validation of simulation model. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Explain the concepts and principles of technology manufacturing system simulation. | Understand |
| CO2 | Describe the role of important elements of discrete event simulation and modeling paradigm. | Analyze |
| CO3 | Design and evaluate a given manufacturing system using simulation. | Analyze |
| CO4 | Generate random numbers and variants to execute a simulation model. | Analyze |
| CO5 | Evaluate queuing networks and algorithms in the context of manufacturing. | Evaluate |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | S | L | - | - | - | - | L | L | - | - | S | - | - |
| CO2 | S | S | S | S | - | - | - | - | L | L | - | - | S | - | - |
| CO3 | S | S | S | M | - | - | - | - | L | L | - | - | S | - | - |
| CO4 | S | S | S | S | - | - | - | - | L | L | - | - | S | - | - |
| CO5 | L | L | S | L | - | - | - | - | L | L | - | - | S | - | - |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION**

Basic concept of system – elements of manufacturing system – concept of simulation – simulation as a decision-making tool – types of simulation – system modeling – types of modeling.

**RANDOM NUMBERS**

Probability and statistical concepts of simulation – Pseudo random numbers – methods of generating random numbers – discrete and continuous distribution – testing of random numbers – sampling – simple, random and simulated.

**DESIGN OF SIMULATION EXPERIMENTS**

Problem formulation – data collection and reduction – time flow mechanical – key variables – logic flow chart starting condition – run size – experimental design consideration – output analysis, interpretation and validation –application of simulation in engineering industry.

**ANALYSIS OF SIMULATION DATA**

Input Modelling: Data collection, Identification and distribution with data, parameter estimation, Goodness of fittests, Selection of input models without data, Multivariate and time series analysis. Verification and Validation of Model – Model Building, Verification, Calibration and Validation of Models.

**QUEUING POLICIES, ALGORITHMS AND CASE STUDIES**

Introduction to basic Single – pass heuristics, meta-heuristics and applications – Application of Geneticalgorithms and Ant colony-based algorithms in Discrete event simulation models with simple examples.

**Text Books**


| | |
|---|---|
| **1** | Geoffrey Gordon, "System Simulation", 2nd Edition, Prentice Hall, India, 2020. |
| **2** | Jerry Banks & John S. Carson, Barry L Nelson, “Discrete event system simulation”, Prentice Hall, 2000. |


**Reference Books**


| | |
|---|---|
| **1** | Pidd, M, “Computer Simulation in Management Science”, Fifth edition, John Wiley & Sons, Inc,2016. |
| **2** | Narsingh Deo, “System Simulation with Digital Computer”, Fifth edition, Prentice Hall,2014. |
| **3** | Law A.M, “Simulation Modelling and Analysis”, Fifth edition, Tata Mc Graw Hill,2014. |
| **4** | Schriber T.J., “Simulation using GPSS”, John Wiley, 2002. |
| **5** | Fishwick P.A., “Imulation Model Design and Execution: Building Digital Worlds” New Jersey: Prentice Hall Int” l Inc., India, 1995. |


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| | | | | | | |
|---|---|---|---|---|---|---|
| | **MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221P08** | | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

This course aims to impart knowledge on various techniques of material characterization.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | On completion of the course the students are expected to be knowledgeable in microstructure evaluation, crystal structure analysis. |
| 2 | On completion of the course the students are expected to be knowledgeable in electron microscopy. |
| 3 | On completion of the course the students are expected to be knowledgeable in chemical thermal analysis. |
| 4 | On completion of the course the students are expected to be knowledgeable in static mechanical testing methods. |
| 5 | On completion of the course the students are expected to be knowledgeable in dynamic mechanical testing methods. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Interpret various materials characterization techniques. | Understand |
| CO2 | Understand the principle and operation of characterization equipment and the adjustment of operation variables to obtain good images / results. | Understand |
| CO3 | Understand the concept of chemical and thermal analysis. | Apply |
| CO4 | Understand the principle of mechanical testing – static Tests. | Apply |
| CO5 | Understand the principle of mechanical testing – dynamic Tests. | Analyze |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | L | - | - | - | M | L | L | - | - | S | - | - |
| **CO2** | S | S | S | L | - | - | - | M | L | L | | | S | - | - |
| **CO3** | S | S | S | M | - | - | - | M | L | L | | | S | - | - |
| **CO4** | S | S | S | M | - | - | - | M | L | L | | | S | - | - |
| **CO5** | S | S | S | M | - | - | - | M | L | L | | | S | - | - |

**S-Strong; M-Medium; L-Low**

## SYLLABUS

**Micro and Crystal Structure Analysis**

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction, Bragg's law – Techniques of X-ray Crystallography, Debye ,Scherer camera – Geiger Diffractometer- analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

**Electron Microscopy**

Scanning Electron Microscopy (SEM) - Introduction, Instrumentation, Contrast formation,Operational variables, Specimen preparation, imaging modes, Applications, Limitations.

**Chemical and Thermal Analysis**

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Thermo Gravity metric Analysis (TGA), Differential Scanning Calorimetry (DSC).

**Mechanical Testing – Static Tests**

Codes and standards for testing metallic and composite materials. Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test, Tensile Test – Stress – Strain plot – Proof Stress, Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test.

**Mechanical Testing – Dynamic Tests**

Fatigue – Low & High Cycle Fatigues, Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests modal analysis - Applications of Dynamic Tests.

**Text Books**


| | |
|---|---|
| **1** | Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001. |
| **2** | Dieter G.E., Mechanical Metallurgy, (3rd Edition), ISBN: 0070168938, McGraw Hill, 1988. |


**Reference Books**


| | |
|---|---|
| **1** | Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004. |
| **2** | Morita.S, Wiesendanger.R, and Meyer.E, ―Non-contact Atomic Force Microscopy‖ Springer, 2002. |
| **3** | Goldsten,I.J., Dale.E., Echin.N.P.& Joy D.C., Scanning Electron Microscopy & X rayMicro Analysis, (2nd Edition), ISBN – 0306441756, Plenum Publishing Corp., 2000. |
| **4** | Newby J., Metals Hand Book- Metallography & Micro Structures, (9th Edition), ASM International, 1989 |
| **5** | Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976. |


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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **40221P19** | **MECHATRONICS** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

This syllabus is formed to create knowledge in Mechatronics systems and impart the source of concepts and techniques, which have recently been applied in practical situation.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To provide overview of need and benefits of mechatronics in manufacturing. |
| 2 | To know the basic working principle of sensors and transducers of use formanufacturing systems. |
| 3 | To know the basic working principle of drives and actuators of use formanufacturing systems. |
| 4 | To know the features, modules and interfaces of microcontrollers andmicroprocessors. |
| 5 | To gain the knowledge of mechatronic systems in design process and case studies. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Infer the knowledge to study the mechatronics in manufacturing systems. | Understand |
| CO2 | Identify and select the sensors and transducers based on the application. | Apply |
| CO3 | Identify the principles and functions of drives and actuators. | Apply |
| CO4 | Distinguish between microprocessor and microcontrollers and itsfunctions | Analyze |
| CO5 | Summarize the various stages of design in mechatronics systems. | Understand |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | M | L | S | - | - | - | - | - | - | S | S | - | - |
| **CO2** | M | M | M | L | M | - | - | - | M | - | - | - | S | - | - |
| **CO3** | L | L | M | L | - | - | - | - | - | - | - | - | S | - | - |
| **CO4** | S | S | M | L | - | M | - | - | - | - | - | - | S | - | - |
| **CO5** | S | M | M | L | - | - | - | - | L | M | - | S | S | - | - |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

**Introduction**

Introduction to Mechatronics-systems – Mechatronics approach to modern engineering and design – History of Mechatronics-Scope and Significance of Mechatronics systems- Elements of Mechatronics systems–Subsystems of Mechatronics -Emerging areas of Mechatronics-Classification of Manufacturing based on Mechatronics- Need and benefits of Mechatronics in Manufacturing.

**Sensors and Transducers**

Introduction – Performance Terminology – Potentiometers – Strain gauges – LVDT – Eddy current sensor – Hall effect sensor – Resistive Transducers – Inductive Transducers-Capacitance Transducers – Digital transducers – Temperature sensors – Optical sensors – Piezo electric sensor-Ultrasonic sensors – Proximity sensors – Chemical and Gas Sensors-Signal processing techniques.

**Drives and Actuators**

Classification of actuators-Role of Linear and Rotary Actuators – Electrical actuators –Servo motors and Stepper motors -Piezoelectric actuators-Solenoids-D.C. Motors–Function of Drives-Solid state relays-MechanicalSwitching Devices-Interfacing with microcontroller through H-bridge Circuits.

**Microprocessors and Microcontrollers**

Introduction – Requirement for Processor – Comparison of 8085 Microprocessor and 8051 Microcontrollers– 8051 Microcontrollers Architecture, PIC Microcontrollers (16f xxx) series – Assembly language programming-Instruction sets, Instruction format, Addressing modes, Basic programing-Interfacing-Sensors, Keyboards, LCD, LED, A/D and D/A Converters-Actuators – Embedded Systems RS 232 serial communication interface, classification of memories.

**Mechatronic Systems**

Design Process-Stages of design in mechatronics systems – Traditional and Mechatronics design concepts – Case studies – Pick and place robots, Automatic car parking system, Automatic camera, Automatic washing machine, Engine management system, Machinery automation.

**Text Books**

| | |
|---|---|
| **1** | Vijayaraghavan G.K., Balasundaram M S, Ramachandran K P, Mechatronics: Integrated Mechanical Electronic Systems, Wiley, 2008. |
| **2** | R.K.Rajput, A Text Book of Mechatronics, Chand &Co, 2007. |

**Reference Books**

| | |
|---|---|
| **1** | Bolton W, ―Mechatronics: Electronic control systems in mechanical and electrical engineering, 6thedition, Pearson Education Limited, 2015. |
| **2** | BenoBenhabib, Manufacturing, design, production, automation and integration, Marcel Dekker, 2003. |
| **3** | Mazidi M A and Mazidi J G, 8051 Microcontroller and Embedded Systems, 2002. |
| **4** | Devadas shetty, Richard A. Kolk, "Mechatronics System Design", PWS Publishing Company, 2001. |

**Course Designers**

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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| 40221P20 | NANO STRUCTURED MATERIALS AND APPLICATIONS | EC-PS | 3 | 0 | 0 | 3 |

**Preamble**

To develop the knowledge of students in nano-structured materials.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | The objective of this course is to make the students familiar with the different methods of synthesis for nano-materials. |
| 2 | To motivate the students to understand the evolution of nano-materials in the scientific era. |
| 3 | To understand different processing methods and properties of nano-materials. |
| 4 | To explore knowledge about the different nanoporus materials. |
| 5 | To provide the various applications of nano-materials for future engineering applications. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Understand the basics of nano materials, types, various structures of nano materials and its applications | Understand |
| CO2 | Understand the various synthesis process of nano-materials, methods and various chemical approaches. | Understand |
| CO3 | Understand the various physical approach methods and techniques involved in the process of nano-materials. | Understand |
| CO4 | Applications and types of various nano porus materials. | Apply |
| CO5 | Analyze the various nano-materials and its principle and design. | Analyze |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | - | - | - | L | S | - | - | - | - | - | - | - | - | |
| **CO2** | S | - | - | - | M | M | - | - | - | - | - | - | - | - | |
| **CO3** | S | - | - | - | M | M | - | - | - | - | - | - | - | - | |
| **CO4** | S | - | - | - | M | M | - | - | - | - | - | - | - | - | |
| **CO5** | S | - | M | - | L | M | - | - | - | - | - | - | M | - | M |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION TO NANO STRUCTURED MATERIALS**

0D, 1D, 2D structures –Size Effects –Fraction of Surface Atoms –specific Surface Energy and Surface Stress –Effect on the Lattice Parameter –Phonon Density of States–the General Methods available for the Synthesisof Nano strutures –precipitative –reactive –hydrothermal/solvo thermal methods –suitability of such methods for scaling –potential Uses.

**BULK SYNTHESIS AND CHEMICAL APPROACHES**

Top down and bottom up approaches–Mechanical alloying and mechanical ball milling- Mechano chemical process, Inert gas condensation technique – Arc plasma and laser ablation, Sol gel processing-Solvo thermal, hydrothermal, precipitation, Spray pyrolysis, Electro spraying and spin coating routes, Self-assembly, self-assembled monolayers (SAMs). Langmuir-Blodgett (LB) films, micro emulsion polymerization- templated synthesis, pulsed electrochemical deposition.

**PHYSICAL APPROACHES**

Vapor deposition and different types of epitaxial growth techniques (CVD, MOCVD, MBE, ALD)- pulsed laser deposition, Magnetron sputtering - lithography: Photo/UV/EB/FIB techniques, Dip pen nanolithography, Etching process: Dry and Wet etching, micro contact printing.

**NANOPOROUS MATERIALS**

Zeolites, mesoporous materials, nanomembranes - Carbon nanotubes and graphene - Core shell and hybrid nanocomposites.

**APPLICATION OF NANOMATERIALS**

Overview of nanomaterials properties and their applications, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications – Quantum Devices – Nanomechanics - Photonics- Nano structures as single electron transistor –principle and design.

**Text Books**


| | |
|---|---|
| **1** | Bhusan, Bharat (Ed), "Springer Handbook of Nanotechnology", 2nd Edition, 2007. |
| **2** | Guozhong Cao, "Nanostructures and Nanomaterials, synthesis, properties andapplications" Imperial College Press, 2004. |
| **3** | Carl C. Koch (ed.)," Nanostructured Materials", Processing, Properties and Potential Applications, Noyes Publications, Norwich, New York, U.S.A. |


**Reference Books**


| | |
|---|---|
| **1** | Modern Physics – Beiser 6th edition 2009. |
| **2** | Quantum Physics – Theory and application, Ajoy Ghatak, Springer 2004. |
| **3** | Quantum Mechanics - Bransden and Joachen 2nd edition 2000. |
| **4** | Principles of Quantum Mechanics 2nd ed. - R. Shankar 2000. |
| **5** | Quantum Mechanics - Vol 1&2 - Cohen-Tannoudji,1997. |
| **6** | Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, 2nd Edition by Eisberg, Robert; Resnick, Robert, 1985. |


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| | | | | | | |
|---|---|---|---|---|---|---|
| | **PROCESS PLANNING AND COST** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221P21** | **ESTIMATION** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

To introduce the process planning concepts to make cost estimation for various products after process planning.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To introduce the process planning concepts to make estimation for various products, process planning and its approaches. |
| 2 | To impart the Knowledge about the job order and techniques involved in shop floor. |
| 3 | To introduce the cost estimation concept to analysis the expense and determination of other cost. |
| 4 | To impart knowledge on cost estimation of a product by considering various manufacturing processes. |
| 5 | To facilitate estimation of time for machining, welding, forging and allied processes. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Select the process, equipment and tools for various industrial products, prepare process planning activity chart. | Understand |
| CO2 | Compute the job order cost for different type of shop floor. | Apply |
| CO3 | Identify the cost estimation concept – Overhead Cost, Expense & depreciation Techniques. | Apply |
| CO4 | Calculate the time taken for various machining operations, apply appropriate methods for calculating depreciation. | Apply |
| CO5 | Identify the various cost elements involved in total cost of the product - welding, casting and forging operations. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | L | - | - | - | - | - | - | - | L | L | S | - | L |
| **CO2** | S | M | L | - | - | L | - | - | - | - | L | L | S | - | L |
| **CO3** | S | M | M | L | - | L | - | - | - | - | M | M | S | - | L |
| **CO4** | S | M | M | M | - | L | - | - | - | - | S | M | S | - | L |
| **CO5** | S | M | M | M | - | L | - | - | - | - | S | M | S | - | L |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION TO PROCESS PLANNING**

Introduction- methods of process planning-Drawing Interpretation-Material evaluation – steps inprocess selection-. Production equipment and tooling selection– Types of chart techniques.

**INTRODUCTION TO COST ESTIMATION**

Estimation of Different Types of Jobs - Cost estimation: Importance and aims of cost estimation - functions of estimation - difference between estimating and costing - importance of preparing realistic estimates - estimating procedure. Elements of cost, Objectives.

**COST ESTIMATION CONCEPT**

Elements of costs - ladder of cost - determination of material cost - labour cost - expenses. Analysis of overhead expenses, Distribution of overhead costs – depreciation - causes of depreciation - methods of calculating depreciation.

**MACHINING COST ESTIMATION**

Estimation of machining time, Calculation of machining time for lathe operations-estimation of drilling time on drilling machine - estimation of time for shaping, planning, milling and grinding.

**PRODUCTION COST ESTIMATION**

Costing for metal forming and fabrication processes, Estimation of cost in welding- Estimation in forging shop - cost estimation of foundry work.

**Text Books**


| | |
|---|---|
| **1** | Banga T. R. and Sharma S. C. – "Mechanical Estimating and Costing including Contracting" -Khanna Publishers – 2011. |
| **2** | Sinha.B.P., "Mechanical Estimating and Costing", Tata McGraw-Hill, Publishing Co.2002. |


**Reference Books**


| | |
|---|---|
| **1** | Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003. |
| **2** | Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002 |
| **3** | Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002. |
| **4** | Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001. |
| **5** | Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9th Edition, John Wiley, 1998. |


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| | PRODUCT DESIGN AND DEVELOPMENT | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| 40221P22 | | EC-PS | 3 | 0 | 0 | 3 |

**Preamble**

To understand the application of product design methods to develop a product.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To enable the students to gain knowledge on the process of product development and concept selection. |
| 2 | To enable the students to understand the product architecture and system level design issues. |
| 3 | To make the students to familiarize with the industrial design process. |
| 4 | To enable the students to understand the planning for prototypes and elements of economic analysis. |
| 5 | To understand the background in managing product development projects. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Explain the basic product development process. | Understand |
| CO2 | Recall the design process for product development. | Understand |
| CO3 | Apply the industrial design process and manufacturing Cost. | Apply |
| CO4 | Analyze the design principles of prototyping and Economic Analysis. | Analyze |
| CO5 | Analyze the Project Budget and Project evaluation- patents. | Analyze |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | S | L | - | - | - | M | L | L | - | - | S | - | - |
| CO2 | S | S | S | M | - | - | - | M | L | L | | | S | - | - |
| CO3 | S | S | S | M | - | - | - | M | L | L | | | S | - | - |
| CO4 | S | S | S | M | - | - | - | M | L | L | | | S | - | - |
| CO5 | S | S | S | M | - | - | - | M | L | L | | | S | - | - |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

**PRODUCT DEVELOPMENT AND CONCEPT SELECTION**

Significance of product design, product design and development process, sequential engineering design method, the challenges of product development – Product development organizations- Identifying the customer needs – Establishing the product specifications – concept generation – Concept selection.

**PRODUCT ARCHITECTURE**

Concept Testing, Response and Interpretation. Product Architecture, Implication of the architecture – Establishing the architecture Platform planning, System level design issues. Embodiment design, Modelling.

**INDUSTRIAL AND MANUFACTURING DESIGN**

Need for industrial design – Impact of industrial design – Industrial design process. Assessing the quality of industrial design- Human Engineering consideration - Estimate the manufacturing cost – Reduce the component cost – Reduce the assembly cost – Reduce the support cost – Impact of DFM decisions on other factors.

**PROTOTYPING AND ECONOMIC ANALYSIS**

Principles of prototyping – Planning for prototypes - Elements of economic analysis – Base case financial model – Sensitivity analysis – Influence of the quantitative factors.

**MANAGING PRODUCT DEVELOPMENT PROJECTS**

Sequential, parallel and coupled tasks - Baseline project planning – Project Budget Project execution – Project evaluation- patents- patent search-patent laws International code for patents.

**Text Books**


| | |
|---|---|
| **1** | Ken Hurst, Engineering Design Principles, Elsevier Science and TechnologyBooks, 2014. |
| **2** | G. E. Dieter, Engineering Design, McGraw – Hill International, 2013. |


**Reference Books**


| | |
|---|---|
| **1** | Karl Ulrich and Steven Eppinger, "Product Design and Development", 5th edition, 2016. |
| **2** | Karal .T. Ulrich, Steven D.Eppinger, Product Design and Development, McGRAW-HILL International Editions.2003. . |
| **3** | Charles Gevirtz, Developing New products with TQM, McGraw – Hill International editions, 1994. |
| **4** | S.Rosenthal, Effective product design and development, Irwin 1992. |

| Course Designers | | | | |
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| | | | | | | |
|---|---|---|---|---|---|---|
| | **PRODUCT LIFECYCLE** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221P23** | **MANAGEMENT** | **EC-PS** | **3** | **0** | **0** | **3** |

**Preamble**

To understand the various PLM approaches for industrial applications.

**Prerequisite**

Nil

**Course Objectives**

| | |
|---|---|
| 1 | To impart the latest knowledge, principles, strategies, practices, and applications in PLM domain. |
| 2 | To provide an in-depth understanding of various applications and solutions of PLM. |
| 3 | Apply PLM concepts for service industry and E-Business. |
| 4 | To build conceptual foundation of PLM, along with the latest industry views on PLMapplications. |
| 5 | To present frameworks which provide economic justifications for PLM projects. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | Understand product data, information, structures and PLM concepts. | Understand |
| CO2 | Apply PLM systems in organization verticals including production, after sales,sales and marketing, and subcontracting. | Apply |
| CO3 | To Apply the concepts of e – Manufacturing in Industrial sectors and Digital Manufacturing. | Apply |
| CO4 | Apply and design the various strategies for process and product data management. | Apply |
| CO5 | Configure organisations, product structures, workflow, projects andrequisite tasks in PLM. | Apply |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | S | S | M | - | - | M | L | - | - | S | - | - |
| **CO2** | S | S | M | S | S | S | S | S | S | L | - | - | S | - | - |
| **CO3** | S | S | S | S | S | M | S | S | S | L | - | - | S | - | - |
| **CO4** | S | M | S | M | S | S | S | S | M | L | - | - | S | - | - |
| **CO5** | M | S | S | S | M | S | S | S | M | L | - | - | S | - | - |

| |
|---|
| **S-Strong; M-Medium; L-Low** |

**SYLLABUS**

**FUNDAMENTALS OF PLM**

Product data or Product information, Product lifecycle management concept, Information models and product structures-Information model, The product information (data) model, The product model, Reasons for the deployment of PLM systems.

**ENTERPRISE SOLUTION WITH PLM**

Use of product lifecycle management systems in different organization verticals, Product Development and Engineering, Impact of Manufacturing with PLM Challenges of product management in Engineering and Manufacturing Industry, Life cycle thinking.

**PLM FOR E-MANUFACTURING**

Significance of product management, Collaborative Manufacturing, Integration of the PLM system with other applications: Different ways to integrate PLM systems, Transfer file, Database integration, System roles, ERP, Optimization of ERP for PLM and CAD.

**TECHNOLOGY FORECASTING**

Future mapping, invocating rates of technological change, methods of technology forecasting such as relevance trees, morphological methods and mission flow diagram, combining forecast of different technologies, uses in manufacture alternative.

**PLM SOLUTIONS**

Human resources in product lifecycle, Methods, Techniques, Phases of product lifecycle and corresponding technologies, Enterprise information, knowledge and IP, Change Process, Product Structure & Configuration, Project, Engineering Process, Information Standards, Vendors of PLM Systems and Components.

**Text Books**

| | |
|---|---|
| **1** | Jaya Krishna S, Product Lifecycle Management: Concepts and cases, ICFAI Publications 2011. |
| **2** | Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2006. |

**Reference Books**

| | |
|---|---|
| **1** | John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2nd Edition). |
| **2** | Antti Saaksvuori and Anselmi Immonen, "Product Lifecycle Management", Springer Publisher, 2008 (3rd Edition). |
| **3** | Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor & Francis 2006. |
| **4** | Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003. |

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# OPEN ELECTIVE COURSES

| 43421O01 | BIOMEDICAL PRODUCT DESIGN AND DEVELOPMENT | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | | OE-EA | 3 | 0 | 0 | 3 |

**PREAMBLE**

The course aims at providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | To understand the global trends and development methodologies of various types of products and services. |
| 2 | To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems. |
| 3 | To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification. |
| 4 | To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics. |
| 5 | To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer. |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| **CO1** Define, formulate and analyze a problem for the product design. | Analyze |
| **CO2** Obtain the domain knowledge of product development and regulatory requirements for the design of prototype. | Apply |
| **CO3** Explain the process of manufacturing, testing and validation for scalable product development. | Apply |
| **CO4** Gain knowledge of the Innovation & Product Development process in the Business Context. | Apply |
| **CO5** Discuss the economics in product development and business strategies for turnover from commercialization. | Apply |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| COS | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | S | M | L | -- | -- | -- | M | -- | -- | -- | M | S | L | M |
| CO2 | S | S | M | L | -- | -- | -- | M | -- | -- | -- | M | S | L | M |
| CO3 | S | S | M | L | -- | -- | -- | M | -- | -- | -- | M | S | L | M |
| CO4 | S | S | S | L | -- | -- | -- | M | -- | -- | -- | M | S | L | M |
| CO5 | S | S | S | L | -- | -- | -- | M | -- | -- | -- | M | S | L | M |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**PRODUCT DESIGN**

Definition, History and Modern Practice – Designs; Design and Product Life Cycle; Design Process; What is a medical device, Challenges in medical device, Understanding the innovation cycle, Good Design Practice. Understanding, analyzing and validating user needs, Screening Needs, Technical Requirements, Concept Generation – Innovation Survey Questionnaire, Morphological Matrix, QFD, Concept Analysis and validation, Concept Modelling, Concept Screening & Validation.

**PRODUCT DEVELOPMENT AND REGULATORY**

Breakthrough Products, Platform Products, Front End of Innovations / Fuzzy Front End, Generic Product Development Process (Concept Development, System Design, Detailed Design, Test & Refinement, Production Ramp-up), Variants of Development Processes (Market Pull, Technology Push, Platform, Process-Intensive, Customized, High-Risk, Quick Build, Complex Systems), Good Documentation Practice, Prototyping Specifications, Prototyping, Medical Device standards, Quality management systems, Medical Device Classification, Design of Clinical Trials, Design Control & Regulatory Requirements, Documentation in Medical Devices, Regulatory pathways.

**CALABLE PRODUCT DEVELOPMENT**

Design for manufacturing, Design for assembly, Design for Serviceability, Design for usability, Medical Device Verification & Validation, Product Testing & Regulatory compliance, Clinical trial & validation, Device Certification.

**MANUFACTURING AND BUSINESS STRATEGIES**

Lean Manufacturing – Toyota Production System, Good Manufacturing Practices, Framework for Product Strategy – Core Strategic Vision (CSV), Characteristics of good CSV, Opportunity Identification Process & Generating Opportunities, Quality of Opportunities – Real-Win-Worth It (3M RWW), Product Planning Process, Technology S-Curve, Evaluating and Prioritizing Projects, Product-Process Change Matrix, Resource Planning, Total Available Market (Segmentation, Targeting & Positioning), Served Available Market, Product Platform Strategy, Market Platform Plan (Product Platform Management, Product Line Strategy).

**PRODUCT ECONOMICS AND MARKET INFUSIONS**

Economics/Finance in Product Development (Sales Forecasting – ATAR Model/ Bases Model, Pricing the product, Cash flow in Product Development, Categorizing the costs, Structuring Manufacturing Costs, Prototyping Costs, Development Costs, Cost Volume Profit Analysis, Breakeven Analysis, Common Return Metrics – Payback/ NPV/ IRR, Common Comparison Metrics – WACC/ RRR/ MARR). Business Model Canvas, Marketing Channels, Sales Models, Post Commercialization Surveillance, End of Life support.

**REFERENCES:**


1. Jones, J.C., Design Methods, John Wiley, 1981.
2. Cross, N., Engineering Design Methods, John Wiley, 1994.
3. Pahl, G., and Beitz, W., Engineering Design, Design Council, 1984.
4. Michael E. McGrath, Product Strategy for High-Technology Companies, 2nd Edition, McGraw Hill.
5. Ulrich, K.T., and Eppinger, S.D., Product Design and Development, Tata McGraw Hill, India.
6. Ehrelspiel. K, and Lindemann U Cost-Efficient Design, Springer, 2007.
7. Paul H king, Richard C. Fries, Arthur T. Johnson, Design of Biomedical Devices and Systems. Third edition, ISBN 9781466569133.
8. Peter J. Ogrodnik, Medical Device Design: Innovation from Concept to Market, Academic Press Inc; Edition (2012), ISBN- 10:0123919428.
9. Stefanos Zenios, Josh Makower, Paul Yock, Todd J. Brinton, Uday N. Kumar, Lyn Denend, Thomas M. Krummel, Biodesign: The Process of Innovating Medical Technologies, Cambridbge University press; Edition (2009), ISBN- 10:0521517427.


**COURSE DESIGNERS**


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| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| 48121O02 | WASTE TO ENERGY | OE-EA | 3 | 0 | 0 | 3 |

**PREAMBLE**

This course is to provide insights into waste management options by reducing the waste destined for disposal and encouraging the use of waste as a resource for alternate energy production.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | To enable students to understand of the concept of Waste to Energy. |
| 2 | To link legal, technical and management principles for production of energy form waste. |
| 3 | To learn about the best available technologies for waste to energy. |
| 4 | To analyze of case studies for understanding success and failures. |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| **CO1:** Understand the knowledge about the operations of Waste to Energy Plants. | Understand |
| **CO2:** Analyze the various aspects of Waste to Energy Management Systems. | Analyze |
| **CO3:** Carry out Techno-economic feasibility for Waste to Energy Plants | Apply |
| **CO4:** Evaluate planning and operations of Waste to Energy plants. | Evaluate |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| COS | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO 10 | PO1 1 | PO1 2 | PSO 1 | PS O2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | M | - | - | L | - | - | - | - | - | - | - | - | L | - | - |
| CO2 | M | M | L | L | - | M | - | - | - | - | - | - | L | - | - |
| CO3 | S | M | S | M | - | L | - | M | - | - | - | - | M | L | - |
| CO4 | S | M | S | - | L | - | - | - | - | - | - | - | M | L | - |
| CO5 | L | L | - | L | - | - | - | - | - | - | - | - | L | - | - |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**INTRODUCTION**

The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source.

**WASTE SOURCES & CHARACTERIZATION**

Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria.

**TECHNOLOGIES FOR WASTE TO ENERGY**

Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation. Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies.

**WASTE TO ENERGY OPTIONS**

Landfill gas, collection and recovery. Refuse Derived Fuel (RDF) – fluff, briquettes, pellets. Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants and Industrial boilers. Conversion of wastes to fuel resources for other useful energy applications Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery. Energy Recovery from wastes and optimization of its use, benchmarking and standardization. Energy Analysis.

**CASE STUDIES - WASTE TO ENERGY PLANTS**

Success/failures of waste to energy Global Best Practices in Waste to energy production distribution and use. Indian Scenario on Waste to Energy production distribution and use in India. Success and Failures of Indian Waste to Energy plants. Role of the Government in promoting 'Waste to Energy'. Waste activities – collection, segregation, transportation and storage requirements. Location and Siting of 'Waste to Energy' plants. Industry Specific Applications – In-house use – sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry and any other industry. Centralized and Decentralized Energy production, distribution and use. Comparison of Centralized and decentralized systems and its operations.

**REFERENCES**


1. Lee, James M., "Biochemical Engineering." PHI, 1st Edition, 1992. Yeh W.K., Yang H.C., James R.M., "Enzyme Technologies: Metagenomics, Biocatalysis and Biosynsthesis", Wiley- Blackwell, 1st Edition, 2010. Blanch H.W., Clark D. S., "Biochemical Engineering", Marcel Dekker, Inc. 2nd Edition, 1997.
2. Palmer, Trevor. "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry." 2nd Edition, East West Press, 2008.


**Course Designers**


| S.No. | Name of the faculty | Designation | Department | Mail ID |
|---|---|---|---|---|
| **1** | Dr.R.Kirubakaran | Assistant Professor | Biotechnology | kirubakaran@vmkvec.edu.in |
| **2** | Dr.M.Sridevi | Professor | Biotechnology | hodbte@vmkvec.edu.in |

| | | CATEGORY | L | T | P | CREDIT |
|---|---|---|---|---|---|---|
| 41421O02 | SUSTAINABLE BUILT ENVIRONMENT | OE-EA | 3 | 0 | 0 | 3 |

**PREAMBLE**

Approaches towards energy saving methods through utilization of sustainable materials. Energy management by monitoring of CO2 consumption and emission in buildings.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | Explaining the role of sustainable architecture to avoid soil erosion & pollution control measures. |
| 2 | Efficiency of waste management with respect to water balance and water efficiency. |
| 3 | Impart knowledge on green concepts in design, construction & operation of buildings. |
| 4 | Intending the exposure to the latest Green Building trends & technologies to the students. |
| 5 | To learn about the importance and Need of Indoor air quality management. |

**COURSE OUTCOMES**

After the successful completion of the course, learner will be able to

| | |
|---|---|
| CO1. Understand the importance of site selection in achieving sustainable environment. | Understand |
| CO2. Applying the efficient water balance concept to achieve the water efficiency. | Apply |
| CO3. Applying the energy efficiency methods to achieve energy efficiency in building. | Apply |
| CO4. Analyzing the sustainable building materials in achieving energy efficiency in building. | Analyze |
| CO5. Analyzing the Internal air quality with respect to the Indian Codes and its Standards. various expression systems. | Analyze |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| COS | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO 7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PS O2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | L | M | L | - | S | - | M | - | - | - | - | L | L | L |
| **CO2** | S | M | L | L | - | S | L | - | - | - | - | - | M | L | -- |
| **CO3** | S | M | M | L | - | S | - | - | - | - | - | - | S | L | -- |
| **CO4** | S | L | S | L | - | S | - | - | M | - | - | - | - | - | M |
| **CO5** | L | M | L | L | - | M | - | - | L | - | - | - | | - | M |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**UNIT I**

**INTRODUCTION TO GREEN BUILDING DESIGN:**

Universal Design: Key accessibility issues and Design guidelines - Integrated Approach for Green Building design: Factors for Site selection, Understanding the importance of Site Ecology & Site Analysis - Microclimate: Factors affecting microclimate & heat Islands - Strategies to handle heat island in built environment, Designing Green Spaces and Enhancing Biodiversity in built environment.

**UNIT II**

**WATER RESOURCE AND WASTEWATER MANAGEMENT**

Rainwater harvesting and utilization, Groundwater recharge techniques: Designconsiderations - Water Balance and approach for water efficiency: 3R Approach for water efficiency – Efficiency towards waste water management - Wastewater treatment & reuse, wastewater treatment technologies.

**UNIT III**

**ENERGY EFFICEINCY IN SUSTAINABLE BUILDINGS**

Introduction, Performance Evaluation and Approach for Energy Efficiency in Buildings - Energy Efficiency Standards & Codes: ECBC 2017 & EPI, ASHRAE 90.1, ASHRAE 62.1,ASHRAE 55, ASHARE 170, ISHRAE 1001, Star labelling for appliances - Efficient Building Envelope: Heating loads in buildings, Building orientation and form,Envelope Heat Transfer & Material Specifications.

**UNIT IV**

## SUSTAINABLE BUILDING MATERIALS

Attributes of Sustainable Building Materials: Recycled content, Regional material, Renewable material, Embodied energy, Embodied carbon, Material performance, Recyclability, Elimination of hazardous materials - Waste management during construction & post-occupancy: Segregation strategies, Types of waste management – organic, inorganic, e-waste, hazardous waste.

**UNIT V**

## INDOOR ENVIRONMENTAL QUALITY

Indoor Air quality: Codes and Standards, Fresh air requirements, Design considerations - Approach for improving Indoor air quality: Measures to reduce sick building syndrome,Demand control ventilation, CO2 monitoring in buildings, Air quality monitoring - Enhancing occupants Comfort, Health and Wellbeing: Thermal Comfort, Visual Comfort, Acoustics, Ergonomics, Olfactory Comfort.

**TEXT BOOKS:**


1. Guide on Green BuiltEnvironment, IGBC, 2021.
2. IGBC Green Homes ratingsystem, IGBC, 2019.
3. IGBC Green New Buildingsrating system, IGBC, 2016.


**REFERENCES:**


1. ECBC, Bureau ofEnergy Efficiency, 2017.
2. National Building Code, Bureau ofIndian Standards, Bureau of Indian Standards, 2016.
3. ASHRAE 90.1, 62.1, 55, ASHRAE, 2010.


**COURSE DESIGNERS**


| S.NO. | NAME OF THE FACULTY | DESIGNATION | DEPARTMENT | MAIL ID |
|---|---|---|---|---|
| 1 | Dr.S.P.Sangeetha | Professor | Civil | sangeetha@avit.ac.in |

| 45121O02 | ADVANCED CYBER SECURITY | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| | | OE-EA | 3 | 0 | 0 | 3 |

**PREAMBLE**

To understand the need for Cyber Security in real time and to study techniques involved in it.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| **1.** | To understand the basic terminologies related to cyber security and current cyber security threat landscape. |
| **2.** | To unserstand the cyberattacks that target computers, mobiles and persons. |
| **3.** | To understand the legal framework that exist in India for cybercrimes and penalties and punishments for such crimes. |
| **4.** | To study the data privacy and security issues related to Social media platforms. |
| **5.** | To understand the main components of cyber security plan. |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| **CO1:** able to understand the basic terminologies related to cyber security and curre cyber security threat landscape. | Understand |
| **CO2:** Able to complete understanding of the cyberattacks that target computers, mobiles and persons | Apply |
| **CO3:** able to understand the legal framework that exist in India for cybercrimes and penalties and punishments for such crimes, It will also expose students to limitations of existing IT Act,2000 legal framework that is followed in other countries and legal and ethical aspects related to new technologies. | Apply |
| **CO4**: Able to get insight into the Data Protection Bill,2019 and data privacy and security issues related to Social media platforms. | Apply |
| **CO5:** Able to understand the main components of cyber security plan. | Apply |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| COs | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO1 2 | PS O1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | M | M | M | M | - | - | - | - | - | - | - | - | M | M | M |
| **CO2** | M | M | M | M | M | - | - | - | - | - | - | - | M | M | M |
| **CO3** | M | M | S | M | M | - | - | - | - | - | - | - | M | M | M |
| **CO4** | S | M | M | M | | - | - | - | - | - | - | - | M | M | S |
| **CO5** | S | M | M | M | S | - | - | - | - | - | - | - | M | M | S |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

| **OVERVIEW OF CYBER SECURITY** | **9 hours** |
|---|---|
| Cyber security increasing threat landscape, Cyber security terminologies- Cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker., Non-state actors, Cyber terrorism, Protection of end user machine, Critical IT and National Critical Infrastructure, Cyberwarfare, Case Studies. | |
| **CYBERCRIMES** | **9 hours** |
| Cybercrimes targeting Computer systems and Mobiles- data diddling attacks, spyware, logic bombs, DoS, DDoS, APTs, virus, Trojans, ransomware, data breach., Online scams and frauds- email scams, Phishing, Vishing, Smishing, Online job fraud, Online sextortion, Debit/ credit card fraud, Online payment fraud, Cyberbullying, website defacement, Cybersquatting, Pharming, Cyber espionage, Cryptojacking, Darknet- illegal trades, drug trafficking, human trafficking., Social Media Scams & Frauds- impersonation, identity theft, job scams, misinformation, fake newscyber crime against persons - cyber grooming, child pornography, cyber stalking., Social Engineering attacks, Cyber Police stations, Crime reporting procedure, Case studies. | |
| **CYBER LAW** | **9 hours** |
| Cybercrime and legal landscape around the world, IT Act,2000 and its amendments. Limitations of IT Act, 2000. Cybercrime and punishments, Cyber Laws and Legal and ethical aspects related to new technologies- AI/ML, IoT, Blockchain, Darknet and Social media, Cyber Laws of other countries, Case Studies. | |
| **DATA PRIVACY AND DATA SECURITY** | **9 hours** |
| Defining data, meta-data, big data, nonpersonal data. Data protection, Data privacy and data security, Personal Data Protection Bill and its compliance, Data protection principles, Big data security issues and challenges, Data protection regulations of other countries- General Data Protection Regulations (GDPR),2016 Personal Information Protection and Electronic Documents Act (PIPEDA)., Social media- data privacy and security issues. | |
| **CYBER SECURITY MANAGEMENT, COMPLIANCE AND GOVERNANCE** | **9 HOURS** |
| Cyber security Plan- cyber security policy, cyber crises management plan., Business continuity, Risk assessment, Types of security controls and their goals, Cyber security audit and compliance, National cyber security policy and strategy. | |
| **REFERENCES** | |
| 1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina God bole, Wiley India Pvt. Ltd.<br>2. Information Warfare and Security by Dorothy F. Denning, Addison Wesley.<br>3. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.<br>4. Data Privacy Principles and Practice by Natraj Venkataramanan and Ashwin Shriram, CRC Press.<br>5. Information Security Governance, Guidance for Information Security Managers by W. Krag Brothy, 1st Edition, Wiley Publication.<br>6. Auditing IT Infrastructures for Compliance by Martin Weiss, Michael G. Solomon, 2nd Edition, Jones Bartlett Learning. | |

**COURSE DESIGNERS**

| Sl.No | Name of the Faculty | Designation | Department | Mail ID |
|---|---|---|---|---|
| 1 | Dr.R.Jaichandran | Assistant Professor G-II | CSE | rjaichandran@avit.ac.in |
| 2 | Mr.B.Sundharamurthy | Assistant Professor | CSE | sundharamurthy@vmkvec.edu.in |

| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **43321O01** | **BIO MEMS** | **OE-EA** | **3** | **0** | **0** | **3** |

**PREAMBLE**

The rapid development of the integrated circuit (IC) industry has led to the emergence of microelectronics process engineering as a new advanced discipline. The combination of MEMS and integrated intelligence has been put forward as a disruptive technology. Gives brief knowledge about applications of Bio-MEMS technology for therapeutics and diagnostics.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | To train the students in the design aspects of Bio MEMS devices and Systems. |
| 2 | To learn the basic principles of BioMEMS/Microfluidic device manufacturing. |
| 3 | To make the students aware of applications in various medical specialists especially the Comparison of conventions methods and Bio MEMS usage. |
| 4 | To Classify the different mechanisms of micro sensors and actuators. |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| CO1 Understand the Micro fluidic Principles and study its applications. | Understand |
| CO2 Explain the principles and applications of Micro Total Analysis. | Understand |
| CO3 Discuss and realize the MEMS applications in Bio Medical Engineering | Understand |
| CO4 Classifying the principles of Micro Actuators and Drug Delivery system | Apply |
| CO5 Utilizing the concept of MEMS with biological applications | Analyze |

| MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO 3** |
| **CO1** | S | L | L | L | L | - | - | - | - | - | - | - | - | - | - |
| **CO2** | S | L | L | L | M | - | - | - | - | - | - | - | - | - | - |
| **CO3** | S | L | M | L | M | - | - | - | - | - | - | - | - | L | - |
| **CO4** | S | M | M | L | M | - | - | - | - | - | - | L | L | L | - |
| **CO5** | S | S | M | L | M | - | - | - | - | - | - | L | L | L | - |
| **S- Strong; M-Medium; L-Low** | | | | | | | | | | | | | | | |

**SYLLABUS**

**Unit I**

Introduction-The driving force behind Biomedical Applications – Biocompatibility - Reliability Considerations-Regularity Considerations – Organizations - Education of Bio MEMS-Silicon Micro fabrication-Soft Fabrication techniques

**Unit II**

Micro fluidic Principles- Introduction-Transport Processes- Electro kinetic Phenomena-Micro valves –Micro mixers- Micro pumps.

**Unit III**

SENSOR PRINCIPLES and MICRO SENSORS: Introduction-Fabrication-Basic Sensors-Optical fibers-Piezo electricity and SAW devices-Electrochemical detection-Applications in Medicine

**Unit IV**

MICRO ACTUATORS and DRUG DELIVERY: Introduction-Activation Methods-Micro actuators for Micro fluidics-equivalent circuit representation-Drug Delivery

**Unit V**

MICRO TOTAL ANALYSIS: Lab on Chip-Capillary Electrophoresis Arrays-cell, molecule and Particle Handling-Surface Modification-Microsphere-Cell based Bioassay Systems Detection and Measurement Methods-Emerging Bio MEMS Technology-Packaging, Power, Data and RF Safety-Biocompatibility, Standards

**Text Books/ References Books**


1. Steven S. Saliterman, Fundamentals of Bio MEMS and Medical Micro devices, Wiley Interscience, 2006.
2. Albert Folch, Introduction to Bio MEMS, CRC Press, 2012
3. Gerald A. Urban, Bio MEMS, Springer, 2006
4. Wanjun wang, steven A. Soper, Bio MEMS, 2006.
5. M. J. Madou, “Fundamentals of Micro fabrication”,2002.
6. G.T. A. Kovacs, “Micro machined Transducers Sourcebook”, 1998.

| COURSE DESIGNERS | | | | |
|---|---|---|---|---|
| **S.No** | **Name of the Faculty** | **Designation** | **Department** | **Mail ID** |
| **1** | Mrs.A.Malarvizhi | Assistant Professor | ECE | malarvizhi@vmkvec.edu.in |
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| 44721O01 | SOLAR AND ENERGY STORAGE SYSTEMS | CATEGORY | L | T | P | C |
|---|---|---|---|---|---|---|
| | | OE-EA | 3 | 0 | 0 | 3 |

**PREAMBLE**

This subject deals with the general concept of Solar and Energy Storage Systems, and improvement.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1. | To explain basics of solar photovoltaic systems and energy storage system. |
| 2. | To understand the concepts and various components of stand-alone system. |
| 3. | To gain the sound knowledge about grid connected PV system. |
| 4. | To know the design of various PV-interconnected systems. |
| 5. | To provide the knowledge about the various applications of solar system. |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| CO1: Describe the basics of solar system. | Understand |
| CO2: Recognize the concepts of standalone PV system. | Analyze |
| CO3: Design the grid connected system for various applications. | Analyze |
| CO4: Select the suitable storage system for particular applications. | Analysis |
| CO5: Recognize the various applications of solar system. | Create |

**Mapping with programme outcomes and programme specific outcomes**

| COS | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | S | M | - | - | M | S | S | M | - | - | L | - | M | - | M |
| CO2 | S | S | - | - | M | S | S | M | - | - | L | - | L | - | L |
| CO3 | S | S | L | - | S | S | S | M | - | - | M | - | M | L | L |
| CO4 | S | M | L | M | S | S | M | M | - | - | M | - | M | - | - |
| CO5 | S | M | L | M | S | S | M | L | L | - | M | - | M | - | M |

**S-STRONG, M-MEDIUM, L-LOW**

**SYLLABUS**

**INTRODUCTION**

Characteristics of sunlight: the sun and its radiation, Solar radiation, Direct and diffusion radiation, greenhouse effect, solar isolation data and estimation-semiconductors and P-N junctions: semiconductors and types, absorption of light, recombination and PN junctions –behavior of solar cells – cell properties: efficiency and losses, Top contact design, Laser grooved, Buried contact solar cell – PV cell interconnection: Module and circuit design, Environmental and thermal protection.

**STAND-ALONE PV SYSTEM**

Solar modules – storage systems: Types, applications, requirements, efficiency, Lead acid batteries – power conditioning and regulation: Diodes, Regulators, Inverters- Balance of system components - protection – standalone PV systems design – sizing: Reliability maps, sizing for high reliability, existing methods.

**GRID CONNECTED PV SYSTEMS**

PV systems in buildings – Utility applications for photo voltaic – design issues for central power stations – safety– Economic aspect – Efficiency and performance - International PV programs – Integration of PV and Wind –Indian Specific Standard for Integration.

**ENERGY STORAGE SYSTEMS**

Impact of intermittent generation: Wind, gas and coal integration, impacts of cycling, PSCO case studies – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage.

**APPLICATIONS**

Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications.

**Total Hours = 45**

**Text book(s):**

1. Solar Energy – S.P. Sukhatme, Tata McGraw Hill, 2017.
2. Stuart R. Wenham, Martin A. Green, Muriel E. Watt and Richard Corkish, “Applied Photovoltaics”, 2011.

**Reference(s):**

1. Frank S. Barnes & Jonah G. Levine, “Large Energy storage Systems Handbook”, CRC Press, 2017.
2. S. Sumathi, “Solar PV and Wind Energy Conversion Systems (Green Energy and Technology)”, L. Ashok Kumar, P. Surekha, 2015.
3.https://nptel.ac.in/courses/112/105/112105051/
4.https://nptel.ac.in/content/storage2/courses/108103009/download/M9.pdf

**COURSE DESIGNERS**



| Sl.No | Name of the faculty | Designation | Department | Mail-id |
|---|---|---|---|---|
| 1 | Mr.A.Balamurugan | AP | EEE | balamurugan@vmkvec.edu.in |
| 2 | Mr.V.Rattan Kumar | AP(Gr-II) | EEE | rattankumar@avit.ac.in |

44121O01

**Operations Research**

| Category | L | T | P | Credit |
|---|---|---|---|---|
| OE-EA | 2 | 1 | 0 | 3 |

## Preamble

Operations Research is the study of optimization techniques. It is applied in decision theory. Rapid development and invention of new techniques occurred since the World War II essentially, because of the necessary to win the war with the limited resources available. It is applied for solving Inventory control problems, Maintenance and Replacement problems, Sequencing and Scheduling problems, Assignment of Jobs to applicants, Transportation problems, Network problems and Decision models. Entire subject is useful for all resource managers of various fields.

## Prerequisite

Nil

## Course Objectives

| |
|---|
| 1. Develop linear programming problems and find solutions of LPP and apply in management decisions. |
| 2. To acquire knowledge of linear programming, assignment and transportation problems. |
| 3. Techniques of PERT, CPM and sequencing. |
| 4. Detailed knowledge of Inventory control. |
| 5. Decision theory and Game theory techniques. |

## Course Outcomes

On the successful completion of the course, students will be able to

| | |
|---|---|
| CO1.Formulate the LPP. Conceptualize the feasible region. Solve the LPP with two variables using graphical method and By simplex method. | Understand& Apply |
| CO2. Become familiar with the types of problems that can be solved by applying a transportation model. Be able to identify the special features of the assignment problem. | Apply |
| CO3. Solve network problems using CPM and PERT techniques and apply sequencing model. | Apply |
| CO4. Determine the order quantity. Determine the reorder point and safety stock for inventory systems. Design a continuous or periodic review inventory control system. | Apply |
| CO5. Apply replacement models. To make decisions in a competitive Environment it is a very common and important one. | Apply |

## Mapping with Programme Outcomes and Programme Specific Outcomes

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | L | -- | S | -- | -- | S | -- | -- | -- | -- |
| **CO2** | S | M | L | -- | S | -- | -- | S | -- | -- | -- | -- |
| **CO3** | S | M | L | -- | S | -- | -- | S | -- | -- | -- | -- |
| **CO4** | S | S | L | -- | M | -- | -- | S | -- | -- | -- | -- |
| **CO5** | S | S | L | -- | M | -- | -- | S | -- | -- | -- | -- |

**S- Strong; M-Medium; L-Low**

## SYLLABUS

### LINEAR PROGRAMMING

Linear programming problem – Graphical method - Simplex method – Big M method – Duality principle.

### TRANSPORTATION MODEL

Transportations problem – Assignment problem – Under Assignment -Travelling salesman problem

### NETWORK MODEL

Project Network – CPM and PERT Networks – Critical path scheduling – Sequencing Models.

### INVENTORY MODELS

Inventory Model – Economic Order Quantity Model – Purchasing Model (with and without shortages) – Manufacturing Model (with and without shortages) - Stochastic Inventory Model (Stock in discrete and continuous units).

### DECISION MODEL

Decision Model – Game theory – Two Person Zero sum game – Algebraic solutions Graphical solutions – Replacement model – Model based on Service life – Economic life single / multivariable search technique.

## Text Books

1. H.A.Taha, "Operations Research",Prentice Hall of India , 1999, Six Edition.
2. KantiSwarup,P.K.Gupta,Man Mohan, SultanChand& Sons, New Delhi(2010)

## Reference Books

1. Sundarasen.V, Ganapathysubramaniyam . K.S. Ganesan.K. "Operations Research", A.R. Publications.
2. Premkumar Gupta, Hira, "Operations Research" Chand & company New Delhi.

## Assessment Pattern/Assessment Methods

| Bloom's Category | Continuous Assessment Tests | | | Terminal Examination |
|---|---|---|---|---|
| | 1 | 2 | 3 | |
| Remember | 20 | 10 | 10 | 0 |
| Understand | 20 | 30 | 30 | 30 |
| Apply | 60 | 60 | 60 | 70 |
| Analyse | 0 | 0 | 0 | 0 |
| Evaluate | 0 | 0 | 0 | 0 |
| Create | 0 | 0 | 0 | 0 |

## Course Designers:

| S.No | Name of the Faculty | Mail ID |
|---|---|---|
| 1 | V.T.Lakshmi | lak_msc@yahoo.co.in |
| 2 | S.Punitha | puni.jeeju80@gmail.com |

| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| 40221O01 | PROJECT MANAGEMENT FOR ENGINEERING BUSINESS AND TECHNOLOGY | OE-EA | 3 | 0 | 0 | 3 |

**PREAMBLE**

Engineering Project Management is a type of Project Management, focuses solely on engineering and Management. Similar to other Project Management it possess standard methodologies and processes with engineering background. It enables to get into the field of Project Management. These skills can provide critical benefits such as improved efficiency, enhanced effectiveness, success replication, perfect leadership and communication, and complete view of the project in the aspect of time and cost.

**PREREQUISITE**

Not Required

**COURSE OBJECTIVES:**

1. To understand the importance of Project Management.
2. To understand the Project management Techniques.
3. To understand the statistical process control.
4. To impart the various Project management tools and software.
5. To understand the Project management and resource utilization.

**COURSE OUTCOMES:**

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

| | |
|---|---|
| CO1: Understand the importance of Project Management and Business. | Understand |
| CO2: Explain the required tools to implement Project Techniques. | Apply |
| CO3: Analyze various Project constraints with help of project tools. | Analyze |
| CO4: Evaluating various Project Techniques. | Analyze |
| CO5: Put forward the Project management in a different organization milieu. | Evaluate |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | - | - | - | M | - | - | M | S | - | M | M | - | - |
| **CO2** | S | S | M | - | M | M | S | M | S | S | - | - | M | S | M |
| **CO3** | S | M | M | M | S | - | M | M | - | M | - | M | S | M | - |
| **CO4** | M | - | S | - | M | | | S | S | | | M | - | S | - |
| **CO5** | M | M | - | - | M | M | M | S | | S | M | S | M | - | S |

**S- Strong; M-Medium; L-Low**

**SYLLABUS:**

**INTRODUCTION**

Project Management concept-Attributes as a project-Project life cycle-The Project Management process-Benefits of Project Management- Needs, Identification-Project selection-preparing a request for proposal-Soliciting proposals-Proposed solutions- Proposal Marketing-Bid/No-Bid Decision-Developing Winning Proposal-Proposal preparation-Proposal contents-Pricing Consideration-Proposal Submission and Follow-up - Customer evaluation as proposals-Types of contracts-Contract provisions.

**PROJECT PLANNING**

Project Planning-Project Planning Objective-Work Break-down structure-Responsibility Matrix-Defining activities-Developing the network plan-Planning for Information system development- -Scheduling-activity duration estimates-project start and finish times-Schedule calculation-Scheduling for information systems development.

**PROJECT CONTROL PROCESS**

Schedule control-Project control process-Effects of actual schedule performance - Incorporating project changes into schedule-Updating the project schedule-Approaches to schedule control-Schedule control for information system development – Resource consideration-Constrained Planning-Planned resources utilization – Resources levelling- Limited scheduling-Project Management software – Cost Planning and Performance - Project cost Estimates-Project Budgeting-Determining actual cost-Determining the value of work performed-Cost performance analysis-Cost forecasting-Cost control-Managing Cash Flow.

**RISK AND FEASIBILITY**

Benchmarking – Reasons - Process- Quality Function Deployment (QFD) – House of Quality- QFD Process- Benefits- Taguchi Quality Loss Function- Total Productive Maintenance (TPM) – Concept- Improvement Needs- FMEA – Stages of FMEA.

**PROJECT MANAGER SKILLS AND ABILITIES**

Project Manager-Responsibilities of the Project Manager-Skills at the Project Manager - Developing the skill needed to be a Project Manager-Delegation-Managing Change – Project Team-Project Team development and Effectiveness- Ethical Behaviour conflict on project-problem solving-Time Management-Project Communication and Personal Communication-Effective listening-Meetings-Presentation-Report-Project documentation and Controlling changes-Types of project organization- Matrix organization.

**TEXT BOOKS:**


1. Samuel J.Mantel JR., Jack R.Meredith, Project Management, Wiley India, Edition 2006.
2. Santakki.V.C., Project Management, Himalaya Publishing House, Edition 2006.


**REFERENCES:**


1. Project Management, Jack Gido and James P Clements, (Edition 2009) Cenage Learning India pvt Ltd., New Delhi.


**COURSE DESIGNERS:**


| S.No | Name of the Faculty | Designation | Department | mail id |
|---|---|---|---|---|
| 1 | B. Rajnarayanan | Assistant Professor | Management Studies | rajsachin.narayanan@gmail.com |
| 2 | Dr. V.Sheelamary | Asso.Professor | Management Studies | sheelamary@avit.ac.in |

| | | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| **40221RP1** | **PROJECT WORK PHASE I** | **EE-P** | **0** | **0** | **12** | **6** |

**PREAMBLE**

The primary emphasis of the project work phase-I is to understand and gain the knowledge of the principles of Computer Science and Engineering practices, so as to participate and manage main projects in future.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | To import the practical knowledge to the students and also to make them to carry out the technical procedures in their project work. |
| 2 | To provide an exposure to the students to refer, read and review the research articles, journals and conference proceedings relevant to their project work and placing this as their beginning stage for their final presentation. |
| 3 | To understand and gain the knowledge of the principles of engineering practices. |
| 4 | To Get good exposure and command in one or more application areas and on the software. |
| 5 | To participate and manage an innovative, social and economic engineering projects in future. |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| 1. Survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selected topic of research. | Analyze |
| 2. Use different experimental techniques/different software / computational/analytical tools. | Apply |
| 3. Design and develop an experimental set up/ equipment/test rig. | Analyze |
| 4.Conduct tests on existing setups/equipments and draw logical conclusions from the results after analyzing them. | Analyze |
| 5. Work in a research environment or in an industrial environment. | Apply |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| **COS** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | M | L | L | S | M | - | - | S | - | S | M | M | M |
| **CO2** | S | S | M | M | S | M | - | - | S | - | M | S | S | S |
| **CO3** | L | M | L | L | M | M | - | - | M | - | L | M | M | M |
| **CO4** | S | S | M | L | S | M | - | - | S | - | S | M | M | M |
| **CO5** | S | S | S | S | S | S | M | M | M | M | S | M | M | M |

S- Strong; M-Medium; L-Low

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M.E/M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

**COURSE DESIGNERS**

| S.No | Name of the Faculty | Designation | Department/ College | Mail ID |
|---|---|---|---|---|
| **1** | Dr.N.Rajan | Professor & HoD | MECH/VMKVEC | rajan@vmkvec.edu.in |
| **2** | Mr.C.Thiagarajan | Associate Professor | MECH/AVIT | cthiagarajan@avit.ac.in |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **PROJECT** | **Category** | **L** | **T** | **P** | **Credit** |
| **40221RP2** | **WORK PHASE II** | **EE-P** | **0** | **0** | **24** | **12** |

**Prerequisite**
Nil

**Course Objective**

| | |
|---|---|
| 1 | To solve the identified problem based on the formulated methodology. |
| 2 | To develop skills to analyze and discuss the test results, and make conclusions. |

**Course Outcomes: On the successful completion of the course, students will be able to**

| | | |
|---|---|---|
| CO1 | On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering design and find better solutions to it. | Create |

**Mapping with Programme Outcomes and Programme Specific Outcomes**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | S | S | S | M | M | M | M | M | S | S | S | M | S | M | M |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner.

**Course Designers**

| **S.No** | **Faculty Name** | **Designation** | **Departme nt/College** | **Email id** |
|---|---|---|---|---|
| **1** | Mr.A.Elanthirayan | Associate Professor | MECH/AVIT | elanthirayan@avit.ac.in |
| **2** | Mr.J.Santhosh | Assistant Professor | MECH/VMKVEC | santhosh@vmkvec.edu.in |

# MANDATORY/ AUDIT COURSES

| COURSE CODE | COURSE TITLE | CATEGORY | L | T | P | C |
|---|---|---|---|---|---|---|
| 44121Z01 | ENGLISH FOR RESEARCH PAPER WRITING | AC | 0 | 0 | 2 | 0 |

**PREAMBLE**

Since the Research Papers are to be presented /published in English, students should be aware of the Research Methodology and Ethics.

**PREREQUISITE**

**Nil**

**Course Objectives**:

1.Understand the research problem formulation.
2.Need to analyze research-related information.
3.Evaluate and Follow research ethic.
4. Acquire the knowledge of compiling the research documents.
5. Acquire the knowledge of submitting a refined thesis.

**Course Outcomes:**

| Students are able to: | |
|---|---|
| 1. Identify the research gap. | Understand |
| 2. Interpret the research analysis. | Apply |
| 3. Understand the ethical values in organizing a research paper. | Apply |
| 4. Understand how a technical report can be organized. | Apply |
| 5. Understand the format of a thesis. | Apply |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| COS | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | - | - | - | L | L | - | - | - | - | L | L | L | M | - | - |
| CO2 | - | S | - | M | M | - | L | L | - | - | - | - | - | - | - |
| CO3 | - | M | - | L | L | L | - | - | - | S | - | - | - | - | - |
| CO4 | - | L | - | M | - | - | - | - | - | L | - | - | - | - | - |
| CO5 | - | M | - | S | - | - | - | S | - | - | - | - | - | - | - |

**S- Strong; M-Medium; L-Low**

**Syllabus**

**Unit I Research**

Meaning of research problem - Sources of research problem- Criteria Characteristics of agood research problem - Errors in selecting a research problem - Scope and objectives of research problem

**Unit II Data Analysis**

Approaches of investigation of solutions for research problem - data collection, analysis,interpretation - Necessary instrumentations

**Unit III Plagiarism**

Effective literature Reviews - approaches, analysis Plagiarism – Definition of Plagiarism –Consequences of Plagiarism – Unintentional Plagiarism – Forms of Plagiarism -Related Issues - Research ethics

**Unit IV Research Paper Format**

Effective technical writing, how to write reports, Paper Developing a Research Proposal

**Unit V Format**

Format of research proposal – Margin – Text Formatting - Heading and Title – Page Numbers –Tables and Illustrations – Corrections and Insertions –Binding – Bibliography

**Total: 45 Periods**

**TEXT BOOK**

# References


1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction forscience & engineering students”.
2. Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”.
3. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guidefor beginners”.



| **COURSE DESIGNERS** | | | |
|---|---|---|---|
| **COURSE INSTRUCTOR** | **DESIGNATION** | **NAME OF THE INSTITUTION** | **MAIL ID** |
| Dr. Premkishor | Assistant Professor | AVIT | prem.english@avit.ac.in |
| Dr.Jennifer G Joseph | HoD-H&S | AVIT | jennifer@avit.ac.in |

| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **44121Z02** | **DISASTER MITIGATION AND MANAGEMENT** | **AC** | **0** | **0** | **2** | **0** |

**PREAMBLE**

**PREREQUISITE**

NIL

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | To study about the Disaster Management Cycles. |
| 2 | To Study about the Disaster Community and planning. |
| 3 | To Understand the Challenges posed by Disasters to the community. |
| 4 | To study about coping concepts for both natural and manmade disasters. |
| 5 | To study about strengthening techniques for structural and nonstructural measures. |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| **CO1.**Understanding Disasters, man-made Hazards and Vulnerabilities. | Understand and Apply |
| **CO2.** Understanding disaster management mechanism. | Apply |
| **CO3.** To gain knowledge about organizations involved in disaster community. | Apply |
| **CO4.**To build skills to respond to disasters. | Apply |
| **CO5.**Understanding capacity building concepts and planning of disaster managements. | Understand and Apply |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| **COs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO 11** | **PO 12** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | L | L | L | L | L | L | M | L | L | M | L | M | M | L | L | M |
| CO2 | M | M | L | L | M | L | S | L | L | M | M | S | S | L | L | S |
| CO3 | S | M | L | L | M | L | M | L | L | M | S | S | M | L | L | S |
| CO4 | M | M | L | L | M | L | M | L | L | S | S | S | S | L | L | M |
| CO5 | S | S | L | L | S | L | S | L | L | S | M | M | S | L | L | S |

**S-Strong; M-Medium; L-Low**

**SYLLABUS**

**UNIT I INTRODUCTION**

Overview of Disaster Management – Distinguishing between an emergency and a Disaster situation. Disaster Management Cycle – Disaster management Act and Policy in India; Organisational structure for disaster management in India; Preparation of state and district disaster management plans- Phase I: Mitigation, and strategies; hazard Identification and vulnerability analysis. Disaster Mitigation and Infrastructure, impact of disasters on development programmes, vulnerabilities caused by development, developing a draft country-level disaster and development policy Phase II: Preparedness, Disaster Risk Reduction (DRR), Emergency Operation Plan (EOP) Phases III and IV: Response and recovery, Response aims, Response Activities, Modern and traditional responses to disasters, Disaster Recovery, and Plan

**UNIT II DISASTER PLANNING**

Disaster Planning-Disaster Response Personnel and duties, Community Mitigation Goals, Pre-Disaster Mitigation Plan, Personnel Training, Volunteer Assistance, School-based Programmes, Hazardous Materials, Ways of storing and safely handling hazardous materials, Coping with Exposure

.

**UNIT III DISASTER COMMUNITY**

Disaster Community-Community-based Initiatives in Disaster management, need for Community-Based Approach, categories of involved organizations: Government, Nongovernment organizations (NGOs), Regional and International Organizations, Panchayaths, Community Workers, National And Local Disaster Managers, Policy Makers, Grass-Roots Workers, Methods Of Dissemination Of Information, Community-Based Action Plan, Advantages/Disadvantages Of The Community Based Approach

**UNIT IV COPING WITH DISASTER**

Coping Strategies; alternative adjustment processes - Changing Concepts of disaster management - Industrial Safety Plan; Safety norms and survival kits - Mass media and disaster management

**UNIT V CAPACITY BUILDING**

Concept - Structural and Nonstructural Measures Capacity Assessment; Strengthening Capacity for Reducing Risk - Counter-Disaster Resources and their utility in Disaster Management - Legislative Support at the state and national levels

**TEXT BOOKS:**


1. Manual on Disaster Management, National Disaster Management, Agency Govt of India.
2. Ayaz, "Disaster Management: Through the New Millennium", Anmol Publications. (2009)
3. Dave, P. K. "Emergency Medical Services and Disaster Management: A Holistic Approach", New Delhi: Jaypee Brothers Medical Publishers (P) Ltd., 2009
4. Disaster Management by Mrinalini Pandey Wiley 2014.
5. Goel, S. L., "Disaster Management", New Delhi: Deep & Deep Publication Pvt. Ltd. ,2008


**REFERENCE BOOKS:**


1. Narayan, B. "Disaster Management", New Delhi: A.P.H. Publishing Corporation ,2009
2. Kumar, N. "Disaster Management". New Delhi: Alfa Publications. ,2009
3. Ghosh, G. K., "Disaster Management", New Delhi: A.P.H Publishing Corporation.

| S.No | Name of the Faculty | Designation | Name of the College | Mail ID |
|---|---|---|---|---|
| 1 | MrsJ.Srija | Assistant Professor - I | AVIT | srija.civil@avit.ac.in |

| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **44121Z03** | **VALUE EDUCATION** | **AC** | **0** | **0** | **2** | **0** |

**PREAMBLE**

The course highlights the importance of values and ethics for human life and organization.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | To understand value of education and self- development. |
| 2 | To inculcate good values in students to make them patriotic with humanity. |
| 3 | To groom the personality with positive thinking with universal brotherhood and religious tolerance. |
| 4 | To impart the value of true friendship and happiness. |
| 5 | To enhance the character and competence for developing into self-control person. |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| CO1. Identify the value of education and self- development with work ethics. | Remember |
| CO2. Interpret sense of duties with good values in students to make them patriotic with humanity. | Understand |
| CO3. Explain the integration, scientific attitude, overall personality with labor dignity. | Understand |
| CO4. Discuss the value of true friendship and happiness. | Understand |
| CO5. Paraphrase the character and competence for developing into self-control person. | Understand |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| COS | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | L | L | - | - | - | - | - | S | - | L | - | - | - | - | - |
| CO2 | L | L | - | - | - | - | - | M | - | - | - | - | - | - | - |
| CO3 | L | L | M | - | - | - | - | M | - | - | - | L | L | L | - |
| CO4 | L | S | - | - | - | - | - | M | - | - | - | - | - | - | - |
| CO5 | L | S | M | - | - | - | - | M | - | L | - | - | L | L | - |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**Unit I**

Values and self-development –Social values and individual attitudes, Work ethics, Indian vision of humanism, Moraland non- moral valuation. Standards and principles, value judgements

**Unit II**

Importance of cultivation of values, Sense of duty. Devotion, Self-reliance. Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity. Power of faith, National Unity, Patriotism, Love for nature, Discipline

**Unit III**

Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking. Integrity and discipline., Punctuality, Love and Kindness, avoid fault Thinking, Free from anger, Dignity of labor, Universal brotherhood and religious tolerance

**Unit IV**

True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation,doing best for saving nature

**Unit V**

Character and Competence –Holy books vs Blind faith, Self-management and good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of Women, all religions and same message, mind your Mind, Self-control, Honesty, Studying effectively

**Text Books/ References Books:**

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, NewDelhi

**COURSE DESIGNERS**

| S.No | Name of the Faculty | Designation | Department | Mail ID |
|---|---|---|---|---|
| | | | | |

| Course Code | Course Title | Category | L | T | P | C |
|---|---|---|---|---|---|---|
| 44121Z04 | CONSTITUTION OF INDIA | AC | 0 | 0 | 2 | 0 |

**Course Objectives:**

On completion of this course, the students will be able:

1 To understand the nature and the Philosophy of the Constitution.

2 To understand the outstanding Features of the Indian Constitution and Nature of the Federal system.

3 To analyse Panchayat Raj institutions as a tool of decentralization.

4 To understand and analyse the three wings of the state in the contemporary scenario.

5 To analyse Role of Adjudicatory Process.

6 To understand and Evaluate the recent trends in the Indian Judiciary.

**Course Content**

**UNIT I**

**The Constitution - Introduction**

The Historical background and making of the Indian Constitution –Features of the Indian Constitution- Preamble and the Basic Structure - Fundamental Rights and Fundamental Duties – Directive Principles State Policy

**UNIT II –Government of the Union**

The Union Executive- Powers and duties of President –Prime Minister and Council of Ministers - Lok Sabha and Rajya Sabha

**UNIT III –Government of the States**

The Governor –Role and Powers - Chief Minister and Council of Ministers- State Legislature

**UNIT IV – Local Government**

The New system of Panchayats, Municipalities and Co-Operative Societies

**UNIT V – Elections**

Powers of Legislature -Role of Chief Election Commissioner-State Election Commission

**TEXTBOOKS AND REFERENCE BOOKS:**

1 Ethics and Politics of the Indian Constitution Rajeev Bhargava Oxford University Press, New Delhi, 2008
2 The Constitution of India B.L. Fadia Sahitya Bhawan; New edition (2017)
3 Introduction to the Constitution of India DD Basu Lexis Nexis; Twenty-Fourth 2020 edition Suggested.

**Total Hours: 30 hours**

**Software/Learning Websites:**

1. https://www.constitution.org/cons/india/const.html

2. http://www.legislative.gov.in/constitution-of-india

3. https://www.sci.gov.in/constitution

**4.** https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of india/ **Alternative NPTEL/SWAYAM Course:**

| S.NO | NPTEL ID | NPTEL Course Title | Course Instructor |
|---|---|---|---|
| **1** | 12910600 | CONSTITUTION OF INDIA AND ENVIRONMENTAL GOVERNANCE: ADMINISTRATIVE AND ADJUDICATORY PROCESS | PROF. M. K. RAMESH NATIONAL LAW SCHOOL OF INDIA UNIVERSITY |

| **COURSE DESIGNER** | | | | |
|---|---|---|---|---|
| **S.NO** | **NAME OF THE FACULTY** | **DESIGNATION** | **NAME OF THE INSTITUTION** | **MAIL ID** |
| 1 | Dr.Sudheer | Principal | AV School of Law | Sudheersurya18@gmail.com |

| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **44121Z05** | **PEDAGOGY STUDIES** | **AC** | **0** | **0** | **2** | **0** |

**PREAMBLE**

The course is designed to provide pedagogical practices towards academic, research activities and professional developments.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | To provide theories and methodologies related to curriculum development and research framework |
| 2 | To familiarize with pedagogical practices in formal and informal classrooms in developing countries |
| 3 | To identify evidence on the effectiveness of the pedagogical practices for enhancing teaching and learning methods |
| 4 | To understand the learning and resource barriers while handling large classes |
| 5 | To identify critical evidence gaps to guide the development |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| CO1.Identify theories and methodologies related to curriculum development and research framework | Remember |
| CO2.Interpret pedagogical practices in formaland informal classrooms in developing countries | Understand |
| CO3.Draw a chart on the effectiveness of the pedagogical practices for enhancing teaching and learning methods | Apply |
| CO4.Explore the learning and resource barriers while handling large classes | Analyze |
| CO5.Examine critical evidence gaps to guide the development | Analyze |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| COS | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | L | L | - | - | - | - | - | - | - | L | - | - | - | - | - |
| CO2 | L | L | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO3 | L | L | M | - | - | - | - | - | - | - | - | L | L | L | - |
| CO4 | L | S | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO5 | L | S | M | - | - | - | - | - | - | L | - | - | L | L | - |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**Unit I**

Introduction and Methodology, Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and searching.

**Unit II**

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

**Unit III**

Evidence on the effectiveness of pedagogical practices, Methodology for the in-depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy, Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.

**Unit IV**

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

**Unit V**

Research gaps and future directions, Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

**Text Books/ References Books:**


1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project(MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.

| COURSE DESIGNERS | | | | |
|---|---|---|---|---|
| **Sl.No** | **Name of the Faculty** | **Designation** | **Department** | **Mail ID** |
| | | | | |
| | | | | |

| | | Category | L | T | P | Credit |
|---|---|---|---|---|---|---|
| **44121Z06** | **PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTEN SKILLS** | **AC** | **0** | **0** | **2** | **0** |

**PREAMBLE**

The main objective of the course is to develop the personality and achieve the highest goal in life so as to lead the nation with mankind and prosperity.

**PREREQUISITE**

Nil

**COURSE OBJECTIVES**

| | |
|---|---|
| 1 | To learn to achieve the highest goal happily. |
| 2 | To become a person with stable mind, pleasing personality and determination. |
| 3 | To awaken wisdom in students. |

**COURSE OUTCOMES**

On the successful completion of the course, students will be able to

| | |
|---|---|
| CO1. Classify the development of versatile personality of students. | Understand |
| CO2. Extract the information from Bhagwad-Geeta to lead the nation and mankind with peace and prosperity. | Understand |
| CO3. Paraphrase the information from Neetishatakam to develop inter-personality skills. | Understand |
| CO4. Articulate the highest goal in life. | Apply |

**MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES**

| COS | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 0 | PO11 | PO1 2 | PSO 1 | PSO 2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | L | M | - | - | - | - | - | - | | - | - | - | - | - | S |
| CO2 | L | M | - | - | M | - | - | - | M | - | - | - | - | - | S |
| CO3 | L | M | - | - | M | - | - | - | M | - | - | - | - | - | S |
| CO4 | L | M | - | - | M | - | - | - | M | - | - | - | - | - | S |

**S- Strong; M-Medium; L-Low**

**SYLLABUS**

**Unit I**

Neetisatakam-Holistic development of personality, Verses- 19,20,21,22 (wisdom), Verses- 29,31,32 (pride & heroism),Verses- 26,28,63,65 (virtue)

**Unit II**

Approach to day to day work and duties, Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21,27, 35, Chapter 6-Verses 5,13,17,23, 35, Chapter 18-Verses 45, 46, 48.

**Unit III**

Statements of basic knowledge, Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68, Chapter 12 -Verses 13, 14,15,16,17, 18, Personality of Role model.

**Unit IV**

Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39, Chapter18- Verses 37,38,63

**Unit V**

Verses- 52,53,59 (dont's), Verses- 71,73,75,78 (do's)

**Text Books/ References Books:**


1. "Srimad Bhagavad Gita" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.


**COURSE DESIGNERS**

| Sl.No | Name of the Faculty | Designation | Department | Mail ID |
|---|---|---|---|---|
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