SYLLABUS

(With effect from 2017-18)

ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2017–18)

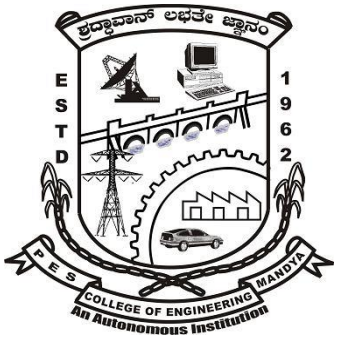
V & VI Semester

Bachelor Degree

in

Industrial and Production Engineering

Out Come Based Education with Choice Based Credit System



P.E.S. College of Engineering

Mandya - 571 401, Karnataka

(An Autonomous Institution Affiliated to VTU, Belagavi)

Grant -in- Aid Institution

(Government of Karnataka)

Accredited by NBA, New Delhi

Approved by AICTE, New Delhi.

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ

ಮಂಡ್ಯ–571 401, ಕರ್ನಾಟಕ

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

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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, which are affiliated to VTU. Other postgraduate programs are MBA and MCA.

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 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 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 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 academic year 2015-16. 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.

Dr. Umesh D R
Deputy Dean (Academic)
Associate Professor,
Dept. of CS &Engg

Dr. Nagarathna
Dean (Academic)
Professor
Dept. of CS & Engg

PES College of Engineering

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 AND PRODUCTION ENGINEERING

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 globalised market which demand quality management people.

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

- To educate them in the fundamental concept, knowledge, skills in theory and practices.
- 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.
- To inculcate qualities of communication skills, professional personality and ethical values to make them the responsible and competent professionals.

Program Educational Objectives (PEOs)

- **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 values as responsible and competent entrepreneur and professionals.

The consistency of PEOs with the Mission of the department.

PEO Statements	Mission 1 Knowledge and skills	Mission 2 Employment / Higher Education	Mission 3 Professional Ethics
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.	3	2	1
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.	2	3	1
PEO3: Industrial and Production Engineering program will prepare graduates, who possess communication skills, professional personality and ethical values as responsible and competent entrepreneur and professionals.	1	2	3

Note: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Program Outcomes (POs)

The department adopted the POs specified by the NBA in the Annexure-1 of the format provided in the SAR application. The graduates of the program will be able to exhibit their skills and knowledge as per the POs.

- **PO-1 Engineering knowledge:** Graduates will have the ability to apply knowledge of Science, Engineering concepts and Management principles to solve the problems.

- **PO-2 Problem analysis:** will have the ability to identify, formulate and solve complex engineering problems using principles of mathematics, natural sciences, and engineering sciences in various design, manufacturing process and industrial management.
- **PO-3 Design/development of solutions:** will be able to design a system to meet desired needs within environmental, economic, political, ethical, health and safety, manufacturing and management knowledge and techniques.
- **PO-4 Conduct investigations of complex problems:** will be able to demonstrate the knowledge of design and conduct experiment as well as interpret data to find the solutions for industrial problems.
- **PO-5 Modern tool usage:** Will have the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- **PO-6 The engineer and society:** Will have the knowledge of recent and advanced techniques related to social, health, and safety, legal and cultural issues in production filed.
- **PO-7 Environment and sustainability:** Will have the ability to understand and analyze the impact of engineering applications in the global and societal context and need for sustainable development.
- **PO-8 Ethics:** Will be able to understand the professional and ethical responsibility in decision making in various engineering fields.
- **PO-9 Individual and team work:** Graduates will be able to exhibit the skills of functioning individually as well as in the multidisciplinary teams.
- **PO-10 Communication:** Will be able to communicate effectively in the manufacturing field and at the societal level and make effective presentations with clear decisions to demonstrate the leadership quality.
- **PO-11 Project management and finance:** Graduates will have the ability to recognize the importance of engineering and management principles and apply them in their own work, as a member and as a leader in the team and to manage the projects even multidisciplinary environments.
- **PO-12 Life-long learning:** Will have the ability to recognize the necessity and importance of knowledge and engage in life-long learning process to update with current scenario.

Program Specific Outcomes (PSOs):

- **PSO1 :** 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. (XXX)								
Sl.No.	**Course Code**	**Course Title**	**Teaching Dept.**	**Hrs/Week L:T:P:H**	**Total Credit**	**Examination Marks**		
						CIE	**SEE**	**Total**
1.	P17IP51	Core Course I- Management & Entrepreneurship	IP	4:0:0:4	4	50	50	100
2.	P17IP52	Core Course II- Work Study and Ergonomics	IP	4:0:0:4	4	50	50	100
3.	P17IP53	Core Course III- Design of Machine Elements	IP	4:0:0:4	4	50	50	100
4.	P17IP54	Foundation Course-I- Modern Machining Methods	IP	4:0:0:4	4	50	50	100
5.	P17IP55X	Foundation Elective	IP	4:0:0:4	3	50	50	100
6.	P17IP56X	Elective-I	IP	4:0:0:4	3	50	50	100
7.	P17IPL57	Mechanical Engineering Lab	IP	0:0:3:3	1.5	50	50	100
8.	P17IPL58	Computer Aided Drafting and Geometric Modelling Lab	IP	0:0:3:3	1.5	50	50	100
9.	P17IP59	Industry Visit & Interaction	IP	0:0:2:2	1	50	--	50
10.	P17IP510	Aptitude and Reasoning Development –Advanced. (ARDA)	HS& M	2:0:0:2	1	50	50	100
Total					27	500	450	950

List of Electives					
Foundation Elective			**Elective - 1**		
Sl.No	Course Code	Course title	Sl.No.	Course Code	Course title
1.	P17IP551	Control Engineering and Machine Tool Technology	1.	P17IP561	Composite Material
2.	P17IP552	Advance Joining Process and NDT	2.	P17IP562	Industrial Robotics
3.	P17IP553	Design of Experiments	3.	P17IP563	Computer Integrated Manufacturing
4.	P17IP554	Finite Element Method	4.	P17IP564	Simulation Modelling and Analysis

Scheme of Teaching and Examination, VI Semester B.E. (XXX)								
Sl.No	**Course Code**	**Course Title**	**Teaching Dept.**	**Hrs/Week L:T:P:H**	**Total Credit**	**Examination Marks**		
						CIE	**SEE**	**Total**
1.	P17IP61	Core Course I- Theory of Metal Cutting	IP	4:0:0:4	4	50	50	100
2.	P17IP62	Core Course II- Theory of Metal Forming	IP	4:0:0:4	4	50	50	100
3.	P17IP63	Core Course III- Quality Assurance and Reliability	IP	4:0:0:4	4	50	50	100
4.	P17IP64	Foundation Course-II- Economics for Engineers	IP	4:0:0:4	4	50	50	100
5.	P17IP65X	Elective-II	IP	4:0:0:4	3	50	50	100
6.	P17IP66X	Elective-III	IP	4:0:0:4	3	50	50	100
7.	P17IPL67	Industrial Engineering Lab	IP	0:0:3:3	1.5	50	50	100
8.	P17IPL68	Computer Aided Analysis Lab	IP	0:0:3:3	1.5	50	50	100
9.	P17IP69	Mini Project	IP	0:0:2:2	1	50	--	50
10.	P17IP610	Aptitude and Reasoning Development – Expert(ARDE)	HS&M	2:0:0:2	1	50	50	100
Total					27	500	450	950

List of Electives					
Elective-II			**Elective - III**		
Sl. No	Course Code	Course title	Sl. No.	Course Code	Course title
1.	P17IP651	Production Planning and Control	1.	P17IP661	Enterprise Resource Planning
2.	P17IP652	Mechanical Vibration	2.	P17IP662	Human Resource Management
3.	P17IP653	Tool Engineering and Design	3.	P17IP663	Value Engineering and Industrial Best Practices
4.	P17IP654	Plant Layout and Design	4.	P17IP664	Lean Manufacturing System

Course Title: Management and Entrepreneurship			
Course Code:P17IP51	**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. **9 Hours**

SSC: Social Responsibility of Manager.

Unit – II

PLANNING, ORGANIZING AND STAFFING:

PLANNING: Nature, 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.

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

SSC: Importance of planning process, MBO and MBE (Meaning only).

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 Coordination. Meaning and steps in controlling – 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**

SSC: Essentials of a sound control system, Roles of Women Entrepreneurs in Economic Development.

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.

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

SSC: Ancillary Industry and Tiny Industry, KIADB Role for SSI.

Unit – V

PREPARATION OF PROJECT: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; 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**

SSC: Contents and Specimen of a project Report**.**

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. Krishna Rao, 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,

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

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: P17IP52	**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

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, **10 Hours**

SSC: Human Factor in the application of the work study.

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. **10 Hours**

SSC: Development of improved methods, define, install and maintain.

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, 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). **12Hours**

SSC: Time study equipment, selecting the job for Time study

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 **10 Hours**

SSC: Development of stress in human body and their consequences, Suggestions for prevention.

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. Design of work places, influence of climate on the efficiency of human performance, Influence of noise, vibrations and lighting systems on human performance.

10Hours

SSC: Layout of panels and machines.

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 Mc Cormic, Mc Graw Hill.

Course Outcomes:

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

1. Understanding the fundamentals of the Productivity, Work study 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 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	PSO2
Understanding the fundamentals of the Productivity, Work study and various types of Wages and Incentives.	3	2		2	2			1			2		1	
Analyze the present method and develop the best	3	2	1	2	3	2				3	1	2	1	1
Compute the standard time for a work.	2	3		2	2	1						1		
Understand Ergonomics and its principles.	3	2	2	1	2	3	1	1				1		3
Design the Man/machine system on basis of principles of Ergonomics.	3	3	2	2	3	3		1			1	1		3

1-Low, 2-Moderate, 3-High

Course Title: **Design of Machine Elements**			
Course Code: P17IP53	**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 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**

SSC- Members subjected to Bi-axial stresses

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**

SSC- Impact load due to axial loading.

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**

SSC- study on Riveted brackets

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

SSC- problems on helical gears.

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**

SSC- problems on journal bearing

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 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 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..(Unit – IV)	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: **Modern Machining Methods**			
Course Code:P17IP54	**Sem: V**	**L-T-P-H: 4-0-0-4**	**Credits: 4**
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.

Unit – I

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

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

Water jet machining: Jet cutting equipment, Process and Practical application. **10Hours**

SSC: Surface finishing of AJM and WJM

Unit – II

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. Applications, Advantages & Disadvantages.

10 Hours

SSC: Surface finish of USM

. **Unit – III**

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

Plasma arc machining (PAM): Plasma, Non thermal generation of plasma. Mechanism of metal removal, PAM parameters, Types of torches, Accuracy & Surface finish, Applications, Advantages and limitations.

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

11Hours

SSC: Difference between PAM & EBM

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, , Applications, advantages and disadvantages.

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

SSC: Selection of Electrode Material for EDM

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, Debarring and Honing.

Chemical machining (CHM): Introduction, Elements of Process, Chemical blanking process steps, application, Advantages & limitations. **10Hour**

SSC: Applications of Electrochemical Grinding, Deburring and Honing

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. Explain the principles and applications of AJM, & WJM
2. Discuss the basic principles involved in ultrasonic machining.
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	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 principles, methodology and applications of AJM, & WJM	2		2		1		1					2	1	
Discuss the basic principles involved in ultrasonic machining.	2		2		2		1						2	
Identify the issues involved in thermal metal removal	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 Title: **Mechanical Engineering Lab**			
Course Code: P17IPL57	**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 Eng g. 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 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 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 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: P17IPL58	**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 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 Content

Solid Works Basics: Introducing Solid Works, Navigating Solid Works 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 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: **Control Engineering and Machine Tool Technology**			
Course Code: P17IP551	**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.

Modeling 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

SSC: Regulating system, Features of Transfer function.

Unit-II

TIME RESPONSE ANALYSIS OF CONTROL SYSTEMS: Definition and classification of time response, Standard test inputs, Steady state Analysis, 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, Analysis of TYPE 0,1 and 2 Systems, Disadvantages of static error coefficient method, simple problems on steady state error. **10 Hours**

SSC: Stable systems, mathematical for stable operating system.

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**

SSC: Analysis of multiple input multiple output systems.

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, safety and convenience of machine tool controls, cutting motion in machine tools, Essential requirement of machine tool, Design of basic features of a machine tool: Bed, Structure of frame, Slides & slide ways, Spindles and spindle bearing, Method of production of surfaces, General requirements of machine tool design. **10 Hours**

SSC: Purposes of machine tool, types of bearing.

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

SSC: Hydraulic drive, advantage and disadvantage.

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**- Sen & 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 analyse the given systems.
3. The students will be able to solve the block diagrams and signal flow graphs.
4. Students should learn and understand the features of machine tool.
5. Students should be able to solve the given gear box.

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											

6. 1-Low, 2-Moderate, 3-High

Course Title: **Advanced joining process and NDT**			
Course Code: P17IP552	**Semester: V**	**L – T – P–H : 4–0–0–4**	**Credits: 3**
Contact Period - Lecture: 52Hrs.; Exam:3 Hrs.		**Weightage: CIE: 50%; SEE: 50%**	

Prerequisites: Basic knowledge of elements of machine tool, Manufacturing Process

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]

Course Outcomes: The students will be able to

1. Explain the necessity of metal joining process.
2. Illustrate the concept of plastic welding process.
3. Demonstrate the concept of underwater welding.
4. Describe the concept of friction stir welding.
5. Demonstrate various types of NDT methods.

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**

SSC: Use of underwater welding

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 weld able plastics and types of weld joint design, surface preparation and plastic welding processes. **10 Hours**

SSC: Problems faced during plastics welding

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**

SSC: Applications of heat treatment in welding process

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**

SSC: Compare Jigs and Fixture

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**

SSC: Applications of NDT in automotive Industry.

Text Books:

1. Howard Cary and Scott Helzer, "Modern Welding Technology", 6th edition, Prentice Hall, 2004.
2. Dr. O.P. Khanna, 'Welding Technology', Dhanpth Rai and Sons,1990

Reference Books

1. Mc Gonnagle 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 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: P17IP553	**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.

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

SSC: Taguchi's quality philosophy.

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.

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

SSC: Factor interactions.

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. **10 Hours**

SSC: Comparison with the classical statistical experiment design.

Unit – IV

STEPS IN ROBUST DESIGN: 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

SSC: Case study on Noise factors and testing conditions**.**

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, digital cases. **11 Hour**

SSC: Introduction to Taguchi Inner and Outer Arrays.

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 Western Methods or Statistical Experimental Design-Robert H. Lochner and Joseph 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 Title: **Finite Element Methods**			
Course Code:P17IP554	**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, 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 Hours

SSC: Advantages and disadvantages of FEM, Engineering Applications of FEM.

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. **10 Hours**

SSC: Jacobian matrix for CST.

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 Hours

SSC: Axi-symmetric elements and its applications.

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 Hours

SSC: Elementary beam theory and equations, Temperature stresses on truss.

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 Hours

SSC: Temperature gradient analysis of tapered bar.

TEXT BOOKS

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

2Introduction 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 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 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.	3	2			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	2			2							2		
Formulate element stiffness matrices and load vectors for different elements by **applying** Variational principle.	3	2			3							2		
Use developed finite element models in the **determination** of stresses, strains and reactions of axially loaded bars, trusses and transversely loaded beams.	3	2			2							2		
Formulate finite element equations for heat transfer problems using Variational and Galerkin techniques and **apply** these models to conduction and convection heat transfer problems.	3	2			3							2		

1-Low, 2-Moderate, 3-High

Course Title: COMPOSITE MATERIALS			
Course Code: P17IP561	**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 Nano composites – Introduction, Nano clay, Carbon Nanofiber.

10Hours

SSC: Introduction to Carbon Nano tubes.

Unit-II

Applications: Aircrafts, missiles, Space hardware, automobile, Electrical and Electronics, Marine, Recreational and sports equipment.

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

SSC: Future Potential of Composites, Application of MMC in Locomotive Industries.

Unit- III

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, Numerical problems. **11 Hours**

SSC: Engineering Constants of an Angle Lamina.

Unit- IV

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**

SSC: Types of Laminates Codes Used.

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. **12 Hours**

SSC: Processing of thermoplastic composites, Acoustic ultrasonic method

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, 8TH 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 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
Identify and classify the different types of fiber and matrix materials used in commercial composites and nano composites.	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:P17IP562	**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 Classifications, geometrical and configuration.[L2]
2. Know the difference between accuracy and repeatability. [L1]
3. Understand basic components and motion analysis of robots.[L2]
4. Learn Euler formulations and trajectory planning processes of Robots.[L1]
5. Understand the programming languages and Robot cell design and control.[L2]
6. Understand different types of sensors**.**[L2]

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. **11 Hours**

SSC: Advantages and disadvantages of drive systems.

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

SSC: Stewart mechanism parallel-link robot

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**

SSC: Applications of Robots in Automotive Industry

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 work cell. Economic analysis for robots-method**.10 Hours**

SSC: Material Handling Application in automotive industry

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**

SSC: Application of Sensors in Automotive Industry.

TEXT BOOKS

1. Groover, " Industrial Robotics", Tata McGraw-Hill Education, 2012
2. YoremKorem, " 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	2		1							1		
Describe basic components of Robots and solve problems on motion	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		
Demonstrate sensor application in robots.	3	2	2		1							2		

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

Course Title: Computer Integrated Manufacturing			
Course Code : P17IP563	**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 Transfer line without storage – upper bound and lower bound approach [L1].
3. Explain the functions of different parts feeding devices and elements of parts delivery system [L1].
4. Explain the concept of automated guided vehicle system used [L1].
5. 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, **11 Hours**

SSC: Automation for machining operation.

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. **11 Hours**
SSC: Problems on Computerized line balancing.

Unit – III

AUTOMATED ASSEMBLY 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 **10 Hours**

SSC: Machine analysis of single station assembly.

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, 1**0 Hours**
SSC: Concepts of MRP and CRP.

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. **10 Hours**
SSC: Robot Sensors and Robot Applications.

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 Title: **Simulation Modeling & Analysis**			
Course Code:P17IP564	**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. [L3]
3. Able to understand analysis of simulation data.[L2]
4. An ability to know applications and selection of simulation software**.** [L1]

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. **11 Hours**

SSC-Other simulation examples

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 **10 Hours**

SSC-Poker test

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 **10 Hours**

SSC-Gamma Distribution

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. **10 Hours**

SSC-Output analysis of steady state simulations

Unit – 5

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

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

SSC-Simulation of Project Management

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 –** NarsinghDeo; 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 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 : Aptitude and Reasoning Development - Advanced (ARDA)		
Course Code : P17HU510	**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 alligation 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-1

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 Hours**

Unit-2

Averages and Alligations mixtures:

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

Unit-3

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 Hours

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 Hours**

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 Hours**

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

T L O

After learning all the topics of UNIT -1, the student is able to

1. Explain the importance of reading skills.
2. Interpret the importance of vocabulary in solving Reading comprehension questions.
3. Identify the main idea and supporting details in the paragraph.
4. Identify purpose and tone of the author.
5. Interpret the use of transition and idea organization pattern.
6. Recognize and evaluate arguments and their common structures.
7. Solve RC questions methodologically.
8. Classify types of questions asked in the RC passages.
9. Apply flow chart or mind map to solve RC questions.

After learning all the topics of UNIT- 2, the student is able to

1. Analyze the properties of average and apply them in the right scenarios.
2. Apply the mean deviation method in certain set of questions.
3. Distinguish between the usage of simple average and weighted average.
4. Apply weighted average concept and formula to solve the problems of mixtures.
5. Compare the weighted average method with the alligation method and understand their strengths and limitations.
6. Apply the technique of alligation to solve problems in very less duration of time.
7. Understand the concept of homogeneity and other properties of mixtures.
8. Apply the basic properties of mixtures while solving the problems under the concept of removal and replacement.
9. Extend the application of alligation technique to solve the problems of other topics such as Profit and loss, time speed and distance, ratio and comparison etc.

After learning all the topics of UNIT -3, the student is able to

1. Define the meaning of basic terms such as Profit, loss, Profit percentage, Loss percentage.
2. Understand the meaning of Discount, Discount percentage, Marked price and mark up percentage and explain them.

3. Describe the importance of percentage in this chapter and combine the concepts of percentage to simplify the methodology of solving.
4. Apply n/d technique the solve the problems efficiently.
5. Apply the percentage fraction table for simplification.
6. Extend the application of n/d technique in other areas of aptitude where concept of product constancy is involved.
7. Solve the problems involving discount and discount percentage.
8. Formulate the mark up concept and apply it for better problem solving.
9. Apply the knowledge of Profit and loss, discount, discount percentage in day-to-day life.
10. Understand the factors to be considered during partnership and solve the solve the problems under partnership.

After learning all the topics of UNIT -4, the student is able to

1. Interpret the series of numbers in Arithmetic, Geometric and Harmonic Progression.
2. Summarize the basic concepts of progressions, i.e., arithmetic mean, nth term of a progression.
3. Predict the missing terms of the given progression.
4. Compare AM, HM and GM.
5. Compute the sum or product of n terms in the given progression.
6. Differentiate between increasing and decreasing progression and solve application based problems accordingly.
7. Understand the theorems governing progressions.
8. Identify the similarity and difference between AP, HP and GP.
9. Analyze application problems involving combination of concepts of AP, HP and GP or all the three.
10. Create own problems based on creative progressive patterns and it's combinations.
11. Solve problems based on average speed using concept of HP and AP.

After learning all the topics of UNIT -5, the student is able to

1. Recognize the concept of money and time, their relation and interdependency with respect to banking.
2. Outline the meaning of Principal, Time, Rate of Interest and Interest earned, and also their relation with one another.
3. Interpret the importance of CI in day to day life.
4. Illustrate the concept of Interest earned.
5. Distinguish between the types of interests.ie, Simple and Compound Interests.
6. Understand the difference between Simple and Compound annual growth.
7. Compute problems based on Simple Interests, Compound Interests and combination of both.
8. Solve application problems based on depreciation value, population of a city etc.
9. Apply various concepts of Percentages, Ratio, Algebra, HCF and LCM to solve application based problems.
10. Construct own questions involving multiple concepts ranging different difficult levels.
11. Solve MCQs faster by application of shortcut methods of Vedic Mathematics to find squares, cubes and roots.

A. Course Assessment Matrix (CaM)															
Course Outcome (CO)	**Program Outcome (ABET/NBA-(3a-k))**														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
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	-	-	-	-	-	-	2	-	2	-	-	-	-	-
Apply the technique of alligation for effective problem solving.	L2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Interpret the requirement of different methods of calculating average and apply the right method at right scenario.	L4	2	-	-	-	-	-	-	-	2	-	-	-	-	-
Effectively solve problems of profit and loss and problems related to discount, simple interest and compound interest.	L5	3	-	-	-	-	-	-	-	2	-	-	-	-	-

Course Title: **Theory of Metal Cutting**			
Course Code: P17IP61	**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, Recommended tool angles. **09 Hours**

SSC-Effect of cutting parameters on Tool Geometry

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 (Mechanical, Lathe tool and Milling), Problems on Merchant's Circle diagram. **11 Hours**

SSC- Hydraulic and pneumatic dynamometers

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. **12 Hours**

SSC- Cost Analysis – Cost per Component

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. Factors Affecting Heat Generation, Measurement of Temperature- Tool Work Thermocouple Technique. **10 Hours**

SSC- Temperature Distribution in Metal Cutting

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. **10Hours**

SSC- Composite tools

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 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
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:P17IP62	**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 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 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 (no numerical problem).

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.

10 Hours

SSC: Residual stresses in Metal Forming.

Unit – II

FORGING: Classification of forging operation, forging equipment, forging strain, open die forging, closed die 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**

SSC: Precision and Powder Metallurgy Forging process, Applications of Cluster and planetary Mills.

Unit – III

EXTRUSION: Classification, equipment's used, hot extrusion, deformation, lubrication and defects in extrusion, analysis of extrusion processes, 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**

SSC: Impact extrusion, Residual Stresses in Rods, Wires and Tubes.

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**

SSC: The application of sheet metal working in various sectors.

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, advantages and limitations. **10 Hours**

SSC: Principle of HERF Process**,** Characteristics of Metal powders.

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 Assessment Matrix (CAM)

Course Outcome – (CO)	**Program outcome (ABET/NBA)**													
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO 12**	**PSO 1**	**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:P17IP63	**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.

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**

SSC: Brief discussion on sporadic and chronic quality problems. Introduction to Quality function deployment.

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.

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**

SSC: Relation to product tolerance and six sigma concept of process capability.

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.

10 Hours

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.

10 Hours

SSC: Normal distribution concept

Unit -V

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

SSC: Failure models of components

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 Title: **Economics for Engineers**			
Course Code:P17IP64	**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. **INTEREST AND INTEREST FACTORS:** Interest rate, simple interest Compound interest and compound-interest factors, Cash-flow diagrams, Exercises and Discussions. **11 Hours**

SSC: Sensitivity and Sub optimization.

Unit – II

PRESENT WORTH COMPARISON: Conditions for present worth comparisons, Basic Present worth comparisons patterns, Assets with unequal lives, infinite lives, , 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**

SSC: Future worth comparisons

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. **10 Hours**

SSC: Tax concepts and types.

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, Cost of capital concept **10 Hours**

SSC: Sources of Finance

Unit – V

ESTIMATING & COSTING: Introduction, Need, Elements of product cost, Determination of selling price, Allocation of overheads, and Estimation for simple components.
BREAK-EVEN ANALYSIS: Basic Concepts, Linear break even analysis. **10 Hours**
SSC: Non-linear break even analysis

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 Assessment Matrix (CAM)

Course Outcome (CO)	Program Outcome (ABET/NBA))													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
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:P17IPL67	**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 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 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 (using video camera)
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.
10. Introduction to ECG, EMG & BP Measurements
11. Demonstration on Tecnomatix software and Jack Simulation Software.

Case study on carrying of object for Jack and Jill

Scheme of Examination:

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

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
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: P17IPL68	**Semester: VI**	**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 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

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 Assessment 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	PS O1	PSO 2
Ability to describe the applications of FEA packages and Validate finite element results with analytical or experimental results.	3	2			2							2		
Ability to Solve structural engineering problems using ANSYS.	3	2			2							2		

Course Title: **Production Planning and Control**			
Course Code:P17IP651	**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 Entrepreneurship Management.

Course Learning Objectives

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

1. Understand the various components and functions of Production Planning.
2. Understand the concept of work study.
3. Understand the components of Product planning and Process Planning.
4. Understand the importance of Scheduling and Inventory Control.
5. To know the recent trends like MRP and ERP.

Relevance of the Course

Production Planning and Control deals with the concept of,

1. Components and Functions of Production Planning.
2. Work Study.
3. Process Planning.
4. Scheduling and Inventory Control.
5. MRP and ERP.

Course Content

Unit - I

INTRODUCTION: Objectives and benefits of planning and control-Functions of production control-Types of production-job- batch and continuous-Product development and design-Marketing aspect – Functional aspects-Operational aspect-Durability and dependability aspect aesthetic aspect. Profit consideration-Standardization, Simplification & specialization. **10 Hours**

SSC: Break Even Analysis – Economics of a new design.

Unit - II

WORK STUDY: Method study, basic procedure-Selection-Recording of process – Critical analysis, Development – Implementation – Micro motion and memo motion study – work measurement – Techniques of work measurement – Time study – Production study – Work sampling – Synthesis from standard data. **10 Hours**

SSC: Predetermined motion time standards.

Unit - III

PRODUCT PLANNING AND PROCESS PLANNING: Product planning-Extending the original product information-Value analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning-Steps in process planning-Quantity determination in batch production-Machine capacity, balancing. **10 Hours**

SSC: Analysis of process capabilities in a multi-product system.

Unit - IV

PRODUCTION SCHEDULING: Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt charts-Perpetual loading-Basic scheduling problems – Line of balance – Flow production scheduling-Batch production scheduling-Product sequencing – Production Control systems-Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting-Manufacturing lead time. **11 Hours**

SSC: Techniques for aligning completion times and due dates.

Unit - V

INVENTORY CONTROL AND RECENT TRENDS IN PPC: Inventory control-Purpose of holding stock-Effect of demand on inventories-Ordering procedures. Two bin system -Ordering cycle system-Determination of Economic order quantity and economic lot size-ABC analysis-Recorder procedure-Introduction to computer integrated production planning systems-elements of JUST IN TIME SYSTEMS. **11 Hours**

SSC: Fundamentals of MRP II and ERP.

TEXT BOOKS:

1. Martand Telsang, "Industrial Engineering and Production Management", First edition, S. Chand and Company, 2000.
2. James.B.Dilworth, "Operations management – Design, Planning and Control for manufacturing and services" Mcgraw Hill International edition 1992.

REFERENCES:

1. Samson Eilon, "Elements of Production Planning and Control", Universal Book Corpn.1984
2. Elwood S.Buffa, and Rakesh K.Sarin, "Modern Production / Operations Management", 8th Edition, John Wiley and Sons, 2000.
3. KanishkaBedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
4. Melynk, Denzler, "Operations management – A value driven approach" Irwin Mc Graw hill.
5. Norman Gaither, G. Frazier, "Operations Management", 9th edition, Thomson learning IE, 2007
6. Jain. K.C&L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers, 1990.
7. Chary. S.N. "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 1995.
8. UpendraKachru, "Production and Operations Management – Text and cases", 1st Edition, Excel books 2007.

Course Outcome

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

1. Prepare Production Planning.
2. Prepare control activities such as Work study, product planning, production scheduling and Inventory control.
3. They can plan manufacturing requirements and Manufacturing requirement.
4. They can prepare MRP and ERP.
5. Understand the importance of JIT.

Course Title: **Mechanical Vibrations**			
Course Code:P17IP652	**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.

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. **12 Hours**

SSC-logarithmic decrement

UNIT – 2

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

SSC-forced vibration with reciprocating unbalance

UNIT – 3

Vibration measuring instruments: Vibrometer, velocity pick-up**.**

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 Hours**

SSC-accelerometer

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, undamped dynamic vibration absorber (No numerical on vibration absorber). Influence coefficients, Maxwell's reciprocal theorem. **10 Hours**

SSC-combined rectilinear and angular modes

UNIT – 5

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

SSC-Holzer's method

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 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	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:P17IP653	**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, 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**

SSC: Chip Breakers, types of chip breakers.

Unit-II

Press and Press Work: Introduction, Types of Presses: classification, Power press parts, Power press driving mechanism, press size, Press tools: method of punch and die support, die accessories, classification of dies based on operation: Shearing, Bending, Drawing, squeezing. **10 Hours**

SSC: Selection of press.

Unit-III

Press Tools: Components of Die and Press, working of a cutting Die, types of dies: compound Die, combination Die and progressive Die, clearance between die and punch, calculation of clearance on blanking and piercing, 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**

SSC: Angular clearance on die.

Unit-IV

Principles of metal cutting in press work: Design procedure for blanking die, cutting force, Die block and Punch Design, die sets, types of die set and material for die, methods of reducing cutting forces, cutting action in a die, Centre of pressure, selection of Tool material for punch and die, Centre for pressure, problems, Types of bending, forces and allowance in Bending. Types of Forming dies.

10 Hours

SSC: Factor effecting the die.

Unit-V

Jigs and Fixtures: Introduction, advantages of employing Jigs and fixtures, Principles of jigs and fixtures design, Principles of location: degree of freedom, three legged object and 3-2-1. Types of

Locators: choosing a locating surface, different types of locator, Clamping: operational factors, types of clamping deices, fool proofing, Indexing arrangement, Swarf removal, Types of Drill Jigs.
10 Hours

SSC: Hydraulic clamping fixture.

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 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**
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	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 and Design**			
Course Code: P17IP654	**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]

Course Learning Outcome

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

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.

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, , 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**

SSC: Make or buy and simple problems.

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**

SSC: Building design and construction.

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**

SSC: Labour utilization, worker convenience and job satisfaction.

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. **10 Hours**

SSC: Space based on present layout, Production-center method.

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. **10 Hours**

SSC: Working conditions, maintenance and supply of storage.

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. SundereshHeragu, "Facilities Design" PWS Publishing Company, ISBN-0-534-95183.
3. Chandrasekhar H , B Raghavendra Reddy, Facility planning and layout design, First Edition 2007, Technical Publication , Pune.

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: P17IP661	**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,

1. Explain the meaning, evolution and growth of ERP market [L2].
2. Define the concept of Integrated Management Information, Business Modeling and Integrated data model [L1].
3. Explain the concept of Business Process reengineering, MIS, DSS, EIS, Data warehousing, Data mining, online analytical processing and Supply Chain Management [L2].
4. Define the concept of JIT and Kanban [L1].
5. 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, **11 Hours**

SSC: Supply Chain Management.

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, Make-to-order, and Make-to Stock, Assemble to order, Engineer to order, Configure-to order. **11 Hours**

SSC: Benefits of PDM.

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, **10 Hours**
SSC: Improved Information Accuracy and Decision – making capability.

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, **10 Hours**
SSC: End user Training, Post implementation.

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, web enabling, market snapshot ERP- Case studies. **10 Hours**
SSC: Application Platforms, New business segments

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 Title: **Human Resource Management**			
Course Code:P17IP662	**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 the concept of Job Analysis.
3. Able to understand the concept Recruitment and Selection.
4. Able to understand the concept of Performance Appraisal and Human Resource Accounting.
5. 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,

- Evolution, Scope, Objectives, principle and policies of HRM.
- Recruitment and Selection process.
- Training and Development process.
- Industrial Relations.
- Industrial Act, Factory Act, ESI Act, etc.,
- 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**

SSC: Process of Job Analysis and its Benefits.

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. **12 Hours**

SSC: Group Discussion and different types of selections.

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**
SSC: Different methods of Counselling.

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**
SSC: Advantages of Communication Process.

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**
SSC: Industrial Tribunal and Adjudication.

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 Title: **Value Engineering & Industrial Best Practice**			
Course Code:P17IP663	**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 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. **12 Hours**

SSC: Value Analysis versus Value Engineering, Detailed case studies of simple products.

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

SSC: Grouping of functions and Case Studies on Functional Costs.

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, Value analysis change proposal. **10 Hours**

SSC: criteria for cost reduction programs.

Unit – IV

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

ADVANCED VALUE ANALYSIS TECHNIQUES: Functional analysis system technique and case studies. 1**0 Hours**

SSC: Role of techniques in Value Engineering and Case Studies.

Unit – V

ADVANCED VALUE ANALYSIS TECHNIQUES: Value analysis of Management practice (VAMP), steps involved in VAMP, application of VAMP to Government, University, College, Hospitals, and (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**

SSC: Application of VAMP to School Problems, Role of Material Management in Value Analysis.

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 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:P17IP664	**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. Learn the basic concept of Lean Manufacturing and methods to be adopted for implementing lean practices.
2. Understand the continuous improvement concept, principles and work involvement.
3. Understand the different concepts of 5S, 3M, VSM, etc.

Course Learning Outcome:

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, setup reduction and bottleneck analysis.
4. Illustrate the concepts and implementation of Jidoka, JIT and Poka-yoke systems.
5. Explain importance Lean six sigma and how to manage people in a Lean environment in order to sustain improvements in production method.

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. **10Hours**
SSC: Compare traditional and Lean thinking

UNIT- II

Stability of lean system: Standardized work, 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. **11Hours**
SSC: Industrial applications of Lean tools

UNIT- III

Theory of Constraints: Introduction, steps to improve process flow, buffer management, Layout management.

Standardization of operations: job rotation, Improvement activities to reduce work force and increase worker morale.

Shortening of production lead times: Practical procedures for reducing setup time. **10 Hours**
SSC: Types of Layouts used in automotive Industries

UNIT- IV

Just In Time: Principles of JIT, JIT system, Kanban, Kanban rules, expanded role of conveyance, production levelling. Jidoka concept,

Poka-yoke (mistake proofing) systems, inspection systems and zone control, use of Poka-yoke systems, three paths of Poka-yoke, Poka-yoke Detection Methods. **10 Hours**

SSC: Differentiate between push and pull system

UNIT -V

Lean Six Sigma: Definition, principles, DMAIC phases, Design for six sigma, DMADV phases, choosing between DMAIC and DMADV.

Worker Involvement and Systematic Planning Methodology: Involvement, Kaizen circle activity, hoshin planning system- PDCA, phases of hoshin planning. **11 Hours**

SSC: How to implement Lean (case study)

TEXT BOOKS:

1. **Lean Production Simplified by Pascal Dennis,** A Plain Language Guide to the World's Most Powerful Production System, (Second edition), Productivity Press, New York, 8th edition 2014.
2. **Lean six sigma by A Wiley brand,** Gopal jee enterprises Delhi, Second edition, 2015

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. **"Just in Time Manufacturing",** M. G. Korgaonker MacMillan. Reprinted 2011

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	Recognize the underlying philosophy and different Standards of the Toyota Production System.	L2	2	2	1		2							2		1
02	Analyse the elements of standards and different lean tools in the lean system.	L2	2	2	1		3							2		1
03	Explain Improvement activities to reduce work force and increase worker morale, setup reduction and bottleneck analysis	L2	2	2	1		2							2		1
04	Illustrate the concepts and implementation of Jidoka, JIT and Poka-yoke systems.	L2	2	2	1		3							2		1
05	Explain importance Lean six sigma and how to manage people in a Lean environment in order to sustain improvements in production method.	L2	1	1	1		3							2		1

Course Title : Aptitude and Reasoning Development - EXPERT (ARDE)			
Course Code : P17HU610	Semester : VI	L:T:P:H -0:0:2:2	Credits: 1
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 Hours**

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 Hours**

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 Hours**

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 Hours**

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 Hours**

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

A. Course Articulation Matrix (CAM)															
Course Outcome (CO)	**Program Outcome (ABET/NBA-(3a-k))**														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
Graphically represent the functions and analyze it.	L5	2	-	-	-	2	-	-	-	-	-	-	-	-	-
Infer the conclusions based on the roots obtained by solving quadratic equations and establish relationship between them.	L6	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Effective solve the problems of permutation and combination.	L4	3	-	-	-	2	-	-	-	2	-	-	-	-	-
Predict different possibilities by the principle of probability.	L3	3	-	-	-	-	-	-	-	2	-	-	-	-	-
Interpret the data given in the graphical format and infer the results.	L5	2	-	-	-	-	-	-	-	-	-	-	-	-	-
L- Low, M- Moderate, H-High															