# SYLLABUS

**With effect from 2015-2016**

**Outcome Based Education and Choice Based Credit System**

# ಪಠ್ಯಕ್ರಮ

**ಶೈಕ್ಷಣಿಕ ವರ್ಷ 2015–16**

**ಫಲಿತಾಂಶ ಆಧಾರಿತ ಶಿಕ್ಷಣ ಹಾಗೂ ಐಚ್ಛಿಕ ವಿಷಯಾಧಾರಿತ ಗಳಿಕೆ ಪದ್ಧತಿ**

## V and VI Semester

## BACHELOR DEGREE
## IN
## INDUSTRIAL & PRODUCTION ENGINEERING

# P.E.S. College of Engineering

Mandya - 571 401, Karnataka
(An Autonomous Institution under VTU, Belagavi)

# ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

**ಮಂಡ್ಯ–571 401, ಕರ್ನಾಟಕ**

**(ವಿ.ಟಿ.ಯು, ಬೆಳಗಾವಿ ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)**

# Preface

PES College of Engineering, Mandya, started in the year 1962, has become autonomous in the academic year 2008-09. Since, then it has been doing the academic and examination activities successfully. The college is running **Eight undergraduate** and **Eight Postgraduate** programs. It consists of Six M.Tech programs and other two postgraduate programs are MBA and MCA, which are affiliated to VTU.

India has recently become a Permanent Member by signing the Washington Accord. The accord was signed by the National Board of Accreditation (NBA) on behalf of India on 13th June 2014. It enables not only the mobility of our degree globally but also establishes equivalence to our degrees with that of the member nations such as Taiwan, Hong Kong, Ireland, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, Australia, Canada and Japan. Among other signatories to the international agreement are the US and the UK. Implementation of Outcome Based Education (OBE) has been the core issue for enabling the equivalence and of Indian degrees and their mobility across the countries.

*Our Higher Educational Institution has adopted the Choice Based Credit System* (*CBCS) based semester structure with OBE scheme and grading system.*

The credit based OBE semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching.

The OBE, emphasize on setting clear standards for observable, measurable outcomes of programs in stages. There lies a shift in thinking, teaching and learning processes moving towards Students Centric from Teacher Centric education. OBE standards focus on mathematics, language, science, attitudes, social skills & moral values.

The key features which may be used to judge, if a system has implemented an outcome based education system is mainly Standard based assessments that determines whether the students have achieved the stated standard. Assessments may take any form, so long as the process actually measure whether the student knows the required information or can perform the required task. Outcome based education is a commitment that all students of all groups will ultimately reach the same minimum standards. Outcome Based Education is a method or means which begins with the end in mind and constantly emphasizes continuous improvement.

Choice Based Credit System (CBCS) provides choice for students to select from the prescribed courses (core, Foundation, Foundation Elective, elective, open elective and minor or soft skill courses). The CBCS provides a 'cafeteria' type approach in which the students can Choose electives from a wide range of courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, adopt an interdisciplinary approach to learning which enables integration of concepts, theories, techniques, and, perspectives from two or more disciplines to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline. These greatly enhance the skill/employability of students.

In order to increase the Industry/Corporate readiness, many Soft Skills and Personality Development modules have been added to the existing curriculum of the 2015 scheme. Industry Interactions have been made compulsory to enhance the field experience. In order to enhance creativity and innovation Mini Project and Industrial visit & Interaction are included in all undergraduate programs.

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Deputy Dean (Academic)
Associate Professor,
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Dean (Academic)
Professor,
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## Vision and Mission of the Institution

# Vision

**"PESCE shall be a leading institution imparting quality engineering and management education developing creative and socially responsible professionals."**

# Mission

- Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching-learning practices.
- Impart engineering and managerial skills through competent and committed faculty using outcome based educational curriculum.
- Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs.
- Promote research, product development and industry-institution interaction.

## DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING

### About The Department

The Department of Industrial & Production Engineering was started during the year 1982 with a mission to produce the students of good management skill to cater the need of the advanced and globalized market which demand quality management people. The program offered in the department is B.E. in Industrial & Production Engineering. The department has very well experienced qualified teaching faculty among which three doctoral degree holders one is submitting his thesis and two are pursuing Post graduate courses.

The department strives hard to bring out well qualified students through all the available sources of teaching audio visual, interactive methods in teaching-learning process. The department has well-equipped laboratories, latest software facilities, to prepare the students industry ready when they become graduates.

The curriculum is designed involving industry, academia personnel to meet the demands of the current scenario and updated constantly according to industrial needs. The department regularly organizes technical talks by inviting experts from various industries and institutes, organizes industrial visits to enhance the practical knowledge of the students.

### Vision and Mission of the Department

- **VISION**

Contribute to achieve or pursue academic excellence for imparting quality education in I & P Engineering and to carry out the research activity on continuous basis to develop competent and social responsible engineers and managers.

- **MISSION**

1. To educate them in the fundamental concept, knowledge, skills in theory and practices.
2. To prepare them through skilled programmes for better Employment as engineers and managers or pursuit of advanced degrees in Industrial, Production and Mechanical Engineering fields.
3. To inculcate qualities of communication skills, professional personality and ethical values to make them the responsible and competent professionals.

## Program Educational Objectives (PEO)

**PEO1:** Industrial and Production Engineering program will prepare graduates who will have the ability to apply the principles and techniques of traditional and modern quantitative, qualitative analysis, synthesis and effectively interpret, evaluate, select, and communicate the desired alternative in both manufacturing and service industries.

**PEO2:** Industrial and Production Engineering program will prepare its graduates who will possess the required engineering competence in industrial engineering, production engineering and managerial skills.

**PEO3:** Industrial and Production Engineering program will prepare graduates, who possess communication skills, professional personality and ethical.

## Program Outcomes

**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.

## Program Specific Outcomes (PSOs):

**PSO 1**: Industrial & Production Engineering graduates will be able to apply the knowledge acquired in the program about materials and finishing process.

**PSO2:** Industrial & Production Engineering graduates will be able design product based on Ergonomic Principles

## SCHEME OF TEACHING AND EXAMINATION
## V Semester B. E. (I&P E)

| Sl No | Subject Code | Subject Title | Teaching Department | Total Credit | Teaching Hours / Week | Examination Duration / Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | L: T: P : H | CIE | SEE | Total |
| 1 | P15IP51 | Management & Entrepreneurship | IP | 4 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 2 | P15IP52 | Work Study and Ergonomics | IP | 4 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 3 | P15IP53 | Design of Machine Elements | IP | 4 | 3 : 2 : 0 : 5 | 50 | 50 | 100 |
| 4 | P15IP54 | Computer Aided Design and Manufacturing **(FC-I)** | IP | 4 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 5 | P15IP55 | **Foundation Elective** | IP | 3 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 6 | P15IP56 | **Elective-1** | IP | 3 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 7 | P15IPL57 | Mechanical Engineering Lab | IP | 1.5 | 0 : 0 : 3 : 3 | 50 | 50 | 100 |
| 8 | P15IPL58 | Computer Aided Drafting and Geometric Modelling Lab | IP | 1.5 | 0 : 0 : 3 : 3 | 50 | 50 | 100 |
| 9 | P15IP59 | Industrial Visit & Interaction | IP | 1 | 0 : 0 : 2 : 2 | 50 | -- | 50 |
| 10 | P15IP510 | Aptitude and Reasoning Development - Advanced (ARDA) | HS & M | 1 | 2 : 0 : 0 : 2 | 50 | 50 | 100 |
| **Total** | | | | **27** | | **500** | **450** | **950** |

| **Foundation Elective** | | | **Elective-1** | | |
|---|---|---|---|---|---|
| **Sl No** | **Course Code** | **Course Title** | **Sl No** | **Course Code** | **Course Title** |
| 1 | P15IP551 | Control Engineering and Machine Tool Technology | 1 | P15IP561 | Composite Material |
| 2 | P15IP552 | Advance Joining Process and NDT | 2 | P15IP562 | Industrial Robotics |
| 3 | P15IP553 | Design of Experiments | 3 | P15IP563 | Computer Integrated Manufacturing |
| 4 | P15IP554 | Finite Element Method | 4 | P15IP564 | Simulation Modelling and Analysis |

| SCHEME OF TEACHING AND EXAMINATION<br>VI Semester B. E. (I&P E) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Sl No** | **Subject Code** | **Subject Title** | **Teaching Department** | **Total Credit** | **Teaching Hours / Week** | **Examination Duration / Marks** | | |
| | | | | | | **CIE** | **SEE** | **Total** |
| | | | | | **L: T: P : H** | | | |
| 1 | P15IP61 | Theory of Metal Cutting | IP | 4 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 2 | P15IP62 | Theory of Metal Forming | IP | 4 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 3 | P15IP63 | Quality Assurance and Reliability | IP | 4 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 4 | P15IP64 | Economics for Engineers **(FC-II)** | IP | 4 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 5 | P15IP65 | **Elective - II** | IP | 3 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 6 | P15IP66 | **Elective - III** | IP | 3 | 4 : 0 : 0 : 4 | 50 | 50 | 100 |
| 7 | P15IPL67 | Industrial Engineering Lab | IP | 1.5 | 0 : 0 : 3 : 3 | 50 | 50 | 100 |
| 8 | P15IPL68 | Computer Aided Analysis Lab | IP | 1.5 | 0 : 0 : 3 : 3 | 50 | 50 | 100 |
| 9 | P15IP69 | Mini Project | IP | 1 | 0 : 0 : 2 : 2 | 50 | -- | 50 |
| 10 | P15HU610 | Aptitude and Reasoning Development - EXPERT(ARDE) | HS&M | 1 | 2 : 0 : 0 : 2 | 50 | 50 | 100 |
| **Total** | | | | **27** | | **500** | **450** | **950** |

| **Elective -II** | | | **Elective - III** | | |
|---|---|---|---|---|---|
| **Sl No** | **Course Code** | **Course Title** | **Sl No** | **Course Code** | **Course Title** |
| 1 | P15IP651 | Modern Machining Methods | 1 | P15IP661 | Enterprise Resource Planning |
| 2 | P15IP652 | Mechanical Vibration | 2 | P15IP662 | Human Resource Management |
| 3 | P15IP653 | Tool Engineering and Design | 3 | P15IP663 | Value Engineering and Industrial Best Practices |
| 4 | P15IP654 | Plant Layout and Design | 4 | P15IP664 | Lean Manufacturing System |

| Course Title: **Management and Entrepreneurship** | | | |
|---|---|---|---|
| **Course Code:P15IP51** | **Sem: V** | **L-T-P-H: 4-0-0-4** | **Credits: 4** |
| **Contact Period: Lecture:52 Hr Exam: 3Hr** | | **Weightage: CIE:50, SEE:50** | |

**Prerequisites:** The students should have basic knowledge of management, organization and the types of organization.

**Course Learning Objectives (CLO)**

At the end of the Course the students should be able to,

1. Explain the Nature, Characteristics, Level and Scope of Management.
2. Explain the concept of planning, organising, directing, Motivating and controlling of workers in the organization.
3. Describe the concept of entrepreneurship, types of entrepreneur and role of entrepreneur in economic development.
4. Summarize the steps involved to start a small scale industry (SSI) and the role of supporting agencies to start the SSI.
5. Identify the business opportunities in the market, and importance of ownership in an industry.

**Relevance of the Course**

Management and entrepreneurship is a basic subject which deals with the concept of,

1. Management that is planning, organising, directing and staffing activities of an organization.
2. Evolution of Entrepreneurship, development of Entrepreneurship, steps in entrepreneurial process and Role of entrepreneurs in Economic Development,
3. Need , Objectives, Scope & role of SSI in Economic Development, Government Support for SSI during 5 year plans,
4. Project Identification; Project Selection; Project Report, and Identification of Business Opportunities,
5. Partnership & kinds of partners in an industry.

# Course Content

## Unit – I

**MANAGEMENT:** Introduction – Meaning – nature and characteristics of Management, Scope and functional areas of management – Management as a science, art or profession – Management and administration – Roles of management, Levels of management, skills and competence for effective managing, development of management thought –early management approaches – modern management approaches classical approach and neo classical approach, social responsibility of manager. **9 Hours**

## Unit – II

**PLANNING, ORGANIZING AND STAFFING:**

**PLANNING:** Nature, importance and purpose of planning process– objectives - Types of plans (Meaning only) - Decision making — steps in planning & Planning premises – Hierarchy of plans.

**ORGANIZING**: Nature and purpose of organization, principles of Organizations – Types of organisation – Documentation, Committees - Centralization vs. Decentralisation of authority and responsibility, span of Control, MBO, and MBE (Meaning only).

**STAFFING:** Nature and importance of Staffing – process of selection and recruitment (in brief). **10 Hours**

**Unit -III**

**DIRECTING, CONTROLLING AND ENTREPRENEUR:**

**DIRECTING:** Meaning and nature of directing – Leadership styles and motivation theories, communication – Meaning and importance – Coordination, meaning and importance and Techniques of Co – ordination. Meaning and steps in controlling – Essentials of a sound control system – Methods of establishing control (in brief).

**ENTREPRENEUR:** Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Concept of Entrepreneurship – Evolution of Entrepreneurship, development of Entrepreneurship, steps in entrepreneurial process, Role of entrepreneurs in Economic Development: Entrepreneurship in India; Barriers of Entrepreneurship. **12 Hours**

**Unit -IV**

**SMALL SCALE INDUSTRY:** Definition; Characteristics; Need and rationale: Objectives: Scope; role of SSI in Economic Development. Advantages of SSI. Steps to start an SSI – Government policy towards SSI; Different Policies of SSI.; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization & Globalization on S.S.I., Effect of WTO/GATT, Ancillary Industry and Tiny Industry (Definition only)

**INSTITUTIONAL SUPPORT:** Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency: SISI; NSIC; SIDBI; KSFC. **11 Hours**

**Unit – V**

**PREPARATION OF PROJECT:** Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Identification of Business Opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. **10Hours**

**TEXT BOOKS:**

1. **Principles of Management** – P.C. Tripathi, P.N. Reddy; Tata McGraw Hill, 5th Edition 2012.
2. **Management and Entrepreneurship** – N.V.R. Naidu & T. KirshnaRao, I.K. International, New Delhi – 2008.

**REFERENCE BOOKS:**

1. **Management Fundamentals** - Concepts, Application, Skill Development– 6th Edition, Robert Lusier –Thomson
2. **Entrepreneurship Development** – S S Khanka – S Chand & Co.
3. **Managemen**t – Stephen Robbins – Pearson Education, PHI -17th Edition.
4. **Dynamics of Entrepreneurial Development & Management** – Vasant Desai–Himalaya Publishing House
5. **Entrepreneurship Development**– Small Business Enterprises – Poornima M Charantimath – Pearson Education –2006, 2nd Edition.

**Course outcomes**

At the end of the Course the students should be able to,

Define the meaning, nature, levels and characteristics of management.

1. Describes the nature, types, purpose of planning and taking decision under different conditions, and defines the different organization structures and staffing policies and procedures.
2. Demonstrate the motivation, leadership theories and communication process model, and define the entrepreneurship concept, process and barriers in entrepreneurship.
3. Explain institutional supports given by the government to start Small Scale Industry.
4. Recognize the guide lines to be followed for writing the project report, and to survey the market.

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome(ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Define the meaning, nature, levels and characteristics of management. | L | | | | | | | M | | H | | | | |
| Describes the nature, types, purpose of planning and taking decision under different conditions, and defines the different organization structures and staffing policies and procedures. | M | | | | | | | M | | H | | M | | |
| Demonstrate the motivation, leadership theories and communication process model and Define the entrepreneurship concept, process and barriers in entrepreneurship. | M | M | | | M | | | H | H | H | M | M | | |
| Explain the Institutional supports given by the government to start Small Scale Industry. | M | M | | | L | | | H | | M | M | M | | |
| Recognize the guide lines to be followed for writing the project report, and to survey the market. | M | | | | | | | M | | H | | | | |

L-Low, M-Moderate, H-High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Define the meaning, nature, levels and characteristics of management. | 1 | | | | | | | 2 | | 3 | | | | |
| Describes the nature, types, purpose of planning and taking decision under different conditions, and defines the different organization structures and staffing policies and Procedures. | 2 | | | | | | | 2 | | 3 | | 2 | | |
| Demonstrate the motivation, leadership theories and communication process model and Define the entrepreneurship concept, process and barriers in entrepreneurship. | 2 | 2 | | | 2 | | | 3 | 3 | 3 | 2 | 2 | | |
| Explain the Institutional supports given by the government to start Small Scale Industry. | 2 | 2 | | | 1 | | | 3 | | 2 | 2 | 2 | | |
| Recognize the guide lines to be followed for writing the project report, and to survey the market. | 2 | | | | | | | 2 | | 3 | | | | |

1-Low, 2-Moderate, 3-High

| Course Title: **Work Study and Ergonomics** | | | |
|---|---|---|---|
| **Course Code: P15IP52** | **Sem: V** | **L-T-P-H: 4-0-0-4** | **Credits: 4** |
| **Contact Period: Lecture:52 Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites**: Students should have the knowledge of activities of Workshop/Machine shop, Layouts, Stop watch, fundamentals of light, sound, vibration.

**Course Learning Objectives:**

At the end of the Course the students should be able to,

1. Summarizing the basics of the Productivity and Work study and various methods of Wages and Incentives.
2. Pointing out the drawbacks of present method and design the best method.
3. Comparing the different methods of calculating standard time of a work.
4. Explaining the fundamentals of Ergonomics.
5. Developing the Man/machine system on foundation of Ergonomics

## Course Content

**Unit – I**

**PRODUCTIVITY & WORK STUDY**: Basic needs, Quality of life and Productivity, Definition of productivity, Productivity in the individual enterprise, The task of Management, Definition of Work study, How the total time of a job is made up, Interrelationship of the various methods used to reduce ineffective time, wage rates, wage incentives and its types, Straight and differential piece rate system, Emerson efficiency plan, Halsey plans, Rowan plan, group incentives.

Work study as a valuable tool, Techniques & Basic procedure of work study, direct means of raising productivity, Human Factor in the application of the work study: **10 Hours**

**Unit – II**

**METHOD STUDY**: Definition, Procedure , Selection of work, Process chart symbols, , Outline process and flow process charts, critical examination, Flow and string diagrams, multiple activity chart, travel chart, principles of motion economy, classification of movements, two-handed process chart Micro motion study. Other recording techniques, Development of improved methods, define, install and maintain. **10 Hours**

**Unit – III**

**WORK MEASUREMENT**: Definition, purpose, uses, Procedure, techniques, Work sampling: Need, determination of sample size, procedure for selecting random observations, conduction of study with the simple problems, Time study: Definition, time study equipment, selecting the job, basic steps in time study. Recording the information, breaking the jobs into elements, types of elements, determination of sample size, timing elements by stop-watch, rating & standard Rating, factors of affecting rate of working, scales of rating, determination of basic time, allowances and standard time determination. Predetermined time standards, Definition, advantages and criticisms, Applications, Methods time measurement (MTM). **12 Hours**

**Unit – IV**

**INTRODUCTION TO ERGONOMICS**: Introduction, Consequences of not using Ergonomics, areas of study covered under ergonomics, system approach to ergonomics models, Man-Machine system, Characteristics of Man-Machine system , work capabilities of industrial worker, Functions performed by Man and Mechanism involved, General principles for carrying out the physical activities, development of stress in human body and their consequences, Suggestions for prevention. **10 Hours**

**Unit – V**

**DESIGN OF MAN-MACHINE SYSTEM**: Concept of fatigue in industrial work, Displays, Quantitative qualitative representation and alphanumeric displays. Controls and their design criteria, control types, relation between controls and displays, layout of panels and machines. Design of work places, influence of climate on the efficiency of human performance, Influence of noise, vibrations and lighting systems on human performance. **10Hours**

**TEXT BOOKS:**

1. Introduction to work study- ILO, IV Revised Edition, 2003.
2. Text book of Work Study and Ergonomics– S Dalela and Saurabh, Standard Publishers Distributors, 5th edition,1999

**REFERENCE BOOKS:**

1. Motion and Time study- Ralph M Barnes, John Wiley, 8th Edition, 1985.
2. Human Factors in Engineering Design-6th Edition, M S Sanders and E J McCormic, Mc Graw Hill.

**Course Outcomes:**

At the end of the Course the students should be able to,

1. Understanding the fundamentals of the Productivity, Workstudy and various types of Wages and Incentives.
2. Analyze the present method and develop the best method.
3. Compute the standard time for a work.
4. Understanding the Ergonomics and its principles.
5. Design the Man/machine system on basis of principles of Ergonomics.

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome(ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 | PS O 2 |
| Understanding the fundamentals of the Productivity, Work study and various types of Wages and Incentives. (Unit-I) | H | M | | M | M | | | L | | | M | | L | |
| Analyze the present method and develop the best method. (Unit – II) | H | M | L | M | H | M | | | | H | L | M | L | L |
| Compute the standard time for a work. – (Unit – III) | M | H | | M | M | L | | | | | | L | | |
| Understand Ergonomics and its principles.–(Unit – IV) | H | M | M | L | M | H | L | L | | | | L | | H |
| Design the Man/machine system on basis of principles of Ergonomics –(Unit – V) | H | H | M | M | H | H | | L | | | L | L | | H |

L-Low, M-Moderate, H-High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Understanding the fundamentals of the Productivity, Work study and various types of Wages and Incentives. (Unit-I) | 3 | 2 | | 2 | 2 | | | 1 | | | 2 | | 1 | |
| Analyze the present method and develop the best method. (Unit – II) | 3 | 2 | 1 | 2 | 3 | 2 | | | | 3 | 1 | 2 | 1 | 1 |
| Compute the standard time for a work. – (Unit – III) | 2 | 3 | | 2 | 2 | 1 | | | | | | 1 | | |
| Understand Ergonomics and its principles.–(Unit – IV) | 3 | 2 | 2 | 1 | 2 | 3 | 1 | 1 | | | | 1 | | 3 |
| Design the Man/machine system on basis of principles of Ergonomics –(Unit – V) | 3 | 3 | 2 | 2 | 3 | 3 | | 1 | | | 1 | 1 | | 3 |

1-Low, 2-Moderate, 3-High

| Course Title: **Design of Machine Elements.** | | | |
|---|---|---|---|
| **Course Code: P15IP53** | **Sem: V** | **L-T-P-H: 3-2-0-5** | **Credits: 4** |
| **Contact Period: Lecture:52 Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** Students should have the knowledge of using Design Data Hand Book, knowledge on stress, strain, tension, compression, shafts, gears etc.

**Course Learning Objectives (CLO):**

At the end of the Course the students should be able to,

1. Define the concept Static strength; Static loads and Failure of materials...
2. Understand the concept of spur and helical gear and stress, tension, and compression in springs.
3. Solve the problems on mechanical joints and rivets, welds.
4. solve the problems on shaft sections under varying loads, etc.,
5. Solve the problems on Ball and Roller bearing.

**Relevance of the Course:**

Strength of materials and Theory of machines is a basic subject which deals with the concept

1. Static strength; Static loads and Failure of materials.
2. Stress, tension, and compression in springs.
3. Shaft sections under varying loads.
4. Spur and helical gear – Problems.

## Course Content

### Unit – I

**Design for static strength:** Design considerations: Codes and Standards, Static strength; Static loads and factor of safety; Theories of failure -Maximum normal stress theory, maximum shear stress theory, Distortion energy theory; Maximum strain theory. Failure of brittle materials, Failure of ductile materials. Stress concentration, Determination of Stress concentration factor. Combined Stress concentration factor. **10Hours**

### Unit –II

**Design for fatigue strength:** Introduction, S -N diagram, Low cycle fatigue, High cycle fatigue, and Endurance limit. Modifying factors –size effect, surface effect, Stress concentration effects; Fluctuating stresses, Fatigue strength under fluctuating stresses, Soderberg and Goodman, Stresses due to combined loading. **10 Hours**

### Unit – III

**Mechanical joints: Riveted Joints** -Types, rivet materials, Failures of Riveted joints, Efficiency, riveted joint for boiler or pressure vessels. **Welded Joints** -Types, Strength of butt and fillet welds, welds subjected axial loads, Eccentric loading - welds subjected to bending moment, and torsional moments. **10 Hours**

### Unit – IV

**Design of gears:** Introduction to Spur, Helical and bevel gears. Design of spur gears, stresses in gear tooth, Lewis equation, form factor, dynamic and wear load.

**Design of springs:** Types of springs -stresses in Helical Coil springs of circular and non-circular cross sections. Tension and compression springs. Design in leaf spring. (Simple problems).

**11 Hours**

### Unit – V

**Design of shafts:** Torsion of shafts, design for strength & rigidity, with steady loading, ASME& BIS codes for design of transmission shafting, Design of shafts under different loads: Combined loads & Fluctuating loads.

**Lubrication and bearings:** Mechanisms of Lubrication - Viscosity, bearing modulus, coefficient of friction, minimum oil film thickness-Heat Generated, Heat dissipated, bearing materials, lubricants and properties. Ball and Roller Bearings: Bearing life, equivalent bearing load, selection of bearings of different types (Problems only on Ball and Roller Bearings). **11 Hours**

**TEXT BOOKS:**

1. **Mechanical Engineering Design** -Joseph Edward Shigley's, Tata McGraw Hill, New Delhi 2014.
2. **Machine Design** -.VL. Maleev and Hartman, CBS Publishers & Distribution, New Delhi, 2001.

**DESIGN DATA HAND BOOK:**

1. **Design Data Hand Book**-K. Mahadevan and Balaveera Reddy, CBS Publication fourth edition, 2013.

**REFERENCE BOOKS:**

1. **Machine Design** -Robert .L, Norton -Pearson Education Asia, New Delhi, 2014.
2. **Design of Machine Elements** -V. B. Bahandri, -Tata McGraw Hill Publishing Co. Ltd., New –Delhi, 2000.
3. **Machine Design** -R.S.Khurmi, J. K.Gupta. – Eurasia publishing house private Ltd. New Delhi, 2005.

**Course Outcome**

At the end of the Course the students should be able to,

1. Describe the theories of failures and determine the dimensions of mechanical components subjected to different types of static load.
2. Compute the dimensions of the machine elements subjected to fatigue and impact loads.
3. Distinguish between different mechanical joints and design welded and riveted joints for various loads.
4. Design spur gear and different types of spring for different applications.
5. Design the shaft for different load condition and comprehend the mechanism of lubrication and compare design of bearing for different applications.

# Course Articulation Matrix (CAM)

| Course Outcome – CO | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Describe the theories of failures and determine the dimensions of mechanical components subjected to different types of static load. | M | M | M | | M | | | | | | | M | L | M |
| Compute the dimensions of the machine elements subjected to fatigue and impact | M | M | H | | M | | | | | | | H | | M |
| Distinguish between different mechanical joints and design welded and riveted joints for various loads. | L | L | M | | M | | | | | | | M | | M |
| Design spur gear and different types of spring for different applications. | H | H | H | | H | | | | | | | H | | L |
| Design the shaft for different load condition and comprehend the mechanism of lubrication and compare design of bearing for different applications. | L | M | M | | M | | | | | | | H | L | H |

1 – Low, 2 – Moderate, 3 – High

# Course Assessment Matrix (CAM)

| Course Outcome – CO | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Describe the theories of failures and determine the dimensions of mechanical components subjected to different types of static load. | 2 | 2 | 2 | | 2 | | | | | | | 2 | 1 | 2 |
| Compute the dimensions of the machine elements subjected to fatigue and impact. | 2 | 2 | 3 | | 2 | | | | | | | 3 | | 2 |
| Distinguish between different mechanical joints and design welded and riveted joints for various loads. | 1 | 1 | 2 | | 2 | | | | | | | 2 | | 2 |
| Design spur gear and different types of spring for different applications. | 3 | 3 | 3 | | 3 | | | | | | | 3 | | 3 |
| Design the shaft for different load condition and comprehend the mechanism of lubrication and compare design of bearing for different applications. | 1 | 2 | 2 | | 2 | | | | | | | 3 | 1 | 3 |

1 – Low, 2 – Moderate, 3 – High

| Course Title: **Computer Aided Design and Manufacturing** | | | |
|---|---|---|---|
| **Course Code: P15IP54** | **Sem: V** | **L-T-P-H: 4-0-0-4** | **Credits: 4** |
| **Contact Period: Lecture:52 Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** Students should have the knowledge on basic concept on influence of computer in design and manufacturing.

**Course Learning Objectives**

At the end of course the students should be able to,

1. Able to define CAD and CAM and the product cycle in conventional and computerized manufacturing environment.
2. Able to understand basic hardware structure, types of hardware and input and output devices.
3. Able to know the software configuration, construction of geometry, wire frame and solid modeling.
4. Able to understand NC, CNC, & DNC technology.
5. Able to understand CNC, tools.
6. Able to understand CNC programming and solve the problems.
7. Able to know in details about group technology and FMS technology.
8. An ability to know robot configuration, programming and sensors.

**Relevance of the Course**

Computer concept & programme is a basic subject which deals with the concept of,

1. Hardware & software
2. NC, CNC, DNC, graphics etc.
3. Flexible manufacturing system.
4. Group technology, Robots technology.
5. Sensors, frameworks.

## Course Content

**Unit –I**

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

**HARDWARE IN CAD:** Basic Hardware structure, working principles, usage and types of hardware for CAD - input and output Devices, memory, CPU, hardcopy and Storage devices. **10Hours**

**Unit – II**

**COMPUTER GRAPHICS:** Software configuration of a graphic system, function of a Graphics package, construction of geometry, wire frame and solid modelling, Geometric 2D and 3D homogeneous transformations with simple problems(problems on 2D transformations). Introduction to exchange of modelling data – Basic features of IGES, STEP, DXF, and DMIS. **10 Hours**

**Unit – III**

**NC, CNC, DNC TECHNOLOGY:** NC, CNC, DNC modes, NC elements, advantages and limitations of NC, CNC. Functions of computer in DNC.

**CNC MACHINE TOOLS:** Turning tools geometry, milling tooling systems, tool presetting, ATC, work holding. CNC machine tools, Overview of different CNC machining centres, CNC turning centres, high speed machine tools. **12 Hours**

**Unit – IV**

**CNC PROGRAMMING:** Part program fundamentals – steps involved in development of a part program. Manual part programming-milling & turning with problems. **10Hours**

**Unit –V**

**GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING:** Part families, Part classification & coding, Machine cell design & benefit of GT, FMS work stations, planning the FMS, FMS layout configuration. Analysis method, application and benefit of FMS.Shop floor control, Functions, Shop floor control system.

**INDUSTRIAL ROBOTICS:** Introduction, Robot Configuration, Robot Motions, End effectors, Robot Sensor, Robot Applications. **10Hours**

**TEXT BOOKS:**


1. **CAD / CAM Principles and Applications**- P.N. Rao, TMH, New Delhi, Edition 3, 2010.
2. **CAD/CAM** – Mikell P Groover, Emory W. ZimrnersJr Pearson Education Inc, 2013.


**REFERENCE BOOKS:**


1. **Principles of Interactive Computer Graphics** - Newman and Sproull, Tata McGraw Hill, 2006.
2. **NC Machine programming & software Design** -Chno-Hwachang, Michel.A. Melkanoff, Prentice Hall, 1989.
3. **Computer Graphics** -Steven Harrington, McGraw Hill Book Co.
4. **Computer Aided Manufacturing** - P.N. Rao, N.K. Tewari and T.K. Kundra Tata McGraw Hill 2010.
5. **Basic Computer Aided Geometric Design** - Ganesh. M – I. K. International, New Delhi – 2011.


**Course Outcome**

At the end of the Course the students should be able to,

1. The students should learn and understand computer design and manufacturing environment.
2. The students should learn the Hardware structure, input output devices, CPU and storage devices.
3. Students will be able to learn computer graphics and construction of geometry and transformations.
4. The students should be able to learn the functions of NC, DNC, and CNC & CNC machine tool.
5. The students should be able to solve the problems on CNC programming.

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome(ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Ability to apply knowledge in the field design & manufacturing with help of CAD / CAM | H | M | M | H | | | | H | H | M | | H | M | |
| Ability to learn concepts of graphics package regarding 2D & 3D transformations. | H | H | M | H | M | | | M | H | H | H | H | | |
| Ability to learn concepts of NC, CNC & DNC technology. And also known CNC machine tool & tooling system. | M | H | M | H | H | | | M | H | H | H | H | M | |
| Ability to develop steps for CNC part programming and able to solve the problems. | M | M | M | H | M | | | M | M | M | M | H | | |
| Ability to known in detail the group technology & coding system also should know FMS technology and know details about the industrial robots and their applications. | M | H | M | H | H | | | M | H | H | H | H | M | |

1 – Low, 2 – Moderate, 3 – High

# Course Assessment Matrix (CAM)

| Course Outcome – CO | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO2 |
| Briefly discuss the role of computers in design & manufactures of industrial products (Unit – I) | 3 | 2 | 2 | 3 | | | | 3 | 3 | 2 | | 3 | 2 | |
| With appropriate sketches briefly explain the wire frame and solid modeling (Unit – II) | 3 | 3 | 2 | 3 | 2 | | | 2 | 3 | 3 | 3 | 3 | | |
| Explain the methods of tool presetting with sketches (Unit – III) | 2 | 3 | 2 | 3 | 3 | | | 2 | 3 | 3 | 3 | 3 | 2 | |
| Write a briefly note on NC part programming languages. (Unit – IV) | 2 | 2 | 2 | 3 | 2 | | | 2 | 2 | 2 | 2 | 3 | | |
| Define briefly the group technology and part families. (Unit – V) | 2 | 3 | 2 | 3 | 3 | | | 2 | 3 | 3 | 3 | 3 | 2 | |

1 – Low, 2 – Moderate, 3 – High

| Course Title: **Mechanical Engineering Lab** | | | |
|---|---|---|---|
| **Course Code: P15IPL57** | **Sem: V** | **L-T-P-H: 0-0-3-3** | **Credits: 1.5** |
| **Contact Period: Lecture:39 Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** The students should have studied Engg. Thermodynamics and Fluid Mechanics.

**Course Learning Objective:** The course aims at empowering the students with practical knowledge about properties of fuels, performance of IC Engines as well as skill enhancement.

## Course Content

- Determination of Flash point and Fire point of lubricating oil using Abel, Pensky Martins Apparatus
- Determination of Calorific value of solid and gaseous fuels.
- Determination of Viscosity of lubricating oil using Redwoods and Saybolts – Viscometers.
- Performance Tests on Four stroke Petrol Engine, Calculations of IP, BP, Thermal efficiencies, SFC, FP and heat balance sheet
- Performance Tests on Four stroke Diesel Engine, Calculations of IP, BP, Thermal efficiencies, SFC, FP and heat balance sheet
- Planimeter.
- Calibration of Pressure Gauge
- Calibration of Thermocouple
- Calibration of Venturimeter
- Flow through pipes
- Performance test on centrifugal pump
- Performance test on Reciprocating pump

**Scheme for Examination:**

| | | |
|---|---|---|
| Two Questions (Including PART-A & B)- | | 40 Marks |
| Viva – voce | - | 10 Marks |
| Total | | 50 Marks |

**Course Outcomes (CO)**

At the end of the course the students should be able to,

1. Determine properties like Flash point, Fire point, and viscosity of lubricating oil
2. Estimate the calorific value of solid and gaseous fuel
3. Estimate the irregular areas using the Planimeter
4. Conduct performance test on I.C.Engine.
5. Conduct performance tests on Venturimeter and pumps

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Ability to Determine properties like Flash point, Fire point, and viscosity of lubricating oil | M | L | | M | | | | | | | | M | | |
| Ability to Estimate the calorific value of solid and gaseous fuel. | H | L | | M | | | | | | | | M | | |
| Ability to Estimate the irregular areas using the Planimeter | M | L | | L | | | | | | | | L | | |
| Ability to Conduct performance test on I.C.Engine | H | L | | M | | | | | | | | M | | |
| Ability to Conduct performance tests on Venturimeter and pumps | H | L | | M | | | | | | | | M | | |

L – Low, M – Moderate, H – High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Ability to Determine properties like Flash point, Fire point, and viscosity of lubricating oil | 2 | 1 | | 2 | | | | | | | | 2 | | |
| Ability to Estimate the calorific value of solid and gaseous fuel. | 3 | 1 | | 2 | | | | | | | | 2 | | |
| Ability to Estimate the irregular areas using the Planimeter | 2 | 1 | | 1 | | | | | | | | 1 | | |
| Ability to Conduct performance test on I.C. Engine | 3 | 1 | | 2 | | | | | | | | 2 | | |
| Ability to Conduct performance tests on Venturimeter and pumps | 3 | 1 | | 2 | | | | | | | | 2 | | |

1 – Low, 2 – Moderate, 3 – High

| Course Title: Computer Aided Drafting and Geometric Modelling Lab | | | |
|---|---|---|---|
| **Course Code: P15IPL58** | **Sem: V** | **L-T-P-H: 0-0-3-3** | **Credits: 1.5** |
| **Contact Period: Lecture:39Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** The students should have undergone the course on Computer aided Engineering drawing and Machine Drawing.

**Course Learning Objectives (CLO):**

At the end of the Course the students should be able to,

- Produce computer-aided mechanical drawings of components and assemblies of machine parts and other mechanical equipments.
- Interpreting and applying drafting standards,
- Using software for CAD such as Solid Works, etc.,
- Drawing sectional views and Assembly drawings.

**Relevance of the Course:**

Computer aided machine drawing is a basic subject which deals with the concept of,

- Visualizing the 2D and 3D drawings,
- Creating CAD drawings,
- Interpreting and applying the drawing standards such as dimensioning, scaling, etc.,
- Use of design software such as Solid Works environment,
- Drawing Assembly drawings using top down and bottom up approach.

## Course Content

**Solid Works Basics:** Introducing Solid Works, Navigating SolidWorks Interface.

**Working with sketches:** Opening a sketch, Identifying sketch entities, Exploring sketch settings, Sketch blocks, working with Reference Geometry, Creating planes, Sketch Relations.

**Creating simple parts:** Symmetry, Relative size or direct dimensions, Offset, Hole Wizard, Cutting a slot, Fillets and Chamfers, Editing Sketch Relations and Copying and Moving Sketch Entities.

**Pattern and Mirroring:** Linear and Circular Pattern, Mirror Entities, Dynamic Mirror, Symmetry sketch relation and Mirroring in 3D sketches.

**Solid Modelling:** Primitive creation, Simple solid shapes - Boolean operations and Surface operations: Chamfering, rounding, filleting. Drafting and shelling.

**Dimension and Tolerance:** Dimensions on Drawings, reference dimensions, dimension options, adding tolerances and Dimensioning Styles.

**Assembly:** Identifying the Elements of an Assembly, Assembly layout sketch, Assembly reference geometry, History-based and non-history based portions of the assembly tree, Parts and Subassemblies, Folders, Mates, Assembly features, Component patterns and mirror components, Creating subassemblies from existing parts and Grouping subassemblies by relative motion.

**Surface Modelling:** Basic Surfacing, Revolved Surface, Swept Surface, Filleting Surfaces etc.

**Minimum of 10 Exercises in Modelling of Mechanical components and 4 assemblies using parametric feature based projects using CAD Software.**

**Text books**


1. Matt Lombard, **"Solid Works bible"**, Wiley Publishing, Inc, USA.
2. Solid Works Manual by Dassault System Inc.


**Scheme for Examination:**

| | | |
|---|---|---|
| Two Questions | - | 40 Marks |
| Viva – voce | - | 10 Marks |
| Total | | 50 Marks |

**Course Outcomes (COs):**

At the end of the Course the students should be able to,

- Recognise the drawing concepts
- Use CAD software such as Solid Works, Solid Edge etc.
- Develop machine parts and parts of equipment's in 3D.
- Construct sectional views and Assembly drawings.
- Develop surface models

## Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Ability to learn Recognise the drawing concepts | H | L | | | | | | | | | | M | | |
| Ability to use CAD software such as Solid Works, Solid Edge etc. | H | L | M | | M | | | | | | | M | | |
| Ability to develop machine parts and parts of equipments in 3D. | H | L | M | | M | | | | | | | M | | |
| Ability to construct sectional views and Assembly drawings. | H | L | M | | M | | | | | | | M | L | |
| Ability to develop surface models | H | L | M | | M | | | | | | | M | L | |

L – Low, M – Moderate, H – High

## Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Ability to learn Recognise the drawing concepts | 3 | 1 | | | | | | | | | | 2 | | |
| Ability to use CAD software such as Solid Works, Solid Edge etc. | 3 | 1 | 2 | | 2 | | | | | | | 2 | | |
| Ability to develop machine parts and parts of equipments in 3D. | 3 | 1 | 2 | | 2 | | | | | | | 2 | | |
| Ability to construct sectional views and Assembly drawings. | 3 | 1 | 2 | | 2 | | | | | | | 2 | 1 | |
| Ability to develop surface models | 3 | 1 | 2 | | 2 | | | | | | | 2 | 1 | |

1 – Low, 2 – Moderate, 3 – High

| Course Title : Aptitude and Reasoning Development - Advanced (ARDA) | | |
|---|---|---|
| **Course Code : P15HU510** | **Semester : V** | **L : T : P : H : 0 : 0 : 2 :2** |
| **Contact Period: Lecture: 32 Hr, Exam: 3 Hr** | | **Weightage: CIE:50;% SEE:50%** |
| **Prerequisites: Vocabulary builder, Concept of Percentage.** | | |

## Course Learning Objectives (CLOs)

**This course aims to**

1. Describe the importance of reading with comprehension.
2. Explain seven dimensions approach to better reading skills.
3. Explain the purpose, plan and the ways to identify specific details in a paragraph for better comprehension.
4. Formulate easier ways to solve problems of averages.
5. Explain the Application of the technique of allegation while solving weighted average and mixture problems.
6. Describe the concepts of profit, loss, discount, Marked price.
7. Explain the application of percentage in our daily life.
8. Discover different ways to identify the progressions and to compare between AP< GP and HP.
9. Explain the basic concepts in calculating simple interest and compound interest.
10. Differentiate between simple interest and compound interest and describes the importance of compound interest and its behaviour.

# Course Content

### Unit – I

**Reading Comprehension:**

**Introduction:** Read more and more, the process of writing and its relevance to the process of writing, how reading skills are important for aspects other than the reading comprehension questions, the daily reading scheme.

**Seven dimension approach to better reading skills:**

Developing the ability of understanding vocabulary in context, Ability to identify and understand main ideas, Ability to predict and identify supporting details, Understanding the use of transition and idea organization patterns, Inferences, Identifying purpose and tone, Recognizing and evaluating arguments and their common structures.

**Theory of reading comprehension:**

Solving RC passages is an exact science, tackling RC on the basis of evaluation of support, All passages have a topic, purpose and a plan, Other things to pick up while reading the passage– The tonality and other software related the author's viewpoint in the passage, specific details and their use in the passage, Types of questions asked in reading comprehension passage. **10 hrs**

### Unit – II

**Averages and Allegations mixtures:**

**Average:** relevance of average, meaning of average, properties of average, deviation method, concept of weighted average. **Allegation method:** situation where allegation technique, general representation of allegations, the straight line approach, application of weighted average and allegation method in problems involving mixtures. Application of allegation on situation other than mixtures problems. **6 Hrs**

### Unit – III

**Profit and Loss:** percentage change, original 100 concept effect of percentage increase or decrease in number, effect of successive percentage change, amount of change, comparison of two numbers through percentage and ratio, return to original concept, net percentage change to keep product fixed.

Definition of basic terms— cost price, selling price, profit percentage, discount and marked price, solving problems using n/d method, techniques to tackle from standard set of problems, the concept of mark up. Concept of partnership and problems involving partnership. **6 Hrs**

**Unit- IV**

**Progression:**

**Arithmetic Progression:** sum of given number of terms in an A.P., arithmetic mean, to insert a given number of arithmetic means between two given quantities, nth term of an A.P., finding common difference of an A.P. given 2 terms of an A.P., types of A.P.s– increasing A.P.s and decreasing A.P. s

**Geometric:** to find, the geometric mean between two given quantities, to insert a given number of geometric means between two given quantities, sum of a number of terms in a G.P. Types of G.P.s— increasing G. P. s type one and two , decreasing G. P. s type one and two.

**Harmonic Progression:** to find the harmonic mean between two given quantities , theorems related with progressions, solved examples sample company questions **6 Hrs**

**Unit- V**

**Simple Interest and Compound Interest**

Concept of time value of money, Terminology pertaining to interest, Relation among Principal, Time, Rate percent per annum and total interest. Compound interest, Depreciation of value, Population, Application of interest in D.I.– The difference between simple annual growth rate and compound annual growth rate. **4 hrs**

**Reference books:**

1. The Trachtenberg speed system of basic mathematics, published by Rupa publications.
2. CAT Mathematics by AbhijithGuha. Published by PHI learning private limited.
3. Quantitative aptitude by Dr. R. S Agarwal, published by S.Chand private limited.
4. Verbal reasoning by Dr. R. S Agarwal, published by S. Chand private limited.
5. Quantitative aptitude for CAT by Arun Sharma, published by McGraw Hill publication.

## Course Outcomes (CO)

**After learning all the units of the course, the student is able to:**

1. Apply the approach of seven dimension to better reading skills. L2
2. Solve the questions under reading comprehension confidently with higher accuracy than random reading. L4
3. Apply the technique of allegation for effective problem solving. L2
4. Interpret the requirement of different methods of calculating average and apply the right method at right scenario. L4
5. Effectively solve problems of profit and loss and problems related to discount, simple interest and compound interest. L5
6. Formulate the equations for summation and other functions for all the kinds of progressions– AP, GP and HP. L1

## Course Articulation Matrix (CAM)

| Course Outcome (CO) | Program Outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Apply the approach of seven dimension to better reading skills. | | | | | | | | | M | | | | | |
| Solve the questions under reading comprehension confidently with higher accuracy than random reading. | | | | | | | M | | M | | | | | |
| Apply the technique of alligation for effective problem solving. | H | | | | | | | | | | | | | |
| Interpret the requirement of different methods of calculating average and apply the right method at right scenario. | M | | | | | | | | M | | | | | |
| Effectively solve problems of profit and loss and problems related to discount, simple interest and compound interest. | H | | | | | | | | M | | | | | |

L – Low, M – Moderate, H – High

## Course Assessment Matrix (CAM)

| Course Outcome (CO) | Program Outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Apply the approach of seven dimension to better reading skills. | | | | | | | | | 2 | | | | | |
| Solve the questions under reading comprehension confidently with higher accuracy than random reading. | | | | | | | 2 | - | 2 | | | | | |
| Apply the technique of alligation for effective problem solving. | 3 | | | | | | | | | | | | | |
| Interpret the requirement of different methods of calculating average and apply the right method at right scenario. | 2 | | | | | | | | 2 | | | | | |
| Effectively solve problems of profit and loss and problems related to discount, simple interest and compound interest. | 3 | | | | | | | | 2 | | | | | |

1 – Low, 2 – Moderate and 3 – High

| Course Title: Control Engineering and Machine Tool Technology | | | |
|---|---|---|---|
| **Course Code: P15IP551** | **Sem:V** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52 Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites**: Basic knowledge of electrical engineering and Kirchhoff's law, Newton's Law, Free body diagram, Fundamentals of Vibration, elements of mechanical Engineering.

**Course Learning Objectives**

At the end of the Course the students should be able to,

1. The objective of the course is to provide the students an opportunity to gain the knowledge in the field of Control Engineering and Machine tool Drive.
2. To learn the basic concepts automatic control system, closed and open loop systems and electrical analogous systems.
3. To learn the response analysis of control systems using first order differential equations and to solve simple problems.
4. Demonstrate the block diagrams and signal flow graphs and to solve problems.
5. The students should learn the knowledge to analyze and design the gear box.

## Course Content

### Unit-I

**BASIC OF CONTROL SYSTEM:** Concept of automatic controls, classification of control systems, open and closed loop systems, concepts of feedback, Requirement of an ideal control system. Any two Real time application of open and closed loop control system, Feedback and feed forward system, Comparison of close loop and open loop system.

Modelling of control system: Analysis of mechanical systems (Translation motion and Rotational motion) and obtaining differential equation, Transfer function for mechanical and electrical (simple) systems, Equivalent mechanical (node system) to Electrical system, Analogous systems (loop analysis and node analysis). DC Servomotors (field controlled and armature controlled).

**12 Hours**

### Unit-II

**TIME RESPONSE ANALYSIS OF CONTROL SYSTEMS:** Definition and classification of time response, Standard test inputs, Derivation of steady state error, Effect of input (Type of Magnitude) on steady state error (Static Error Coefficient Method), Effect of Change in G(s) H(s) on Steady State Error: step, ramp, parabolic, simple problems. **10 Hours**

### Unit-III

**BLOCK DIAGRAMS SIGNAL FLOW GRAPHS:** Derivation of Transfer function of simple closed loop system, Rules for Block Diagram Reduction, Critical Rules, Procedure to solve block diagram in canonical form, Problems on block diagram.

Signal flow graphs: Properties of signal flow graphs, Terminology, Methods to obtain Signal Flow Graph, Mason's gain formula, Problems on signal flow graph. **10 Hours**

### Unit-IV

**BASIC FEATURE AND KINEMATIC REQUIREMENTS OF MACHINE TOOLS:** Machine tool, characteristics of Machine tool, Objectives of machine tool, classification of machine tools, control system of machine tools, cutting motion in machine tools, Essential requirement of machine tool, Design of basic features of a machine tool, Method of production of surfaces, General requirements of machine tool design. **10 Hours**

## Unit-V

**KINEMATIC DRIVES OF MACHINE TOOLS:** Drive, Individual and group drive, stepped and stepless drive, Machine tool spindle speeds: Arithmetic, Geometric and Logarithmic progression, Mechanical stepless drives, PIV drive, Hydraulic drives for machine tool, practical subdivisions and Number of stages in geared transformation, Ray diagram, Speed diagram, Gear box design,(Problems on Gear box design), Ruppert drive (gear box with clutch drives) problems on Ruppert drive.

**10 Hours**

**TEXT BOOKS:**


1. **Modern Control Engineering** –K Ogatta, Prentice Hall (India) Pearson Education 2003.
2. **Automatic Control Systems**-Francis. H Raven 5thEdition.McGraw Hill 1995.
3. **Principles of Machine tools**-G C Sen and A Bhattacharyya, New Central Book Agency 2011.


**REFERENCE BOOKS:**


1. **Feedback control system**-Schaum'S series, 2001.
2. **Control systems**-I J Nagarath& M Gopal, New age International Publishers, 2002.
3. **Control systems** –M Gopal, TATAMcGraw Hill New Delhi 2nd Edistion, 2002.
4. **Control Engineering** –U A Bakshi V.U. Bakshi. Technical Publications Pune. New edition 2012.
5. **Modern Control Systems**- Richard C Drof and Robert.H.Bishop Addison-Wesley, 8th Edition, 1998.


**Course Outcomes**

At the end of the Course the students should be able to,

1. The students should learn and understand necessity of basics of Control Engineering and Machine tool Drive.
2. Demonstrate ability to analyze the systems.
3. Students will be able solve the problems using first order differential equations.
4. The students will be able to solve the block diagrams and signal flow graphs.
5. Students should be able to solve the given gear box.

## Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Ability to apply knowledge in the field Control Engineering and Machine Tool Drive. | H | L | M | L | | | | | | | | | | |
| Ability to identify basic concepts of automatic control system and understanding the electrical analogous systems. | M | | L | | H | | | | | | | | | |
| Ability to identify and learn response analysis of control system and solve engineering problems. | | M | L | | H | | | | | | | | | |
| Ability to identify formulate block diagram and signal flow graphs and solve engineering problems. | M | L | | | H | | | | | | | | | |
| Ability to apply knowledge of kinematic requirements of Machine tools and design the gear box. | L | M | | | H | | | | | | | | | |

L-Low, M-Moderate, H-High

## Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Explain Analysis of mechanical systems (Unit – I) | 3 | 1 | 2 | 1 | | | | | | | | | | |
| Evaluate the effect of input on study state error reference input is step on magnitude of 'A'(Unit – II) | 2 | | 1 | | 3 | | | | | | | | | |
| Solve block diagram in canonical order (Unit – III) | | 2 | 1 | | 3 | | | | | | | | | |
| Evaluate design of basic features of a machine tool (Unit – IV) | 2 | 1 | | | 3 | | | | | | | | | |
| Design gear box for 8 speed progression ratio 1.326 (Unit – V) | 1 | 2 | 3 | | | | | | | | | | | |

1-Low, 2-Moderate, 3-High

| Course Title: Advanced joining process and NDT | | | |
|---|---|---|---|
| **Course Code: P15IP552** | **Semester: V** | **L – T – P–H : 3 – 0 – 0 –4** | **Credits: 3** |
| **Contact Period - Lecture: 52Hrs.; Exam:3 Hrs.** | | **Weightage: CIE: 50%; SEE: 50%** | |

**Prerequisites**: Basic knowledge of elements of machine tool, Manufacturing Process-1, Manufacturing Process-2.

**Course Learning Objectives:**

The course aims to:

1. Objective is to provide the students to apply the knowledge in the field of metal joining process. [L3]
2. Understand the potential to learn the plastic welding. [L2]
3. The student should be able to understand the concept of underwater welding. [L2]
4. To understand general concept on thermal stress in welding. [L2]
5. The students should apply various types of NDT methods. [L3]

**Relevance of the Course:**

Advance joining process and NDT helps in judging the quality of welding work and to develop the knowledge in the field of NDT. The course aims at understanding the type welding joint and helps the students in applying these ideas.

## Course Content

**Unit-I**

**INTRODUCTION TO UNDER WATER WELDING TECHNIQUES:** Introduction, problems encountered in under water welding, types of underwater welding processes, characteristics of good underwater welding, application of underwater welding processes. Friction stirs welding: Introduction, principle, application. **10 hours**

**Unit-II**

**WELDING OF DISSIMILAR METALS:** Introduction, concept of dissimilar metal welding, metallurgical problems in dissimilar metal welding, techniques for dissimilar metal welding.

**WELDING OF PLASTICS:** History, principle of welding plastics, common wieldable plastics and types of weld joint design, surface preparation and plastic welding processes. **10 hours**

**Unit-III**

**RESIDUAL WELDING STRESSES:** Introduction, concept, types of residual stress, causes of thermal stress, effect of thermal stress, control of residual welding stresses, residual stress measurements.

**HEAT TREATMENT OF WELDMENTS**: Introduction, need, methods to reduce welding stresses to a minimum. **10 hours**

**Unit-IV**

**DEFECTS IN WELDING:** Introduction, types of welding defects; Welding Distortion: introduction concept of distortion, types of distortion, control of welding distortion

**WELDING JIGS AND FIXTURES:** Introduction, welding jigs, welding fixtures, consideration in fixture selection, principles of good welding fixture, various types of jigs and fixtures, welding symbols. **11 hours**

**Unit-V**

**INSPECTION AND TESTING OF WELDS:** Introduction, weld inspection and weld testing, destructive testing of welds; different methods.

**NON DESTRUCTIVE TESTING:** Introduction, methods of NDT, Selection of ND methods, visual inspection, leak testing, Stethoscopic test, x-ray, radiography method, Magnetic Particle Inspection, Fluorescent penetration method, Ultrasonic method, Eddy Current Inspection. Principles of operation, equipment's, procedure, application and limitations. **11 hours**

**Text Books:**

1. Dr. O.P. Khanna, 'Welding Technology', Dhanpth Rai and Sons,1990

**Reference Books**

1. McGonnagle J.J., "Non-Destructive Testing" – garden and reach, New York
2. Metals Handbook, "Non-Destructive Evaluation and Quality Control", Vol.17 of 9th Edition – ASM International 1989.
3. ASM Handbook, "Welding, Brazing and Soldering", Vol. 6, 2005.

**Course Outcomes:**

1. The students will be able to explain the necessity of metal joining process.
2. Students gain the knowledge of plastic welding process.
3. Students will be able demonstrate the concept of underwater welding.
4. The students will describe the concept of friction stir welding.
5. Students will be able to demonstrate various types of NDT methods.

## Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| The students will be able to explain the necessity of metal joining process | M | M | | | M | | | | | | | M | L | |
| Students gain the knowledge of plastic welding process. | M | M | | | M | | | | | | | L | | |
| Students will be able demonstrate the concept of underwater welding | M | M | | | M | | | | | | | L | | |
| The students will describe the concept of friction stir welding. | M | M | | | M | | | | | | | H | M | |
| Students will be able to demonstrate various types of NDT methods | M | M | | | M | | | | | | | M | L | |

L-Low, M-Moderate, H-High

## Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| The students will be able to explain the necessity of metal joining process | 2 | 2 | | | 2 | | | | | | | 2 | 1 | |
| Students gain the knowledge of plastic welding process. | 2 | 2 | | | 2 | | | | | | | 1 | | |
| Students will be able demonstrate the concept of | 2 | 2 | | | 2 | | | | | | | 1 | | |
| The students will describe the concept of friction stir welding. | 2 | 2 | | | 2 | | | | | | | 3 | 2 | |
| Students will be able to demonstrate various types of NDT methods | 2 | 2 | | | 2 | | | | | | | 2 | 1 | |

1-Low, 2-Moderate, 3-High

| Course Title: **Design of Experiments** | | | |
|---|---|---|---|
| **Course Code: P15IP553** | **Sem:V** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52 Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Course Learning Objectives (CLO):**

At the end of the Course the students should be able to,

1. Define the concept of quality engineering L1
2. Understand the Taguchi Approach to Quality. L2
3. Define the concept Full Factorial Designs. L1
4. Understand the dummy level technique. L2
5. Understand the classical statistical experiment design. L2

## Course Content

### UNIT – I

**INTRODUCTION:** History of quality engineering: Japan versus U.S. track records. Taguchi Approach to Quality: Definition of quality. Loss function. Offline and online quality control. Taguchi's quality philosophy.

**BASIC DESIGNS:** Completely Randomized Design, Randomized Block Design, Latin Square Designs, one way analysis of variance and two way analysis of variance. **11 Hours**

### UNIT – II

**FACTORIAL EXPERIMENTATION-TWO LEVELS:** Full Factorial Designs: Experimentation as a learning process. Traditional scientific experiments. Two-factor design. Four-factor design, replicating experiments. Factor interactions.

**FACTORIAL EXPERIMENTATION-EIGHT AND SIXTEEN RUN EXPERIMENTS:** Fractional factorial designs based on eight-run experiments, folding over an eight run and sixteen – run experiment. **11 Hours**

### UNIT – III

**CONSTRUCTING ORTHOGONAL ARRAYS:** Counting degrees or freedom, selecting a standard orthogonal array, dummy level technique, and compound factor method. Linear graphs and interaction assignment. Modification of linear graphs, column merging method, branching design. Strategy for constructing an orthogonal array. Comparison with the classical statistical experiment design. **10 Hours**

### UNIT – IV

**STEPS IN ROBUST DESIGN:** case study discussion. Noise factors and testing conditions. Quality characteristics and objective functions. Control factors and their levels. Matrix experiment and data analysis plan. Conducting the matrix experiment, data analysis, verification experiment and future plan. **9 Hours**

### UNIT – V

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

**SIGNAL-TO-NOISE RATIO FOR DYNAMIC PROBLEMS**: S/N ratios forContinuous-continuous, continuous-digital, digital-continuous, digitalcases. Introduction to Taguchi Inner and Outer Arrays **11 Hour**

**TEXT BOOKS:**

1. Quality Engineering Using Robust Design-Madhav S. Phadke,Prentice Hall PTR, Englewood Cliffs, New Jersey 07632.

2. Design of Experiments- D.C. Montgomery, John Wiley and Sons,2002.

**REFERENCE BOOK:**

1. Designing for Quality -an Introduction Best of Taghuchi and WesternMethods or Statistical Experimental Design-Robert H. Lochner andJoseph E. Matar, Chapman and Hall Madras, 2ndedition.

**Course Outcomes:**

Design of experiments application subject which deals with the concept of,

1. Explain the Concept of quality engineering,
2. Explain the Taguchi Approach to Quality
3. Describe the Replicating experiments. (L2)
4. Describe the Branching design. (L2)
5. Differentiate between continuous-digital and digital-continuous(L3)

| **Course Articulation Matrix (CAM)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcome (CO)** | **Program Outcome** | | | | | | | | | | | | | |
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO12 | PSO 1 | PSO 2 |
| Explain the Concept of quality engineering, | M | L | | | | | | | | | | | M | |
| Explain the Taguchi Approach to Quality | L | M | | | | | | | | | | | | L |
| Describe the Replicating experiments. | H | M | H | - | H | | | | | | | | | |
| Describe the Branching design. | H | M | M | - | M | | | | | | | | | M |
| Differentiate between continuous-digital and digital-continuous | H | H | M | - | H | | | | | | | | M | |
| L- Low, M- Moderate, H-High | | | | | | | | | | | | | | |

| **Course Articulation Matrix (CAM)** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcome (CO)** | **Program Outcome** | | | | | | | | | | | | | |
| | 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 |
| Explain the Concept of quality engineering, | 2 | 3 | | | | | | | | | | | 2 | |
| Explain the Taguchi Approach to Quality | 3 | 2 | | | | | | | | | | | | 1 |
| Describe the Replicating experiments. | 1 | 2 | 1 | | 1 | | | | | | | | | |
| Describe the Branching design. | 1 | 2 | 2 | | 2 | | | | | | | | | 2 |
| Differentiate between continuous-digital and digital-continuous | 1 | 1 | 1 | 2 | | 1 | | | | | | | | 2 |
| L- Low, M- Moderate, H-High | | | | | | | | | | | | | | |

| Course Title: **Finite Element Methods** | | | |
|---|---|---|---|
| **Course Code:P15IP554** | **Sem: V** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** The students should have basic knowledge of Mathematics & Mechanics of Materials.

**Course Learning Objectives (CLO):**

At the end of the Course the students should be able to,

- Explain the Steps involved in FEM, Types of elements and methods used to solve linear algebraic problems.
- Solve problems on 1D, 2D and on Nodes.
- Solve problems on Strain Displacement, Stiffness Matrix and Stepped bars.
- Derive an expression for the Hermite Shape Function for beam element.
- Analyze the shear force and bending moment.
- Solve problems on Heat Transfer related to 1D.

**Relevance of the Course:**

Finite Element Methods is a subject which deals with the concept of,

- 1D, 2D and Linear Algebraic Equations.
- Displacement Functions, Different co-ordinate systems used in FEM.
- Strain Displacement Matrix, Stiffness matrix and Load Vector for linear and quadratic bar element.
- Analysis of heat transfer WRT 1D.

## Course Content

### Unit -1

**INTRODUCTION TO FEM**: Need for use of FEM, Advantages and disadvantages of FEM, Engineering Applications of FEM, Steps involved in FEM, Discretization process – types of elements (1D,2D,3D), size of the elements, location of nodes, node numbering scheme, Method of solution of linear algebraic equations – Gauss elimination method. Numerical integration by Gaussian quadrature (one point and two point formula). Basic elastic equations – body force and traction force, strain-displacement relations. Principle of minimum potential energy and derivation of potential energy functional for a 3D elastic body, concept of plane stress and plane strain and their stress-strain relations. **10 hrs**

### Unit -II

**INTERPOLATION MODELS**: Displacement function, selection of the order of displacement function, convergence criteria, geometric isotropy, Pascal's triangle for 2D polynomial, Different co-ordinate systems used in FEM, Interpolation or shape functions for 1D linear and quadratic bar elements and 2D linear triangular (CST) element in cartesian and natural co-ordinate systems. Lagrangian polynomial – Shape functions for linear quadrilateral element (QUAD 4) and quadratic quadrilateral element (9-noded), Iso-parametric, sub-parametric and super-parametric elements, Concept of Jacobian matrix, Jacobian matrix for CST. **10 hrs**

### Unit -III

**ELEMENT STIFFNESS MATRIX AND LOAD VECTORS**: Strain displacement matrix, Stiffness matrix and load vector for linear and quadratic bar element and CST element. Assembly of elements by direct stiffness method, special characteristics of stiffness matrix, Treatment of boundary conditions- elimination and penalty methods. Analysis of axially loaded uniformly tapered and stepped bars. **12 hrs**

**Unit -IV**

**ANALYSIS OF PLANE TRUSSES AND BEAMS**: Local and global coordinate systems, stiffness matrix for plane truss element, analysis of truss members. Hermite shape function for beam element in Cartesian coordinates, Stiffness matrix and load vector for beam element, element shear force and bending moment, analysis of beams. **10 hrs**

**Unit -V**

**ANALYSIS OF HEAT TRANSFER PROBLEMS**: Steady state heat transfer, 1D heat conduction-governing equation, boundary conditions, one-dimensional element, Galerkin's approach to heat conduction, heat flux boundary condition. 1D heat transfer in thin fins- Formulation of equations. Simple numerical of 1D heat transfer problems on composite walls and fins with conduction and convection. **10 hrs**

**TEXT BOOKS**

**1 Introduction to the Finite Element Method:** C. S. Desai and J.F. Abel, EWP an East-West Edition 2000

**2 Introduction to Finite Elements in engineering:** T R Chandrupatla and A D Belegundu, PHI.2001

**REFERENCES BOOKS**

1.**Finite Element Method**: J.N.Reddy, McGraw –Hill International Edition.
2.**Finite Element Methods:** by Daryl. L. Logon, Thomson Learning 3rd edition.
3.**Fundamentals of Finite Element Analysis:** David V. Hutton,–Tata McGraw Hill
4.Publishing Co. Ltd, New Delhi.

**Course Outcomes**

At the end of the course the students should be able to:

1. **Explain** the concept of finite element method as well as finite element discretization process. **Apply** Gauss elimination algorithm to **solve** linear algebraic equations and Gauss quadrature technique for numerical integration.
2. **Develop** interpolation models for different types of elements that satisfy convergence criteria and geometric isotropy. **Use** iso-parametric concept in the finite element analysis.
3. **Formulate** element stiffness matrices and load vectors for different elements by **applying** Variational principle.
4. **Use** developed finite element models in the **determination** of stresses, strains and reactions of axially loaded bars, trusses and transversely loaded beams.
5. **Formulate** finite element equations for heat transfer problems using Variational and Galerkin techniques and **apply** these models to conduction and convection heat transfer problems.

| Course Title: COMPOSITE MATERIALS | | | |
|---|---|---|---|
| **Course Code: P15IP561** | **Semester: V** | **L–T–P-H : 4 -0- 0-4** | **Credit:3** |
| **Contact Period - Lecture: 52Hrs.;Exam: 3 Hrs.** | | **Weightage: CIE: 50 %; SEE: 50%** | |

**Prerequisites:** The students should have basic knowledge of material science & production technology.

**Course Learning Objectives (CLO):**

At the end of the Course the students should be able to,

- Explain the role of reinforcement and matrix in composite materials.
- Analyze the role of Prepegs in composites.
- List the application & uses of composites materials.
- Derive an expression for the Number of elastic constants, Hooke's law for two-dimensional angle lamina in composites.
- Explain the laminate codes in developing composite materials.
- Explain the different methods of composite material synthesis and testing methods for composites.

**Relevance of the Course:**

Composite Materials is a basic subject which deals with the concept of,

- Matrix & Reinforcement in Composite materials.
- Hooke's law for different types of composite materials,
- Stress-Strain relations for lamina of arbitrary orientation,
- Manufacturing and Testing of composite materials.

## Course Content

### UNIT-I

**Introduction to Composite Materials**: Definition, Classification, Types of matrices material and reinforcements, Characteristics & selection, Fiber composites, laminated composites, Particulate composites, Prepegs, and sandwich construction.

Advanced Composites: Polymer Nanocomposites – Introduction, Nano clay, Carbon Nanofiber, Carbon Nanotubes. **10 Hours**

### UNIT-II

**Applications**: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment-future potential of composites.

**Metal Matrix Composites:** Reinforcement materials, Types, Characteristics and selection, Base metals, Selection, Applications. **9 Hours**

### UNIT- 3

**Macro Mechanics of a Lamina**: Hooke's law for different types of materials, Number of elastic constants, Derivation of nine independent constants for orthotropic material, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. **11 Hours**

**UNIT- 4**

**Macro Mechanical Analysis of Laminate:** Introduction, code, Kirchhoff hypothesis, CLT, A, B, and D matrices (Detailed derivation) Engineering constants, Special cases of laminates, Numerical problems. **10 Hours**

**UNIT-V**

**Manufacturing and Testing**: Layup and curing - open and closed mould processing, Hand lay-up techniques, Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining, joining and repair. NDT tests – Purpose, Types of defects. NDT method - Ultrasonic inspection, Radiography, Acoustic emission and Acoustic ultrasonic method. **12 Hours**

**Text Books:**


1. Mein Schwartz, "Composite Materials Handbook", McGraw Hill Book Company, 1984.
2. Autar K. Kaw, "Mechanics of composite materials", CRC Press New York, 8$^{TH}$ Edition 2005.


**Reference Books:**


1. Rober M. Joness, "Mechanics of Composite Materials", McGraw Hill Kogakusha Ltd.
2. Michael W, Hyer, "Stress analysis of fiber Reinforced Composite Materials", McGraw Hill International.
3. Composite Material Science and Engineering, Krishan K. Chawla Springer.
4. P.K. Mallik,"Fibre Reinforced Composites",Marcel Decker, Inc 1993, CRC Press, Third Ed.


## Course Outcomes:

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

1. Identify and classify the different types of fiber and matrix materials used in commercial composites and nanocomposites.
2. Outline various applications of composites, its characterization and Role of MMC in engineering application.
3. Derive the expression for Hooke's Law, Maximum Stress and Strain Theory and number of elastic constants.
4. Distinguish the different orientation of laminates and Kirchhoff hypothesis used in composites.
5. Summarize various methods of composite fabrication techniques and also understand the importance of ceramic matrix composites.

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome(ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Identify and classify the different types of fiber and matrix materials used in commercial composites and nanocomposites. | M | | | | | | | | | | | M | M | |
| Outline various applications of composites, its characterization and Role of MMC in engineering application. | M | L | | | M | | | | | | | M | M | |
| Derive the expression for Hooke's Law, Maximum Stress and Strain Theory and number of elastic constants. | H | M | | | M | | | | | | | M | M | |
| Distinguish the different orientation of laminates and Kirchhoff hypothesis used in composites | H | M | | | M | | | | | | | M | M | |
| Summarize various methods of composite fabrication techniques and also understand the importance of ceramic matrix composites. | M | M | | | H | | | | | | | M | M | |

L-Low, M-Moderate, H-High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Identify and classify the different types of fiber and matrix materials used in commercial composites and nanocomposites. | 2 | | | | | | | | | | | 2 | 2 | |
| Outline various applications of composites, its characterization and Role of MMC in engineering application. | 2 | 1 | | | 2 | | | | | | | 2 | 2 | |
| Derive the expression for Hooke's Law, Maximum Stress and Strain Theory and number of elastic constants. | 3 | 2 | | | 2 | | | | | | | 2 | 2 | |
| Distinguish the different orientation of laminates and Kirchhoff hypothesis used in composites. | 3 | 2 | | | 2 | | | | | | | 2 | 2 | |
| Summarize various methods of composite fabrication techniques and also understand the importance of ceramic matrix composites. | 2 | 2 | | | 3 | | | | | | | 2 | 2 | |

1-Low, 2-Moderate, 3-High

| Course Title: **Industrial Robotics** | | | |
|---|---|---|---|
| **Course Code:P15IP562** | **Sem: V** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites**: Basic knowledge of Theory of Machines

**Course Learning Objectives:**

At the end of the Course the students should be able to:

1. Understand advantages, disadvantages and applications of Robots in industries.[L2]
2. Understand Classifications, geometrical and configuration.[L2]
3. Know the difference between accuracy and repeatability. [L1]
4. Understand basic components and motion analysis of robots.[L2]
5. Learn Euler formulations and trajectory planning processes of Robots.[L1]
6. Understand the programming languages and Robot cell design and control.[L2]
7. Understand different types of sensors**.**[L2]

# Course Contents

**Unit – I**

**Automation in Manufacturing :** Introduction : Automation and robotics, brief history of robotics, social and economic aspects of robots, advantages and disadvantages of using robots, advantages and disadvantages of using robots in industries. Overview of robots – present and future applications.

**Classification And Structure of Robotic Systems:** Classifications, geometrical configuration, wrist and its motions and effectors and its types, links and joints. Robot drive system: Hydraulic, electric and pneumatic drive system resolution, accuracy and repeatability, advantages and disadvantages of drive systems. **11 Hours**

**Unit – II**

**Control System and Components:** Basic control system concepts and models, transformation and block diagram of spring mass system, controllers – NO and OFF, promotional, integral, proportional –plus- integral, transient and response to second order system.

**Robot Motion Analysis :** Kinematics – Introduction, direct and inverse kinematics, rotation matrix, composite rotation matrix, rotation matrix about and arbitrary axis, Euler angles representations, homogeneous transformations, links, joints and their parameters. **11 Hours**

**Unit – III**

**Robot Arm Dynamics:** La Grange Euler formulations– joint velocities, kinetic energy potential energy and motion equations of robot manipulator, Newton, Euler formulations- Rotating coordinate systems,.

**Trajectory Planning:** Introduction, general considerations on trajectory planning, joint interpolated trajectories, 4 – 3 – 4 trajectory example. Planning of Cartesian path trajectories-Homogeneous transformation matrix. **10 Hours**

**Unit –IV**

**Robot Programming:** Methods of robot programming, Lead through programming methods, a robot program as a path in space, motion interpolation, commands-WAIT, SIGNAL, capabilities &limitations of Lead through methods.

**Robot Cell Design and Control:** Robot cell layouts, workcell control, error detection and recovery, graphical simulation of robotic workcell. Economic analysis for robots-method**.** **10 Hours**

**Unit – V**

**Sensors:** Transducers and sensors, Sensors in robots- tactile sensors, non - tactile sensor, proximity sensing, range sensing, and force – torque sensors. Elements of computer vision, sensing and digitizing function in machine vision – image device – lighting techniques – analog to digital signal convention – sampling – quantitization – encoding – image – storage, Image processing and analysis. **10 Hours**

**TEXT BOOKS**


1. Groover, " Industrial Robotics", Tata McGraw-Hill Education, 2012
2. Yorem Korem, " Robotics" McGraw Hill Intl. Book Co.,New Delhi, 1985
3. Fu, Gonzales and Lee, "Robotics", McGraw Hill. Edition, 1987


**REFERENCE BOOKS**


1. Robotics Engineering An integrated approach - Richard D Klafter, Thomas A Chmielewski, Michael Negin – Prentice Hall of India Pvt. Ltd. - Eastern Economy Edition, 1989.
2. Robert J. Schiling, "fundamentals of Robotics" McGraw Hill. Edition, 1987


**Course Outcomes:**

The students should be able to

1. Explain necessity of basics of Industrial Robots application.
2. Describe basic components of Robots and solve problems on motion analysis.
3. Illustrate trajectory planning processes of Robots and able to solve problems on Euler formulations.
4. Explain different programming languages and Robot cell design and control.
5. Demonstrate sensor application in robots.

## Course Assessment Matrix (CAM)

| Course Outcome – CO | Program outcome | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Explain necessity of basics of Industrial Robots application. | 3 | 2 | | | 1 | 1 | | | | | | 1 | | |
| Describe basic components of Robots and solve problems on motion analysis. | 2 | 2 | | | 2 | 1 | | | | | | 1 | | |
| Illustrate trajectory planning processes of Robots and able to solve problems on Euler formulations. | 2 | 2 | | | 2 | 1 | | | | | | 1 | | |
| Explain different programming languages and Robot cell design and control. | 3 | 2 | | | 2 | 1 | | | | | | 2 | | 1 |
| Demonstrate sensor application in robots. | 3 | 2 | | | 2 | 1 | | | | | | 2 | | 1 |

L-Low, M-Moderate, H-High.

## Course Articulation Matrix (CAM)

| Course Outcome – CO | Program outcome | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 |
| Explain necessity of basics of Industrial Robots application. | H | M | | | L | L | | | | | | L | | |
| Describe basic components of Robots and solve problems on motion analysis. | M | M | | | M | L | | | | | | L | | |
| Illustrate trajectory planning processes of Robots and able to solve problems on Euler formulations. | M | M | | | M | L | | | | | | L | | |
| Explain different programming languages and Robot cell design and control. | H | M | | | M | L | | | | | | M | | L |
| Demonstrate sensor application in robots. | H | M | | | M | L | | | | | | M | | L |

1-Low, 2-Moderate, 3-High

| Course Title: Computer Integrated Manufacturing | | | |
|---|---|---|---|
| **Course Code : P15IP563** | **Semester : V** | **L – T – P–H : 4 – 0 – 0 –4** | **Credits: 3** |
| **Contact Period – Lecture : 52 Hrs ; Exam : 03 Hrs** | | **Weightage : CIE : 50%** | **SEE : 50%** |

**Prerequisites:** The students should have undergone the course on CAD/CAM, Robotics and Operations Management.

**Course Learning Objectives (CLO):**

At the end of the Course the students should be able to,

1. Define the meaning and types of Computer Integrated Manufacturing systems [L1].
2. Analyze the importance of CIMS in manufacturing process [L1].
3. Define the concept of automated flow line and line balancing [L1].
4. Analyze the Transfer line without storage – upper bound and lower bound approach [L1].
5. Solve the problems on Balance delay, largest candidate rule, Kilbridge and Westers method [L3].
6. Explain the functions of different parts feeding devices and elements of parts delivery system [L1].
7. Explain the concept of automated guided vehicle system used [L1].
8. Solve the problems on Quantitative analysis of AGV system [L3].
9. Define the Generative type of process planning, MRP inputs and Capacity Planning [L1].
10. Understand the different elements of CNC [L1].
11. Know the steps involved in writing the CNC part programming [L1].
12. Understand the concept of robots, robot configuration and different robot motion [L1].

**Relevance of the Course:**

Computer Integrated Manufacturing is a subject which deals with the concept of,

1. Computer Integrated manufacturing system.
2. CIM manufacturing process.
3. Automated flow line and line balancing.
4. Automated guided vehicle system.
5. MRP, Inputs of MRP and Capacity Planning.
6. CNC and Robots programming.

## Course Content

### Unit – I

**COMPUTER INTEGRATED MANUFACTURING SYSTEMS :** Introduction, Automation definition, types of automation, CIM, processing in manufacturing, production concepts, Mathematical Models – Manufacturing lead time, production rate, components of operation time, capacity, Utilization and availability, work – in – process, WIP ratio, TIP ratio, Problems using mathematical model equations.

**HIGH VOLUME PRODUCTION SYSTEM :** Introduction Automated flow line – symbols, objectives, work part transport – continuous, Intermittent synchronous, pallet fixtures, Transfer Mechanism – Linear – Walking beam, roller chain drive, Rotary – rack and pinion, Ratchet & Pawl, Geneva wheel, Buffer storage, control functions – sequence , safety, Quality, Automation for machining operation. **11 Hrs**

### Unit – II

**ANALYSIS OF AUTOMATED FLOW LINE & LINE BALANCING :** General terminology and analysis, Analysis of Transfer Line without storage – upper bound approach, lower bound approach and problems, analysis of Transfer lines with storage buffer, Effect of storage, buffer capacity with simple problem, Partial automation – with numerical problems, flow lines with more than two stages, Manual Assembly lines, line balancing problem .

**MINIMUM RATIONAL WORK ELEMENT :** Work station process time, Cycle time, precedence constraints, Precedence diagram, Balance delay methods of line balancing – largest Candidate rule, Kilbridge and Westers method, Ranked positional weight method, Numerical problems covering above methods and computerized line balancing . **11 Hrs**

**Unit – III**

**AUTOMATED ASSEMBLE SYSTEMS :** Design for automated assembly systems, types of automated assembly system , Parts feeding devices – elements of parts delivery system – hopper, part feeder, Selectors, feedback, escapement and placement analysis of Multi station assembly Machine analysis of single station assembly. **10 Hrs**

**Unit – IV**

**Automated Guided Vehicle System:** Introduction, Vehicle guidance and routing, system management, Quantitative analysis of AGV's with numerical problems and application .
**COMPUTERIZED MANUFACTURING PLANNING SYSTEM :** Introduction, Computer aided Process Planning, Retrieval types of process planning, Generative type of process planning, Material requirement planning, Fundamental concepts of MRP inputs to MRP, Capacity planning. 1**0 Hrs**

**Unit –V**

**CNC MACHINING CENTERS:** Introduction to CNC, elements of CNC, CNC machining centers, part programming, fundamental steps involved in development of part programming for milling and turning.
**ROBOTICS:** Introduction to robot configuration, Robot motion, programming of Robots end effectors, Robot sensors and Robot application. **10 Hrs**

**TEXT BOOKS:**


1. Automation, Production system & Computer Integrated manufacturing,- M. P Groover Pearson India, 2007 2nd edition.
2. Principles of Computer Integrated Manufacturing, - S. Kant Vajpayee, Prentice Hall India.


**REFERENCE BOOKS:**


1. Computer Integrated Manufacturing,- J.a.Rehg & Henry. W. KrCAD/ CAM by Zeid, Tata McGraw Hill.


**Course outcomes**

At the end of the Course the students should be able to,

1. Explain the mathematical models, the terms used in mathematical models, and different types of transfer mechanisms used.
2. Define the upper bond and lower bond approach, Work station process time, Cycle time, precedence constraints, Precedence diagram, Balance delay methods of line balancing, explain the effect of storage in industry.
3. Design the assembly systems and parts feeding devices.
4. Explain the role and importance of AGV, CAPP and MRP.
5. Explain the different elements of CNC, the steps involved in writing the CNC part programming and the concept of robots, robot configuration and different robot motion.

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome(ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Explain the mathematical models, the terms used in mathematical models, and different types of transfer mechanisms used. | M | | | | M | | | | | | | | | |
| Define the upper bond and lower bond approach, Work station process time, Cycle time, precedence constraints, Precedence diagram, Balance delay methods of line balancing, explain the effect of storage in industry. | M | M | | | M | | | | | | | M | M | |
| Design the assembly systems and parts feeding devices. | M | M | | | M | | | | | | M | H | | |
| Explain the role and importance of AGV, CAPP and MRP. | M | M | | | M | | | | | | | M | | |
| Explain the different elements of CNC, the steps involved in writing the CNC part programming and the concept of robots, robot configuration and different robot motion. | M | | | | M | | | | | | | H | M | |

L-Low, M-Moderate, H-High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Explain the mathematical models, the terms used in mathematical models, and different types of transfer mechanisms used. | 2 | | | | 2 | | | | | | | | | |
| Define the upper bond and lower bond approach, Work station process time, Cycle time, precedence constraints, Precedence diagram, Balance delay methods of line balancing, explain the effect of storage in industry. | 2 | 2 | | | 2 | | | | | | | 2 | 2 | |
| Design the assembly systems and parts feeding devices. | 2 | 2 | | | 2 | | | | | | 2 | 3 | | |
| Explain the role and importance of AGV, CAPP and MRP. | 2 | 2 | | | 2 | | | | | | | 2 | | |
| Explain the different elements of CNC, the steps involved in writing the CNC part programming and the concept of robots, robot configuration and different robot motion. | 2 | | | | 2 | | | | | | | 3 | 2 | |

1-Low, 2-Moderate, 3-High

| Course Title: Simulation Modeling & Analysis | | | |
|---|---|---|---|
| **Course Code:P15IP564** | **Sem: V** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Course Learning Objectives (CLOs).**

At the end of the Course the students should be able to:

1. To explain modeling , simulation and analysis of a manufacturing system using various techniques.[L2]
2. To discuss the case studies on MONTE CARLO principle. [L6]
3. Able to understand analysis of simulation data.[L2]
4. An ability to know applications and selection of simulation software**.** [L1]

## Course Contents

**UNIT – 1**

**Introduction to simulation:** Simulation, advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study.

**Simulation examples:** Simulation of Queuing systems, Simulation of Inventory System, Other simulation examples **11 Hours**

**UNIT –2**

**General principles:** Concepts in discrete - events simulation, event scheduling / Time advance algorithm, simulation using event scheduling.

**Random numbers:** Properties, Generations methods, Tests for Random number- Frequency test, Runs test, Autocorrelation test, Gap test, Poker test **10 Hours**

**UNIT – 3**

**Random Variate Generation:** Inverse Transform Technique- Exponential, Uniform, Weibull, Triangular distributions, direct transformation for Normal and log normal Distributions, convolution methods- Erlang distribution, Acceptance – Rejection Techniques – Poisson distribution, Gamma Distribution. **10 Hours**

**UNIT – 4**

**Analysis of Simulation Data: Input Modeling**: Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis.

**Output Analysis:** Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations

**10 Hours**

**UNIT – 5**

**Applications:** Simulation of Manufacturing and Material Handling Systems, Simulation of Computer Systems, Simulation of Plant Layout, Simulation of Project Management

**Simulation Software: S**election of Simulation Software, Simulation packages, Experiment and Statistical Analysis tool. **11 Hours**

**Text Books:**

1. **Discrete Event system Simulation** – Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol, III Edition, Pearson Education, Asia, ISBN - 81- 7808 – 505 - 4.

**References**

1. **Simulation Modelling & Analysis** – Averill M Law, W David Kelton; McGraw Hill International Editions – Industrial Engineering series, ISBN – 0-07-100803-9.

2. **Systems Simulation with Digital Computer –** Narsingh Deo; PHI Publication (EEE), ISBN – 0-87692-028-8

**Course Outcomes**

1. Describe the steps and models of simulations with examples.
2. Represent the geometrical details of the parts to facilitate the manufacturing operations
3. Select the suitable material and the manufacturing processes considering the machine and process capabilities
4. Characterize a given engineering system in terms of its essential elements, that is, purpose, parameters, constraints, performance requirements, subsystems, interconnections and environmental context
5. Interpret the simulation results of an engineering system model, within the context of its capabilities and limitations, to address critical issues in an engineering project

## Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome(ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Describe the steps and models of simulations with examples. | M | | M | | M | | | | | | | L | | L |
| Represent the geometrical details of the parts to facilitate the manufacturing operations | M | | M | | M | | | | | | | L | | L |
| Select the suitable material and the manufacturing processes considering the machine and process capabilities | M | | M | | M | | | | | | | L | | L |
| Characterize a given engineering system in terms of its essential elements, that is, purpose, parameters, constraints, performance requirements, subsystems, interconnections and environmental context | M | | M | | M | | | | | | | L | | |
| Interpret the simulation results of an engineering system model, within the context of its capabilities and limitations, to address critical issues in an engineering project | M | | M | | M | | | | | | | L | | |

L-Low, M-Moderate, H-High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Describe the steps and models of simulations with examples. | 2 | | 2 | | 2 | | | | | | | 1 | | **1** |
| Represent the geometrical details of the parts to facilitate the manufacturing operations | 2 | | 2 | | 2 | | | | | | | 1 | | **1** |
| Select the suitable material and the manufacturing processes considering the machine and process capabilities | 2 | | 2 | | 2 | | | | | | | 1 | | **1** |
| Characterize a given engineering system in terms of its essential elements, that is, purpose, parameters, constraints, performance requirements, subsystems, interconnections and environmental context | 2 | | 2 | | 2 | | | | | | | 1 | | |
| Interpret the simulation results of an engineering system model, within the context of its capabilities and limitations, to address critical issues in an engineering project | 2 | | 2 | | 2 | | | | | | | 1 | | |

1-Low, 2-Moderate, 3-High

| Course Title: **Theory of Metal Cutting** | | | |
|---|---|---|---|
| **Course Code: P15IP61** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits: 4** |
| **Contact Period: Lecture:52 Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** The students should have undergone the course on Elements of Mechanical Engineering, Mechanics of Materials and Production Technology.

**Course Learning Objectives (CLO):**

At the end of the Course the students should be able to,

1. Define the mechanism of metal cutting principles and formation of chips in different types of metals.
2. Explain the terminology of Single Point and Multi Point cutting tools.
3. Explain the cutting forces involved and their relationship with respect to the resultant force in orthogonal metal cutting process.
4. Describe the concept of Machinability and Economics of Machining.
5. Explain the effect of temperature in metal working and the purpose and types of lubricants used in the process.
6. Explain the properties of different types of materials used in manufacturing tools and their properties.

**Relevance of the Course:**

Theory of Metal Cutting is a subject which deals with the concept of,

1. Metal cutting principles, types of metal cutting, formation of chips, etc.,
2. Different types of tools and their nomenclature systems.
3. Different forces involved in the process and their relationship.
4. Temperature generation and the ways of reducing the temperature.
5. Different types, purpose and properties of Cutting fluids.
6. Different materials used to manufacture the tools and their properties.

## Course Content

### Unit – I

**PROCESS OF METAL CUTTING:** Metal Cutting, Metal Cutting Principle, Types of Metal Cutting Process, Chip Formation, Chip Thickness Ratio, Chip Breaker, Cutting Speed, Feed and Depth of Cut – Economical cutting speed, Tool Geometry – Single Point Cutting Tool and Multipoint Cutting Tool (only drill bit), Tool Nomenclature Systems –ASA, ISO System, Conversion from one system to another system, Recommended tool angles, Effect of cutting parameters on Tool Geometry. **09 Hours**

### Unit - II

**MECHANICS OF METAL CUTTING:** Cutting forces in Orthogonal Cutting, Stress and Strain in the Chip, Shear Strain, Work done and Power required, Power Consumed in Metal cutting, Determination of shear plane angle, Merchant's Circle diagram and analysis, Co-efficient of friction, Measurement of Cutting Forces – Reasons for measuring cutting forces, Dynamometry, Types of Dynamometers – Problems on Merchant's Circle diagram. **11 Hours**

### Unit - III

**TOOL WEAR AND TOOL LIFE:** Machinability, Machinability Index, Objectives of Machining. Tool Failure – types of Tool wear. Tool Life, Relationship between the Cutting Speed and Tool Life, Effect of Feed and Depth of cut on Tool Life. Economics of Machining - Basic Objectives of Economical Machining, Production Cost, Economic Tool Life, Optimum Cutting Speed for Maximum Production, Tool Life for Maximum Production. Cost Analysis – Cost per Component. **12 Hours**

## Unit – IV

**CUTTING FLUIDS:** Cutting Fluids, Sources of Heat in Metal Cutting, Thermal Aspects of Metal Machining, Functions of Cutting Fluids, Types of Cutting Fluids, Selection and Application of Cutting Fluids, Effect of Cutting Fluid on Cutting Speed and Tool Life, Recommended Cutting Fluids and Reuse of Cutting Fluids. **10 Hours**

## Unit - V

**TOOL MATERIALS AND THEIR PROPERTIES:** Characteristics of tools materials, types of tool materials – carbon tool steels, high speed steels, cast alloys, cemented carbides, ceramics, diamonds, sialon, CBN, UCON, recommended cutting speeds for the above tools, tool & die steels – air, water, oil hardening of tools and their applications, Composite tools. **10 Hours**

**Text Books:**


1. Fundamentals of Metal Cutting and Machine Tools, B. L Juneja and G. S. Sekhon, Willy Eastern Limited, 2015
2. Tool Engineering and Design-G.R. Nagpal, Khanna Publishers -6TH Edition.


**Reference Books:**


1. Metal cutting theory, Black P.H, MC Graw Hill, 1996.
2. Metal cutting theory and cutting tool design, Arshinov and Atekseev, Mir Publishers, 1976.
3. Fundamentals of Machining and Machine Tools", R.K.Singal, IK International Publishing house Pvt. Lt, 2008.
4. Metal Cutting Principles, M. C. Shaw Oxford & I.B.H, 1st Edition.
5. Metal Cutting and Tool Design", Dr. B. J. Ranganath, Vikas Publishing House, 1999.


**Course Outcomes:**

At the end of the Course the students should be able to

1. Recognize the geometry of cutting tools based on the materials used for machining.
2. Elaborate on mechanics of machining in metal cutting, and to demonstrate the measurement of cutting forces for various machining operations.
3. Identify the tool life based on different cutting speed, feed and depth of cut and understand the importance of economy in machining.
4. Govern cutting tool temperature and appreciate the importance of cutting fluids.
5. Explain the characteristics and properties of different tool material.

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome(ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Recognize the geometry of cutting tools based on the materials used for machining. | M | M | | | | | | | | | | L | | |
| Elaborate on mechanics of machining in metal cutting, and to demonstrate the measurement of cutting forces for various machining operations. | H | M | | M | M | | | | | | | M | | |
| Identify the tool life based on different cutting speed, feed and depth of cut and understand the importance of economy in machining. | M | M | | | M | | | | | | | M | M | |
| Analyze cutting tool temperature and appreciate the importance of cutting fluids. | M | M | | | M | | | | | | | H | M | |
| Explain the characteristics and properties of different tool material. | M | M | | | H | | | | | | | H | H | |

L-Low, M-Moderate, H-High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Recognize the geometry of cutting tools based on the materials used for machining. | 2 | 2 | | | | | | | | | | 1 | | |
| Elaborate on mechanics of machining in metal cutting, and to demonstrate the measurement of cutting forces for various machining operations. | 2 | 2 | | 2 | 2 | | | | | | | 2 | | |
| Identify the tool life based on different cutting speed, feed and depth of cut and understand the importance of economy in machining. | 2 | 2 | | | 2 | | | | | | | 2 | 2 | |
| Govern cutting tool temperature and appreciate the importance of cutting fluids. | 2 | 2 | | | 2 | | | | | | | 3 | 2 | |
| Explain the characteristics and properties of different tool material. | 2 | 2 | | | 3 | | | | | | | 3 | 3 | |

1-Low, 2-Moderate, 3-High

| Course Title: **Theory of Metal Forming** | | | |
|---|---|---|---|
| **Course Code:P15IP62** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits: 4** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** The students should have undergone the course on Elements of Mechanical Engineering, Mechanics of Materials and Production Technology.

**Course Learning Objectives (CLO).**

At the end of the Course the students should be able to,

1. Derive an Expression for Von Mises criterion and Tresca criterion and classify the forming process and Role of Lubrication in Forming Process.
2. Explain different types of Forging and Rolling Process and their Defects.
3. Explain the role of Extrusion Equipment in used in Extrusion process and wire and Tube drawing Process.
4. Describe the shearing, blanking, punching, and bending of sheet metal.
5. Explain the HERF and Steps in Powder Metallurgy Process.

**Relevance of the Course**

Manufacturing process and Metallurgy is a basic subject which deals with the concept of,

1. Metal Forming process such as Forging, Rolling, Extrusion, Drawing.
2. Material properties and structure.
3. Hot and cold operations, temperature, friction etc.
4. Metallurgical structure of materials.
5. Effects on stress, strain, temperature etc.
6. Simple process like punching, stretching, bending etc.

## Course Content

### Unit - I

**FUNDAMENTALS OF METAL WORKING:**

Elements of the Theory of Plasticity: Flow curves, True stress and True strain, Yield Criteria for ductile materials, Von Mises criterion and Tresca criterion.

Fundamentals of Metal working: Classification of forming processes, Mechanics of Metal working – slab method, flow stress determination, temperature in Metal working, Hot working, Cold working, Warm working, strain - rate effects, metallurgical structure, friction and Lubrication, Residual stresses. **10 Hours**

### Unit – II

**FORGING:** Classification of forging operation, forging equipment, forging strain, open die forging, closed die forging, precision forging, and forging defects.

**ROLLING:** Classification of rolling mills- hot and cold. Rolling forces and geometrical relationships in rolling, simplified analysis of rolling load, defects in rolled products. **11 Hours**

### Unit – III

**EXTRUSION:** Classification, equipment's used, hot extrusion, deformation, lubrication and defects in extrusion, analysis of extrusion processes, Impact extrusion, hydrostatic extrusion, tube extrusion, production of seamless pipe and tubing, Extrusion defects.

**DRAWING OF RODS, WIRES AND TUBES:** Rod and wire drawing process, drawing dies, analysis of wire drawing, wire and tube drawing. Defects in drawing, tube drawing. **11 Hours**

**Unit- IV**

**SHEET METAL FORMING PROCESS:** Introduction, Forming methods, shearing, blanking, punching, bending, spring back, elimination of spring back, spinning, deep drawing stretch forming, redrawing, reverse drawing, defects in drawing, factors affecting drawability ratio. **10 Hours**

**Unit- V**

**HIGH ENERGY RATE FORMING (HERF):** Introduction to HERF, Process advantages, explosive forming, electro discharge forming and electromagnetic forming, Rubber forming.

**POWDER METALLURGY:** Basic steps in Powder metallurgy brief description of methods of production of metal powders, Characteristics of powder, advantages and limitations. **10 Hours**

**TEXT BOOKS:**

1. Mechanical Metallurgy - Dieter. G. E - McGraw Hill, 2015.
2. Manufacturing Process III, Radhakrishna K, Sapna Book House 2013

**REFERENCE BOOK:**

1. ASM- Metals handbook, Sach G. fundamentals of working of metals, Pergamon Press.
2. Manufacturing Engineering and Technology by Serope Kalpakjian & Stevan

**Course Outcomes**

At the end of the Course the students should be able to,

1. Explain the theory behind the forming of the metal.
2. Demonstrate the concept of forging of metals, forces and defects involved in rolling of metals.
3. Recognize the basic knowledge of extrusion and drawing metals and the defects.
4. Demonstrate the basic concept of sheet metal forming processes and methods involved in forming process.
5. Identify the basic methods of high energy forming process, powder metallurgy and its applications.

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Explain the theory behind the forming of the metal. | M | L | | | | | | | | | | | | |
| Demonstrate the concept of forging of metals, forces and defects involved in rolling of metals. | M | M | | | H | | | | | | | M | L | |
| Recognize the basic knowledge of extrusion and drawing metals and the defects. | M | M | | | H | | | | | | | M | M | |
| Demonstrate the basic concept of sheet metal forming processes and methods involved in forming process. | M | M | | | M | | | | | | | L | M | |
| Identify the basic methods of high energy forming process, powder metallurgy and its applications. | M | M | | | H | | | | | | | M | M | |

L-Low, M-Moderate, H-High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Explain the theory behind the forming of the metal. | 2 | 1 | | | | | | | | | | | | |
| Demonstrate the concept of forging of metals, forces and defects involved in rolling of metals. | 2 | 2 | | | 3 | | | | | | | 2 | 1 | |
| Recognize the basic knowledge of extrusion and drawing metals and the defects. | 2 | 2 | | | 3 | | | | | | | 2 | 2 | |
| Demonstrate the basic concept of sheet metal forming processes and methods involved in forming process. | 2 | 2 | | | 2 | | | | | | | 1 | 2 | |
| Identify the basic methods of high energy forming process, powder metallurgy and its applications. | 2 | 2 | | | 3 | | | | | | | 2 | 2 | |

1-Low, 2-Moderate, 3-High

| Course Title: **Quality Assurance and Reliability** | | | |
|---|---|---|---|
| **Course Code:P15IP63** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits: 4** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Requirements:** Students should have the knowledge Quality, Quality audit concept, audit reporting X bar and S control charts with variable sample size, control charts for individual measurements, Fraction non- conforming (defectives) development and operation of control chart Guidelines for implementing control charts, accepting sampling**,** Failure models of components, reliability, MTBF, Failure rate , Redundancy, etc.

**Course Learning Objectives:**

At the end of the Course the students should be able to,

1. The aim of the course is to provide the students an opportunity to gain the knowledge in the field of Quality,
2. Apply the fundamental concepts of Quality principal and to solve the Quality problems.
3. To demonstrate the advantages, applications, limitations of the several of Quality functions and charts.
4. To gain the knowledge for various control charts for attributes.
5. The students gain the knowledge of different sampling inspection
6. The students understands the different methods of Failure models of components, MTBF, Failure rate, common failure rate curve, types of failure.

## Course Content

### Unit-I

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

**QUALITY ASSURANCE:** Definition and concept of quality assurance, departmental assurance activities. Quality audit concept, audit approach etc. structuring the audit program, planning and performing audit activities, audit reporting, ingredients of a quality program. **10Hours**

### Unit-II

**STATISTICAL PROCESS CONTROL:** Introduction to statistical process control – chance and assignable causes variation. Basic principles of control charts, choice of control limits, sample size and sampling frequency, rational subgroups. Analysis of patterns of control charts. Process capability – Basic definition, standardized formula, relation to product tolerance and six sigma concept of process capability.

**CONTROL CHARTS FOR VARIABLES:** Controls charts for X bar and Range R, statistical basis of the charts, development and use of X bar and R charts, interpretation of charts. Control charts for X bar and standard deviation (S), development and use of X bar and S chart. Brief discussion on – Pre control X bar and S control charts with variable sample size, control charts for individual measurements. **12Hours**

### Unit -III

**CONTROL CHARTS FOR ATTRIBUTES:** Controls chart for fraction non- conforming (defectives) development and operation of control chart, brief discussion on variable sample size. Control chart for non-conformities (defects) – development and operation of control chart for constant sample size and variable sample size. Choice between variables and attributes control charts. Guidelines for implementing control charts. **10Hours**

**Unit -IV**

**SAMPLING INSPECTION:** Concept of accepting sampling, economics of inspection, Acceptance plans – single, double and multiple sampling. Operating characteristic curves – construction and use. Determinations of average outgoing quality, average outgoing quality level, average total inspection, producer risk and consumer risk, published sampling plans. **10Hours**

**Unit -V**

**RELIABILITY AND LIFE TESTING:** Failure models of components, definition of reliability, MTBF, MTTF, Failure rate, common failure rate curve, types of failure, reliability evaluation in simple cases of exponential failures in series, paralleled and series-parallel device configurations, Redundancy and improvement factors evaluations. **10Hours**

**TEXT BOOKS:**


1. Introduction to statistical Quality Control- D C Montgomery 3rd Edition, John Wiley and Sons.
2. Quality Planning & Analysis- J M Juran, Frank M Gryna; 3rd edition, Tata McGraw Hill.


**REFERENCE BOOKS:**


1. Statistical Quality Control- Grant and Leavenworth, 6th Edition McGraw Hill,
2. The QS9000 Documentation Toolkit- Janet L Novak and Kathleen C Bosheers, 2nd Edition, Prenctice Hall PTR.
3. ISO 9000 a Manual for Total Quality Management-, Suresh Dalela and Saurabh, 1st Edition, S Chand and Co.
4. Total Quality Management-I KesavanR.K. International, New Delhi – 2007.
5. Statistical Quality control – M. Mahajan, Dhanpat Rai & Co. (p) LTD


**Course Outcome**

At the end of the Course the students should be able to,

1. The students should learn and understand necessity of quality assurance and reliability.
2. Demonstrate ability to make use of various Quality functions and charts.
3. Students will be able to use different types of control charts for attributes
4. The students get exposure to different types sampling inspection.
5. Students should be able to demonstrate the knowledge of various methods of Failure models of components, MTBF, Failure rate, common failure rate curve.

# Course Articulation Matrix

| Course Outcomes | Program Outcomes (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Explain history of quality control methodology – (Unit – I) | | M | | | M | | | | H | L | | | M | |
| Determine trial control limits for $\overline{X}$ and R charts. | | | H | | | M | | | | | | | | |
| Differentiate between defects and defective – (Unit – III) | | | | M | M | | | | | | | L | H | |
| List the advantages of acceptance sampling techniques. – (Unit – IV) | | | | | | H | | | | | L | | | |
| Explain the characteristics of good sampling plan – (Unit –IV) | H | M | | | | | | | | | | | | |
| Explain the failure rate curve, types of parallel redundant –(Unit – V) | | | | | | H | | | | | L | | M | |

1-Low, 2-Moderate, 3-High

# Course Assessment Matrix (CAM)

| Course Outcomes | Program Outcomes (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Explain history of quality control methodology – (Unit – I) | | 2 | | | 2 | | | | 3 | 1 | | | 2 | |
| Determine trial control limits for $\overline{X}$ and R charts. –(Unit – II) | | | 3 | | | 2 | | | | | | | | |
| Differentiate between defects and defective – (Unit – III) | | | | | 2 | 2 | | | | | 1 | | 3 | |
| List the advantages of acceptance sampling techniques. – (Unit – IV) | | | | | | 3 | | | | | 1 | | | |
| Explain the characteristics of good sampling plan – (Unit –IV) | 3 | 2 | | | | | | | | | | | | |
| Explain the failure rate curve, types of parallel redundant –(Unit – V) | | | | | | 3 | | | | | 1 | | 2 | |

1-Low, 2-Moderate, 3-High

| Course Title: **Economics for Engineers** | | | |
|---|---|---|---|
| **Course Code:P15IP64** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits: 4** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites**: Basic engineering Mathematics

**Course Learning Objectives**

At the end of the Course the students should be able to,

1. Illustrating the basics of Economics and the Interest & the various Interest factors
2. Analyzing the various projects using Present worth and Equivalent annual comparison methods
3. Determining the Rate of return and Depreciation of various Projects/Assets
4. Comparing the different Alternatives & Replacement criteria in the back ground of inflation, time value of money & Sources of capital
5. Computing the cost of a product/project & assessing the Breakeven point

**Relevance of the Course Description**

Engineering Economics is a foundation course in BE (Industrial and Production) program that equip the students in analyzing the various projects in the background of time value of money.

## Course Content

### Unit – I

**INTRODUCTION:** Engineering Decision- Makers, Engineering and Economics, Problem solving and Decision making: Intuition and Analysis, Tactics and Strategy. Sensitivity and Sub optimization.

**INTEREST AND INTEREST FACTORS:** Interest rate, simple interest Compound interest and compound-interest factors, Cash- flow diagrams, Exercises and Discussions. **11 Hours**

### Unit – II

**PRESENT WORTH COMPARISON:** Conditions for present worth comparisons, Basic Present worth comparisons patterns, Assets with unequal lives, infinite lives, Future worth comparisons, Pay – back comparison, Exercises, Discussions.

**EQUIVALENT ANNUAL WORTH COMPARISONS:** Equivalent Annual Worth Comparison methods, Situations for Equivalent Annual Worth Comparisons, Consideration of asset life, Use of sinking fund method, Exercises and Discussions. **11 Hours**

### Unit – III

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

**DEPRECIATION:** Causes of Depreciation, Basic methods of computing depreciation charges: Straight-line, Declining balance, Sum-of the Years-Digits & Sinking fund Methods, Tax concepts and types. **10 Hours**

### Unit – IV

**STRUCTURAL ANALYSIS OF ALTERNATIVES:** Identifying and Defining alternatives, classification of alternatives.

**REPLACEMENT ANALYSIS:** Deterioration, obsolescence, inadequacy

**EFFECTS OF INFLATION:** Causes, consequences and control & Measuring of inflation, Lease or Buy decisions

**FINANCIAL MANAGEMENT:** Types of capital, Sources of Finance, Cost of capital concept

**10 Hours**

**Unit – V**

**ESTIMATING & COSTING:** Introduction, Need, Elements of product cost, Determination of selling price, Allocation of overheads, Estimation for simple components.

**BREAK-EVEN ANALYSIS:** Basic Concepts, Linear & non-linear break even analysis. **10 Hours**

**TEXT BOOKS:**


1. Engineering economics- RIGGS J.L and others , 4th edition, Tata McGraw Hill, 2015 Reprint
2. Engineering economics- R.K.Hegade, Sapna Book house, 1st edition, 2015 Reprint


**REFERENCE BOOKS:**


1. Engineering economy -THUESENH.G. PHI, 2002
2. Engineering Economy – NVR. NAIDU, KM BABU and G. RAJENDRA, New Age International Pvt. Ltd. – 2006
3. Engineering economics- K.R.Phaneesh, Sudha Publications, 3rd revised edition, 2008


**Course Outcomes (CO's)**

At the end of the Course the students should be able to,

1. Understanding the fundamentals of the Engineering economics.
2. Compare the various Project(s) using present worth/ Equivalent Annual worth methods.
3. Compute the Rate of return of the Project(s) and Depreciation charges of the Machine/Equipment
4. Analyze the various alternatives & criteria of replacement, Sources of capital and predict the effect of inflation on it.
5. Estimate the cost of a product/process and Judging the Breakeven point

# Course Articulation Matrix (CAM)

| Course Outcome (CO) | Program Outcome (ABET/NBA)) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PS O1 | PS O2 |
| Understanding the fundamentals of the Engineering economics (Unit–I) | M | M | M | L | | | | | | L | L | | | |
| Compare the various Project(s) using present worth/ Equivalent Annual worth methods. (Unit – II) | M | L | H | M | | | | | | M | L | | L | L |
| Compute the Rate of return of the Project(s) and Depreciation charges of the Machine/Equipment(Unit–III) | M | M | H | L | | | | | | M | L | | L | L |
| Analyze the various alternatives & criteria of replacement, Sources of capital and predict the effect of inflation on it. (Unit – IV) | M | M | H | M | | | M | | | M | L | L | | |
| Estimate the cost of a product/process and Judging the Breakeven point – (Unit – V) | M | M | H | M | | | | L | | M | L | L | L | L |

1-Low, 2-Moderate, 3-High

# Course Assessment Matrix (CAM)

| Course Outcome (CO) | Program Outcome (ABET/NBA)) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Understanding the fundamentals of the Engineering economics (Unit – I) | 2 | 2 | 2 | 1 | | | | | | 1 | 1 | | | |
| Compare the various Project(s) using present worth/ Equivalent Annual worth methods. (Unit – II) | 2 | 1 | 3 | 2 | | | | | | 2 | 1 | | 1 | 1 |
| Compute the Rate of return of the Project(s) and Depreciation charges of the Machine/Equipment(Unit – III) | 2 | 2 | 3 | 1 | | | | | | 2 | 1 | | 1 | 1 |
| Analyze the various alternatives & criteria of replacement, Sources of capital and predict the effect of inflation on it. (Unit – IV) | 2 | 2 | 3 | 2 | | | 2 | | | 2 | 1 | 1 | | |
| Estimate the cost of a product/process and Judging the Breakeven point – (Unit – V) | 2 | 2 | 3 | 2 | | | | 1 | | 2 | 1 | 1 | 1 | 1 |

1-Low, 2-Moderate, 3-High

| Course Title: **Industrial Engineering Lab** | | | |
|---|---|---|---|
| **Course Code:P15IPL67** | **Sem: VI** | **L-T-P-H: 0-0-3-3** | **Credits: 1.5** |
| **Contact Period: Lecture:39Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Course objective:** To train the students with the practical knowledge of instruments, methods of analysis, application of work study and Ergonomics in engineering system design.

**Prerequisites:** Students should have studied the Work Study.

**Course Learning Objectives (CLO):**

After completion of lab the student should be able to:

- Learn the various processes of layouts and charts for an industry.
- Determine the Performance ratings of different activities.
- Analyse the effect of different noise levels at work places.
- Determine the acceptance samplings and normal distribution.
- Determine the effect of work on human efficiency.

## Course Contents

1. Recording Techniques: preparing the following charts and diagrams
   - Out line process chart
   - Flow process chart
   - Flow diagram
   - Multiple activity charts
   - String diagram
   - Two handed process charts
2. Application of principle of motion economy
3. Measurement of effect of work on human body (Ergometer, Treadmill)
4. Conceptual design of displays and controls
5. Rating exercises
6. Determining the standard time for simple operation using stop watches and PMTS
7. Application of Acceptance Sampling Techniques (singe sampling plan & Plotting the O.C. Curve)
8. Experiments to generate data the results in normal distribution, and its interpretation.
9. Effect of Noise on human efficiency.

**Scheme of Examination:**

| | | |
|---|---|---|
| Experiments | | : 40 Marks |
| Viva – Voce | | : 10 Marks |
| | Total | **: 50 Marks** |

**Course Outcomes (COs)**

After completion of lab the student should be able to:

1. Construct the Charts and diagrams to record the methods
2. Illustrating the Principles of motion economy, Acceptance sampling and Normal distribution.
3. Evaluate the effect of work, Noise on human body
4. Determine the Rating and Standard time for simple operations
5. Design of Displays and controls

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Construct the Charts and diagrams to record the methods | M | M | | | | | | | | | | M | | |
| Illustrating the Principles of motion economy, Acceptance sampling and Normal distribution. | M | M | | | | | | | | | | M | | |
| Evaluate the effect of work, Noise on human body | M | M | L | | | | | | | | | M | | L |
| Determine the Rating and Standard time for simple operations | H | M | L | | | | | | | | | M | | L |
| Design of Displays and controls | M | M | L | | | | | | | | | M | | M |

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Construct the Charts and diagrams to record the methods. | 2 | 2 | | | | | | | | | | 2 | | |
| Illustrating the Principles of motion economy, Acceptance sampling and Normal distribution. | 2 | 2 | | | | | | | | | | 2 | | |
| Evaluate the effect of work, Noise on human body . | 2 | 2 | 1 | | | | | | | | | 2 | | 1 |
| Determine the Rating and Standard time for simple operations. | 3 | 2 | 1 | | | | | | | | | 2 | | 1 |
| Design of Displays and controls. | 2 | 2 | 1 | | | | | | | | | 2 | | 2 |

| Course Title: **Computer Aided Analysis Lab** | | | |
|---|---|---|---|
| **Course Code: P15IPL68** | **Semester: VII** | **L–T–P-H : 0 - 0 – 3 - 3** | **Credit:1.5** |
| **Contact Period - Practical: 39Hrs. Exam: 3Hrs.** | | **Weightage: CIE: 50 %; SEE: 50%** | |

**Course Learning Objective:**
The course aims at prepare the students to use Finite Element Analysis tools for solving simple structural problems to enhancing their analysis skills in the field of Computer Aided Engineering.

## Course content

1. Introduction to ANSYS Application software
2. Application of line elements: bars of constant cross section area, tapered cross section area, stepped bars.
3. Application of line elements: Plane trusses, beams with point, uniform and variable loads.
4. Application 2-D elements: Beams, Plate with hole
5. Application of 2-D elements to axisymmetric problems.
6. Modal analysis of fixed - fixed beam
7. Simple Harmonic analysis of axially loaded bar, Fixed - fixed beam
8. Buckling analysis of columns.
9. Modelling of torsion problem.

**References**

1. Saeed Moaveni, “Finite Element Analysis Theory and Application with ANSYS”, Pearson Education
2. ANSYS 15 Documentation.


**Course Outcomes (COs)**
At the end of the course the students should be able to:
1. Explain the applications of commercial FEA packages like ANSYS 2015.
2. Solve structural engineering problems using ANSYS
3. Validate finite element results with analytical or experimental results.
4. Apply the right finite elements techniques on various kind of machine parts

**Scheme of Examination:**
1. Experiments : 40 Marks
2. Viva – Voce : 10 Marks

Total **: 50 Marks**

## Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Ability to describe the applications of FEA packages | H | M | | | M | | | | | | | M | | |
| Ability to Solve structural engineering problems using ANSYS | H | M | | | M | | | | | | | M | | |
| Ability to Validate finite element results with analytical or experimental results. | H | M | | | M | | | | | | | M | | |
| Ability to Apply the right finite elements techniques on various kind of machine parts | H | M | | | M | | | | | | | M | | |

## Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Ability to describe the applications of FEA packages. | 3 | 2 | | | 2 | | | | | | | 2 | | |
| Ability to Solve structural engineering problems using ANSYS. | 3 | 2 | | | 2 | | | | | | | 2 | | |
| Ability to Validate finite element results with analytical or experimental results. | 3 | 2 | | | 2 | | | | | | | 2 | | |
| Ability to Apply the right finite elements techniques on various kind of machine parts. | 3 | 2 | | | 2 | | | | | | | 2 | | |

| Course Title : Aptitude and Reasoning Development - EXPERT (ARDE) | | |
|---|---|---|
| **Course Code : P15HU610** | **Semester : VI** | **L : T : P : H - 0 : 0 : 2 : 2** |
| **Contact Period: Lecture: 32 Hr, Exam: 3 Hr** | **Weightage: CIE:50%; SEE:50%** | |
| **Prerequisites: Number system, Concept of percentage, Analytical reasoning-2.** | | |

**Course Learning Objectives (CLOs)**

**This course aims to**

1. Explain different types of functions, representation of different functions on the graphs.
2. Describe the properties of quadratic equations and application of quadratic equations.
3. Demonstrates the principle of counting.
4. Differentiates between permutation and combination and solve problems conceptually.
5. Predict the probabilities in different scenarios and its application in our day-to-day life.
6. Evaluate the cause and effect of the statements logically.
7. Recognize different ways in which a statement can be strengthened or weakened.
8. Explain the criticality of data sufficiency chapter., universal methodology to solve any problem.
9. Analyse the data in a bar graph , pie chart and tabular column and line graph and the combination of these graphs.
10. Compare the data in different format and understand the difference between them

## Course Content

### Unit – I

**Functions and Quadratic equations:**

**Functions:** Basic methods of representing functions– Analytical representation, tabular representation, graphical representation of functions. Even and odd functions, Inverse of a function, Shifting of graph. Representation of standard set of equations. Methodology to tackle inverse functions. Graphical process for solving inequalities, graphical view of logarithmic function.

**Quadratic equations:** Theory, properties of quadratic equations and their roots, the sign of quadratic equation, Equations in more than one variable. Simultaneous equations, number of solutions of the simultaneous equations. **6 hrs**

### Unit – II

**Permutation and Combination:** Understanding the difference between the permutation and combination, Rules of Counting-rule of addition, rule of multiplication, factorial function, Concept of step arrangement, Permutation of things when some of them are identical, Concept of $2^n$, Arrangement in a circle.

**Probability:** Single event probability, multi event probability, independent events and dependent events, mutually exclusive events, non-mutually exclusive events, combination method for finding the outcomes. **8 hrs**

### Unit – III

**Analytical reasoning 3: Punchline:** Introduction, format of the problem, An analysis, Does a suggested statement qualify as a punchline? If a given statement fits as a punchline, what is its idea or wavelength? The complete method of solving a punchline problem, Solved examples, conclusion, Sample company questions.

**Strengthening and Weakening arguments:** Format of the problem, An analysis, Suggested methods, solved examples, conclusion, sample company questions.

**Cause and Effect:** Cause and Effect—A theoretical discussion, Immediate cause, Principal cause, A quick check– Cause always antecedent. The strategy for solution. **6 hrs**

**Unit IV**

**Data Sufficiency:** Introduction, answer choices in data sufficiency, tips to solve data sufficiency problems, directions of questions, classification of sections in data sufficiency– Number system, Algebra, series and sequence, logical, geometry and mensuration, arithmetic. **6 hrs**

**Unit V**

**Data Interpretation:** Approach to interpretation - simple arithmetic, rules for comparing fractions, Calculating (approximation) fractions, short cut ways to find the percentages, Classification of data– Tables, Bar graph, line graph, Cumulative bar graph, Pie graph, Combination of graphs. Combination of table and graphs **6 hrs**

**Reference Books:**


1. "The Trachtenberg speed system of basic mathematics, published by Rupa publications.
2. CAT Mathematics by Abhijith Guha. published by PHI learning private limited.
3. Quantitative aptitude by Dr. R. S Agarwal, published by S.Chand private limited.
4. Verbal reasoning by Dr. R. S Agarwal , published by S. Chand private limited.
5. Quantitative aptitude for CAT by Arun Sharma, published by McGraw Hill publication.
6. Analytical reasoning by M.K Pandey BSC Publishing Co. Pvt. Ltd.


**Course Outcomes (CO)**

After learning all the units of the course, the student is able to:

1. Graphically represent the functions and analyze it. L5
2. Infer the conclusions based on the roots obtained by solving quadratic equations and establish relationship between them. L6
3. Effective solve the problems of permutation and combination. L4
4. Predict different possibilities by the principle of probability. L3
5. Interpret the data given in the graphical format and infer the results. L5
6. Analyze the statement critically and solve the questions from verbal logic section. L5

| Course Articulation Matrix (CAM) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcome (CO)** | **Program Outcome (ABET/NBA)** | | | | | | | | | | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Graphically represent the functions and analyze it. | M | | | | M | | | | | | | | | |
| Infer the conclusions based on the roots obtained by solving quadratic equations and establish relationship between them. | M | | | | | | | | | | | | | |
| Effective solve the problems of permutation and combination. | H | | | | M | | | | M | | | | | |
| Predict different possibilities by the principle of probability. | H | | | | | | | | M | | | | | |
| Interpret the data given in the graphical format and infer the results. | M | | | | | | | | | | | | | |
| L- Low, M- Moderate, H-High | | | | | | | | | | | | | | |

| Course Assessment Matrix (CAM) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcome (CO)** | **Program Outcome (ABET/NBA)** | | | | | | | | | | | | | |
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Graphically represent the functions and analyze it. | 2 | | | | 2 | | | | | | | | | |
| Infer the conclusions based on the roots obtained by solving quadratic equations and establish relationship between them. | 2 | | | | | | | | | | | | | |
| Effective solve the problems of permutation and combination. | 3 | | | | 2 | | | | 2 | | | | | |
| Predict different possibilities by the principle of probability. | 3 | | | | | | | | 2 | | | | | |
| Interpret the data given in the graphical format and infer the results. | 2 | | | | | | | | | | | | | |
| 1 – Low, 2 – Moderate and 3 – High | | | | | | | | | | | | | | |

| Course Title: **Modern Machining Methods** | | | |
|---|---|---|---|
| **Course Code:P15IP651** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** Students should have the knowledge on Modern machining technique of different types of machining processes and also the rate of metal removal.

**Course Learning Objectives**

At the end of course the students should be able to,

1. Identifying the classification of unconventional machining processes.
2. To understand the principle, mechanism of metal removal of various unconventional machining processes.
3. To study the various process parameters and their effect on the component machined on various unconventional machining processes.
4. To understand the applications of different processes.

**Relevance of the Course**

Production Technology-II and Theory of metal cutting is a basic subject which deals with the concept of,

1. Conventional methods such as metal cutting theory, MRR etc.….
2. Material properties.
3. Cutting fluids.
4. Different types of tool and process characteristics.
5. Effects on temperature materials and tools.

## Course content

**Unit – I**

**Introduction:** History, Classification, Comparison between conventional and non-conventional machining process selection.

**Mechanical process:** Ultrasonic machining (USM): Introduction, Equipment, tool materials & tool Size, Abrasive slurry, Tool feed Mechanism, Cutting tool system design- Magnetostriction assembly, Tool cone (Concentrator), Exponential concentrator of circular cross section & rectangular cross section. Mechanics of cutting: Theory of Miller, Effect of parameter, Material removal rate, Accuracy, surface finish. Applications, Advantages & Disadvantages. **10 Hours**

**Unit – II**

**Abrasive jet machining (AJM):** Introduction, working principle, abrasive flow machining system, Equipment, Variables in AJM, Process characteristics – Material removal rate, Applications, Advantages & Disadvantages.

**Water jet machining:** Jet cutting equipment, Process and Practical application.

**Laser beam machining:** Principle, Material Removal, Cutting speed and accuracy of cut, Metallurgical effects, Advantages and limitations. **10Hours**

**Unit – III**

**Plasma arc machining (PAM):** Plasma, Non thermal generation of plasma. Mechanism of metal removal, PAM parameters, Types of torches, Accuracy & Surface finish, Equipment for DC plasma torch unit, Safety precautions, Applications, Advantages and limitations.

**Electron beam machining (EBM):** Generation and control of electron beam, Theory of electron beam machining, Comparison of thermal and non-thermal process. Applications, Advantages and limitations. **11Hours**

**Unit – IV**

**EDM process and characteristics:** Introduction, machine, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, Electrode wear, Dielectric fluids, Flushing and types, Metal removal rate, Accuracy and surface finish, Selection of Electrode Material, Applications, advantages and disadvantages.

**Wire EDM:** Principle, elements, process variables, characteristic and application. **10 Hours**

**Unit – V**

**Electrochemical machining:** Electrochemical machining (ECM): Introduction, Study of ECM machine, Elements of ECM process, Chemistry of the process, Metal removal rate, Accuracy and surface finish. Process of Electrochemical Grinding, Deburring and Honing.

**Chemical machining (CHM):** Introduction, Elements of Process, Chemical blanking process steps, application, Advantages & limitations. **11Hours**

**TEXT BOOKS**

1. Modern machining process – Pandey and Shan, TATA McGraw Hill 2016.
2. Advance Machining Processes by Vijay K. Jain – Allied Publishers Private Ltd, 2013

**REFERENCE BOOKS**

1. Production Technology - HMT TATA McGraw Hill 2016.

**Course Outcome**

At the end of course the students should be able to,

1. Discuss the basic principles involved in modern and ultrasonic machining.
2. Explain the principles, methodology and applications of AJM, WJM & LBM.
3. Identify the issues involved in thermal metal removal process.
4. Describe various parameters which govern the different techniques of analysing EDM process and characteristics.
5. Illustrate the chemistry and metal removal process in electro-chemical and chemical machining techniques.

# Course Assessment Matrix (CAM)

| Course Outcome – CO | Program Outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Discuss the basic principles involved in non-traditional and ultrasonic machining | 2 | | 2 | | 1 | | 1 | | | | | 2 | 1 | |
| Explain the principles, methodology and applications of AJM, WJM & LBM. | 2 | | 2 | | 2 | | 1 | | | | | | 2 | |
| Identify the issues involved in thermal metal removal process. | 2 | | 2 | | 2 | | 1 | | | | | | 2 | |
| Describe various parameters which govern the different techniques of analysing EDM process and characteristics. | 3 | | 2 | | 1 | | 2 | | | | | 2 | 2 | |
| Illustrate the chemistry and metal removal process in electro-chemical and chemical machining techniques. | | 2 | 2 | | 2 | | 1 | | | | | | 2 | |

1 – Low, 2 – Moderate, 3 – High

# Course Articulation Matrix (CAM)

| Course Outcome – CO | Program Outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Discuss the basic principles involved in non-traditional and ultrasonic machining | M | | M | | L | | L | | | | | M | L | |
| Explain the principles, methodology and applications of AJM, WJM & LBM. | M | | M | | M | | L | | | | | | M | |
| Identify the issues involved in thermal metal removal process. | M | | M | | M | | L | | | | | | M | |
| Describe various parameters which govern the different techniques of analysing EDM process and characteristics. | H | | M | | L | | L | | | | | M | M | |
| Illustrate the chemistry and metal removal process in electro-chemical and chemical machining techniques. | | M | M | | M | | L | | | | | | M | |

1 – Low, 2 – Moderate, 3 – High

| Course Title: **Mechanical Vibrations** | | | |
|---|---|---|---|
| **Course Code:P15IP652** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Course Objectives:** The course aims at enabling the students to synthesize their knowledge of engineering science and mathematics to formulate the solutions of mechanical vibratory systems.

## Course Content

**UNIT – 1**

**Undamped Free Vibrations:** Introduction, basic concepts of vibration, Simple harmonic motion, types of vibration, elements of vibrating system, Single degree of freedom systems, determination of natural frequency using Newton's law and energy methods. **Damped Free Vibrations:** Introduction, types of damping, and free vibrations with viscous damping, under-damped, over-damped and critically-damped systems, and logarithmic decrement. **12 hrs**

**UNIT – 2**

**Forced Vibrations:** Introduction, forced vibration with constant harmonic excitation, steady state vibrations, forced vibration with rotating and reciprocating unbalance. Vibration isolation, force transmissibility. Forced vibrations due to excitation of the support: Absolute motion and relative motion. **10hrs**

**UNIT – 3**

**Vibration measuring instruments:** Vibrometer, velocity pick-up and accelerometer**. Whirling of Shafts:** Introduction, critical speed of a light shaft having a single disc without damping, critical speed of a light shaft having a single disc with damping. **Fourier series and Harmonic Analysis:** Analytical methods and numerical methods. **08 hrs**

**UNIT – 4**

**Two Degrees of Freedom Systems:** Introduction, undamped systems, principle and normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, free vibration in terms of initial conditions, combined rectilinear and angular modes, undamped dynamic vibration absorber (No numerical on vibration absorber). Influence coefficients, Maxwell's reciprocal theorem. **10 hrs**

**UNIT – 5**

**Multi Degree Freedom Systems:** Introduction, determination of natural frequencies, Rayleigh's method, Dunkerley's method, Stodola's method, Holzer's method. Orthogonality principle, matrix iteration method. **12 hrs**

**TEXT BOOKS**

**1 Mechanical vibrations:**G.K. Grover, Nem Chand & brothers, Roorkee, 8th edition, 2009
**2 Mechanical Vibrations:**V.P. Singh, Dhanpat Rai & Company Pvt. Ltd.2014

**REFERENCES BOOKS**

**1Mechanical Vibrations**: S.S. Rao, Pearson Education Inc, 4th Edition, 2003.
**2Mechanical Vibrations:**S. Graham Kelly, Schaum's Outline Series, Tata McGraw Hill, Special Indian edition, 2007.
**3Theory & Practice of Mechanical vibrations:** J.S. Rao & K. Gupta, New Age International Publications, New Delhi, 2001.

**Course Outcomes**

At the end of the course the students should be able to:

1. Formulate mathematical models of single degree of freedom, free, undamped and damped vibrating systems and determine their natural frequencies. Formulate mathematical models for damped free vibratory systems.
2. Determine the response of simple single degree of freedom systems subjected to forced vibration.
3. Explain the working principle of vibration measuring instruments. Determine the whirling speed of shafts. Compute harmonics of general forcing functions using Fourier series.
4. Formulate mathematical models and Solve vibration problems related to Two degrees of freedom. Determine influence coefficients.
5. Solve multi degree of freedom systems using Rayleigh and Dunkerley, Stodola, Holzer and Matrix iteration methods.

**Course Articulation Matrix**

| Sl. No | Course Outcome – CO | Program outcome | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| 01 | **Formulate** mathematical models of single degree of freedom, free, undamped and damped vibrating systems and **determine** their natural frequencies. **Formulate** equation of motion for damped free vibratory systems. | H | H | M | | M | | | | | | | M | | M |
| 02 | **Determine** the response of simple single degree of freedom systems subjected to forced vibration. **Design** mechanical systems with vibration | H | H | M | | M | | | | | | | M | | M |
| 03 | **Explain** the working principle of vibration measuring instruments. **Determine** the whirling speed of shafts. **Compute** harmonics of general forcing functions using Fourier series. | H | H | M | | M | | | | | | | M | | M |
| 04 | **Formulate** mathematical models and **Solve** vibration problems related to Two degrees of freedom. **Determine** influence coefficients. | H | H | M | | M | | | | | | | M | | M |
| 05 | **Solve** multi degree of freedom systems using Rayleigh and Dunkerley, Stodola, Holzer and Matrix iteration methods. | H | H | M | | M | | | | | | | M | | L |

## Course Assessment Matrix (CAM)

| Sl. No | Course Outcome – CO | Program outcome | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| 01 | **Formulate** mathematical models of single degree of freedom, free, undamped and damped vibrating systems and **determine** their natural frequencies. **Formulate** equation of motion for damped free vibratory systems. | 3 | 3 | 2 | | 2 | | | | | | | 2 | | 2 |
| 02 | **Determine** the response of simple single degree of freedom systems subjected to forced vibration. **Design** mechanical systems with vibration isolation. | 3 | 3 | 2 | | 2 | | | | | | | 2 | | 2 |
| 03 | **Explain** the working principle of vibration measuring instruments. **Determine** the whirling speed of shafts. **Compute** harmonics of general forcing functions using Fourier series. | 3 | 3 | 2 | | 2 | | | | | | | 2 | | 2 |
| 04 | **Formulate** mathematical models and **Solve** vibration problems related to Two degrees of freedom. **Determine** influence coefficients. | 3 | 3 | 2 | | 2 | | | | | | | 2 | | 2 |
| 05 | **Solve** multi degree of freedom systems using Rayleigh and Dunkerley, Stodola, Holzer and Matrix iteration methods. | 3 | 3 | 2 | | 2 | | | | | | | 2 | | 1 |

| Course Title: **Tool Engineering and Design** | | | |
|---|---|---|---|
| **Course Code:P15IP653** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50, SEE:50** | |

**Prerequisites**: Basic knowledge of elements of machine tool, single point cutting tools and multi point cutting tools, PT-1, PT-2.

**Course Learning Objectives:**

At the end of the Course the students should be able to,

1. The course objective is to provide the students an opportunity to gain the knowledge in the field of Machine tools and cutting tools.
2. To learn the basic design concepts of single point cutting tools and multi point cutting tools.
3. To learn the Methods the profile of form tool by graphical and analytical method
4. To learn the concept of Press works and press tools.
5. To understand and demonstrate the ability to design metal cutting in press work
6. The students should learn the knowledge to analyze and design the Jigs and Fixtures.

## Course Content

**Unit-I**

**Design of Metal Cutting Tools:** Single point tool: strength and rigidity calculation for different shapes, Design consideration, Chip Breakers, Types of form Tools, Method of determining the profile of form tool by graphical and analytical method (problems). Design of twist drills, forces acting on drill, Design of flute of cutter, Broaching methods, Broaching: Nomenclature, types and shapes, push and pull broach, broaching operation, Design of broach tool, simple problems.

**12 hours**

**Unit-II**

**Press and Press Work:** Introduction, Types of Presses: classification, Power press parts, Power press driving mechanism, press size, classification of dies based on operation: Shearing, Bending, Drawing, squeezing. **10 hours**

**Unit-III**

**Press Tools**: Components of Die and Press, working of a cutting Die, compound Die, combination Die, progressive Die, Die and punch: stresses and clearance, Deep drawing operation, Ironing operation, Redrawing operation, Bending methods, Hydro mechanical forming, Stretch forming, Roll forming, Flow turning, Metal spinning and Tube spinning. **10 hours**

**Unit-IV**

**Principles of metal cutting in press work:** Design procedure for blanking die, cutting force, Clearance, Die block Design, Punch Design, methods of reducing cutting forces, cutting action in a die, Centre of pressure, selection of Tool material for punch and die, Centre for pressure, simple problems. **10 hours**

**Unit-V**

**Jigs and Fixtures:** Introduction, advantages of employing Jigs and fixtures, Principles of jigs and fixtures design, Principles of location: six point of rectangular and three legged object, Types of Locators, Clamping, types of clamps, fool proofing, Indexing arrangement, Swarf removal, Types of Drill Jigs. **10 hours**

**TEXT BOOKS:**


1. Tool Engineering and Design-G.R. Nagpal, Khanna Publishers -1999
2. Tool design-Cyril Donaldson, George H LeCain, V C Goold, Third Ed, TMH-2004
3. Production Engineering- P.C. Sharma, S. Chand & Company Ltd., New Delhi– 2001

4. Elements of Workshop Technology-Vol.II - S.K. Hajra Choudhury, S.K. Bose, A.K. Hajra Choudhury, Nirjhar Roy, Media Promotors and Publishers Pvt. Ltd. - 2003

**REFERENCE BOOKS:**

1. Metal cutting theory and Tool Design- V.Arshinov and G. Alekseev, MIR Publications, Moscow, 1976
2. Jigs & Fixtures- Hiram E.Grant, Tata McGraw-Hill, 1971.
3. Introduction to Jig and Tool Design- M.H.A. Kempster, Viva Book Pvt. Ltd.3rdEdn. 2004.

**Course Outcome:**

The students will be able to

1. Determine the necessity of Cutting tools and form tool.
2. Explain the power driving mechanism in press working.
3. Determine the requirement of press tool.
4. Design concept of punch and die in press work.
5. Demonstrate the principal of jig and fixtures.

## Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Determine the necessity of Cutting tools and form tool. | H | L | L | | | | | | | | | L | L | |
| Explain the power driving mechanism in press working. | H | M | | | L | | | | | | | L | | |
| Determine the requirement of press tool. | H | L | L | | | | | | | | | L | | |
| Design concept of punch and die in press work. | H | L | L | | M | | | | | | | | | |
| Demonstrate the principal of jig and fixtures | H | L | M | | L | | | | | | | L | L | |

L-Low, M-Moderate, H-High

## Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Determine the necessity of Cutting tools and form tool. | 3 | 1 | 1 | | | | | | | | | 1 | 1 | |
| Explain the power driving mechanism in press working. | 3 | 2 | | | 1 | | | | | | | 1 | | |
| Determine the requirement of press tool. | 3 | 1 | 1 | | | | | | | | | 1 | | |
| Design concept of punch and die in press work. | 3 | 1 | 1 | | 2 | | | | | | | | | |
| Demonstrate the principal of jig and fixtures. | 3 | 1 | 2 | | 1 | | | | | | | 1 | 1 | |

1-Low, 2-Moderate, 3-High

| Course Title: **Plant Layout & Design** | | | |
|---|---|---|---|
| **Course Code: P15IP654** | **Semester: VI** | **L – T – P -H: 4 – 0 – 0 - 4** | **Credit: 3** |
| **Contact Period - Lecture: 52Hrs.; Exam:3 Hrs.** | | **Weightage: CIE: 50%; SEE: 50%** | |

**Prerequisites**: Concept of Work study and Engineering ergonomics.

**Course Learning Objectives (CLOs).**
This course aims to:

1. **Understand** and **apply** the concept of different plant layouts and plant design [L3]
2. **Understand** the ability to **identify** the objective to recognize about plant location problems.[L3]
3. The student should be able to **understand** the concept of objectives of plant layout [L2]
4. **Apply** the basic concepts of material and processing [L3]
5. **Understand** the general concept of material handling equipment and storage in plant layout [L2]

**Relevance of the Course:**
Plant layout and design helps in developing the systematic and economic plant layout for manufacturing systems, also aims in reducing the production time during the process. The course aims at understanding the material equipment and storage system. It helps the students in applying these ideas to summarize which material handling is suitable for process.

## Course Content

### Unit-I

**Introduction to plant design:** Types of manufacturing processes, Plant design: Graphical portrayal of some of the phases of plant design, Acquisition of capital, Product design, Sales planning for requirements, Selection of the production of process, Make or buy, Plant size, Product price range, Plant location, plant layout, building-type selection, Diversification, Organization development. Factors influencing plant location, Theories of plant location and location economics. **10 hours**

### Unit-II

**Sales planning for plant design:** Introduction, Importance of sales planning, Determination of volume of output, Market method, Market research. Plant location: Introduction, Plant location problem, Levels of location problems, Location factors, Location theory and models. **10 hours**

### Unit-III

**The plant-layout problem:** Introduction, Plant layout problem, Classes of plant layout problems, Objectives of good plant layout, Classical types of layouts, Advantages of good plant layout.
Operation process chart, Calculation of equipment requirements, Product flow, Space requirements (simple problems). **10 hours**

### Unit-IV

**Evaluation of layouts:** Introduction, Systematic evaluation: sequence demand – straight line method, sequence demand- non directional, simple problems.
**Data Collection:** Introduction, material and processes, equipment required for product layout, simple problems. **11 hours**

### Unit-V

**Materials handling equipment:** Introduction, conveyers; portable conveyers, power conveyers, overhead conveyers, cranes; mobile crane, overhead traveling crane, elevators and hoists. Industrial vehicles; fork trucks, high lift platform truck, powered hand trucks, industrial tractor,
**Storage:** Methods of storage

**Line balancing:** requirement for line balancing, Assembly line balancing and problems on Dr. J R Jackson method **11 hours**

**Text Books:**


1. James M Apple, "Plant Layout and Material handling" 3rd Edition, John, Wiley and Sons, ISBN 0-471-07171-4
2. Francies, R.L. and White, J.A. "Facility layout and Location", Mc Graw Hill 2nd Edition, 2009
3. James M Moore, "Plant Layout Design" - McMillan Company. Published by Prentice Hall College Div, New York (1962)


**Reference Books**


1. Muther Richard, "Practical layout", Mc Graw Hill-1955.
2. Sunderesh Heragu, "Facilities Design" PWS Publishing Company, ISBN-0-534-95183.
3. Chandrashekar H , B Raghavendra Reddy, Facility planning and layout design, First Edition 2007, Technical Publication , Pune.


**Course Outcome**

At the end of the Course the students should be able to

1. **Apply** the concept of different plant layouts and plant design Students gain the knowledge of acquisition of capital.
2. Ability to **identify** the objective to recognize about plant layout and students will outline the concept of different plant layout.
3. The student should be able to classify the plant layout and problems
4. **Apply** the basic concepts of material and processing
5. **Evaluate** the general concept of material handling equipment and storage in plant layout

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome(ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Apply the concept of different plant layouts and plant design | M | M | L | | L | | | | | | | L | | L |
| Ability to identify the objective to recognize about plant | H | M | L | | L | | | | | | | | | |
| The student should be able to classify the plant layout and problems | M | M | L | | L | | | | | | | | | |
| Apply the basic concepts of material and processing | M | M | L | | L | | | | | | | L | | |
| Evaluate the general concept of material handling equipment and storage in plant layout | M | M | L | | L | | | | | | | L | | L |

L-Low, M-Moderate, H-High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome(ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Apply the concept of different plant layouts and plant design | 2 | 2 | 1 | | 1 | | | | | | | 1 | | 1 |
| Ability to identify the objective to recognize about plant | 2 | 2 | 1 | | 1 | | | | | | | | | |
| The student should be able to classify the plant layout and problems | 2 | 2 | 1 | | 1 | | | | | | | | | |
| Apply the basic concepts of material and processing | 2 | 2 | 1 | | 1 | | | | | | | 1 | | |
| Evaluate the general concept of material handling equipment and storage in plant layout | 2 | 2 | 1 | | 1 | | | | | | | 1 | | 1 |

1-Low, 2-Moderate, 3-High

| Course Title: **Enterprise Resource Planning** | | | |
|---|---|---|---|
| **Course Code: P13IP661** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52 Hr Exam: 3Hr** | | **Weightage: CIE:50%; SEE:50%** | |

**Prerequisites:** The students should have undergone the course on Entrepreneurship and Management and Operations Management.

**Course Learning Objectives (CLO):**

At the end of the Course the students should be able to,

- Explain the meaning, evolution and growth of ERP market [L2].
- Define the concept of Integrated Management Information, Business Modeling and Integrated data model [L1].
- Explain the concept of Business Process reengineering, MIS, DSS, EIS, Data warehousing, Data mining, online analytical processing and Supply Chain Management [L2].
- Construct the BOM, Closed Loop MRP and DRP [L5].
- Define the concept of JIT and Kanban [L1].
- Explain the Importance of Plant Maintenance, Quality Management and Materials Management [L2].

**Relevance of the Course:**

Operations Management is a subject which deals with the concept of,

- Manufacturing and Non-Manufacturing Organizations.
- Evolution and growth of ERP Market.
- IMS, Business modeling and integrated data model.
- Business Process reengineering, MIS, DSS, EIS, Data warehousing, Data mining, online analytical processing and supply chain management.
- Bill of Material, MRP, Closed Loop MRP and DRP.
- JIT and Kanban, PDM, ERP modules, etc.,

## Course Content

### UNIT – I

**Introduction to ERP:** Introduction, Evolution of ERP, What is ERP? Reasons for the growth of the ERP market, The advantages of ERP, Why do Man ERP Implementations Fail? Why are ERP packages being used now?

**Enterprise–an Overview:** Introduction, Integrated Management Information, Business modeling, Integrated Data Model.

**ERP and Related Technologies:** Introduction, Business Process Reengineering, Management Information System, Decision Support System, Executive Information Systems, Data Warehousing, Data Mining, On-line Analytical Processing, Supply Chain Management. **11 Hrs**

### UNIT – II

**ERP- Manufacturing Perspective:** Introduction, ERP. CAD/CAM, Materials Requirements Planning, Bill of Material, Closed Loop MRP. Manufacturing Resource Planning, Distribution Requirements Planning.

**KANBAN:** JIT and Kanban, Product Data Management, Benefits of PDM, Make-to-order, and Make-to Stock, Assemble to order, Engineer to order, Configure-to order. **11 Hrs**

### UNIT – III

**ERP Modules:** Introduction, Finance, Plant Maintenance, Quality Management, Materials Management.

**Benefits of ERP:** Introduction, Reduction of Lead time, On-time shipment, Reduction in Cycle Time, Improved Resource Utilization, Better Customer Satisfaction, Improved Suppler Performance,

Increased Flexibility, Reduced Quality Costs, Improved Information Accuracy and Decision – making capability. **10 Hrs**

**UNIT – IV**

**ERP Market:** Introduction, SAP AG, Baan Company, Oracle Corporation, PeopleSoft, JD Edwards World Solutions company, System Software Associates, Inc. QAD

**ERP Implementation Life Cycle:** Pre-evaluations Screening, Package Evaluation, Project Planning Phase, Gap Analysis, Reengineering, Configuration, Implementation of Team Training, Testing, Going Live, End user Training, Post implementation. **10 Hrs**

**UNIT – V**

**ERP Implementation Life Cycle:** Implementation of Team Training, Testing, Going Live, End user Training, Post implementation

**Vendor, Consultants and Users:** Introduction, In-house implementation – Pros and Cons, Vendors, Consultants, End-users.

**Future Direction in ERP:** Introduction, New Markets, New Channels, Faster Implementation Methodologies, Business models and BAPIs, Convergence on Windows NT, Application Platforms, New business segments, web enabling, market snapshot ERP- Case studies **10 Hrs**

**TEXT BOOKS:**

1. **Enterprise Resource Planning** -Alexis Leon, Tata McGraw Hill, 1999
2. **Enterprise Resource Planning Concept and Practice** –Vinod Kumar Garg and Venkitakrishnan, 2nd Edition, Prentice-Hall India.

**REFERENCE TEXT BOOK:**

**Manufacturing Planning and Control for Supply Chain Management**, F. Robert Jacobs,, William Berry, D. Clay Why bark, Thomas Vollmann,1st Edition, McGraw Hill, 2011

**Course Outcomes**

After learning all the units of the course, the student is able to,

1. Analyze and evaluate the critical stage of implementation in the development of enterprise wide systems.
2. Explain the role of CAD/CAM, MRP, BOM, JIT and PDM in developing ERP.
3. Explain ERP Modules used and Benefits of ERP to the organization.
4. Exhibit effective multi-disciplinary team participation with a high level of personal autonomy and accountability that respects the role of culture, and differing values and dispositions as they affect the achievement of project goals.
5. Analyze the concept of Life Cycle, role of vendor and Computers in ERP.

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome(ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Analyze and evaluate the critical stage of implementation in the development of enterprise wide systems. | M | | | | | | | | | M | | | | |
| Explain the role of CAD/CAM, MRP, BOM, JIT and PDM in developing ERP. | M | M | | | H | | | | M | M | | M | | |
| Explain ERP Modules used and Benefits of ERP to the organization. | M | M | | | M | | | | M | | | M | | |
| Exhibit effective multi-disciplinary team participation with a high level of personal autonomy and accountability that respects the role of culture, and differing values and dispositions as they affect the achievement of project goals. | M | | | | H | | | | | | | M | | |
| Analyze the concept of Life Cycle, role of vendor and Computers in ERP. | M | | | | H | | | | M | | | M | | |

L-Low, M-Moderate, H-High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Analyze and evaluate the critical stage of implementation in the development of enterprise wide systems. | 2 | | | | | | | | | 2 | | | | |
| Explain the role of CAD/CAM, MRP, BOM, JIT and PDM in developing ERP. | 2 | 2 | | | 3 | | | | 2 | 2 | | 2 | | |
| Explain ERP Modules used and Benefits of ERP to the organization. | 2 | 2 | | | 2 | | | | 2 | | | 2 | | |
| Exhibit effective multi-disciplinary team participation with a high level of personal autonomy and accountability that respects the role of culture, and differing values and dispositions as they affect the achievement of project goals. | 2 | | | | 3 | | | | | | | 2 | | |
| Analyze the concept of Life Cycle, role of vendor and Computers in ERP. | 2 | | | | 3 | | | | 2 | | | 2 | | |

1-Low, 2-Moderate, 3-High

| Course Title: **Human Resource Management** | | | |
|---|---|---|---|
| **Course Code:P15IP662** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** The students should have undergone the course on Management and Entrepreneurship.

**Course Learning Objectives (CLO)**

At the end of the Course the students should be able to,

1. Able to define the evolution and objectives of Human Resource Management.
2. Able to understand process of HRP.
3. Able to understand the concept of Job Analysis.
4. Able to understand the various forecasting techniques in HRP.
5. Able to understand the concept Recruitment and Selection.
6. Able to understand the concept of Performance Appraisal and Human Resource Accounting.
7. Able to understand the concept of Industrial Relations.
8. Able to understand the different acts such as Factory Act, ESI Act, etc.,

**Relevance of the Course**

Human Resource Management is a basic subject which deals with the concept of,

1. Evolution, Scope, Objectives, principle and policies of HRM.
2. Recruitment and Selection process.
3. Training and Development process.
4. Industrial Relations.
5. Industrial Act, Factory Act, ESI Act, etc.,
6. Industrial Disputes.

## Course Content

### Unit - I

**INTRODUCTION:** Introduction, Evolution of HRM, Scope of HRM, Functions and Objectives of HRM – Societal Objectives, Functional Objectives, Organizational Objectives and Personal Objectives. Policies and Principles of HRM.

**HUMAN RESOURCE PLANNING:** Introduction, Uses and benefits of HRP, Importance of HRP, Factors affecting HRP, HRP Process - Man Power Inventory, Man Power Forecasting, Methods of Man Power Forecasting. Job Analysis - Job Description, Job Specification.

**10 Hours**

### Unit – II

**RECRUITMENT:** Introduction, Factors affecting Recruitment process, Recruitment Process, Sources of Man power, Advertisement, Short Listing of Candidates calling Candidates for selection Process.

**SELECTION:** Selection procedure – Written Test, Group Discussion. Interview – Different methods, advantages and Limitations, Psychological testing – Advantages and limitations, Induction procedure, transfers, promotion exit interview, (Tutorial on written test, Group Discussion, Interviews). **12 Hours**

### Unit – III

**TRAINING AND DEVELOPMENT:** Identification of Training needs, Training Evaluation, Training Budget, Executive Development – Different Approaches, Non-executive development – Different methods.

**PERFORMANCE APPRAISAL:** Components (all round performance appraisal), Methods. Advantages and limitations of different methods, Personal Counselling based on Annual Confidential Reports. **12 Hours**

**Unit – IV**

**COUNSELLING AND HUMAN RESOURCE ACCOUNTING:** Characteristics, Need, Function, Types, Suggestions for personnel development, communication function, communication process, effective communication. Human resource records, Advantages of HR accounting and various methods of accounting. **10 Hours**

**Unit – V**

**INDUSTRIAL RELATIONS:** Indian trade union act, standing orders act, Indian factories act, ESI act.

**INDUSTRIAL DISPUTES AND SETTLEMENT:** Indian Industrial Disputes act, Industrial disputes settlement machinery. Works committee, Board of Conciliation, Voluntary Arbitration, Compulsory arbitration, Court of inquiry, Industrial tribunal and Adjudication. **08 Hours**

**TEXT BOOKS:**


1. Dr. K Ashwathappa, "Human Resources Management", Tata McGraw Hill, Edition 2008.
2. Hersey and Blanchard, "Management of Organisations Behaviour", Prentice Hall of India 10th Edition – 2016.


**REFERENCES BOOKS:**


1. Decenoz and robbins, "Personnel / Human resource Management", PHI, 2002.
2. CB Mamoria, "Management of Human Resources", Himalaya Publication House, 2003
3. Arun Monappa , "Industrial Relations", TMH, ISBN – 0-07- 451710-8


**Course Outcome**

At the end of the Course the students should be able to,

1. Define Scope, Evolution, Function of HRM and able to understand the importance of HRP.
2. Understand the process of Recruitment and Selection process
3. Define the importance and different methods of Training, Development and Performance Appraisal process.
4. Understand process of Counselling and the different methods of Human Resource Accounting process.
5. Understand the importance of Industrial Relations and the importance of different types of Industrial Acts.

# Course Articulation Matrix (CAM)

| Course Outcome (CO) | Program Outcome (ABET/NBA)) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Define Scope, Evolution, Function of HRM and able to understand the importance of HRP. | | | H | M | M | H | H | | M | | | M | | |
| Understand the process of Recruitment and Selection process. | M | M | L | M | | H | H | | M | | | L | | |
| Define the importance and different methods of Training, Development and Performance Appraisal process. | H | | L | M | | H | H | | | | | | | |
| Understand process of Counselling and the different methods of Human Resource Accounting process. | M | | M | M | | H | H | M | M | | | M | | |
| Understand the importance of Industrial Relations and the importance of different types of Industrial Acts. | M | | M | M | | H | H | | M | | | | | |

1-Low, 2-Moderate, 3-High

# Course Assessment Matrix (CAM)

| Course Outcome (CO) | Program Outcome (ABET/NBA)) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | P O9 | PO 10 | PO 11 | PO1 2 | PS O1 | PSO 2 |
| Define Scope, Evolution, Function of HRM and able to understand the importance of HRP. | | | 3 | 2 | 2 | 3 | 3 | | 2 | | | 2 | | |
| Understand the process of Recruitment and Selection process. | 2 | 2 | 1 | 2 | | 3 | 3 | | 2 | | | 1 | | |
| Define the importance and different methods of Training, Development and Performance Appraisal process. | 3 | | 1 | 2 | | 3 | 3 | | | | | | | |
| Understand process of Counselling and the different methods of Human Resource Accounting process. | 2 | | 2 | 2 | | 3 | 3 | 2 | 2 | | | 2 | | |
| Understand the importance of Industrial Relations and the importance of different types of Industrial Acts. | 2 | | 2 | 2 | | 3 | 3 | | 2 | | | 1 | | |

1-Low, 2-Moderate, 3-High

| Course Title: Value Engineering & Industrial Best Practice | | | |
|---|---|---|---|
| **Course Code:P15IP661** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits:3** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** The students should have undergone the course on Quality Assurance and Reliability, Manufacturing and Management.

**Course Learning Objectives (CLO)**

At the end of the Course the students should be able to,

1. Define the concept of Value Analysis and Value Engineering.
2. Understand the scope and objectives of Value Management.
3. Understand the difference between Value Engg and Value Analysis.
4. Understand types of Values and their effect in cost reduction.
5. Define the rules for functional definition and types of functions.
6. Define the MISS technique and numerical evaluation of functional relationships.
7. Understand the problem solving system.
8. Understand the various stems involved in problem solving.

**Relevance of the Course**

Value Engineering and Industrial Best Practice is a subject which deals with the concept of,

1. Value Analysis and Value Engineering.
2. Value Management.
3. Types of Values and the effect of Cost reduction.
4. MISS techniques.
5. Problem solving systems.

## Course Content

### Unit – I

**INTRODUCTION TO VALUE ANALYSIS:** Definition of Value, Value Analysis, Value Engineering, Value Management, Value Analysis versus Value Engineering, Value Analysis versus Traditional cost reduction techniques, uses, Applications, advantages and limitations of Value analysis. Symptoms to apply value analysis, Coaching of Champion concept.

**TYPE OF VALUES:** Reasons for unnecessary cost of product, Peeling cost Onion concept, unsuspected areas responsible for higher cost, Value Analysis Zone, attractive features of value analysis. Meaning of Value, types of value & their effect in cost reduction. Value analysis procedure by simulation. Detailed case studies of simple products. **12 Hours**

### Unit – II

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

**PROBLEM SETTING & SOLVING SYSTEM:** A problem solvably stated is half solved, Steps in problem setting system, Identification, Separation and Grouping of functions. Case studies.

**10 Hours**

## Unit – III

**PROBLEM SETTING & SOLVING SYSTEM:** Goods system contains everything the task requires. Various steps in problem solving, case studies.

**VALUE ENGINEERING JOB PLAN:** Meaning and Importance of Value Engineering Job plan. Phases of job plan proposed by different value engineering experts,. Information phase, Analysis phase, Creative phase, Judgement phase, Development planning phase, and case studies. Cost reduction programs, criteria for cost reduction program, Value analysis change proposal.

**10 Hours**

## Unit – IV

**VALUE ENGINEERING TECHNIQUES:** Result Accelerators or New Value Engineering Techniques, Listing, Role of techniques in Value Engineering, Details with Case examples for each of the Techniques.

**ADVANCED VALUE ANALYSIS TECHNIQUES:** Functional analysis system technique and case studies. **10 Hours**

## Unit – V

**ADVANCED VALUE ANALYSIS TECHNIQUES:** Value analysis of Management practice (VAMP), steps involved in VAMP, application of VAMP to Government, University, College, Hospitals, School Problems etc., (service type problems).

**APPLICATION OF VALUE ANALYSIS:** Application of Value analysis in the field of Accounting, Appearance Design, Cost reduction, Engineering, manufacturing, Management, Purchasing, Quality Control, Sales, marketing, Material Management Etc., Comparison of approach of Value analysis & other management techniques. **10 Hours**

**TEXT BOOKS:**


1. Lawrence D Miles, “Techniques of Value Engineering and Analysis”, McGraw Hill Book Co.
2. M.S. Vittal, “Value engineering for COST REDUCTION and PRODUCT IMPROVEMENT”, Systems Consultancy ServicesEdn 1993.


**REFERENCE BOOKS:**


1. W.L. Gage, “Value Analysis”, McGraw Hill Book Company.
2. Edward D Heller Addison, “Value Management, Value Engineering and Cost Reduction”, Wesley Publishing Company 1971.
3. Warren J Ridge, “Value Analysis for Better Management”, American Management Association Edn 1969.
4. Arther E Mudge, “Value Engineering”, McGraw Hill Book Comp. Edn 1981.
5. C R Kothari, “An Introduction to Operational Research’, Vikas Pub. House Ovt. Ltd., Edn. 1982.


**Course Outcomes**

At the end of the Course the students should be able to,

1. Compare value analysis and value Engineering.
2. Evaluate the functional cost methods.
3. Determine the cost reductions programme in value Engineering job plan.
4. Analyse the value Engineering Techniques.
5. Explain the applications of value analysis in the field of Accountant.

## Course Articulation Matrix

| Course Outcomes | Program Outcomes (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Compare value analysis and value Engineering | M | M | | | | | | | | | | L | | |
| Evaluate the functional cost methods. | M | M | | | L | | | | | | | L | | |
| Determine the cost reductions programme in value Engineering job plan. | M | M | | | | | | | | | | M | | |
| Analyse the value Engineering Techniques. | H | M | | | L | | | | | | | M | | |
| Explain the applications of value analysis in the field of Accountant | M | M | | | M | | | | | | | M | | |

## Course Assessment Matrix

| Course Outcomes | Program Outcomes (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 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 |
| Compare value analysis and value Engineering | 2 | 2 | | | | | | | | | | 1 | | |
| Evaluate the functional cost methods. | 2 | 2 | | | 1 | | | | | | | 1 | | |
| Determine the cost reductions programme in value Engineering job plan. | 2 | 2 | | | | | | | | | | 2 | | |
| Analyse the value Engineering Techniques. | 3 | 2 | | | 1 | | | | | | | 2 | | |
| Explain the applications of value analysis in the field of Accountant | 2 | 2 | | | 2 | | | | | | | 2 | | |

| Course Title: **Lean Manufacturing System** | | | |
|---|---|---|---|
| **Course Code:P15IP664** | **Sem: VI** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period: Lecture:52Hr Exam: 3Hr** | | **Weightage: CIE:50; SEE:50** | |

**Prerequisites:** Students should have the knowledge on reduction of waste using different lean methods.

**Course Learning Objectives**

At the end of course the students should be able to,

1. Explain the basic concept of Lean Manufacturing and methods to be adopted for implementing lean practices.
2. Describe the continuous improvement concept, principles and work involvement.
3. Explain the different concepts of 5S, 3M, VSM, etc.

## Course content

**Unit -I**

**Introduction:** Mass production system, origin of lean production system, necessity, lean revolution in Toyota, systems and systems thinking, basic image of lean production, customer focus. Standards in the lean system, total productive maintenance, standardized work. **10 Hours**

**Unit -II**

**Stability of lean system:** Elements of standardized work, charts to define standardized work, man power reduction, overall efficiency - standardized work and kaizen, common layouts.
**Lean tools:** 5S system, why-why analysis, Ishikawa diagram, value stream mapping. **10 Hours**

**Unit -III**

**Standardization of operations:** job rotation, Improvement activities to reduce work force and increase worker morale foundation for improvements. Just In Time: Principles of JIT, JIT system, Kanban, Kanban rules, expanded role of conveyance, production levelling. **10 Hours**

**Unit -IV**

**Shortening of production lead times:** Reduction of setup times: practical procedures for reducing setup time. Jidoka concept, Poka-yoke (mistake proofing) systems, inspection systems and zone control, types and use of Poka-yoke systems. **10 Hours**

**Unit -V**

**Worker Involvement and Systematic Planning Methodology:** Involvement, activities to support involvement, quality circle activity, kaizen training - suggestion programmes, hoshin planning system (systematic planning methodology), phases of hoshin planning.
**Managing lean enterprise:** Global enterprises and their benefits. Mini project on "Application of Lean manufacturing concepts to production / process/ product". **12 Hours**

**TEXT BOOKS:**


1. Pascal Dennis, Lean Production Simplified: A Plain Language Guide to the World's Most Powerful Production System, (Second edition), Productivity Press, New York, 8th edition 2014.
2. Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities, S.R. Devadasan, V.Mohan Sivakumar, R.Murugesh, P.R.Shalij, 2012 edition.

**REFERENCES:**


1. The Machine that changed the World: James P. Womack, Daniel T. Jones and Daniel Roos, First edition, Simon and Schuster, 2007.
2. Toyota production system –An integrated approach to just in time by Yasuhiro Monden – Engineering and Management press – Institute of Industrial Engineers Norcross Georgia 3rd edition 1998.
3. Japanese Manufacturing Techniques. The Nine Hidden Lessons by simplicity by Richard Schourberger, 1982.
4. "Just in Time Manufacturing", M. G. Korgaonker MacMillan. Reprinted 2011


**Course Outcome**

At the end of course the students should be able to,

1. Recognize the underlying philosophy and different Standards of the Toyota Production System.
2. Analyse the elements of standards and different lean tools in the lean system.
3. Explain Improvement activities to reduce work force and increase worker morale using JIT and Kanban.
4. Illustrate the concepts and implementation of Jidoka and Poka-yoke systems.
5. Explain how to manage people in a Lean environment in order to sustain improvements in production method.

# Course Articulation Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Recognize the underlying philosophy and different Standards of the Toyota Production System. | M | L | | | M | | | | H | | | | | |
| Analyse the elements of standards and different lean tools in the lean system. | H | M | | | H | | | | H | | | M | | |
| Explain Improvement activities to reduce work force and increase worker morale using JIT and Kanban. | M | M | | | H | | | | H | | | M | | |
| Illustrate the concepts and implementation of Jidoka and Poka-yoke systems. | M | M | | | H | | | | M | | | M | | |
| Explain how to manage people in a Lean environment in order to sustain improvements in production method. | H | M | | | M | | | | M | | | L | | |

L-Low, M-Moderate, H-High

# Course Assessment Matrix (CAM)

| Course Outcome – (CO) | Program outcome (ABET/NBA) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| Recognize the underlying philosophy and different Standards of the Toyota Production System. | 2 | 1 | | | 2 | | | | 3 | | | | | |
| Analyse the elements of standards and different lean tools in the lean system. | 3 | 2 | | | 3 | | | | 3 | | | 2 | | |
| Explain Improvement activities to reduce work force and increase worker morale using JIT and Kanban. | 2 | 2 | | | 3 | | | | 3 | | | 2 | | |
| Illustrate the concepts and implementation of Jidoka and Poka-yoke systems. | 2 | 2 | | | 3 | | | | 2 | | | 2 | | |
| Explain how to manage people in a Lean environment in order to sustain improvements in production method. | 3 | 2 | | | 2 | | | | 2 | | | 1 | | |

1-Low, 2-Moderate, 3-High