SYLLABUS

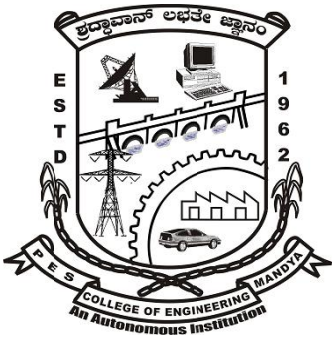
(With effect from 2013-2014)
Out Come Based Education

ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2013–14)
ಫಲಿತಾಂಶ ಆಧಾರಿತ ಶಿಕ್ಷಣ

V and VI Semester

BACHELOR DEGREE
IN
INDUSTRIAL & PRODUCTION ENGINEERING



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.

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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 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.

In order to increase the Industry/Corporate readiness, many Soft Skills and Personality Development modules have been added to the existing curriculum of 2013-14.Industry Interactions have been made compulsory to enhance the field experience. In order to enhance creativity and innovation Mini Project is included in all undergraduate programs.

(Dr.H.V.RAVINDRA)
Dean (Academic)
Professor
Dept. of Mechanical Engg.

(B.DINESH PRABHU)
Deputy Dean (Academic)
Associate Professor
Dept. of Automobile Engg.

P.E.S.COLLEGE OF ENGINEERING, MANDYA-571401
(KARNATAKA)
(An Autonomous Institution under VTU, Belagavi)

Vision

"An institution of high repute, imparting quality education to develop innovative and Humane engineers"

Mission

"Committed to develop students potential through high quality teaching- learning processes and state of the art infrastructure"

DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING

ABOUT THE DEPARTMENT

PROFILE:

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

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

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

VISION

Our Vision is to produce Competent, Disciplined, Quality Engineers.

MISSION

The mission of Industrial and Production Engineering Program is to prepare student

- For Employment
- For the pursuit of advanced degrees in Industrial, Production and Mechanical Engineering fields.
- For educating them in the fundamental concept, knowledge and skills in laboratory techniques.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

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

PEO1.1: apply the principles and techniques of traditional and modern quantitative and qualitative analysis

PEO1.2: 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 and ability to recognize the need for life-long learning to understand the impact of engineering solutions on society at all levels of an organization.

PEO2.1. analyze reallifeproblem

PEO 2.2. recognize the need for life-long learning

PEO3: Industrial and Production Engineering program will prepare graduates who will demonstrate the ability to identify, formulate, and solve engineering problems and apply continuous improvement in practice both individually and as members and/or leaders of multidisciplinary teams.

PEO3.1: ability to identify, formulate, and solve engineering problems

PEO3.2: ability to work both individually and as members and/or leaders of multidisciplinary teams

PROGRAMME OUTCOMES (POs):

PO-1 Graduates will demonstrate the ability to apply knowledge of Science and Engineering.

PO-2 Graduates will demonstrate the ability to design and conduct experiment as well as interpret data.

PO-3 Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

PO-4 Graduates will demonstrate the skill to use latest CAD/CAM/CAE software and solving engineering problems.

PO-5 will demonstrate the ability to function on multidisciplinary teams

PO-6 will demonstrate the ability to identify, formulate, and solve engineering problems.

PO-7 will demonstrate the understanding of professional and ethical responsibility

PO-8 will demonstrate the ability to communicate effectively

PO-9 The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

PO-10 A recognition of the need for, and an ability to engage in life-long learning

PO-11 A knowledge of contemporary issues

PO-12 An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

PO-13 Graduation will have the alertly to recognise the importance of programme development by polis post graduate studies on complete exam that for challenging and rewinding career in Industrial 7 Production engineering

PO-14 Graduates 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 to estimate fare, resources to complete project

P.E.S.COLLEGE OF ENGINEERING, MANDYA-571401
(An Autonomous Institution under VTU, Belagavi)

SCHEME OF TEACHING AND EXAMINATION
V Semester B. E. (IPE)

Sl No	Subject Code	Subject Title	Teaching Department	Credits	Teaching Hours / Week L :T:P:H	Examination Duration / Marks			
						Duration (Hrs)	CIE	SEE	Total
1	P13IP51	Management & Entrepreneurship	IP	3	3:0:0:3	03	50	50	100
2	P13IP52	Control Engg and Machine Tool Technology	IP	4	4:0:0:4	03	50	50	100
3	P13IP53	Theory of Metal Cutting	IP	4	4:0:0:4	03	50	50	100
4	P13IP54	Work Study and Ergonomics	IP	4	4:0 0 4	03	50	50	100
5	P13IP55	Computer Aided Design and Manufacturing	IP	4	4:0:0:4	03	50	50	100
6	P13IP56	Design of Machine Elements	IP	4	3:2:0:5	03	50	50	100
7	P13IPL57	Mechanical Engineering Laboratory	IP	1.5	0:0:3:3	03	50	50	100
8	P13IPL58	Computer Aided Drafting and Geometric Modelling.	IP	1.5	0:0:3:3	03	50	50	100
9	P13HU59	Professional and Efficient Avocation-I(PEA-I)	HS&M	--	2:0:0:2	(50)	---	---	---
10	P13IPL510	Industry visit and interaction-II	IP	--	0:0:1:1	(50)	--	--	--
Total				26		24	400	400	800

VI Semester B. E. (IPE)

Sl No	Subject Code	Subject Title	Teaching Department	Credits	Teaching Hours / Week L:T:P:H	Examination Duration / Marks			
						Duration (Hrs)	CIE	SEE	Total
1	P13IP61	Theory of Metal Forming	IP	4	4 0:0:4	03	50	50	100
2	P13IP62	Economics for Engineers	IP	4	4:0:0:4	03	50	50	100
3	P13IP63	Tool Engineering and Design	IP	4	4:0:0:4	03	50	50	100
4	P13IP64	Non-Traditional Machining Methods	IP	4	3:2:0:5	03	50	50	100
5	P13IP65	Quality Assurance and Reliability	IP	4	4:0:0:4	03	50	50	100
6	P13IP66	Elective - I (Group A)	IP	4	4:0:0:4	03	50	50	100
7	P13IPL67	Industrial Engineering Laboratory	IP	1.5	0:0:3:3	03	50	50	100
8	P13IPL68	Machine Tools Laboratory	IP	1.5	0:0:3:3	03	50	50	100
9	P13HU69	Professional and Efficient Avocation-I (PEA-II)	HS&M	---	2:0:0:2	(50)	---	---	---
10	P13IPL610	Mini Project - II		--	0:0:1:1	(50)	--	--	--
Total				27		24	400	400	800

Note:-L : Lecture, **T :** Tutorial, **P :** Practical's, **CIE :** Continuous Internal Evaluation, **SEE :** Semester End Examination

* PEA-I, Industry visit and interaction-II, PEA-II, Mini Project: All students shall have to pass this mandatory learning courses before completion of VIII-Semester. **Mandatory : Industrial Visit for 3 days during Vacation.**

Elective - 1 (Group - A)

Sl No	Course Code	Course Title	Sl No	Course Code	Course Title
1	P13IP661	Value Engineering and Industrial Best Practices	3	P13IP663	Finite Element Method
2	P13IP662	Mechanical Vibrations	4	P13IP664	Human Resource Management

EVALUATION SCHEME

Scheme	Weightage	Marks	Event Break Up				
			Test I	Test II	Quiz I	Quiz II	Assignment
CIE	50%	50	35	35	5	5	10
SEE	50%	100	Questions to Set: 10		Questions to Answer: 5		

Scheme of SEE Question Paper (100 Marks)

Duration: 3Hrs	Marks: 100	Weightage: 50%

- Each of the two questions set shall be so comprehensive as to cover the entire contents of the unit.
- There will be direct choice between the two questions within each Unit
- Total questions to be set are 10. All carry equal marks of 20
- The number of subdivisions in each main question shall be limited to three only
- Number of questions to be answered by students is 5

V SEMESTER SYLLABUS

Course Title: Management and Entrepreneurship			
Course Code:P13IP51	**Sem: V**	**L-T-P-H: 3-0-0-3**	**Credits: 3**
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.

a) Course Learning Objectives (CLO) :

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

- Able to understand the nature, characteristics and Scope of management.
- Able to understand the concept of planning, organising, directing and controlling of workers.
- Able to understand the concept of entrepreneurship, types of entrepreneur and role of entrepreneur in economic development.
- Able to understand the steps involved to start a small scale industry (SSI).
- Able to understand the role of supporting agencies to start the SSI.
- Able to learn the identification of business opportunities in the market.
- Able to understand the concept and importance of ownership in an industry.

b) Relevance of the Course :

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

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

Course Content

UNIT – 1

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, development of management thought –early management approaches – modern management approaches.

PLANNING: Nature, importance and purpose of planning process– objectives - Types of plans (Meaning only) - Decision making — steps in planning & Planning premises – Hierarchy of plans. **10 Hours**

UNIT – II

ORGANIZING AND STAFFING: Nature and purpose of organization, principles of Organizations – Types of organisation - Departmentation Committees - Centralization vs.

Decentralisation of authority and responsibility, span of Control, MBO, and MBE(Meaning only) Nature and importance of Staffing – process of selection and recruitment (in brief).

DIRECTING: Meaning and nature of directing – Leadership styles and motivation theories, communication – Meaning and importance – Coordination, meaning and importance and Techniques of Co – ordination. **10 Hours**

UNIT-III

CONTROLLING: Meaning and steps in controlling – Essentials of a sound control system – Methods of establishing control (in brief).

ENTREPRENEUR: Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Concept of Entrepreneurship – Evolution of Entrepreneurship, development of Entrepreneurship, steps in entrepreneurial process, Role of entrepreneurs in Economic Development: Entrepreneurship in India; Barriers of Entrepreneurship. **10 Hours**

UNIT -IV

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

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

UNIT – V

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

INDUSTRIAL OWNERSHIP: Definition and meaning of partnership, characteristics of partnership, kinds of partners, rights, duties and liabilities of partners, advantages and disadvantages of partnership. Sole proprietorship: features, scope, advantages and disadvantages. **11Hours**

TEXT BOOKS:

1. Principles of Management – P.C. Tripathi, P.N. Reddy; Tata McGraw Hill, 2nd Edition.
2. Dynamics of Entrepreneurial Development & Management – Vasant Desai–Himalaya Publishing House
3. Entrepreneurship Development – Small Business Enterprises – Poornima M Charantimath – Pearson Education –2006, 2nd Edition.
4. Management and Entrepreneurship – N.V.R. Naidu & T. KirshnaRao, I.K. International, New Delhi – 2008.

REFERENCE BOOKS:

1. Management Fundamentals - Concepts, Application, Skill Development– 1st Edition, Robert Lusier –Thomson
2. Entrepreneurship Development – S S Khanka – S Chand & Co.
3. Management – Stephen Robbins – Pearson Education, PHI -17th Edition, 2000

Unit wise Plan

Unit – I

Management & Planning Planned Hours: 10

Learning Objectives:

The Students should be able to,

1. Define Management [L1].
2. Explain the functional areas of management [L2].
3. Explain the roles and levels of management [L2].
4. Explain the steps involved in planning process [L2].
5. Differentiate between planning and decision making process [L4].

Unit – II

Organizing, Staffing and Directing Planned Hours: 10

Learning Objectives:

The Students should be able to,

1. Explain the types of organization [L2].
2. Define the concept of MBO and MBE [L1].
3. Define staffing [L1].
4. Explain the process of selection and recruitment of staffing [L2].
5. Explain the motivation theories [L2].
6. Explain the importance of communication [L2].

Unit – III

Controlling and Entrepreneur Planned Hours:10

Learning Objectives:

The Students should be able to,

1. Explain the steps in controlling [L2].
2. Define entrepreneur [L1].
3. Explain the types of entrepreneur [L2].
4. Analyse the role of entrepreneur in economic development [L4].
5. Explain the Steps in entrepreneurial process [L2].
6. Explain the functions of entrepreneur L2].

Unit – IV

Small Scale Industry Planned Hours:11

Learning Objectives:

The Students should be able to,

1. Define Small Scale Industry [L1].
2. Explain the Steps to start an SSI [L2].
3. List the importance and advantages of SSI [L1].
4. Explain the role of SSI in economic development [L1].
5. Differentiate between the different methods of Heat Treatment process L4].

Unit – V

Preparation of Project Industrial Ownership Planned Hours: 11

Learning Objectives:

The Students should be able to,

1. Explain the need and significance of project report [L2].
2. Explain the networking techniques for project scheduling [L2].
3. Identify the business opportunities [L1].
4. Define the partnership [L1].
5. Explain the types of partnership [L2].

Lesson Plan

Unit -1

1 Introduction – Meaning – nature and characteristics of Management.

2 Scope and functional areas of management.

3 Management as a science, art or profession – Management and administration.
4 Roles of management, Levels of management.
5 Development of management thought –early management approaches.
6 Modern management approaches.
7 **PLANNING:** Nature, importance and purpose of planning process.
8 Objectives - Types of plans.
9 Decision making, steps in decision making.
10 Steps in Planning & Planning premises – Hierarchy of plans.

Unit – 2

1. Nature and purpose of organization, principles of Organizations.
2. Types of organisation.
3. Types of organisation.
4. Departmentation Committees - Centralization vs. Decentralisation of authority and responsibility
5. Span of Control, MBO, and MBE.
6. Nature and importance of Staffing – process of selection and recruitment.
7. Meaning and nature of directing – Leadership styles.
8. Motivation theories.
9. Communication – Meaning and importance.
10. Coordination, meaning and importance and Techniques of Co – ordination.

Unit – 3

1. Meaning and steps in controlling.
2. Essentials of a sound control system.
3. Methods of establishing control.
4. Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur.
5. Functions of an Entrepreneur.
6. Types of Entrepreneur.
7. Concept of Entrepreneurship – Evolution of Entrepreneurship, development of Entrepreneurship.
8. Steps in entrepreneurial process.
9. Role of entrepreneurs in Economic Development: Entrepreneurship in India.
10. Barriers of Entrepreneurship.

Unit – 4

1. Definition, Characteristics, Need and rationale of SSI.
2. Objectives, Scope, role of SSI in Economic Development.
3. Advantages of SSI, Steps to start an SSI.
4. Government policy towards SSI, Different Policies of SSI.
5. Government Support for SSI during 5 year plans.
6. Impact of Liberalization, Privatization & Globalization on S.S.I.
7. Effect of WTO/GATT, Ancillary Industry and Tiny Industry.
8. Different Schemes; TECKSOK, KIADB.
9. KSSIDC, KSIMC,SISI.
10. DIC Single Window Agency.
11. NSIC, SIDBI, KSFC.

Unit – 5

1. Definition, Characteristics, Need and rationale of SSI.
2. Objectives, Scope, role of SSI in Economic Development.
3. Advantages of SSI, Steps to start an SSI.
4. Government policy towards SSI, Different Policies of SSI.
5. Government Support for SSI during 5 year plans.
6. Impact of Liberalization, Privatization & Globalization on S.S.I.
7. Effect of WTO/GATT, Ancillary Industry and Tiny Industry.

8. Different Schemes; TECKSOK, KIADB.
9. KSSIDC, KSIMC,SISI.
10. DIC Single Window Agency.
11. NSIC, SIDBI, KSFC.

Review Questions

1. Define management? Explain the functional areas of management.
2. Explain the roles of management.
3. Explain the early management approaches.
4. Explain the modern management approaches.
5. Differentiate between management and administration.
6. Define planning? Explain the importance of planning.
7. Explain the objectives of planning.
8. Explain the types of decisions.
9. Explain the steps in decision making.
10. Explain the steps in planning and planning premises.
11. State and explain principles of organization.
12. Explain with sketch the line organization.
13. Explain with sketch the line and staff organization.
14. Explain with sketch functional organization.
15. Explain the principles of committee.
16. Differentiate between MBO & MBE.
17. What is recruitment? Explain the technique of selection.
18. Explain the principle of directing.
19. Define leadership? Explain the types of leadership.
20. Explain the Maslow's theory of motivation.
21. Explain Herzberg theory of motivation.
22. Define communication? Explain the different systems of communication.
23. Define controlling explain the steps in controlling.
24. Explain the methods of establishing sound controlling.
25. Define entrepreneurship? Explain the types of entrepreneur.
26. Explain the various stages of entrepreneurial process.
27. Explain the role of entrepreneur in economic development.
28. List and explain the characteristic of entrepreneur.
29. Explain the functions of entrepreneur.
30. Write about evaluation of entrepreneurship.
31. Define SSI? List the characteristic of SSI.
32. Explain the objectives of SSIs.
33. Explain the role of SSI in economic development.
34. Explain the steps to start SSI.
35. Explain the government support for SSIs during 5 year plan.
36. Write a note on LPG.
37. Explain the role of SISI in developing SSIs.
38. Explain the role of DICs.
39. Explain the role of KIADB.
40. Explain the role of TECKSOK and SIDBI.
41. Define the project? Explain the phase of project identification with its resources.
42. Write about the need and significance of project report.
43. Explain the guidelines of planning commission for project report.
44. Define network analysis? Explain the various techniques used for network analysis.
45. Explain the process of project appraisal.
46. Write a note on market feasibility, financial feasibility, technical feasibility and social feasibility study.

47. Explain the errors in project report.
48. List the advantages and disadvantages of sole proprietorship.
49. Explain the various kinds of partnership.
50. Explain the characteristics of partnership.

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO)		Program outcome (ABET/NBA-(3a-k)											
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Ability to Understand the Functional Areas of Management.							**H**	**M**	**M**			
02	Able to Understand the different Motivation Theories.						**M**		**H**	**M**			**L**
03	Able to define the role of Entrepreneur in Economic Development.							**H**	**M**		**M**	**L**	
04	Able to understand the steps involved to start Small Scale Industry.					**M**		**M**	**H**				**L**
05	Able to identify the need and significance of Project Report& techniques of Project Scheduling.							**H**	**M**		**M**		

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Describe the Meaning & Roles of Management (Unit – I)	**L2**			**2**	**3**		**1**					
02	Learn how to Motivate the Workers in an Industry(Unit – II)	**L1**	**1**			**2**			**3**				
03	Able to understand the stages involved in Entrepreneurial process (Unit – III)	**L2**				**3**			**2**				**1**
04	Able to know the different Government Agencies to Support SSI (Unit – IV)	**L2**						**2**			**3**		**2**
05	Able to understand the Meaning & types of Partnership (Unit – V)	**L1**				**2**		**3**	**2**			**1**	

1-Low, 2-Moderate, 3-High

Course Title: Control Engineering and Machine Tool Technology			
Course Code: P13IP52	**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: 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:

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. To learn the basic feature and Kinematic requirements of Machine tools and different drives.
6. The students should learn the knowledge to analyze and design the gear box.

Course Learning Outcomes:

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

Course Content

Unit-I

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

Modelling of control system: Analysis of mechanical systems (Translation motion and Rotational motion) Equivalent mechanical system (node system), Electrical systems, Analogous systems (loop analysis and node analysis). DC Servomotors (field controlled and armature controlled).

10 Hours

Unit-II

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

Unit-III

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

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

Unit-IV

BASIC FEATURE AND KINEMATIC REQUIREMENTS OF MACHINE TOOLS: Machine tool, characteristics of Machine tool, Objectives of machine tool, classification of machine tools, control system of machine tools, cutting motion in machine tools, Essential

requirement of machine tool, Design of basic features of a machine tool, Method of production of surfaces, General requirements of machine tool design **12 Hours**

Unit-V

KINEMATIC DRIVES OF MACHINE TOOLS : Basic principle of mechanical drives, stepped and stepless output, Layout of speeds in Arithmetic , Geometric and Logarithmic progression, Mechanical stepless drives ,PIV drive, Hydraulic drives for machine tool drives, practical subdivisions and Number of stages in geared transformation, Machine tool spindle speeds, Ray diagram, Speed diagram, Gear box design,(Problems on Gear box design), Ruppert drive (gear box with clutch drives) problems on ruppert drive. **10 Hours**

TEXT BOOKS:

1. Modern Control Engineering –K Ogatta, Prentice Hall (India) Pearson Education 2003.
2. Automatic Control Systems-Francis. H Raven 5th Edition.McGraw Hill 1995.
3. Principles of Machine tools-Sen and Bhattacharyya

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.
5. Modern Control Systems- Richard C Drof and Robert.H.Bishop Addison- Wesley,8th Edition,1998.
6. Automatic Control System –B.C Kuo- Prentice Hall (India),1995.
7. System Dynamics & Control-EroniniumezTho Learning 2002.

Unit wise Plan

Unit-I

Basic of Control System Modeling of Control System Planned Hours: **10**

1. Describe Concept of automatic controls (L1).
2. Distinguish between open and closed loop systems (L1).
3. Describe ideal control system (L1).
4. Describe with a neat sketch any two open loop and closed system. (L3)
5. Explain Requirement of Real time application of control system (L2).
6. Compare Feedback and feed forward system (L4).
7. Compare close loop and open loop system (L2).
8. Explain Analysis of mechanical systems (L2)
9. Compare Electrical systems and mechanical systems (L4).
10. Explain DC Servomotors field controlled and armature controlled (L2).

Unit-II

Time Response Analysis of Control Systems. Planned Hours: **10**

1. Differentiate between study state and transient state (L4)
2. Describe time response and Standard test inputs (L1).
3. Describe steady state error and Effect of input (L1).
4. Describe steady state error (L1).
5. Compare the effect of Change in G(s) H(s) on Steady State Error (Type of a System). (L4).
6. Explain first order subjected to step input (L2).
7. Compare step input and ramp input (L4).
8. Explain first order subjected ramp input (L2)
9. Evaluate the effect of input on study state error reference input is step on magnitude of 'A' (L4)
10. Evaluate a unit feedback system has G(S)=40(S+2) / S(S+1)(S+4) determine (L4)

i. Type of system
ii. All the error coefficient
iii. Error for ramp input with magnitude of 4

Unit-III

Block Diagrams Signal Flow Graphs, Signal Flow Graphs Planned Hours: **10**

1. Describe transfer functions (L1).
2. Describe rules for block diagram reduction (L1).
3. Solve block diagram in canonical order (L4).
4. Explain Critical Rules in block diagram (L2).
5. Describe terminology of signal flow graphs (L1).
6. Explain signal flow graphs (L2).
7. Solve signal flow graph. (L4).
8. Explain Properties of signal flow graphs (L2).
9. Explain terminology and methods to obtain signal flow graph (L2).
10. Evaluate mason's gain formula (L4).

Unit-IV

Basic feature and Kinematic requirements of Machine tools Planned Hours: **12**

1. Describe Machine tool (L1).
2. Describe characteristics of Machine tool (L1).
3. Describe objectives of machine tool and classification of machine tools (L1).
4. Explain cutting motion in machine tools (L2).
5. Describe control system of machine tools (L2).
6. Explain Essential requirement of machine tool (L2).
7. Evaluate design of basic features of a machine tool (L4).
8. Explain kinematic requirements of machine tools (L2)
9. Explain method of production of surfaces (L2).
10. Solve general requirements of machine tool design (L3).

Unit-V

Kinematic drives of machine tools Planned Hours: **10**

1. Describe machine tool drive (L1).
2. Describe PIV drive (L1).
3. Distinguish Hydraulic drives and mechanical drive for machine tool drives (L3).
4. Explain Machine tool spindle speeds (L2).
5. Explain ray diagram (L2).
6. Design gear box for 8 speed progression ratio 1.326, minimum speed 200rpm and maximum speed 1200rpm. Determine spindle speed, speed distribution, gear box layout, number of teeth on each gear, torque transmitted on each of shaft (L4).
7. Explain ruppert drive (L2).
8. Design ruppert drive (L4).
9. Design gear box for 12 speed progression ratio 1.412, minimum speed 200rpm and maximum speed 1200rpm. Determine spindle speed, speed distribution, gear box layout, number of teeth on each gear, torque transmitted on each of shaft (L4).
10. Design gear box for ruppert drive for combination 1 x 3 x 4 speed, minimum speed 60rpm and maximum speed 1000rpm. Determine progression ratio spindle speed, speed distribution, gear box layout, number of teeth on each gear, torque transmitted on each of shaft (L4).

Lesson Plan

1. Basic of control system:
2. Concept of automatic controls, classification of control systems,
3. Open and closed loop systems,
4. Concepts of feedback, Requirement of an ideal control system.

5. Any two Real time application of open and closed loop control system, Feedback and feed forward system,
6. Comparison of close loop and open loop system.
7. Modelling of control system
8. Analysis of mechanical systems (Translation motion and Rotational motion) Equivalent mechanical system (node system),
9. Electrical systems, Analogous systems (loop analysis and node analysis).
10. DC Servomotors (field controlled and armature controlled).

Unit – 2

11. Time Response Analysis of Control Systems:
12. Continuation
13. Definition and classification of time response,
14. Continuation
15. Standard test inputs, Derivation of steady state error,
16. Continuation
17. Effect of input (Type of Magnitude) on steady state error (Static Error Coefficient Method)
18. Continuation
19. Effect of Change in G(s) H(s) on Steady State Error: step, ramp, parabolic,
20. Simple problems.

Unit – 3

21. Block Diagrams Signal Flow Graphs
22. Derivation of Transfer function of simple closed loop system,
23. Rules for Block Diagram
24. Reduction, Critical Rules,
25. Procedure to solve block diagram in canonical form,
26. Problems on block diagram.
27. Signal flow graphs: Properties of signal flow graphs,
28. Terminology, Methods to obtain Signal Flow Graph,
29. Mason's gain formula,
30. Problems on signal flow graph.

Unit – 4

31. Basic Feature and Kinematic Requirements of Machine Tools: introduction
32. Machine tool, characteristics of Machine tool,
33. Objectives of machine tool,
34. Classification of machine tools,
35. Continuation
36. Control system of machine tools,
37. Continuation
38. Cutting motion in machine tools,
39. Essential requirement of machine tool,
40. Design of basic features of a machine tool,
41. Method of production of surfaces,
42. General requirements of machine tool design

Unit – 5

43. Kinematic Drives of Machine Tools**:** Basic principle of mechanical drives
44. Stepped and stepless output
45. Layout of speeds in Arithmetic, Geometric and Logarithmic progression
46. Mechanical stepless drives
47. PIV drive, Hydraulic drives for machine tool drives
48. Practical subdivisions and Number of stages in geared transformation,
49. Machine tool spindle speeds,
50. Ray diagram, Speed diagram

51. Gear box design, Problems on Gear box design
52. Ruppert drive (gear box with clutch drives), problems on ruppert drive.

Review Questions

Unit – 1

1. Describe Concept of automatic controls (L1).
2. Distinguish between open and closed loop systems (L1).
3. Describe ideal control system (L1).
4. Describe with a neat sketch any two open loop and closed system. (L3)
5. Explain Requirement of Real time application of control system (L2).
6. Compare Feedback and feed forward system (L4).
7. Compare close loop and open loop system (L2).
8. Explain Analysis of mechanical systems (L2)
9. Compare Electrical systems and mechanical systems (L4).
10. Explain DC Servomotors field controlled and armature controlled (L2).

Unit – II

1. Differentiate between study state and transient state (L4)
2. Describe time response and Standard test inputs (L1).
3. Describe steady state error and Effect of input (L1).
4. Describe steady state error (L1).
5. Compare the effect of Change in G(s) H(s) on Steady State Error (Type of a System). (L4).
6. Explain first order subjected to step input (L2).
7. Compare step input and ramp input (L4).
8. Explain first order subjected ramp input (L2)
9. Evaluate the effect of input on study state error reference input is step on magnitude of 'A' (L4)
10. Evaluate a unit feedback system has G(S)=40(S+2) / S(S+1)(S+4) determine (L4)
    i. Type of system
    ii. All the error coefficient
    iii. Error for ramp input with magnitude of 4

Unit – III

1. Describe transfer functions (L1).
2. Describe rules for block diagram reduction (L1).
3. Solve block diagram in canonical order (L4).
4. Explain Critical Rules in block diagram (L2).
5. Describe terminology of signal flow graphs (L1).
6. Explain signal flow graphs (L2).
7. Solve signal flow graph. (L4).
8. Explain Properties of signal flow graphs (L2).
9. Explain terminology and methods to obtain signal flow graph (L2).
10. Evaluate mason's gain formula (L4).

Unit – IV

1. Describe Machine tool (L1).
2. Describe characteristics of Machine tool (L1).
3. Describe objectives of machine tool and classification of machine tools (L1).
4. Explain cutting motion in machine tools (L2).
5. Describe control system of machine tools (L2).
6. Explain Essential requirement of machine tool (L2).
7. Evaluate design of basic features of a machine tool (L4).

8. Explain kinematic requirements of machine tools (L2)
9. Explain method of production of surfaces (L2).
10. Solve general requirements of machine tool design (L3).

Unit –V

1. Describe machine tool drive (L1).
2. Describe PIV drive (L1).
3. Distinguish Hydraulic drives and mechanical drive for machine tool drives (L3).
4. Explain Machine tool spindle speeds (L2).
5. Explain ray diagram (L2).
6. Design gear box for 8 speed progression ratio 1.326, minimum speed 200rpm and maximum speed 1200rpm. Determine spindle speed, speed distribution, gear box layout, number of teeth on each gear, torque transmitted on each of shaft (L4).
7. Explain ruppert drive (L2).
8. Design ruppert drive (L4).
9. Design gear box for 12 speed progression ratio 1.412, minimum speed 200rpm and maximum speed 1200rpm. Determine spindle speed, speed distribution, gear box layout, number of teeth on each gear, torque transmitted on each of shaft (L4).
10. Design gear box for ruppert drive for combination 1 x 3 x 4 speed, minimum speed 60rpm and maximum speed 1000rpm. Determine progression ratio spindle speed, speed distribution, gear box layout, number of teeth on each gear, torque transmitted on each of shaft (L4).

Course Articulation Matrix (CAM)												
Sl. No	Course Outcome – (CO)	Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Ability to apply knowledge in the field Control Engineering and Machine Tool Drive		H	L	M	L							
02	Ability to identify basic concepts of automatic control system and understanding the electrical analogous systems.		M		L		H						
03	Ability to identify and learn response analysis of control system and solve engineering problems.			M	L		H						
04	Ability to identify formulate block diagram and signal flow graphs and solve engineering problems		M	L			H						
05	Ability to apply knowledge of kinematic requirements of Machine tools and different drives		L	M			H						
06	Ability to analyze and design the gear box.		M	L	H								

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)													
Sl. No	Course Outcome – CO	Program outcome (ABET/NBA-(3a-k)											
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Explain Analysis of mechanical systems (Unit – I)	L2	3	1	2	1							
02	Evaluate the effect of input on study state error reference input is step on magnitude of 'A'(Unit – II)	L4	2		1		3						
03	Solve block diagram in canonical order (Unit – III)	L4		2	1		3						
04	Evaluate design of basic features of a machine tool (Unit – IV)	L4	2	1			3						
05	Design gear box for 8 speed progression ratio 1.326 (Unit – V)	L4	2	1	3								

1-Low, 2-Moderate, 3-High

Course Title: Theory of Metal Cutting			
Course Code: P13IP53	**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 undergone the course on Elements of Mechanical Engineering, Mechanics of Materials and Production Technology.

c) Course Learning Objectives (CLO) :

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

- Able to define the mechanism of metal cutting principles and formation of chips in different types of metals.
- Able to understand the terminology of Single Point and Multi Point cutting tools.
- Able to understand the different types of nomenclature systems of tools.
- Able to understand the cutting forces involved and their relationship with respect to the resultant force in orthogonal metal cutting process.
- Able to understand the concept of Machinability and Economics of Machining.
- Able to understand the concept of Temperature and their effects.
- Able to understand the purpose and types of lubricants used in the process.
- Able to understand the different types of materials used in manufacturing tools and their properties.

d) Relevance of the Course :

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

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

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, Tool Nomenclature Systems –ASA, ISO System, Conversion from one system to another system, Recommended tool angles, Effect of cutting parameters on Tool Geometry. **09 Hours**

Unit - II

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

11 Hours

Unit - III

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

Unit – IV

CUTTING FLUIDS: Cutting Fluids, Sources of Heat in Metal Cutting, Thermal Aspects of Metal Machining, Functions of Cutting Fluids, Types of Cutting Fluids, Selection and Application

of Cutting Fluids, Effect of Cutting Fluid on Cutting Speed and Tool Life, Recommended Cutting Fluids. **10 Hours**

Unit - V

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

Text Books:

1. Fundamentals of Metal Cutting and Machine Tools, B. L Juneja and G. S. Sekhon,Willy Eastern Limited, 1987
2. Metal Principles, M. C. Shaw Oxford & I.B.H, 1st Edition.
3. Principles of Metal Cutting", Sen& Bhattacharya, New Central Book Agency, 1969
4. Metal Cutting and Tool Design", Dr. B. J. Ranganath, Vikas Publishing House, 1993.

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.

Unit wise Plan

Unit – I

Process of Metal Cutting. **Planned Hours: 08**

Learning Objectives:

The Students should be able to,

1. Define the principle of metal cutting. [L1].
2. Define the Concept of chip formation, types and chip breakers.[L1].
3. Understand the Tool Geometry. [L2].
4. Define the different Nomenclature systems – ASA, ISO System. [L1].
5. Understand the effect of cutting parameters on Tool Geometry. [L2].

Unit – II

Mechanics of Metal Cutting. **Planned Hours: 12**

Learning Objectives:

The Students should be able to,

6. Define the concept of cutting forces in Orthogonal Cutting process [L1].
7. Define the concepts of Stress, Strain, Shear Strain, Work done and Power required in the Metal cutting process [L1].
8. Derive the equations between the various forces involved in the metal cutting process [L3].
9. Describe the concept of Dynamometry and different types of dynamometers and force measurements [L1].

Unit – III

Machinability. **Planned Hours: 12**

Learning Objectives:

The Students should be able to,

10. Define the concept of Machinability and Machinability Index. [L1].
11. Understand the Tool failure, Tool life and the relationship between the cutting speed and the tool life [L2].

12. Understand the effect of feed and depth of cut on Tool life [L2].
13. Define the objectives of economical machining process [L1].
14. Derive the equations for Tool life for maximum Production [L3].

Unit – IV

Cutting Fluids. **Planned Hours: 10**

Learning Objectives:

The Students should be able to,

15. Define the properties, functions and uses of Cutting Fluids [L1].
16. Understand the various sources of heat generation in metal cutting process. [L2].
17. Understand the selection of various cutting fluids in the application [L2].
18. Define the effect of cutting fluid on cutting speed and tool life [L1].

Unit – V

Tool Materials and their properties. **Planned Hours: 10**

Learning Objectives:

The Students should be able to,

19. Define the various characteristics of tool materials [L1].
20. Understand the various tool materials. [L2].
21. Understand the recommended cutting speeds for the above tools, tool and die steels [L2].

Lesson Plan

Unit-I

1 Introduction, Concept of Metal cutting principles.
2 Types of Metal cutting process – Orthogonal and Oblique cutting process.
3 Chip Thickness ratio and Chip breaker.
4 Cutting Speed, Feed and Depth of Cut – Economical Cutting Speed.
5 Tool Geometry – Single Point Cutting Tool.
6 Tool Geometry – Multi Point Cutting Tool.
7 Tool Nomenclature Systems –ASA, ISO System, Conversion from one system to another system.
8 Recommended tool angles and Effect of cutting parameters on Tool Geometry.

Unit-II

1. Introduction, Cutting forces in Orthogonal cutting.
2. Stress and strain in Chip, Shear Strain, Work done and Power required.
3. Power Consumed in Metal cutting and Determination of shear plane angle.
4. Merchant's circle diagram – Assumptions made.
5. Merchant's circle diagram – Derivation.
6. Problems on Merchant's circle diagram.
7. Coefficient of friction.
8. Measurement of Cutting Forces – Introduction.
9. Reasons for measuring cutting forces and Dynamometry.
10. Types of Dynamometers and Force Measurement,
11. Problems on Merchant's Circle diagram.
12. Problems on Merchant's Circle diagram.

Unit-III

1. Machinability – Introduction and Machinability Index.
2. Tool Failure and Tool life.
3. Relationship between the Cutting Speed and Tool Life.

4. Effect of Feed and Depth of cut on Tool Life.
5. Economics of Machining - Basic Objectives of Economical Machining.
6. Production Cost and Economic Tool Life.
7. Optimum Cutting Speed for Maximum Production.
8. Tool Life for Maximum Production.
9. Cost Analysis – Cost per Component.
10. Objectives of Machining.
11. Problems on Taylor's Tool Life Equation.
12. Problems on Taylor's Tool Life Equation.

Unit-IV

1. Cutting Fluids : Introduction.
2. Properties of cutting fluids.
3. Sources of Heat in Metal Cutting – Primary, Secondary and Tertiary Zone.
4. Thermal Aspects of Metal Machining.
5. Functions of Cutting Fluids.
6. Types of Cutting Fluids.
7. Selection and Application of Cutting Fluids.
8. Effect of Cutting Fluid on Cutting Speed.
9. Effect of cutting fluid on Tool Life.
10. Recommended Cutting Fluids.

Unit-V

1. Tool Materials and their properties: Introduction.
2. Characteristics of tools materials.
3. Types of tool materials – carbon tool steels.
4. High speed steels and cast alloys.
5. Cemented carbides and ceramics.
6. Diamonds and Sialon.
7. CBN and UCON,
8. Recommended cutting speeds for the above tools, tool & die steels.
9. Air, water, oil hardening of tools,
10. Applications of tools.

Review Questions

1. Define metal cutting process.
2. With a neat sketch explain different types of chips formed during metal cutting process.
3. What is chip breaker?
4. With a neat sketch explain the purpose of chip breaker.
5. Define Cutting speed, feed and depth of cut.
6. With a neat sketch explain the nomenclature of Single point cutting tool.
7. With a neat sketch explain the nomenclature of Multi point cutting tool.
8. Explain ASA and ISO system of tool nomenclature system.
9. Write a note on recommended tool angle.
10. Explain the effect of cutting parameters on tool geometry.
11. Define orthogonal and oblique cutting process with a neat sketch.
12. Define the principles of metal cutting process.
13. Mention the various forces involved in orthogonal cutting process with a neat sketch.
14. Explain the concept of stress and strain in the chip.
15. Define Shear Strain.

16. With the help of neat sketch derive the relationship among the various forces in metal cutting.
17. Mention the purpose of measurement of cutting forces.
18. Mention the different types of dynamometers.
19. With a neat sketch explain Lathe Tool Dynamometer.
20. Problems on Merchant's circle diagram.
21. Problems on Merchant's circle diagram.
22. Define Machinability.
23. Define Machinability Index.
24. Explain the concept of Tool Failure and Tool Life.
25. With a neat sketch explain Tool Failure Criteria.
26. Explain the basic objectives of Economical Machining.
27. Define Production Cost and Economic tool life.
28. Derive an equation for optimum cutting speed for maximum production.
29. Derive an equation for Tool life for Maximum Production.
30. Define the concept of Cost analysis.
31. Mention the objectives of machining process.
32. Mention the Properties of Cutting Fluids.
33. With a neat sketch explain the different sources of heat in metal cutting process.
34. Define the concept of thermal aspects of metal machining.
35. Mention the functions of cutting fluids.
36. Explain the different types of cutting fluids.
37. Explain the application of cutting fluids in metal cutting process.
38. Explain the effect of cutting fluids on cutting speed and tool life.
39. Write a note on recommended cutting fluids.
40. Write a note on selection of cutting fluids.
41. Explain the different characteristics of tool materials.
42. Mention the different materials used in manufacturing a tool.
43. Briefly explain the Carbon steels and High speed tools.
44. Write a note on Diamonds an SIALON.
45. Mention the properties of HSS and Cast alloys.
46. Mention the advantages of CBN materials.
47. Explain Air and Water hardening of Tools.
48. Mention the disadvantages of Diamond tools.
49. Mention the applications of UCON tool materials.
50. Explain oil hardening of tools.

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO)		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Ability to apply knowledge in the field Machine tools and cutting tools		**H**		M		**L**						
02	Ability to design the single point cutting tools and multi point cutting tools.		M		H		**M**						
03	Ability to derive a relationship between the various forces in the metal cutting process.		M		H		**H**						
04	Ability to understand the concept of dynamometry and types of dynamometer		M	L			**H**						
05	Ability to understand the different types and properties of cutting fluids.		L	M			**H**						
06	Ability to define the concept of Machinability.		M	L	**H**		**H**						

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Describe the principles and mechanism of metal cutting process. (Unit – I)	L4	3		2		1						
02	Derive an equation between the various forces in the metal cutting process (Unit – II)	L3	2		3		2						
03	Able to understand the concept of Machinability, Tool Life and Tool Failure Criteria (Unit – III)	L3		2	3		3						
04	Able to understand the sources of heat generation and how to reduce the temperature (Unit – IV)	L4	2	1			3						
05	Describe properties and characteristics of various materials used for tool manufacturing (Unit – V)	L3	2	1	3		3						

1-Low, 2-Moderate, 3-High

Course Title: Work Study and Ergonomics			
Course Code: P13IP54	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:

-Nil-

Course Learning Objectives:

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

Course Outcome

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

UNIT – I

PRODUCTIVITY & WORKSTUDY: Basic needs, Quality of life and Productivity, Definition of productivity, Productivity in the individual enterprise, The task of Management, Definition of Work study, How the total time of a job is made up, Interrelationship of the various methods used to reduce ineffective time, wage rates, wage incentives and its types, Straight and differential piece rate system, Emerson efficiency plan, Halsey plans, Rowan plan, group incentives. Work study as a valuable tool, Techniques & Basic procedure of work study, direct means of raising productivity, Human Factor in the application of the work study. **10 Hours**

UNIT – II

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

UNIT –III

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

UNIT – IV

INTRODUCTION TO ERGONOMICS: Introduction, Consequences of not using Ergonomics, areas of study covered under ergonomics, system approach to ergonomics models, Man-Machine system, Characteristics of Man-Machine system , work capabilities of industrial worker, Functions performed by Man and Mechanism involved, General principles for carrying out the

physical activities, development of stress in human body and their consequences, Suggestions for prevention. **10Hours**

UNIT – V

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

Unit wise Plan

Unit-1

Productivity & Work Study **Planned Hours: 10**

Learning Objectives

The student learns

1. Stating the Basic needs of human being/Society (L1)
2. Definition of Productivity and its importance in enterprise (L1)
3. Identifying components of Total time and how to minimize (L1)
4. Definition of Work study and its importance (L1)
5. Computing the various types of wages and incentives (L3)
6. Listing the procedure of work study(L1)
7. Outlining the role of Human factor in work study (L4)

Unit-II

Method study **Planned Hours: 10**

Learning Objectives

The student learns

1. Identify the work to be selected for Method study (L1)
2. Classifying the Process chart symbols (L2)
3. Preparing the various charts and diagrams (L3)
4. Criticizing the present Method (L5)
5. Developing the Best method (L6)
6. Rewriting the present method (L6)

Unit-III

Work Measurement **Planned Hours: 12**

Topic Learning Objectives or Unit Learning Objectives

The student learns

1. Stating the purpose, uses and procedure of Work measurements (L1).
2. Determining the sample size for work sampling (L4).
3. Assessing the Rating and allowances (L5)
4. Analyzing the various methods of Work measurements (L4).
5. Evaluating the Standard time of an activity by different methods (L5).

Unit-IV

Introduction to Ergonomics **Planned Hours: 10**

Topic Learning Objectives or Unit Learning Objectives

The student learns

1. Describing the scope of Ergonomics (L2).
2. Explaining the Man-Machine system (L2).
3. Analyzing the work capabilities of an Industrial worker (L4).
4. Concluding the general principles for carrying out the physical activities (L5)
5. Outlining the development of stress in human body (L4)

Unit-V

Design of Man-Machine System **Planned Hours: 10**

Topic Learning Objectives or Unit Learning Objectives

The student learns

1. Illustrating the concept of fatigue in Industrial work (L2).
2. Designing of Displays and controls (L6).
3. Distinguishing between displays and controls (L4).
4. Designing of panel of Layouts and Work places (L6).
5. Appraising the influence of Climate, Noise, Vibration and Lighting on Human Performance (L5)

Lesson Plan

Unit -I

1. Productivity & Work study: Basic needs, Quality of life and Productivity,
2. Definition of productivity, Productivity in the individual enterprise, the task of Management
3. Definition of Work study, how the total time of a job is made up,
4. Interrelationship of the various methods used to reduce ineffective time
5. Wage rates, wage incentives and its types, Straight and differential piece rate system, Emerson efficiency plan
6. Halsey plans, Rowan plan, group incentives
7. Work study as a valuable tool, Techniques
8. Basic procedure of work study, direct means of raising productivity,
9. Human Factor in the application of the work study
10. Human Factor in the application of the work study

Unit -II

11. Method study: Definition, Procedure, Selection of work
12. Process chart symbols
13. Outline process chart
14. Flow process chart
15. Critical examination, Flow and string diagrams
16. Multiple activity charts
17. Travel chart, Principles of motion economy
18. Classification of movements, Two-handed process chart
19. SIMO chart and micro motion study, other recording techniques
20. Development of improved methods, Define, Install and Maintain

Unit -III

21. Work Measurement: Definition, purpose, uses, Procedure
22. Techniques, Work sampling: Need, Determination of sample size
23. Procedure for selecting random observations, Conduction of study with the simple problems
24. Time study: Definition, time study equipment, selecting the job
25. Basic steps in time study. Recording the information, breaking the jobs into elements
26. Types of elements, Determination of sample size
27. Timing elements by stop-watch, Rating & Standard rating
28. Factors of affecting Rate of working, Scales of rating
29. Determination of basic time

30. Allowances and Standard time determination
31. Predetermined time standards, Definition, Advantages and criticisms, Applications,
32. Motion time study – Methods time measurement (MTM)

Unit – IV

33. Introduction to Ergonomics: Introduction, Consequences of not using Ergonomics
34. Areas of study covered under ergonomics.
35. System approach to ergonomics models
36. Man-Machine system, Characteristics of Man-Machine system
37. Work capabilities of industrial worker
38. Functions performed by Man and Mechanism involved
39. General principles for carrying out the physical activities
40. General principles for carrying out the physical activities
41. Development of stress in human body and their consequences
42. Suggestions for prevention

Unit –V

43. Design of Man-Machine system: Concept of fatigue in industrial work
44. Displays, Quantitative
45. Qualitative, Representation and alphanumeric displays.
46. Controls and their design criteria
47. Control types, Relation between controls and displays
48. Layout of panels and machines
49. Design of work places
50. Influence of climate on the efficiency of human performance
51. Influence of noise, vibrations on human performance
52. Influence of lighting systems on human performance

Review Questions

1. What are the Basic needs? Discuss about them.
2. Sketch the role of Management in coordinating the resources of an enterprise.
3. How the total time of a job is made up?
4. Explain the Work content added by Inefficient methods of manufacture or operation. What are the management techniques to reduce it?
5. Distinguish clearly between the Time rate and piece rate of wage.
6. Differentiate between the Straight and differential piece rate systems
7. A factory decides to introduce incentive scheme. The basic rate is Rs.50/hour. The standard time for the task is 8 hours while worker completes the task in 5 hours. Calculate the earnings under
   a) Halsey plan
   b) Halsey-weir plan
   c) Rowan plan
8. Why is Work study valuable? Explain.
9. "People lower down tend to take their attitudes from the person at the top". Comment on this statement.
10. Narrate the role of supervisor in implementation of Work study.
11. How do you select the work to be studied? Explain.
12. Sketch and explain the Process chart symbols.
13. Write an Outline process chart for an activity "Repair of a Bicycle puncture". State your assumptions.
14. List and explain the Primary questions.
15. Distinguish clearly between the Flow process chart Man type and Material type**.**
16. Explain the following:

a) String diagram
b) Travel chart
c) Multiple activity chart

17. List the principles of motion economy with reference to the "Use of the Human body"
18. Draw a two handed process chart for an activity "Cleaning eyeglasses with Handkerchief". State your assumptions.
19. What is Micro motion study? State the advantages of film and video over direct observation.
20. Distinguish clearly between the Cyclegraph and chronocycle graph
21. Define Work measurement. State the purpose of it.
22. Narrate the basic procedure of Work measurement.
23. How do you determine the scope of Work sampling study? Explain.
24. How do you select a job for Time study?
25. Give examples for the following:
    a) Occasional element
    b) Constant element
    c) Foreign element
26. What are various types of Allowances given for Basic time to extend into Standard time? Describe with help of an example.
27. An activity was observed for 10 trials. The following times were observed ; 0.35, 0.36, 0.34, 0.38, 0.37, 0.35, 0.34, 0.35, 0.36 and 0.35min. The average rating for the operator was 130%. Find the standard time for the activity if the delay allowance given was 5%, relaxation allowance of 7% and a policy allowance of3% of the basic time.
28. The continuous time recording was conducted for a work cycle having four work elements. Calculate the standard time for each element and then for the complete work-cycle.

Data recording for all the 4 Manual elements

Element No.	Time Recording [observations in (1/100) th min]				Average Rating	Allowances permitted
	t_1	t_2	t_3	t_4		
1	09	41	71	107	115%	15%
2	15	46	79	13	105%	15%
3	28	59	94	27	97%	15%
4	32	62	98	30	120%	15%

29. Define PTS. State the advantages and criticisms of PTS systems.
30. Explain the meaning of the following:
    a) R300C
    b) M375B
    c) P_2NSD
    d) T90L
31. Compare the Design and use of present day and Traditional tools/machines
32. What are Areas of study covered under Ergonomics? Explain.
33. Draw a Flow loop which exhibits "Ergonomic model".
34. Write the simple model of a Man-Machine system.
35. List the various factors for improving performance
36. Sketch and discuss about the Input data for man-job matching
37. Sketch the approximate proportions of human stature
38. Point out the functions performed better by a man.
39. State the General Principles for carrying out the Physical activities
40. Summarize the development of stresses in human body.

41. Discuss about the causes fatigue in Industrial work.
42. Distinguish clearly between the Quantitative and Qualitative Displays.
43. Write a note on "Criteria for control Design"
44. Name the normal Displays & Controls in "Car"
45. "Designer must take care to minimize the conflicts that may arise when designing array of controls and displays". How to achieve it?
46. Design a suitable chair for "Desk top computer operation".
47. What is "Climate Toxicology"? Explain.
48. Outline the effects of exposure to Noise or Vibration.
49. Propose the amount of light required for adequate visual performance various tasks.
50. What are the general guidelines for Industrial lighting?

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO)	Program outcome (ABET/NBA-(3a-k))											
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Understand the fundamentals of the Productivity and Work study – (Unit – I)	L1									**H**	**L**	
02	Compare the various types of Wages and Incentives (Unit – I)	L5						**M**	**L**				**L**
03	Analyze the present method and develop the best method. –(Unit – II)	L5	H	M									
04	Compute the standard time for a work. – (Unit – III)	L3					**M**	**M**					**L**
05	Understand Ergonomics and its principles.–(Unit – IV)	L1									**H**	**L**	
06	Design the Man/machine system on basis of principles of Ergonomics –(Unit – V)	L6		M	H								

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k))										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Understand the fundamentals of the Productivity and Work study – (Unit – I)	L1									**3**	**1**	
02	Compare the various types of Wages and Incentives (Unit – I)	L5						**2**	**1**				**1**
03	Analyze the present method and develop the best method. –(Unit – II)	L5	3	2									
04	Compute the standard time for a work. – (Unit – III)	L3					**2**	**2**					**1**
05	Understand Ergonomics and its principles.– (Unit – IV)	L1									**3**	**1**	
06	Design the Man/machine system on basis of principles of Ergonomics –(Unit – V)	L6		2	3								

1-Low, 2-Moderate, 3-High

Course Title: Computer Aided Design and Manufacturing			
Course Code: P13IP55	**Sem: V**	**L-T-P-H: 4-0-0-4**	**Credits: 4**
Contact Period: Lecture:52 Hr Exam: 3Hr		**Weightage: CIE:50; SEE:50**	

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

Course Learning Objectives:

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

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

Course Learning Outcome:

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

Relevance of the Course :

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

- Hardware & software
- NC, CNC,DNC, graphics etc…..
- Flexible manufacturing system.
- Group technology, Robots technology.
- Sensors, frameworks.

UNIT –I

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

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

10Hours

UNIT – II

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

10 Hours

UNIT – III

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

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

UNIT – IV

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

UNIT –V

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

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

TEXT BOOKS:

1. CAD / CAM Principles and Applications- P.N. Rao, TMH, New Delhi, 2002.
2. CAD/CAM – Mikell P Groover, Emory W. ZimrnersJr Pearson Education Inc, 2003.
3. Automation, production systems and computer integrated Manufacturing – Mikell P. Groover.

REFERENCE BOOKS:

1. Principles of Interactive Computer Graphics - Newman and Sproull, Tata McGraw Hill, 1995.
2. NC Machine programming & software Design -Chno-Hwachang, Michel.A. Melkanoff, Prentice Hall, 1989.
3. Computer Graphics -Steven Harrington, McGraw Hill Book Co.
4. Computer Aided Manufacturing - P.N. Rao, N.K. Tewari and T.K. Kundra Tata McGraw Hill 1999.
5. Basic Computer Aided Geometric Design - Ganesh. M – I. K. International, New Delhi – 2008

Unit wise Plan

Unit – I

Introduction & Hardware In Cad **Planned Hours:10**

Learning Objectives:

The Students should be able to,

1. Define the concept of CAD-CAM. [L1].
2. Explain product cycle in computerized manufacturing environment. [L2].
3. Describe the significance of geometric modeling in CAN. [L1].
4. Explain CAD-CAM advantages and disadvantages .[L2]
5. Explain the role of computer in design & manufacturing. [L2].
6. Explain the hardware structure, storage device of CAD. [L2].
7. Explain the working principle of hardware in CAD [L2].

Unit – II

Computer Graphics Planned Hours: **10**

Learning Objectives:

The Students should be able to,

1. Define the concept of computer graphic. [L1].
2. Explain three types of geometric modeling system [L2].
3. Describe briefly 2D-3D dimensional transaction [L1].

4. Explain the functions of a modern graphic package .[L2]
5. Compare wire frame and solid models [L4].
6. List the applications of computer graphic. [L2].
7. Explain Basic features of IGES, STEP, DXF, and DMIS. [L2].

Unit – III

NC, CNC, DNC Technology & CNC Machine Tools Planned Hours: **12**

Learning Objectives:

The Students should be able to,

1. Define the concept of NC, CNC, DNC technology. [L1].
2. Explain the elements of NC, DNC [L2].
3. Describe the mechanics of cutting [L1].
4. Explain the principal functions of CNC .[L2]
5. Compare NC, CNC & DNC technology [L4].
6. Explain the Turning tools geometry. [L2].
7. Explain tool presetting& ATC work holding devices. [L2].

Unit – IV

CNC Programming Planned Hours:**10**

Learning Objectives:

The Students should be able to,

1. Define the fundamental concept of part programming. [L1].
2. Explain the steps in part programme [L2].
3. Solve problems on CNC turning [L1].
4. Solve problems on CNC milling [L1].

Unit – V

Group Technology & Flexible Manufacturing & Industrial Robotics Planned Hours:**10**

Learning Objectives:

The Students should be able to,

1. Define the concept of group technology, FMS & Robots. [L1].
2. Explain coding system. [L2].
3. Describe the FMS layout configuration [L1].
4. Explain Shop floor control, Functions, Shop floor control system.[L2]
5. Explain Robot- Programming Languages [L2].
6. Explain the Robot Configuration. [L2].
7. Write notes on Robot Sensor, Robot Applications.[L3]
8. Write notes on Robot Motions & End effectors .[L3]

Lesson Plan

Unit -1

1. Role of computers in design and manufacturing.
2. Influence of computers in manufacturing environment.
3. Product cycle in conventional & computerized manufacturing environment.
4. Introduction to CAD, Introduction to CAM.
5. Advantages and disadvantages of CAD and CAM.
6. HARDWARE IN CAD: Basic Hardware structure,
7. working principles,
8. usage and types of hardware for CAD - input and output Devices,
9. memory, CPU,
10. Hardcopy and Storage devices.

Unit -2

11. Software configuration of a graphic system,
12. function of a Graphics package,
13. construction of geometry,
14. Wire frame and solid modeling

15. Geometric 2 D and 3 D homogeneous transformations
16. Simple problems.
17. Simple problems.
18. Introduction to exchange of modeling data
19. Basic features of IGES, STEP,
20. DXF and DMIS.

Unit - 3

21. NC,CNC, DNC modes,
22. NC elements,
23. Advantages and limitations of NC, CNC.
24. Functions of computer in DNC.
25. CNC Machine Tools: Turning tools geometry,
26. milling tooling systems,
27. tool presetting,
28. ATC work holding.
29. CNC machine tools,
30. Overview of different CNC machining centers,
31. CNC turning centers,
32. High speed machine tools.

Unit-4

33. Part program fundamentals
34. Steps involved in development of a part program.
35. Manual part programming-milling
36. Manual part programming turning
37. problems on milling
38. Problems
39. Problems
40. problems on turning
41. Problems
42. Problems

Unit-5

43. Part families, Part classification & coding,
44. Machine cell design & benefit of Gt,
45. FMS work stations, planning the FMS,
46. FMS layout configuration. Analysis method,
47. Application and benefit of FMS.
48. Shop floor control, Functions, Shop floor control system.
49. Industrial Robotics: Introduction, Robot Configuration,
50. Robot Motions, Programming the Robots,
51. Robot- Programming Languages, End effectors,
52. Robot Sensor, Robot Applications.

Review Questions

Unit-I

1. Briefly discuss the role of computers in design & manufactures of industrial products.
2. With neat block diagram explain the computerized product cycle for a medium scale industry
3. Explain the concepts of various storage devices used in a workstation.
4. Define what is CAD and CAM? Briefly explain the benefits of CAD/CAM and also list the important advantages.
5. With a block diagram explain the basic hardware structure used in CAD.
6. List all the input & output devices used in CAD. With neat sketch explain any two from each category

7. Draw the neat diagram of CRT &explain briefly.
8. Write a note on cursor control devices.
9. Define CPU and discuses briefly
10. List the benefits of CAD/CAM

Unit-II

11. Write a neat sketch explain briefly the soft ware configuration of a graphics system.
12. Write a note on Concatenated transformation.
13. List the functions of a graphics package. Briefly explain.
14. Define transformation Write a Transformation principles, also explain with example the translation of a line
15. Describe briefly 2D&3D homogeneous transformations.
16. Briefly explain the Cad exchange file formation in STEP with block diagram.
17. Explain the following exchange extensions files i) IGES ii) DMIS
18. A line is defined by its end points (4,6)and (8,12) in two dimensional graphics system. Explain the line in matrix rotation and perform the following transformation.
    i) Translate the line by3 units in x-direction and 2 units in y-direction.
    ii) Scale the original line by a scaling factor of 3
19. With appropriate sketches briefly explain the wire frame and solid modeling.
20. A line is detrained by its and points (3,5) & (10,12) in 2-D graphic system .Express the line in matrix rotation and perform the following transformations.
    i) Translate the line by 6 units in x-direction and 4 units in y-direction.
    ii) Scale the original line by a factor by 3 units in x-direction & 2.0 unit in y-direction.

Unit-III

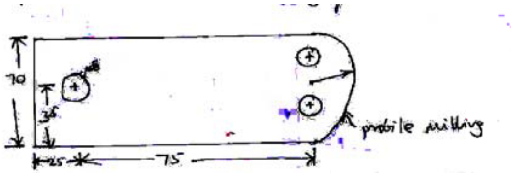
21. With a neat sketch briefly explain the straight cut NC motion control system.
22. List & explain the problems associated with conventional NC system.
23. With a neat diagram explain the DNC with satellite mini computers.
24. Explain the following CNC tuning centres.

i) Turn mill centres (x y z) ii) Twin turret tuning

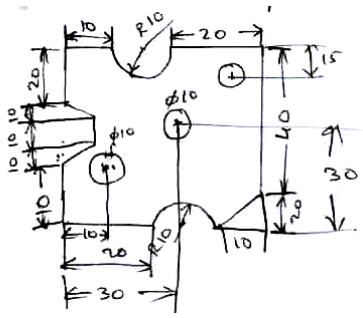
25. Write a note on i) Automatic tool changes ii) CNC tuning centres
26. Define NC technology. Briefly explain the basic components of NC systems.
27. List the types of DNC system. Explain with block diagram.
28. List the advantages of CNC machine.
29. With a neat sketch briefly explain the milling tooling system.
30. Explain the methods of tool presetting with sketches.

Unit-IV

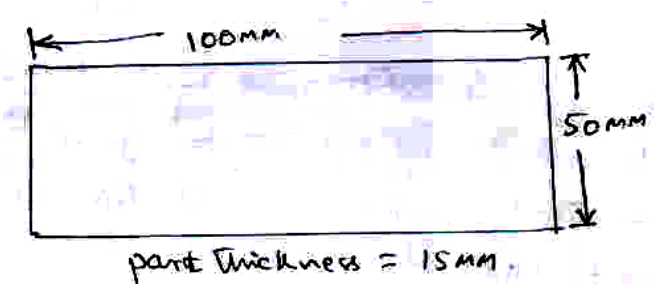
31. Explain the concepts of part programming of the following.
    i)Fixed zero & Floating zero.
    ii) Right hand thumb rule & axis representation.
    iii) Absolute and incremental dimensioning.
32. Briefly explain the steps/procedure in part programming.
33. Write a manual part program to machine part show in fig using standard format. Indicate cutter path. Assume suitable cutting parameters.



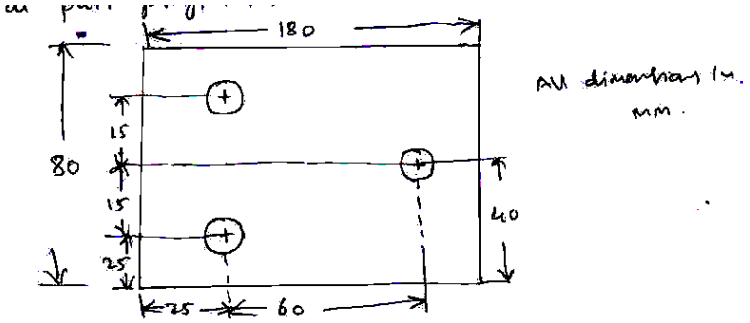
34. Write the CNC part programming for the component shown in fig, for the drilling operations. Take the depth of cut as 0.5mm & total depth 10mm.



35. Briefly discuss the NC words in details.
36. List the steps followed in computer-assisted part programming and explain.
37. Write a briefly note on NC part programming languages.
38. Write a manual part program for milling a rectangular block shown in fig. Indicate the cutter path and the suitable cutting parameters are given below.



39. A part is to be produced in NC machine as per the drawing shown in fig. The rectangular block is ready, only holes are to be drilled. Write a manual part program to drill the holes.



40. Discuss in briefly the part programmers responsibility in computer –assisted part programming

Unit-V

41. Define briefly the group technology and part families.
42. List the major benefits of a well-designed classification & coding system of group technology.
43. List the types of machine cell design and explain with neat block diagram.
44. Define flexible manufacturing system. List the components of an FMS and explain them briefly
45. List the categories of FMS layout configurations. Explain them with block diagram.

46. Briefly explain the factors to be considered while planning the FMS.
47. List & explain the Applications & benefits of an FMS
48. Define what is an industrial robot? With schematic diagram explain the robot physical configurations.
49. Write a note on the following i) End effectors ii) Robot sensor iii) Applications of Robot
50. With a neat block diagram discuss briefly the three phases in a shop floor control system.

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO	Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Ability to apply knowledge in the field design & manufacturing with help of CAD / CAM		M	M	L								
02	Ability to learn concepts of graphics package regarding 2D & 3D transformations.		M	M	L								
03	Ability to learn concepts of NC, CNC & DNC technology. And also known CNC machine tool & tooling system.		M	M	L								
04	Ability to develop steps for CNC part programming and able to solve the problems.		M	M	L								
05	Ability to known in detail the group technology & coding system also should know FMS technology.		M	M	L								
06	Ability to know details about the industrial robots about their applications.		M	L	L								

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO	Program outcome (ABET/NBA-(3a-k)											
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Briefly discuss the role of computers in design & manufactures of industrial products (Unit – I)	L2	2	2	1								
02	With appropriate sketches briefly explain the wire frame and solid modeling (Unit – II)	L2	2	2	1								
03	Explain the methods of tool presetting with sketches (Unit – III)	L2	2	2	1								
04	Write a briefly note on NC part programming languages. (Unit – IV)	L2	2	2	1								
05	Define briefly the group technology and part families. (Unit – V)	L1	2	1	1								

Course Title: Design of Machine Elements.			
Course Code: P13IP56	**Sem: V**	**L-T-P-H: 4-2-0-5**	**Credits: 4**
Contact Period: Lecture:52 Hr Exam: 3Hr		**Weightage: CIE:50; SEE:50**	

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

Course Learning Objectives (CLO) :

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

- Able to define the concept Static strength; Static loads and Failure of materials.
- Able to solve the problems on keys and coupling.
- Able to solve the problems on shaft sections under varying loads, etc.,
- Able to understand the concept of spur and helical gear.
- Able to understand the concept of stress, tension, and compression in springs.
- Able to solve the problems on mechanical joints and rivets, welds.

Course Learning Outcome

1. The students should learn and understand necessity of Metrology and basic of Non destructive testing.
2. Demonstrate ability to make use of different gauges.
3. Students will be able to use different type's comparators.
4. The students get exposure to different types of surface measurements methods.
5. Students should be able to demonstrate the knowledge of various screw threads and gear terminology.

Relevance of the Course:

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

- Static strength; Static loads and Failure of materials.
- Stress, tension, and compression in springs.
- Shaft sections under varying loads.
- Spur and helical gear – Problems.
- Mechanical joints and rivets, welds – 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; Failure of brittle materials, Failure of ductile materials. Stress concentration, Determination of Stress concentration factor. Combined Stress concentration factor. **10Hours**

UNIT –II

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

UNIT – III

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.

KEYS AND COUPLING: Types of keys**,** Design for shear and crushing strength. Design of rigid and flange coupling **10 Hours**

UNIT – IV

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, strength of lap or fillet weld, welded joint- Eccentric loading. **10 Hours**

UNIT – V

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.

BALL AND ROLLER BEARINGS: Types of bearings, Advantages Disadvantages Selection of bearings. **12 Hours**

TEXT BOOKS:

1. Mechanical Engineering Design -Joseph Edward Shigley, Tata McGraw Hill, New Delhi 1986.
2. Machine Design -.VL. Maleev and Hartman, CBS Publishers & Distribution, Delhi, 1983.

DESIGN DATA HAND BOOK:

1. Design Data Hand Book-K. Mahadevan and Balaveera Reddy, CBS Publication.

REFERENCE BOOKS:

1. Machine Design -Robert .L, Norton -Pearson Education Asia, New Delhi, 2001.
2. Elements of Machine Design -N. C. Pandey and C. S. Shah, 2002 - Chorotar Publishing House
3. Design of Machine Elements -V. B. Bahandri, -Tata McGraw Hill Publishing Co. Ltd., New –Delhi, 2000.
4. Design of Machine Elements – Abdulla sheriff – DhanpatRai& sons
5. Machine Design -R.S.Khurmi ,J,K.Gupta. – DhanpatRai& sons

Unit wise Plan

Unit – I

Design for Static Strength. **Planned Hours: 10**

Learning Objectives:

The Students should be able to,

1. Define the concept of Simple stress, strain and factor of safety. [L1].
2. Identify the different methods of reducing stress concentration [L1].
3. Solve the problems on Maximum normal stress theory, maximum shear stress theory, Distortion energy theory [L3].
4. Solve stress concentration factor [L3].
5. Define Codes and Standards[L1]
6. Compare the theories of failure and suggest their usage [L4].

Unit – II

Design for Fatigue Strength **Planned Hours: 10**

Learning Objectives:

The Students should be able to,

1. Define the concept of Low cycle fatigue, High cycle fatigue, and Endurance limit. [L1].
2. Solve the problems on various forms of variable stresses[L3].
3. Solve the problems on Soderberg's and Goodman's equations[L3].
4. Define the concept of Stress concentration effects, size effect, surface effect [L1].
5. Solve Stress concentration effects [L3].
6. Solve Stresses due to combined loading [L3].

Unit – III

Design of Shafts. Keys and coupling **Planned Hours: 10**

Learning Objectives:

The Students should be able to,

1. Compare the strength and stiffness of a hallow shaft and solid shaft. [L4].
2. Solve the problems on force acting on the shaft due to belt drive and gear drive [L3].

3. Define the concept of dynamic and fluctuating loads [L1].
4. Define the concept of transmission shaft and machine shaft [L1].
5. Define the concept of keys and coupling [L1].
6. Compare the rigid and flexible coupling [L4].

Unit – IV:

Mechanical Joints **Planned Hours: 10**

Learning Objectives:

The Students should be able to,

1. Define rivets, butt and lap joints [L1].
2. Define Welded Joints [L1].
3. Explain the different types of failure of riveted joints. [L2].
4. Solve the problems on longitudinal and circumferential joins [L3].
5. Solve the problems on butt and fillet welds [L3].
6. Solve the problems on Welded joint for Eccentric loading [L3].

Unit – V

Design of Gears, Design of Springs Bearings **Planned Hours: 12**

Learning Objectives:

The Students should be able to,

1. Compare the strength and stiffness of a hallow shaft and solid shaft. [L4].
2. Solve the problems on force acting on the shaft due to belt drive and gear drive [L3].
3. Define the concept of transmission shaft and machine shaft [L1].
4. Solve the problem to identify module, number of teeth's etc [L3].
5. Define the concept of energy stored in a helical spring [L1].
6. Define the concept shear stress induced in a helical compression spring [L1].
7. Solve the problem on circular and non circular helical spring [L3].
8. Define the concept of selection of bearings [L1].

Lesson Plan

Unit - 1

1. Design considerations, Codes and Standards,
2. Static strength; Static loads and factor of safety.
3. Theories of failure -Maximum normal stress theory, maximum shear stress theory, Distortion energy theory.
4. Problems on above theories.
5. Problems on above theories.
6. Failure of brittle materials, Failure of ductile materials, Stress concentration.
7. Problems on above materials.
8. Problems on above materials.
9. Determination of Stress concentration factor, Combined Stress concentration factor.
10. Problems on above concepts.

Unit - 2

1. Introduction, S -N diagram,
2. Low cycle fatigue, High cycle fatigue, and Endurance limit.
3. Modifying factors –size effect, surface effect
4. Stress concentration effects
5. Fluctuating stresses, Fatigue strength under fluctuating stresses
6. Goodman and Soderberg relationship.
7. Problems on Goodman and Soderberg equation.
8. Problems
9. Stresses due to combined loading.
10. Problems

Unit - 3

1. Torsion of shafts with steady loading,
2. design for strength &rigidity, with steady loading
3. ASME& BIS codes for design of transmission shafting
4. Design of shafts under different loads: Combined loads
5. Fluctuating loads.
6. Problems on above concept.
7. Problems on above concept.
8. Types of keys**,** Design for shear and crushing strength.
9. Design of rigid and flange coupling.
10. Problems on couplings.

Unit - 4

1. Riveted Joints -Types, rivet materials
2. Failures of Riveted joints, Efficiency
3. riveted joint for boiler or pressure vessels
4. Problems on riveted joints.
5. Welded Joints -Types
6. Strength of butt and fillet welds
7. strength of lap or fillet weld
8. Problems on welded joints
9. Welded joint- Eccentric loading
10. Problems.

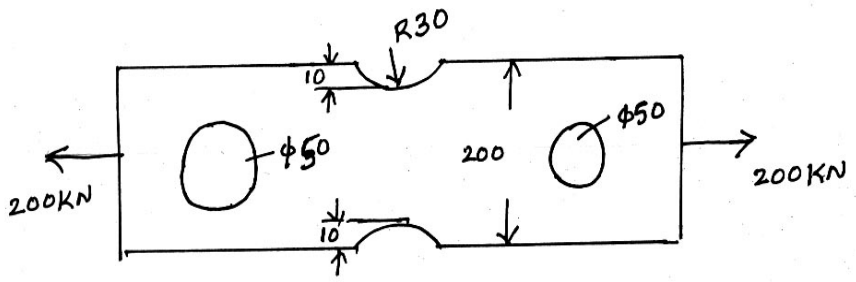
Unit - 5

1. Introduction to Spur, Helical and bevel gears.
2. Design of spur, Helical and bevel gears, stresses in gear tooth.
3. Lewis equation, form factor, dynamic and wear load.
4. Problems on spur gear.
5. Problems on spur gear.
6. Design of Helical and bevel gears.
7. Types of springs -stresses in Helical Coil spring of circular and non-circular cross sections.
8. Problems on circular spring.
9. Problems on non-circular spring.
10. Tension and compression springs.
11. Problems on tension & compression springs.
12. Types of bearings, Selection of bearings.

Review Questions

1. Explain codes and standards.
2. Define and explain factor of safety.
3. Compare the theories of failure and suggest their usage.
4. Define stress concentration show how the stress concentration can be minimised.
5. Define the following a) static Strength b) static load.

6. A rectangular plate as shown in Fig is subjected to an axial pull of 200 kN. Determine the thickness of the plate if the maximum tensile stress in the plate is limited to 200 MPa.



7. A machine element is subjected to the following stresses σ_x = 60 MPa, σ_y = 45 MPa and τ_{xy} = 30 MPa. Find the factor of Safety if it is made of C45 Steel using the following theories of failure.
   i. Maximum Normal Stress theory,
   ii. Maximum Shear Stress theory,
   iii. Maximum Strain Theory.
8. Determine the maximum stress induced in the following cases taking stress concentration into account.
   i. A rectangular plate 80 mm wide, 12 mm thick with a central hole of dia 16 mm subjected to a tensile load of 30 KN.
   ii. A stepped shaft stepped down from 60 mm dia to 40 mm dia with a fillet radius of 8 mm subjected to a twisting moment of 120 KN.
9. Explain briefly the failure of Brittle and Ductile material.
10. Explain briefly Endurance Limit.
11. Explain the various forms of variable stresses.
12. Derive soderberg‘s equation.
13. Derive goodman‘s equation.
14. Define S-N diagram explain its importance?
15. Give comparison between high and low cycle fatigue
16. Give comparisons between rigid and flexible coupling
17. A SAE 1025 annealed steel rod of circular cross section is subjected to completely reverse bending moment of 500 N-m. Determine the diameter of the rod required if the factor of safety is 2.

18. A shaft is made of SAE 1045 steel is subjected to completely reversed bending moment of 500 N-m. The shaft is to be designed for a factor of safety of 2. Shaft is also subjected to variable torque which varies from 300 N-m to -200 N-m. The fatigue stress concentration factors are 2.1 and 1.8 for bending and torsion respectively. Determine the diameter of the shaft.

19. A piston rod is subjected to a maximum reversed axial load of 110KN. It is made of steel having an ultimate stress of 900N/mm2 and the surface is machined. The average endurance limit is 50% of the ultimate strength. Take FOS as 1.75. Determine the diameter of the rod.
20. A cantilever beam is subjected to load variation from –F to 3F. Determine the maximum load that is member can withstand for an infinite life using a FOS as 2. The material of the beam is SAE 1025 water quenched steel.
21. A solid steel shaft of length 1.8m b/n bearings rotates at 250 rpm in CW direction as seen from right side A 20^0 in volute spur gear D of 300mm diameter is located at 150mm to the left of right hand bearing Two pulleys B & C are located at distance of 450mm & 1200mm respectively to the right of the left hand bearing pulley B is 600mm & pulley C is if 750mm in diameter. The ration of belt tension for both pulley B & C is 2. A power of 29.5 kw is

supplied to the gear D by another gear directly below it At pulley B, a power of 18.5 kw is taken off by means of a belt drive inclined 60^0 to the horizontal below the shaft & behind it .The remaining power of 11kw is taken off at pulley C by a belt drive vertically below it shear stress for shaft is 40 MPa take C_m=1.5 & C_t = 2.0 respectively calculate size of the shaft .Draw the bending moment & torque diagrams.

22. Prove that a hollow shaft is stronger than a solid of same length, weight and material.

23. A section of a steel shaft of 2 m long supported between bearings running at 1000 rpm carries a 20º involute spur gear of pitch circle diameter 200 mm at its mid point. The gear delivers 20 kW power to its ma mating gear located directly above the shaft. If the shaft material selected has an allowable shear stress of 40 MPa. Determine the diameter of the shaft. Assume the loads are steady.

24. A section of a solid steel shaft of 1000 m long supported between bearings running at 1000 rpm carries a 20º involute spur gear of pitch circle diameter 300 mm at its mid point. The gear delivers 20 kW power to its ma mating gear located directly above the shaft. If the shaft material selected has an allowable shear stress of 60 MPa. Determine the diameter of the shaft.

25. A Countershaft is supported on bearing 800 mm between centres, a 600 mm gear is located at 200 mm to the right of left hand bearing and a 700 mm diameter pulley is mounted at a distance of 250 mm to beyond the right hand bearing. The gear is driven by a pinion with downward tangential force and the pulley drives an horizontal belt on opposite side. The pulley also serves as a flywheel and weighs 2000 N, the belt is 150 mm wide, 8 mm thick and as a tension ratio of 3:1. The allowable stress in the belt is 1.15 MPa. Gear has 14.5^o pressure angle. Recommend a suitable diameter of the shaft, if the allowable stress in tension is 80 $N/mm^{2.}$

26. A steel shaft of length 1 m b/n bearings rotates at 250 rpm in CW direction as seen from right side A 20^0 in volute spur gear D of 300mm diameter is located at 150mm to the right of left hand bearing. Two pulleys B & C are located at distance of 450mm & 1200mm respectively to the left of the right hand bearing pulley B is 600mm & pulley C is if 750mm in diameter. The ration of belt tension for both pulley B & C is 2. A power of 29.5 kw is supplied to the gear D by another gear directly below it At pulley B, a power of 18.5 kw is taken off by means of a belt drive inclined 45^0 to the horizontal below the shaft & behind it .The remaining power of 11kw is taken off at pulley C by a belt drive vertically below it shear stress for shaft is 40 MPa. Calculate size of the shaft .Draw the bending moment & torque diagrams.

27. List the practical application of shaft coupling.

28. Design a rigid flange coupling to transmit 18 kW at 1440 rpm. The allowable shear stress in the cast iron flange is 4 MPa. The shaft and keys are made of C - 40 steel.

29. Design a flexible flanged coupling to transmit a power of 45kw at a speed of 500rpm

30. Design a marine type flange coupling for a shaft diameter of 15 mm, assume the safe allowable shear stress in shaft and bolt as 300MPa

31. Design a triple riveted double cover butt joint with unequal cover plate to connect two plate of 20mm thickness. Take σ_t =90mpa, C=60mpa, σ_c =150mpa.

32. A plate of 100mm wide & 10mm thickness is to be welded to another plate by means of transverse fillet weld at the ends .It the allowable tensile stress is 90 N/mm^2. Determine the length of weld.

33. Determine the size of the weld for a bracket loaded as shown in fig. The allowable stress in weld is 72 Mpa.

34. Design a longitudinal and circumferential joint for 1.8m diameter boiler subjected to an internal pressure of 0.9N/mm^2. The ultimate strength for the plate material is 525 n/mm2 and FOS as 5. The allowable stresses for the rivet materials are shear stress 60 N/mm^2 and crushing stress 150N/mm^2

35. Explain different types of riveted joints.

36. Design a triple riveted double cover butt joint with equal cover plate to connect two plate of 20mm thickness. Take σ_t =90mpa, C=60mpa, σ_c =150mpa.

37. A triple riveted lap joint is to be made of 8mm plates. Find the diameter of reverts, pitch, and shank length, margin and the efficiency of the joint. The allowable tensile stress of the plate is 124 MPa, Shear stress is 93 MPa, and the crushing stress of river is 165 MPa. Design the riveted joint, if the pitch in the outermost row is twice the pitch of rivets in the inner row.

38. Explain the different failure modes in a riveted joint?

39. A single riveted lap joint is to be made of 8mm plates. Find the diameter of reverts, pitch, and shank length, margin and the efficiency of the joint. The allowable tensile stress of the plate is 124 MPa, Shear stress is 93 MPa, and the crushing stress of river is 165 MPa.

40. Two plates are joined by means of fillet welds. The dimensions of the welds are 10mm and the permissible shear stress at the throat cross-section is 75N/mm^2. Determine the length of each weld.

41. Derive Lewis Equation.

42. Give comparisons between spur gear and helical gear.

43.A machine running at 360 rpm is driven by 12 kW, 1440 rpm motor through a 14½º involute gear. The center distance between the drive being 250 mm. The pinion is made of heat treated cost steel of 450 HBN. And the gear is of untreated cast steel. Assume light shock conditions and 8 hours per day operatins determine.

i 0 Module, face width and the No. of teeths on each gear.

ii) Check the gears for wear. Take (σ_p) pinion = 191 N/mm^2, (σ_g) gear = 137 N/mm^2

44. It is required to transmit 7.35 KW from a shaft running at 1500 rpm to a parallel shaft with a speed reduction of 25:1 by a pair of spur gears. Design the gears completely.

45.Design a pair of spur gear to transient 20kw from a shaft rotating at 1000rpm to a parallel shaft which is to rotate at 310rpm .Assume no of teeth on pinion 31 & 20 full depth tooth from .The material for pinion is C45 steel untreated & for gear cast steel 2.20% C untreated .Assume C_3=1.5 Determine BHN .

46. A reciprocating M/C running at 400 rpm is driver by a 25 kw, 120 rpm motor through a pair of 14 ½ involutes spear gear .The centre distance is around 400mm. The pinion is made of forged steel of static allowable stress 190 MN/m^2& 350 BHN. Gear is to be made of cost steel of static allowable stress 180MN/mm^2& 300 BHN. Design the gear for safe continuous operation, (i) Module (ii) face width.

47. List the applications of Springs?

48. Derive the shear stress induced in the Helical Coil Spring.

49. A Helical valve spring is to be designed for an operating load range of 100 N to 150 N. 100 N when the valve is closed and 150 N when the valve is opened. The deflection of the spring in the above load range is to be about 8 mm. Assume the Spring index as 10. Design the spring completely

50. Design a helical compression spring to carry a load of 500 N with a deflection of 20 mm. The allowable shear stress in the spring material is 350 MN/m^2. And the modulus of rigidity is 82.7x10^3 MN/m^2 the spring index is 6.

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO)	Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Ability to apply knowledge in the field theories of failure and stress concentration on materials.		M	M	M		H						
02	Ability to learn the concepts of fatigue strength and solve the problems.		M		L		H						
03	Ability to design the shafts, keys and couplings.		M		L		H						
04	Ability to identify types of joints and analyse the failures in joints.		M	M	M		H						
05	Ability to design the gears and springs.		M		L		H						
06	Ability to apply knowledge on selection of bearings.		H		M		L						

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO	Program outcome (ABET/NBA-(3a-k)											
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	**Explain** theories of failure**, determine** stress concentration factors,(Unit – I)	L2	2	2	2		3						
02	**Explain** fatigue failure concept**, recognize** the influence of load, surface and size factors on fatigue life and **determine** safe stresses under fatigue loading conditions.(Unit – II)	L2	2		1		3						
03	**Design** power transmission shafts subjected to bending and torsional loads. **Design** keys and couplings. (Unit – III)	L5	2		1		3						
04	**Design** riveted joints and welded joints.(Unit – IV)	L5	2	2	2		3						
05	**Design** spur, helical, bevel and worm gears **Design** helical, tension and compression springs (Unit – V)	L5	2		1		3						

Course Title: Mechanical Engineering Lab			
Course Code: P13IPL57	**Sem: V**	**L-T-P-H: 0-0-3-3**	**Credits: 1.5**
Contact Period: Lecture:39 Hr Exam: 3Hr		**Weightage: CIE:50; SEE:50**	

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

Course 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 Learning Outcomes (CLO)

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

- Identify safe operating practices and requirements for laboratory experiments
- Determine properties like Flash point, Fire point, and viscosity of lubricating oil
- Estimate the calorific value of solid and gaseous fuel
- Use the Planimeter
- Carry out performance test on I.C. Engine.
- Carryout the performance tests on Venturimeter and pumps

PART - A

1. Determination of Flash point and Fire point of lubricating oil using Abel, Pensky Martins Apparatus
2. Determination of Calorific value of solid and gaseous fuels.
3. Determination of Viscosity of lubricating oil using Redwoods and Saybolts – Viscometers.
4. Performance Tests on Four stroke Petrol Engine, Calculations of IP, BP, Thermal efficiencies, SFC, FP and heat balance sheet
5. Performance Tests on Four stroke Diesel Engine, Calculations of IP, BP, Thermal efficiencies, SFC, FP and heat balance sheet
6. Planimeter.

PART - B

7. Calibration of Venturimeter
8. Flow through pipes
9. Performance test on centrifugal pump
10. Performance test on Reciprocating pump

Scheme for Examination:

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

Course Title: Computer Aided Drafting and Geometric Modelling			
Course Code: P13IPL58	**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,

- Able to produce computer-aided mechanical drawings of components and assemblies of machine parts and other mechanical equipments.
- Visualizing and applying basic drafting fundamentals.
- Preparing and editing engineering drawings,
- 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.

Scheme for Examination:

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

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 Modeling: 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.

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.

VI SEMESTER SYLLABUS

Course Title: Theory of Metal Forming			
Course Code: P13IP61	**Sem: VI**	**L-T-P-H: 4-0-0-4**	**Credits: 4**
Contact Period: Lecture:52Hr Exam: 3Hr		**Weightage: CIE:50; SEE:50**	

Course Objectives (CO): Students should have the knowledge of using equipments, Tools, Temperature measuring instruments etc, knowledge on pressure, load, Friction & Lubrications.

Course Learning Objectives (CLO).

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 Metal Forming process such as Forging, Rolling, Extrusion, Drawing, etc…..
2. Apply the fundamental concepts of pressure, load, defects, etc and to solve all these problems.
3. To demonstrate the operation principles, advantages, applications, limitations of the various Metal Forming process.
4. Able to derive the expression on plain strain, flat dies, wire circular tubes.
5. To gain the knowledge for various sheet metals forming operations such as shearing, blanking, punching, bending, spring back etc.

Course Learning Outcome

1. The students should learn and understand necessity of Metal Forming process and basic of Powder metallurgy.
2. Demonstrate ability to make use of different equipments, Tools.
3. Students will be able to solve different die angle problems, hot & cold operation problems.
4. The students get exposure to avoid different types of defects during process.
5. Students should be able to demonstrate the knowledge of various high energy rate forming.
6. Students will be able to demonstrate the need of Sheet metals, blanks, billets.

Relevance of the Course:

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

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

Course Content

UNIT - 1

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

UNIT – 2

FORGING: Classification of forging operation, forging equipment, forging strain, open die forging, closed die forging, 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.**11Hours**

UNIT – 3

EXTRUSION: Classification, equipments used, hot extrusion, deformation, lubrication and defects in extrusion, analysis of extrusion processes, hydrostatic extrusion, tube extrusion, production of seamless pipe and tubing.

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

UNIT- 4

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 ration.

10Hours

UNIT- 5

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

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

10Hours

TEXT BOOKS:

1. Mechanical Metallurgy - Dieter. G. E - McGraw Hill, 2001
2. Manufacturing Process III, Radhakrishna K, Sapna Book House
3. Principle of Industrial metal working process–Rowe Edward Arnold, London, CBS Publishers - 2002.

REFERENCE BOOK:

1. ASM- Metals handbook, Sach G. fundamentals of working of metals, Pergamon Press.
2. Manufacturing Engineering and Technology by SeropeKalpakjian&Stevan
3. Metal Forming Technology, Dr. R. Narayanswamy, Ahuja Book Co.
4. Principles of Metal Working by Surender Kumar,
5. Mechanical working of metals by J.N. Harris

Unit wise Plan

Unit – I

Fundamentals of Metal Working. Planned hours: 10

Learning Objectives:

The Students should be able to,

6. Define the concept of Metal forming flow stress. [L1].
7. Explain residual stress [L2].
8. Describe temperature in metal working [L1].
9. Define stress strain effects.[L1]
10. Compare the hot, cold and worm working [L4].
11. Explain friction and lubrication. [L2].

Unit – II

Forging, Rolling Planned hours: 11

Learning Objectives:

The Students should be able to,

1. Define the concept of forging and forging equipments. [L1].
2. Describe the concept of plane strain and loads in forging [L1].
3. Define stress strain effects.[L1]
4. Explain forging and rolling defects [L2].
5. Compare the open die and closed die forging [L4].
6. Compare the hot and cold rolling [L4].
7. Define rolling and types of rolling [L1].
8. Describe geometrical relationship in rolling [L1].

Unit – III

Extrusion, Drawing Planned hours : 11

Learning Objectives:

The Students should be able to,

1. Define the concept of extrusion and types of extrusion. [L1].
2. Describe the concept of plane strain and loads in forging [L1].
3. Define Hydrostatic extrusion.[L1]
4. Explain extrusion and drawing defects [L2].
5. Compare the hot and cold extrusion, wire, rod, tubes in drawing [L4].
6. Explain the production of seamless pipe and tubing[L2].
7. Define drawing and types of drawing [L1].
8. Describe the concept of tube drawing [L1].

Unit – IV

Sheet Metal Forming Planned hours: 11

Learning Objectives:

The Students should be able to,

1. Define the concept of Sheet metal forming. [L1].
2. Describe the concept of drawability ratio, spring back, spinning, deep drawing stretch forming, redrawing, and reverse drawing [L1].
3. Define the concept of shearing, blanking, punching, bending.[L1]
4. Explain the type of components produced in metal forming [L2].
5. Compare the combination die and progressive die [L4].
6. Explain different types of defectsL2].

Unit – V

High Energy Rate Forming, Powder Metallurgy Planned hours: 10

Learning Objectives:

The Students should be able to,

1. Define the concept of high energy rate forming, powder metallurgy. [L1].
2. Describe the principle of explosive forming, electro discharge forming and electromagnetic forming, Rubber forming [L1].
3. Describe the basic steps in powder metallurgy.[L1]
4. Explain the advantages and limitation of high energy rate forming, powder metallurgy [L2].
5. Explain different types of methods of production of metal powdersL2].

Lesson Plan

Unit - 1

1. Classification of forming processes.
2. Mechanics of Metal working – slab method.
3. Flow stress determination.
4. Temperature in Metal working.
5. Hot working, Cold working.
6. Warm working, difference between hot, cold, worm working.
7. Strain - rate effects.
8. Metallurgical structure.
9. Friction and Lubrication.
10. Residual stresses.

Unit - 2

1. Classification of forging operation,
2. forging equipment,
3. forging strain,
4. open dies forging – closed die forging,
5. Forging defects.
6. Classification of rolling mills,
7. hot and cold rolling forces
8. geometrical relationships in rolling,
9. Simplified analysis of rolling load,
10. Defects in rolled products.
11. Problems on above concept.

Unit - 3

1. Classification.
2. Equipments used, hot extrusion.
3. Deformation lubrication and defects in extrusion.
4. analysis of extrusion processes
5. Hydrostatic extrusion, tube extrusion.
6. Production of seamless pipe and tubing.
7. Rod and wire drawing process
8. drawing dies, analysis of wire drawing
9. Wire and tube drawing.
10. Defects in drawing, tube drawing.
11. Problems on above concept.

Unit - 4

1. Introduction,
2. Forming methods
3. shearing, blanking
4. punching, bending
5. spring back, elimination of spring back
6. spinning, deep drawing
7. stretch forming, redrawing
8. reverse drawing
9. defects in drawing
10. Factors affecting drawability ration.

Unit - 5

1. Introduction to HERF.
2. Process advantages.
3. Explosive forming.
4. electro discharge forming
5. Electromagnetic forming, Rubber forming.
6. Basic steps in Powder metallurgy.
7. Methods of production of metal powders.
8. Continue methods of production of metal powders.
9. Characteristics of powder.
10. advantages and limitations.

Review Questions

1. Define metal forming classify the forming processes
2. Derive an expression for mechanics of metal working by slab method
3. Writ note on temperature in metal working
4. Give a comparison between hot and cold working
5. What are the effects of residual stresses?
6. Explain different mechanisms of lubrication in metal working.
7. Explain the effects of friction in metal forming
8. Explain the importance of metallurgical structure.
9. Explain stress- strain effects.
10. Explain the important variables that affect metal working processes?
11. Define forging. Explain different forging equipment with schematic drawings.
12. List the operations that can be performed by forging.
13. Give a comparison between closed die forging and open die forging
14. List the advantages and limitations of forging and rolling?
15. Derive an expression for forging pressure and loads.
16. Give a comparison between crank press and hydraulic press.
17. Explain the various defects in forging and rolling?
18. Define rolling explain types of rolling.
19. With a neat sketch explain a planetary mill.
20. Give a comparison between hot and cold rolling.
21. Define drawing. Explain the methods of tube drawing.
22. With a neat sketch explain wire drawing
23. Derive an expression for the drawing force.
24. Discuss the defects in drawn wires and rods
25. Explain tube drawing process using floating mandrel
26. Define extrusions. Give a brief classification of extrusion processes.
27. Give a comparison between direct and indirect extrusion
28. With a neat sketch explain hydrostatic extrusion process.
29. Explain different types of extrusion dies
30. Explain the various defects in extrusion?
31. Define sheet metal forming. Explain different forming methods
32. Give a comparison between progressive and compound die.
33. Explain factors affecting drawability ration
34. Define spring back. Explain elimination of spring back.
35. Describe with neat sketches the difference between blanking and piercing
36. Explain the various defects in drawn products
37. List the advantages and limitation of deep drawing.
38. Explain redrawing and reverse drawing
39. Explain the terms a) Blanking b) Drawing c) Bending d) Shearing
40. With a neat sketch explain spinning operation
41. Explain the basic principle of high energy rate forming processes.
42. Give a brief classification of high energy rate forming processes
43. With a neat sketch explain electro hydraulic forming.
44. With a neat sketch explain electromagnetic forming.
45. Explain principles of rubber forming and explosion forming.
46. List the advantages and limitation of high energy rate forming process.
47. Briefly explain the basic steps in powder metallurgy process.
48. Explain the various method of powder production.
49. List the advantages and limitation of powder metallurgy.
50. Explain the explosion forming technique for standoff operation.

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Ability to apply knowledge in the field metal working, temperature.		M	M	L								
02	Ability to explain concepts of forging, rolling and different equipment.		M	M	H								
03	Ability to explain concepts of extrusion, drawing & defects.		M	M	H	L							
04	Ability to learn the methods of sheet metal forming.		M	M	H								
05	Ability to identify and learn the concepts on High Energy Rate Forming.		M	M	L								
06	Ability to identify basic concepts on powder metallurgy.		M	L	L								

Course Assessment Matrix (CAM)

Sl. No	Course Outcome		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Explain Hot, cold and worm working (Unit – I)	L2	2	2	1								
02	Explain the various defects in forging and rolling (Unit – II)	L2	2	2	3								
03	Compare the hot and cold extrusion, wire, rod, tubes in drawing(Unit – III)	L4	2	2	3	1							
04	Describe the concept of drawability ratio,spring back, spinning, deep drawing stretch forming, redrawing, and reverse drawing (Unit – IV)	L1	2	2	3								
05	Briefly explain the basic steps in powder metallurgy process. (Unit – V)	L2	2	2	1								

Course Title: Economics For Engineers			
Course Code: P13IP62	**Sem: VI**	**L-T-P-H: 4-0-0-4**	**Credits: 4**
Contact Period: Lecture:52Hr Exam: 3Hr		**Weightage: CIE:50; SEE:50**	

Prerequisites:

-Nil-

a) Course Learning Objectives (CLO)/Course Objectives (CO).
At the end of the Course the students should be able to:

Course Learning Objectives:

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

Course Outcomes (CO's):

1. Understand 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)
4. Determine the Depreciation charges of the Machine/Equipment.
5. Analyze the various alternatives & criteria of replacement and predict the effect of inflation on it.
6. Estimate the cost of a product/process and Judge 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 – 1

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 Discussion. **11Hours**

UNIT – 2

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

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, Problems. **11 Hours**

UNIT – 3

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

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

UNIT – 4

STRUCTURAL ANALYSIS OF ALTERNATIVES: Identifying and Defining alternatives, classification of alternatives, IRR analysis of mutually exclusive alternatives.

REPLACEMENT ANALYSIS: Deterioration, obsolescence, inadequacy

EFFECTS OF INFLATION: Causes consequences and control & Measuring of inflation, Lease or Buy decisions. **10Hours**

UNIT – 5

ESTIMATING & COSTING: Introduction, Need, Elements of product cost, Determination of selling price, Methods of costing, standard costing, and Procedure for standard costing Estimation for simple components.

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

10 Hours

TEXT BOOKS:

1. Engineering economics- RIGGS J.Landothers ,4th edition, TataMcGraw Hill, 2002.
2. Engineering economics- K.R.Phaneesh, Sudha Publications, 3rdRevised edition, 2008

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

Unit wise Plan

Unit-1

Introduction, Interest and Interest factors Planned Hours: 11 hrs

Topic Learning Objectives or Unit Learning Objectives

The student learns

1. Illustrating the Engineering Decision making process with problem solving (L2)
2. Relating the Engineering and Economics (L3)
3. Distinguishing between Intuition & Analysis and Tactics & Strategies (L2)
4. Defining Interest, Simple interest & compound interest, Effective interest (L1)
5. Developing expressions for different interest factors (L6)
6. Drawing cash flow diagrams (L4)
7. Evaluating the various interest factors for different problems (L5)

Unit-2

Present worth and Equivalent Annual comparison. Planned Hours: 11 hrs

Topic Learning Objectives or Unit Learning Objectives

The student learns

1. Defining Present worth and Equivalent worth, Future worth and Infinite lives (L1)
2. Stating the conditions for Present worth and Equivalent worth comparisons (L1)
3. Determining the Present worth of various projects for comparison (L4)
4. Determining the Equivalent annual worth of various projects for comparison (L4)
5. Estimating the Payback period and Future worth of different projects for comparison (L4)
6. Use of Sinking fund in comparison of alternatives (L3)

Unit-3

Rate of Return Calculations and Depreciation Planned Hours: 10hrs

Topic Learning Objectives or Unit Learning Objectives

1. Defining Rate of return, MARR, ERR and Cost of capital & Depreciation (L1)
2. Outlining the misconceptions of Rate of return (L4)
3. Estimating the Rate of return of a project(s) for decision making(L4)
4. Listing the causes of Depreciation (L1)

5. Evaluating the Depreciation of an Asset by various methods (L5)
6. Comparing the various methods of computing Depreciation (L5)

Unit-4

Structural analysis of alternatives, Replacement analysis and Effects of Inflation

Planned Hours: 10 hrs

Topic Learning Objectives or Unit Learning Objectives

1. Defining alternatives and Inflation (L1)
2. Identifying & classifying alternatives (L1)
3. Assessing the best alternative(s) (L5)
4. Listing the reasons for Replacement of an asset (L1)
5. Proposing the time/duration of Replacement of an Asset (L6)
6. Stating the causes, consequences , control and Measurement of Inflation (L1)
7. Judging, whether to Lease or Buy (L5)

Unit-5

Estimating & Costing and Break-Even Analysis Planned Hours: 10 hrs

Learning Objectives or Unit Learning Objectives

The student learns

1. Stating the need of Estimating and Costing (L1)
2. Listing the elements of product cost (L1)
3. Distinguishing the different methods of costing (L2)
4. Writing the procedure for Standard costing (L6)
5. Estimating the total cost of a simple components (L4)
6. Illustrating the Basic concepts of Break- even analysis (L2)
7. Predicting the BEP for Linear and Non linear systems (L3)

Lesson Plan

1. **Unit 1: Introduction:** Engineering Decision- Makers
2. Engineering and Economics
3. Problem solving and Decision making
4. Intuition and Analysis
5. Tactics and Strategy.
6. **Interest and interest factors:** Interest rate
7. simple interest, Compound interest
8. compound-interest factors
9. Cash- flow diagrams
10. Exercises and Discussion.
11. Exercises and Discussion.
12. **Unit2:Present worth comparison:** Conditions for present worth comparisons
13. Basic Present worth comparisons patterns,
14. Asset with unequal lives, Infinite lives
15. Future worth comparisons, Pay – back comparison
16. Exercises, Discussions
17. Problems
18. **Equivalent annual worth comparisons:** Equivalent Annual Worth Comparison methods
19. Situations for Equivalent Annual Worth Comparison
20. Consideration of asset life
21. Use of sinking fund method
22. Exercises & Problems
23. **Unit 3: Rate of return calculations:** Rate of return

24. Minimum acceptable rate of return
25. IRR
26. IRR misconceptions
27. Cost of capital concepts
28. **Depreciation:** Causes of Depreciation
29. Basic methods of computing depreciation charges, Straight-line, Methods
30. Declining balance method
31. Sum-of the Years-Digits method
32. Sinking fund method
33. **Unit 4: Structural analysis of alternatives:** Identifying and Defining alternatives,
34. Classification of alternatives
35. IRR analysis of mutually exclusive alternatives
36. IRR analysis of mutually exclusive alternatives
37. **Replacement analysis:** Deterioration
38. Obsolescence
39. Inadequacy
40. **Effects of inflation:** Causes, consequences
41. Control & Measuring of inflation
42. Lease or Buy decisions
43. **Unit – 5 :Estimating & Costing:** Introduction, Need,
44. Elements of product cost, Determination of selling price
45. Methods of costing
46. Standard costing, Procedure for standard costing
47. Estimation for simple components.
48. Estimation for simple components.
49. **Break-even analysis:** Basic Concepts
50. Linear break even analysis
51. Linear break even analysis
52. Non-linear break even analysis

Review Questions

1. "Money matters will be handled by someone else. It is not something that I need to worry about'. Interpret the meaning of this sentence.
2. Define the terms: i) Engineering economics ii) Decision making process
3. Describe the Problem-solving process with help of a diagram.
4. Distinguish clearly between the terms Intuition and Analysis.
5. Differentiate between the Tactics and Strategy.
6. Discriminate the cash flow diagram for lender's and borrower's point of view.
7. Develop an expression for Compound Interest.
8. Illustrate the term "Effective interest rate".
9. How much money must be deposited in a saving account each month to accumulate Rs.20, 000 at the end of 5 years, if the bank pays interest at the rate of 12% per year, compounded.
    i. Monthly
    ii. Semi-annually
    iii. Quarterly
    iv. Daily.
10. A company has to replace a present facility after 10 years at an outlay of Rs 5,00,000. It plans to deposit an equal fixed amount at the end of every year for the next 10 years at the interest rate of 18% compounded annually. Determine the amount that must be deposited at the end of every year.
11. State the conditions for Present worth comparison
12. Compare the Present worth and Equivalent annual worth comparison methods

13. Differentiate between the common-multiple method and Study-period methods of comparison of assets that have unequal lives.
14. Two devices are available to perform a necessary function for 3 years. Theinitial cost (Negative) for each device at time 0 and subsequent annual savings (Positive), both in Rs. are shown in the following table. The required interest rate is 10 percent. Draw cash flow diagrams. Compare the devices by Net Present worth comparison method.

	Year			
	0	1	2	3
Device A	9,000	4,500	4,500	4,500
Device B	14,500	6,000	8,000	6,000

15. Following are the estimates of 2 different machines in an industry. Evaluate the fastest payback period.

Sl.No	Particulars	Machine A	Machine B
1	Initial investment (Rs)	30,000	42,000
2	Annual Receipts	20,000	26,000
3	Annual Expenditures	5,500	7,000
4	Economic life	4	4

16. Discriminate between the terms EAW and EAC.
17. Define the terms: Ownership life, Accounting life
18. "The assumption of infinite life in terms of capital recovery is slightly more reasonable than the physical interpretation." Justify this statement
19. An asset was purchased 5 years ago for Rs.52,000. It was expected to have an economic life 8 years, at which time salvage value would be Rs.4,000. If the function that the asset was serving is no longer needed, for what price must it be sold now to recover the invested capital when i=12 percent. Use Equivalent annual comparison method.
20. A company can purchase a piece of equipment for Rs.20,000 and sell it for the Rs.4,000 at the end of a 6-year service life, or it can lease the unit for the same period by making first-of -the year payments of Rs.3,000. Compare the EAC of the alternatives, using an interest rate of 15 percent.
21. Explain the following :
    I. MARR
    II. ERR
22. Point out the misconceptions of the IRR.
23. "The cost of capital is troublesome to estimate, despite the apparent precision of its formula". Justify this statement.
24. A Rs.1000 utility bond with 14 years remaining before maturity can now be purchased for Rs.760. It pays interest of Rs.20 in each 6- month period. What rate of return is earned by purchasing the bond at the current market price plus brokerage charge of Rs.20?
25. A device has developed a unique prototype and spends Rs. 5 lakhs. The return of Rs. 7 lakhs is expected at the year end and it is expected to fetch Rs.3 lakhs for the next three years. Compute the rate of return for his prototype.
26. Define Depreciation. Name the causes of declining of value of an asset.
27. Explain the Declining balance method of Depreciation. Also, state its advantages and disadvantages.
28. Distinguish clearly between the Straight line and Sinking fund methods of Depreciation.
29. Evaluate the depreciation fund at the end of each year if the first cost of the machine is Rs. 10,000, salvage value is Rs.500 and life is 5 years. Use Sum of years digits method.

30. A person has purchased a sewing machine worth Rs.20,000. The value of the machine at the end of its 10 years life is Rs.6,000. Determine the following using Sinking fund method of depreciation. Assume i=10%.
    i. Depreciation at the end of 3rd and 4th year
    ii. Book value at the end of 4th and 5th year
31. Define Alternatives.
32. Differentiate between Dependent and Independent alternatives.
33. Data for three alternative investment plans are as follows:

Alternative	Investment (Rs.)	Salvage value(Rs.)	Life (Years)	Annual net cash flow (Rs.)
X	6,000	0	3	2,600
Y	12,000	3,000	6	2,500
Z	18,000	0	6	4,000

When the minimum attractive rate of return is 10 percent, appraise the alternatives under each of the following conditions.
    i. Individual alternatives are mutually exclusive
    ii. Individual alternatives are independent
34. Write the flow chart for "Evaluating mutually exclusive alternatives when MARR is required".
35. "Replacement decisions are critically important to a firm". Explain the meaning of this statement.
36. Illustrate the following with the help of an example:
    i. Replacement due to Deterioration
    ii. Replacement due to Obsolescence
37. A city's data processing manager is considering replacing the minicomputer that is being used for utility billing. Known and estimated costs relating to the current system are as follows:

End of Year	Trade-in value (Rs.)	Annual maintenance costs (Rs.)	Annual operating costs (Rs.)
0	12,000	-	-
1	8,000	5,000	28,000
2	3,000	6,500	32,000

With a MARR of 10 percent, how do the first-year and second-year annual costs relate to the equivalent annual costs over the two year period?
38. Define Inflation. State its consequences.
39. "Inflation is difficult to measure". Support this statement by your explanation.
40. Define leasing. Cite the reasons why leasing may be more attractive than purchasing.
41. State the need for Estimating & Costing.
42. Distinguish clearly between the following:
    i. Direct material cost and Indirect material cost
    ii. Direct labour cost and Indirect labour cost
43. Write the procedure for calculating the standard costing.
44. MICO factory produces 500 spark plugs a day involving Direct material cost ofRs. 40,000 and Direct labour cost of Rs.35,000 and factory overheads of Rs.10000.Assuming a profit of 15% of the selling price and selling overheads to be 30% of thefactory cost. Estimate the selling price of one spark plug.

45. Find the factory cost of a forge hammer made from solid cast iron press ofcircular cross section of 30cm dia and 160 cm length. The casting and machiningtime to make the press is 300 minutes and labour rate is Rs.60 per hour. Factory overheads are 50% of direct labour cost. The density of the material is 6.8 gm/cm³ and cost of the material is Rs.12/kg.
46. Distinguish clearly between the Fixed costs and Variable costs.
47. Derive an expression for Break-even point.
48. Define Nonlinear Break-even analysis? Explain with the help of the graph.
49. An airline is evaluating its feeder routes. These routes connect smaller cities to major terminals. These routes are seldom very profitable themselves, but they feed passengers into the major flights which yield better returns. One feeder route has a, maximum capacity of 1000 passengers per month. The contribution from the fare of each passenger is 75 percent of the Rs.120 ticket price. Fixed costs per month are Rs.63,000. Determine the Break-even point and net profit when the effective income tax rate is 40 percent.
50. A privately owned summer camp for youngsters has the following operating data a 12-week season.

Charge per camper	Rs.130 per week
Variable cost per camper	Rs.90 per week
Fixed costs	Rs.48000 per season
Capacity	150 campers

a) What is the total no. of campers that will allow the camp to justbreak even?
b) What is the profit for the 12-week season if the camper operates at 80 percent capacity?

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO)		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Understand the fundamentals of the Engineering economics – (Unit – I)	L1									**H**	**L**	
02	Compare the various Project(s) using present worth/ Equivalent Annual worth methods (Unit – II)	L5						**M**	**L**				**L**
03	Compute the rate of return of the Project(s). – (Unit – III)	L3					**M**	**M**					**L**
04	Determine the Depreciation charges of the Machine/Equipment (Unit – III)	L4						**H**					**L**
05	Analyze the various alternatives & criteria of replacement and predict the effect of inflation on it – (Unit – IV)	L5	**H**	**M**									
06	Estimate the cost of a product/process and Judge the Breakeven point – (Unit – V)	L4						**H**					**L**

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Understand the fundamentals of the Engineering economics – (Unit – I)	L1									**3**	**1**	
02	Compare the various Project(s) using present worth/ Equivalent Annual worth	L5						**2**	**1**				**1**
03	Compute the rate of return of the Project(s). –(Unit – III)	L3					**2**	**2**					**1**
04	Determine the Depreciation charges of the Machine/Equipment (Unit – III)	L4						**3**					**1**
05	Analyze the various alternatives & criteria of replacement and predict the effect of inflation on it–(Unit – IV)	L5	**3**	**2**									
06	Estimate the cost of a product/process and Judge the Breakeven point –(Unit – V)	L4						**3**					**1**

1-Low, 2-Moderate, 3-High

Course Title: Tool Engineering and Design			
Course Code: P13IP63	**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 knowledge of elements of machine tool, single point cutting tools and multi point cutting tools. MP-1,MP-2.

Course Learning Objectives:

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 Learning Outcome:

1. The students will be able to understand the necessity of Cutting tools.
2. Students gain the knowledge of designing cutting tools.
3. Students will be able solve the problems on form tools.
4. The students will be able to understand the design concept of cutting tools in press work.
5. Students will be able to demonstrate the design of fixtures.

Course Content

Unit-I

Design of Metal Cutting Tools: Single point tool, Tool strength and rigidity calculation, Design consideration, Chip Breakers, types of form Tools, Method of determining the profile of form tool by graphical and analytical method, problems. Design of twist drills, forces acting on drill, Broaching methods, Broaching machine, broaching operation, Design of broach tool, problems. **12 hours**

Unit-II

Press Working: Introduction, Types of Power-Press, types of press work operation, Power press parts and Power press driving mechanism. **10 hours**

Unit-III

Press Tools: Press size, Press tool terminology and components, requirement of press tool design, Types of Dies, Die accessories. **08 hours**

Unit-IV

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

Unit-V

Jigs and Fixtures: Introduction, advantages of employing Jigs and fixtures, Principles of jigs and fixtures design, Principles of location, Types of Locators, Clamping, types of clamps, fool proofing. Types of Drill Jigs, Turning fixtures. **12 hours**

TEXT BOOKS:

1. **Tool Engineering and Design**-G.R. Nagpal, Khanna Publishers -1999
2. **Tool design** –Cyril Donaldson, George H LeCain, V C Goold, Third Ed, TMH-2004
3. **Production Engineering** – P.C. Sharma, S. Chand & Company Ltd., New Delhi– 2001
4. **Elements of Workshop Technology - Vol.II -** S.K. HajraChoudhury, S.K. Bose, A.K. HajraChoudhury, 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**- Grant – 1976.
3. **Introduction to Jig and Tool Design**- M.H.A. Kempster.Viva Book Pvt. Ltd.3rd Edn. 2004.

Unit wise Plan

Unit-I

Design of Metal Cutting Tools: Single point tool, Tool strength and rigidity calculation, Design consideration, Chip Breakers, types of form Tools, Method of determining the profile of form tool by graphical and analytical method, problems. Design of twist drills, forces acting on drill, Broaching methods, Broaching machine, broaching operation, Design of broach tool, problems. Planned Hours**:12 hrs**

Learning Objectives

The student learns

1. Evaluate the design of single point cutting tool (L4)
2. Describe Chip Breakers (L1).
3. Explain the types of form tools (L2).
4. Evaluate the form tool by graphical and analytical method (L4).
5. Explain the design of twist drills (L2).
6. Evaluate the forces acting on drill tools (L2)
7. With a neat sketch explain forces acting on drill bit (L2)
8. Explain Broaching methods (L2)
9. With a neat sketch explain Broaching machine (L2)
10. Evaluate the design of broach tool (L4)

Unit-II

Press Working: Introduction, Types of Power-Press, types of press work operation, Power press parts and Power press driving mechanism. Planned Hours**: 10 hrs**

1. Describe press work terminology (L1).
2. Describe the types of presses (L1).
3. With a neat sketch explain the hand press or fly press parts (L2).
4. With a neat sketch explain the power press parts (L2)
5. Distinguish between piercing and punching (L3).
6. With a neat sketch explain the distinguish between crank and connecting rod drive and eccentric power press driving mechanism in press work (L3)
7. With a neat sketch explain cam drive mechanism (L2).
8. Distinguish between drawing and cupping operation (L3)
9. Describe the factors to specify size of press (L2)
10. With a neat sketch explain embossing (L2)

Unit-III

Press Tools: Press size, Press tool terminology and components, requirement of press tool design, Types of Dies, Die accessories. Planned Hours**: 8hrs**

1. Describe with a neat sketch the press working equipment (L1).
2. Explain the types of dies (L2).
3. Distinguish between simple and compound die (L3)
4. Describe with a neat sketch the compound die (L3)
5. Distinguish between combination die and rubber die (L3)
6. With a neat sketch explain the combination die (L2)
7. With a neat sketch explain the progressive die (L2)
8. Describe the methods of die support (L1).
9. Evaluate the working of cutting die (L3).

10. With a neat sketch explain the die accessories (L2)

Unit-IV

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

1. With a neat sketch explain the principle of sheet metal cutting in press work (L2)
2. Distinguish between die and punch (L3)
3. With a neat sketch explain the clearance between die and punch (L2)
4. Describe the method of calculating cutting forces in blanking (L2).
5. Describe with a neat sketch the methods of reducing cutting forces in shearing (L3)
6. Evaluate the blanking of die design (L4)
7. Design and Sketch a progressive die to make steel washer 30mm outside diameter with 15 mm hole from 1.6mm thick steel plate. The ultimate shear strength of the material is 32 N/mm^2 (L4)
8. A steel component 20mm*60mm is to make from 2mm thick sheet sketch this scrap strip layout. Also determine percentage of stock utilized. (L4)
9. To holes 40mm and 60mm diameter are to be cut in a metallic sheet 3mm thick. If shear strength of the material is 2500 N/mm^2, determine cutting force and stripping force. (L4)
10. A component 100 x 60mm is made from mild steel sheet of 3mm thick and 2m long. Determine (i). Strip layout
    (ii). No of parts that can be punched from strip.
    (iii). Percentage of stock used (L4)

Unit-V

Jigs and Fixtures: Introduction, advantages of employing Jigs and fixtures, Principles of jigs and fixtures design, Principles of location, Types of Locators, Clamping, types of clamps, fool proofing. Types of Jigs and fixtures. Planned Hours**: 12 hrs**

1. Define jigs and fixtures (L1)
2. Differentiate jigs and fixtures (L2)
3. Outline the principal of jigs and fixtures (L3)
4. Illustrate the principal of location (L2)
5. With a neat sketch explain the principle of six point location of a rectangular block (L3)
6. Describe various methods of locating component with neat sketch (L3)
7. Outline the operational factors while considering efficient clamping (L2)
8. With a neat sketch explain pivoted clamp (L2)
9. Describe with a neat sketch wedge clamp and cam clamp (L3)

Lesson Plan

1. Design of Metal Cutting Tools: introduction Planned hours 12
2. Single point tool,
3. Tool strength and rigidity calculation,
4. Design consideration
5. Problems on single point cutting tool
6. Chip Breakers, types of form Tools
7. Method of determining the profile of form tool by graphical and analytical method
8. Problems on form tool by graphical and analytical method
9. Design of twist drills, forces acting on drill,
10. Broaching methods, Broaching machine,
11. broaching operation,
12. Design of broach tool, problems.

Unit -2

13. Press Working: Introduction, 10 hours
14. Types of Power-Press,
15. Types of Power-Press continued
16. Types of press work operation
17. continuation
18. Power press parts
19. Power press driving mechanism
20. Continuation
21. Continuation
22. Continuation

Unit - 3

23. Press Tools: introduction 08 hours
24. Press size,
25. Press tool terminology and components
26. Continuation
27. Requirement of press tool design
28. Continuation
29. Types of Dies, Die accessories
30. Continuation

Unit - 4

31. Principles of metal cutting in press work 10 hours
32. Design procedure for blanking die
33. cutting force,
34. Clearance, Die block Design,
35. Punch Design,
36. Problems on punch design
37. Methods of reducing cutting forces,
38. Cutting action in a die, Centre of pressure,
39. Selection of Tool material for punch and die
40. Problems.

Unit – 5

41. Jigs and Fixtures: Introduction 12 hours
42. advantages of employing Jigs and fixtures,
43. continuation
44. Principles of jigs and fixtures design,
45. continuation
46. Principles of location,
47. Types of Locators,
48. Clamping, types of clamps,
49. Continuation
50. Fool proofing.
51. Types of Drill Jigs,
52. Turning fixtures.

Review questions

Unit 1

1. Evaluate the design of single point cutting tool (L4)
2. Describe Chip Breakers (L1).
3. Explain the types of form tools (L2).
4. Evaluate the form tool by graphical and analytical method (L4).
5. Explain the design of twist drills (L2).
6. Evaluate the forces acting on drill tools (L2)
7. With a neat sketch explain forces acting on drill bit (L2)
8. Explain Broaching methods (L2)
9. With a neat sketch explain Broaching machine (L2)
10. Evaluate the design of broach tool (L4)

Unit 2

1. Describe press work terminology (L1).
2. Describe the types of presses (L1).
3. With a neat sketch explain the hand press or fly press parts (L2).
4. With a neat sketch explain the power press parts (L2)
5. Distinguish between piercing and punching (L3).
6. With a neat sketch explain the distinguish between crank and connecting rod drive and eccentric power press driving mechanism in press work (L3)
7. With a neat sketch explain cam drive mechanism (L2).
8. Distinguish between drawing and cupping operation (L3)
9. Describe the factors to specify size of press (L2)
10. With a neat sketch explain embossing (L2)

Unit 3

1. Describe with a neat sketch the press working equipment (L1).
2. Explain the types of dies (L2).
3. Distinguish between simple and compound die (L3)
4. Describe with a neat sketch the compound die (L3)
5. Distinguish between combination die and rubber die (L3)
6. With a neat sketch explain the combination die (L2)
7. With a neat sketch explain the progressive die (L2)
8. Describe the methods of die support (L1).
9. Evaluate the working of cutting die (L3).
10. With a neat sketch explain the die accessories (L2)

Unit 4

1. With a neat sketch explain the principle of sheet metal cutting in press work (L2)
2. Distinguish between die and punch (L3)
3. With a neat sketch explain the clearance between die and punch (L2)
4. Describe the method of calculating cutting forces in blanking (L2).
5. Describe with a neat sketch the methods of reducing cutting forces in shearing (L3)
6. Evaluate the blanking of die design (L4)
7. Design and Sketch a progressive die to make steel washer 30mm outside diameter with 15 mm hole from 1.6mm thick steel plate. The ultimate shear strength of the material is 32 N/mm^2 (L4)
8. A steel component 20mm*60mm is to make from 2mm thick sheet sketch this scrap strip layout. Also determine percentage of stock utilized. (L4)
9. To holes 40mm and 60mm diameter are to be cut in a metallic sheet 3mm thick. If shear strength of the material is 2500 N/mm^2, determine cutting force and stripping force. (L4)
10. A component 100 x 60mm is made from mild steel sheet of 3mm thick and 2m long. Determine
    i. Strip layout

ii. No of parts that can be punched from strip.
iii. Percentage of stock used (L4)

Unit 5

1. Define jigs and fixtures (L1)
2. Differentiate jigs and fixtures (L2)
3. Outline the principal of jigs and fixtures (L3)
4. Illustrate the principal of location (L2)
5. With a neat sketch explain the principle of six point location of a rectangular block (L3)
6. Describe various methods of locating component with neat sketch (L3)
7. Outline the operational factors while considering efficient clamping (L2)
8. With a neat sketch explain pivoted clamp (L2)
9. Describe with a neat sketch wedge clamp and cam clamp (L3)
10. Describe with a neat sketch explain box jig (L3)

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO)	Program outcome (ABET/NBA-(3a-k)											
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Ability to apply knowledge in the field Machine tools and cutting tools		**H**		M		**L**						
02	Ability to design the single point cutting tools and multi point cutting tools.		M		H		**M**						
03	Ability to learn the Methods the profile of form tool by graphical and analytical method		M		H		**H**						
04	Ability to explain the concept of Press works and press tools.		M	L			**H**						
05	Ability to demonstrate the design of metal cutting in press work		L	M			**H**						
06	Ability to analyze and design the Jigs and Fixtures		M	L	**H**		**H**						

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Outcome	Program outcome (ABET/NBA-(3a-k)											
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Evaluate the design of single point cutting tool (Unit – I)	L4	3		2		1						
02	With a neat sketch explain the power press parts (Unit – II)	L3	2		3		2						
03	Evaluate the working of cutting die (Unit – III)	L3		2	3		3						
04	Design and Sketch a progressive die (Unit – IV)	L4	2	1			3						
05	Describe various methods of locating component with neat sketch (Unit – V)	L3	2	1	3		3						

1-Low, 2-Moderate, 3-High

Course Title: Non-Conventional Machining Methods			
Course Code: P13IP64	**Sem: VI**	**L-T-P-H: 3-2-0-5**	**Credits: 4**
Contact Period: Lecture:52Hr Exam: 3Hr		**Weightage: CIE:50; SEE:50**	

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

a) Course Learning Objectives (CLO)/Course Objectives (CO).
At the end of the Course the students should be able to:

Course Learning Objectives:

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

1. Know the difference between conventional and non-conventional machining process also know the classification of non-conventional machining.
2. Know the details of ultrasonic machining (USM) technique, regarding tool cone concentrator, mechanics of cutting, grains and material removal rate (MRR). .
3. Know the details of AJM regarding equipment, types of abrasive, work material, standoff distance, accuracy and surface finish, nozzle ware, etc...
4. Know the abrasive finishing processes such as machining system, process variables, abrasive flow, abrasive wear and Process performance.
5. Know the electrochemical machining technique such as ECM machine cathode tool and anode work piece, source of DC power electrolyte, chemistry of the process, characteristics, MRR and accuracy & surface finish.
6. Know the chemical machining (ChM) process, such as, elements of the process, preparation of the work piece, maskants, etching, characteristics, MRR and accuracy & surface finish .
7. Know the EDM process such as EDM machine, die electric fluid, spark generator, tools electrode feed control, electrode wear, EDM tool design, MRR and EDM process characteristics.
8. Know the plasma arc machining process such as equipment, generation of plasma, selection of gas, PAM parameters process characteristics and MRR.
9. Know the electron beam machining (EBM) process such as working principle, machining system, process parameters and characteristic of the process.

Course Learning Outcome

1. The students should learn and understand necessity of basics of machining process.
2. The students should learn the difference between the conventional and non-conventional machining techniques.
3. Students will be able to learn different types of non-conventional machining techniques such as USM, AJM, EDM, EBM, CHM, PAM etc….
4. The students should be able to learn the advantages and disadvantages of non-conventional machining techniques.
5. The students should be able to learn the applications of non-conventional machining techniques.

e) Relevance of the Course :

Manufacturing process and Theory of metal cutting is a basic subject which deals with the concept of,

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

Course content

UNIT – 1

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

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

UNIT – 2

ABRASIVE JET MACHINING (AJM): Introduction, working principle, abrasive flow machining system, processes variables, Equipment, Variables in AJM: carrier Gas Type of abrasive, Size of abrasive grain, velocity of the abrasive jet, Mean No. abrasive particles per unit volume of the carrier gas, Work material, standoff distance (SOD), Process characteristics – Material removal rate, Applications, Advantages & Disadvantages.

ABRASIVE FINISHING PROCESSES, machined surfaces, number of active grains, wear of abrasive grains, process performance application. **10Hours**

UNIT – 3

ELECTROCHEMICAL AND CHEMICAL METAL REMOVAL PROCESS: Electrochemical machining (ECM): Introduction, Study of ECM machine, Elements of ECM process: Cathode tool, Anode work piece, source of DC power, Electrolyte, Chemistry of the process Metal removal rate, Accuracy and surface finish.

CHEMICAL MACHINING (CHM): Introduction, Elements of process Chemical blanking process:-Preparation of work piece. Preparation of etchants, maskants, etching for blanking, application, Advantages & limitations. **12 Hours**

UNIT – 4

EDM PROCESS and CHARACTERISTICS: Introduction, machine, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, Electrode wear, Flushing and types, Metal removal rate, Accuracy and surface finish, Applications, advantages and disadvantages. **10 Hours**

UNIT – 5

PLASMA ARC MACHINING (PAM): Introduction, equipment non-thermal generation of plasma, selection of gas and introduction to torches, Mechanism of Metal removal, PAM parameters, Process characteristics. Safety precautions, Applications, Advantages and limitations.

ELECRON BEAM MACHINING (EBM): working principle, electron beam machining system, process parameters, and characteristics of the process, Applications, Advantages and limitations.

10Hours

TEXT BOOKS:

1. **Modern machining process** - Pandeyand Shah, TATA McGraw Hill 2000.
2. **New Technology-** Bhattacharaya 2000.

REFERENCE BOOKS:

1. **Production Technology**, - HMT TATA McGraw Hill 2001.
2.**Modern Machining Process** - Adityan, 2002.
3.**Fundamentals of Machining and MachineTools** by R.K.Singal – I K International Publishing house Pvt. Ltd,
4. **Thermal Metal Cutting Process -**Dr. B.J. Ranganath, I.K. International, New Delhi. – 2008.

Unit wise Plan

Unit – I

Introduction & Machining Process Planned Hours: 10

Learning Objectives:

The Students should be able to,

1. Define the concept of non-conventional machining process. [L1].
2. Explain Ultrasonic machining [L2].
3. Describe the mechanics of cutting [L1].
4. Explain USM process characteristics .[L2]
5. Compare conventional and non-conventional machining process[L4].
6. Explain the tool cone concentrator. [L2].

Unit – II

Abrasive Jet Machining (AJM) Planned Hours: 10

Learning Objectives:

The Students should be able to,

7. Define the concept of AJM. [L1].
8. Describe the concept standoff distance on a) width of cut (b) material removal rate [L1].
9. Explain the variables of AJM process.[L2]
10. Explain working principle AJM process [L2].
11. List the applications, advantages and limitations [L1].
12. Describe the wear of abrasive grains process performance [L1].

Unit – III

Electrochemical and Chemical Metal Removal Process & Machining Process

Planned Hours : 12

Learning Objectives:

The Students should be able to,

13. Define the concept of ECM. [L1].
14. Explain working principle ECM process [L2].
15. Describe the Elements of ECM and ChM process [L1].
16. Explain source of DC power and chemistry of the ECM process .[L2]
17. Explain characteristics of ECM process [L2].
18. List the applications, advantages and limitations. [L2].
19. Explain MRR, accuracy and surface finish. .[L2]
20. Describe the concept of preparation of the work piece. [L1].
21. Define maskants& explain the types of maskants [L1].

Unit – IV

EDM Process & EDM Process Characteristics Planned Hours : 12

Learning Objectives:

The Students should be able to,

1. Define the concept of EDM. [L1].
2. Explain working principle EDM process [L2].
3. Derive an expression for R-C circuits [L2].
4. Explain electrical discharge grinding and travelling wire EDM .[L2]
5. Explain characteristics of EDM process [L2].
6. List the applications, advantages and limitations. [L1].
7. Explain different flushing methods in EDM. .[L2]

Unit – V

Plasma Arc Machining (PAM)&Electron Beam Machining (EBM) Planned Hours : 12

Learning Objectives:

The Students should be able to,

1. Define the concept of PAM& EBM. [L1].

2. Explain working principle PAM& EBM process [L2].
3. Describe the Elements of PAM process [L1].
4. List the safety precautions used in PAM .[L2]
5. Explain characteristics of PAM process [L2].
6. List the applications, advantages and limitations. [L2].
7. Explain the parameters of EBM.[L2]
8. Explain the mechanisms of PAM. [L1].

Lesson plan

Unit-1

1. History, Classification, Comparison between conventional and non-conventional machining process selection.
2. Ultrasonic machining (USM): Introduction.
3. Equipment, tool materials & tool Size, Abrasive slurry, Cutting tool system design.
4. Magnetostriction assembly, Tool cone (Concentrator), Exponential concentrator of circular cross section
5. Rectangular cross section Hallow cylindrical concentrator.
6. Mechanics of cutting : Theory of Miller & Shaw Effect of parameter
7. Effect of grain diameter ,
8. Effect of slurry, Tool and work material,
9. USM process Characteristics; Material removal rate, tool wears, Accuracy, surface finish.
10. Applications, Advantages & Disadvantages of USM.

Unit-2

1. Introduction, Equipment,
2. Variables in AJM: carrier Gas Type of abrasive, Size of abrasive grain, velocity of the abrasive jet, Mean No. abrasive particles per unit volume of the carrier gas, Work material,
3. Standoff distance (SOD). Process characteristics – Material removal rate,
4. Accuracy & surface finish.
5. Applications, Advantages & Disadvantages of AJM.
6. ABRASIVE FINISHING PROCESSES: working principle,
7. abrasive flow machining system, processes variables,
8. machined surfaces,
9. number of active grains, wear of abrasive grains,
10. Process performance application.

Unit-3

1. Electrochemical machining (ECM): Introduction, Study of ECM machine,
2. Elements of ECM process : Cathode tool, Anode work piece
3. Source of DC power, Electrolyte,
4. Chemistry of the process ECM process characteristics – Material removal rate, Accuracy, Surface finish.
5. CHEMICAL MACHINING (CHM): Introduction,
6. Elements of process Chemical blanking process:-Preparation of work piece. Preparation of masters,
7. masking with photo resists, etching for blanking,
8. applications of chemical blanking,
9. chemical milling
10. (Contour machining) :-Process steps – masking,
11. Etching, process characteristics of CHM :-material removal rate accuracy, surface finish,
12. Advantages & application of CHM

Unit-4

1. Introduction, machine,
2. mechanism of metal removal, dielectric fluid,
3. spark generator, EDM tools (electrodes) Electrode feed control,
4. Electrode manufacture, Electrode wear,
5. EDM tool design: Choice of matching operation, electrode materiel selection, under sizing and length of electrode Machining time.
6. EDM Process Characteristics: Flushing – Pressure flushing synchronized with electrode movement,
7. EDM process characteristic: Metal removal rate, Accuracy surface finish,
8. Heat affected Zone,
9. Application: EDM accessories / applications,
10. Electrical discharge grinding, Travelling wire EDM.

Unit-5

1. Introduction,
2. equipment non-thermal generation of plasma, selection of gas,
3. Mechanism of Metal removal,
4. PAM parameters, Process characteristics. Safety precautions,
5. Applications, Advantages and limitations.
6. ELECRON ARC MACHINING (PAM):working principle,
7. electron beam machining system,
8. process parameters,
9. characteristics of the process,
10. Applications.

Review Questions

UNIT – I

1. State the need of advanced machining processor (L-1)
2. Classify the non – conventional machining (L-2)
3. Explain the principle of Ultrasonic machining (L-2)
4. With a neat schematic diagram explain the ultrasonic machining process (L-4)
5. List and explain the elements of USM (L-1)
6. Describe briefly the exponential types of tool cone used in ultrasonic machining (L-2)
7. Briefly discuss the theory of miller
8. List and explain the effect of parameters which supports the material removal in USM
9. Discuss the applications of USM
10. Briefly explain the model for analysis of material removal rate in USM proposed by Kazantsevet. al.

UNIT – II

1. State the principle of AJM process
2. With neat block diagram explain the components of AJM system.
3. List the parameters of AJM and how these are influencing the material removal rate in case of AJM process.
4. Show graphically the effect of nozzle pressure and stand –off-distance on MRR and explain briefly.
5. Establish the process capabilities of AJM process.
6. Briefly discuss the applications of AJM process
7. Show the diagram of relationship between stand –off-distance and shape of the machined cavity in AJM process
8. With a neat sketch explain the elements of abrasive flow machining (AFM) system.
9. List the important factors the affect performance of the process and product quality in AFM
10. Briefly discuss the process performance and the applications of AFM

UNIT – III

1. Define the electrolysis. Explain with a neat sketch
2. With a schematic diagram explain briefly the chemistry of Electrochemical Machining process.
3. List and explain in detail, the elements of ECM process.
4. Briefly discuss the characteristics of ECM process.
5. Find how the MRR takes and derive the an expression for volume of material removal and feed rate of an electrode.
6. Write a note on (1) Accuracy & (2) Surface finish
7. How the chemical machining (ChM) process works explain.
8. With schematic diagram explain ChM process
9. Define maskants and etchants explain the types of maskants with a neat sketch.
10. List and explain industrial application of ChM

UNIT – IV

1. With a neat sketch explain mechanism of metal removal in EDM process
2. List the types of spark generators used in EDM process. Explain any two of them with sketch.
3. Sketch electrode feed control used in EDM process.
4. Discuss briefly the working principles of EDM with appropriate sketch
5. Define flushing. Explain the different flushing methods in EDM
6. With a neat sketch explain the process characteristics of EDM.
7. List the applications of EDM?
8. Explain with a neat sketch, travelling wire EDM
9. List the advantage, applications and limitations of EDM
10. Explain the following with sketch

(i) Electrical discharge grinding
(ii) Travelling wire EDM

UNIT – V

1. Explain the transferred andnon-transferred mode?
2. With a neat sketch explain the non- thermal generation of plasma.
3. List the application of PAM.
4. List the safety precautions used in PAM.
5. Explain with a neat sketch non thermal generation of plasma and mechanism of metal removal in PAM.
6. With a neat sketch explain the process characteristics of EDM.
7. Explain with a neat diagram the working principle of EBM.
8. Explain the process parameters of EBM.
9. List the applications of EBM process.
10. List the limitations of EBM process.

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Ability to apply knowledge in the field metal removal using Non conventional machining technique .(USM)		M	M	L								
02	Ability to explain concepts of AJM process & the principles which have been used for removing material from the work piece.		M	M	L								
03	Ability to apply knowledge of ECM process and chemical machining process.		M	M	L								
04	Ability to learn the methods of EDM and characteristics.		M	M	L								
05	Ability to identify and learn the concepts on Plasma arc machining.		M	M	L								
06	Ability to identify basic concepts of EBM process.		M	M	L								

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO		Program outcome (ABET/NBA-(3a-k)										
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Classify the non – conventional machining (Unit – I)	L2	2	2	1								
02	List the parameters of AJM and how these are influencing the material removal rate in case of AJM process (Unit – II)	L1	2	2	1								
03	Write a note on (1) Accuracy & (2) Surface finish (Unit – III)	L3	2	2	1								
04	Discuss briefly the working principles of EDM with appropriate sketch(Unit – IV)	L2	2	2	1								
05	Explain the process parameters of EBM. (Unit – V)	L2	2	2	1								

Course Title: Quality Assurance and Reliability			
Course Code: P13IP65	**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:

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 ofQuality 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 Learning Outcome

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.
6. Students will be able to demonstrate the need of types of failure methods.

Course Content

UNIT-I

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

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

UNIT-II

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

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

UNIT-III

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

UNIT-IV

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

UNIT-V

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

TEXT BOOKS:

1. Introduction to statistical Quality Control- D C Montgomery 3rd Edition, John Wiley and Sons.
2. Quality Planning & Analysis- J M Juran, Frank M Gryna; 3rd edition, Tata McGraw Hill.
3. Statistical Quality control – M. mahajan, DhanpatRai& Co. (p) LTD

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 Kesavan R.K. International, New Delhi – 2007.

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Unit wise Plan

Unit-I

Introduction to Quality Assurance Planned Hours**:10hrs**

Unit Learning Objectives

The student learns

1. Explain the quality function explain with diagram?
2. Explain history of quality control methodology.
3. Describe the Dimensions of Quality?
4. List and explain all eight dimensions of quality?
5. Define quality cost?
6. Explain the different categories of quality cost.
7. Differentiate between sporadic and chromic quality problems.
8. Define quality assurance
9. Explain the departmental quality assurance activities.
10. Explain planning and performing audits on activities.
11. Explain the scope of quality audit.

Unit-II

Statistical Process Control and Control Charts for Variables Planned Hours**: 12 hrs**

Unit Learning Objectives

The student learns

1. Define statistical control?
2. List the advantages of statistical control?
3. Explain the chance causes and assignable causes?
4. Distinguish between assignable cause of variation and chance cause of variation
5. List and explain methods used for estimating process capability study.
6. List 7 QC tools and explain Pareto chart with neat sketch.
7. Explain type I and type II errors.
8. Determine trial control limits for $\overline{X}$ and R charts
9. Explain preliminary conclusions about statistical control, can you draw from your observation
10. Describe the analysis data on the control charts

Unit-III

Control Charts for Attributes Planned Hours**: 10hrs**

Unit Learning Objectives

The student learns

1. Write a note on P Chart and C Chart
2. List the control chart for Attributes.
3. Differentiate between control chart and Attributes.
4. Explain the advantages of control chart and Attributes.
5. Explain the objectives of control chart for Attributes.
6. Differentiate between defects and defective?
7. When c- charts are used? Give examples.
8. Compare between P-chart and NP- chart.
9. Write the producer for operation of control chart.
10. Compare between C-chart and U- chart.

Unit-IV

Sampling Inspection Planned Hours**: 10hrs**

Unit Learning Objectives

The student learns

1. Explain Double sampling plan.
2. Explain different types of samplings plans.
3. List the advantages of acceptance sampling techniques.
4. Write a note on average outgoing quality.
5. Explain O.C. curve with a neat diagram.
6. Draw flow charts for single and double sampling plan.
7. Write a suitable examples on producers risk and consumers risk
8. Describe the LTPD.
9. Explain the average total inspection.
10. Explain the characteristics of good sampling plan.

Unit-V

Reliability and Life Testing Planned Hours**: 10hrs**

Unit Learning Objectives

The student learns

1. Define reliability?
2. Explain the importance of reliability.
3. List the basic elements of reliability.
4. Explain the reliability test.
5. Explain the quality in connection with reliability
6. Describe the maintenance in connection with reliability
7. Describe the system reliability in connection with reliability
8. Define the MTBF.
9. Explain different types of parallel redundant systems.
10. Explain the failure rate curve.

Lesson plan

Unit-I

- Introduction: Definition of Quality, Quality functions
- Dimensions of Quality, Quality Engineering terminology
- Brief history of quality methodology, Statistical methods for quality improvement,
- Quality costs – four categories costs and hidden costs
- Brief discussion on sporadic and chronic quality problem
- Introduction to Quality function deployment.
- Definition and concept of quality assurance, departmental assurance activities

- Quality audit concept, audit approach etc.
- planning and structuring the audit program
- performing audit activities, audit reporting
- Ingredients of a quality program.

Unit-II

- Introduction to statistical process control
- Chance and assignable causes variation. Basic principles of control charts,
- choice of control limits, sample size and sampling frequency,
- Rational subgroups. Analysis of patterns of control charts.
- Process capability – Basic definition, standardized formula,
- Relation to product tolerance and six sigma concept of process capability.
- Controls charts for X bar and Range ®, statistical basis of the charts,
- Development and use of X bat and R charts, interpretation of charts.
- Control charts for X bar and standard deviation (S), development
- Use of X bat and S chart. Brief discussion on – Pre control X bar and S control charts with variable sample size, control charts for individual measurements.
- problems
- problems

Unit-III

- Control charts for attributes**:** Controls chart for fraction non- conforming (defectives)
- Operation of control chart, brief discussion on variable sample size.
- Control chart for non-conformities development (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.
- problems

Unit-IV

- 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.
- problems
- Failure models of components,

Unit-V

- Definition of reliability,
- MTBF, Failure rate, common failure rate curve,
- Types of failure,
- Reliability evaluation in simple cases of exponential failures in series
- Paralleled and series-parallel device configurations
- Redundancy and improvement factors evaluations.
- problems

Review Questions

1. Explain the quality function explain with diagram?
2. Explain history of quality control methodology.
3. Describe the Dimensions of Quality?
4. List and explain all eight dimensions of quality?
5. Define quality cost?

6. Explain the different categories of quality cost.
7. Differentiate between sporadic and chromic quality problems.
8. Define quality assurance
9. Explain the departmental quality assurance activities.
10. Explain planning and performing audits on activities.
11. Explain the scope of quality audit.
12. Define statistical control?
13. List the advantages of statistical control?
14. Explain the chance causes and assignable causes?
15. Distinguish between assignable cause of variation and chance cause of variation
16. List and explain methods used for estimating process capability study.
17. List 7 QC tools and explain Pareto chart with neat sketch.
18. Explain type I and type II errors.
19. Determine trial control limits for $\overline{X}$ and R charts
20. Control charts for $\bar{x}$ and σ are maintained on the weight is ounces of contents of a container filling plant, with the subgroup size 5. After eighteen subgroups $\sum \bar{x} = 595.8$ and $\sum \sigma = 8.24$ compute 3 limits for $\bar{x}$ and σ - charts and estimate the parameters of the universe assuming the process to be in statistical control.
21. The following data were obtained over a ten day period to initiate $\overline{X}$ & R control chart for a quality characteristics of a certain manufacturing of a product that had required substantial amount of rework. All the figure apply to the product made on a single machine by a single operator. Subgroup size was 5 and 2 subgroups were taken per day.

Sub groups	$\overline{X}$	R	Sub groups	$\overline{X}$	R
1	177.6	23	11	179.8	9
2	176.6	08	12	176.4	8
3	178.4	22	13	178.4	7
4	176.6	12	14	178.2	4
5	177.0	07	15	180.6	6
6	178.6	08	16	179.6	6
7	179.6	16	17	177.8	10
8	178.8	06	18	178.4	9
9	178.2	07	19	181.6	7
10	179.4	12	20	177.6	10

(i) Determine trial control limits for $\overline{X}$ and R charts
(ii) List the preliminary conclusion about statistical control, can you draw from your observation and analysis data on the control charts
(iii) The specification requirements is 171± 11, if product characteristics falls below lower of 160, it must be scrapped, where as if it falls above upper limit of 182, it can be reworked. It is desired to hold the scrap in a low figure without causing excessive rework. If the process average can be shifted by a relatively simple adjustment, what would you suggest as the aimed at value for the process centering in the immediate future?

22. Explain preliminary conclusions about statistical control, can you draw from your observation
23. Describe the analysis data on the control charts
24. Write a note on P Chart and C Chart
25. List the control chart for Attributes.
26. Differentiate between control chart and Attributes.
27. Explain the advantages of control chart and Attributes.

Following table gives number of missing rivets listed at the final inspection of boilers

Boiler number	1	2	3	4	5	6	7	8	9	10
Missing rivets	8	10	12	19	15	11	8	21	5	30

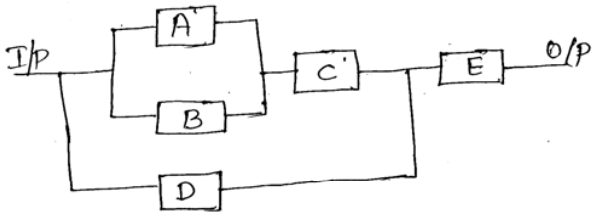
(i) Find $\overline{C}$ and trail control limits and plot the control chart

28. Explain the objectives of control chart for Attributes.
    (ii) What value of C^1 would you recommend for future use?
29. A textile manufacturer initiates the use of c = chart to monitor the no. of imperfection found in a bale of cloth. Easy is of same length, width and fiber composition. A total 191 imperfection were found in the last 25 bales inspected. The four highest and lowest counts were as follows.

Highest	22	19	14	12
Lowest	4	4	5	5

    i) Calculate the 3 control limits
    ii) Is the process in control
    iii) What aimed value of C_1 and control limits would you suggest for the future period.
30. Differentiate between defects and defective?
31. When c- charts are used? Give examples.
32. Compare between P-chart and NP- chart.
33. Write the producer for operation of control chart.
34. Compare between C-chart and U- chart.
35. Explain Double sampling plan.
36. Explain different types of samplings plans.
37. List the advantages of acceptance sampling techniques.
38. Write a note on average outgoing quality.
39. Explain O.C. curve with a neat diagram.
40. Draw flow charts for single and double sampling plan.
41. Write a suitable examples on producers risk and consumers risk
42. Describe the LTPD.
43. Explain the average total inspection.
44. Explain the characteristics of good sampling plan.
45. A double sampling plan is as follows:
    N = 4000, n_1 = 150, n_2 = 200, C_1 = 4, C_2 = 7, P = 0.015 calculate Pa, ATI, AOQ, ASN of the above plan.
46. Define reliability?
47. Explain the importance of reliability.
48. List the basic elements of reliability.
49. Explain the reliability test.
50. Explain the quality in connection with reliability
51. Describe the maintenance in connection with reliability
52. Describe the system reliability in connection with reliability
53. Define the MTBF.
54. Explain different types of parallel redundant systems.
55. Explain the failure rate curve.
56. A ground support equipment f8r missile launch has a specified mean time between failures of 100 hrs. What is the reliability for the mission time of 1 hrs? 10 hrs? 50 hrs? 100 hrs? 200 hrs? And 300 hrs? Graph then answers by plotting mission time v/s reliability. Assume an exponential distribution.

57. Calculate the reliability of the system shown below Fig.



$R_A = 0.7$ $R_D = 0.8$

$R_B = 0.7$ $R_E = 0.9$

$R_C = 0.9$

Course Articulation Matrix (CAM)

Sl. No	Course Outcome – (CO)	Program outcome (ABET/NBA-(3a-k)											
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Explain history of quality control methodology – (Unit – I)	L2	M		L	M					M	H	
02	Determine trial control limits for $\overline{X}$ and R charts. –(Unit – II)	L4	H	H									
03	Differentiate between defects and defective –(Unit – III)	L6	M	M	L								
04	List the advantages of acceptance sampling techniques. – (Unit – IV)	L1	M	H									
05	Explain the characteristics of good sampling plan –(Unit –IV)	L2	M	M	L								
06	Define reliability –(Unit – V)	L1	M	L									

L-Low, M-Moderate, H-High

Course Assessment Matrix (CAM)

Sl. No	Course Outcome – CO	Program outcome (ABET/NBA-(3a-k)											
			a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
01	Explain history of quality control methodology – (Unit – I)	L1	1		1	2					2	3	
02	Determine trial control limits for $\overline{X}$ and R charts. –(Unit – II)	L2	2	3									
03	Differentiate between defects and defective –(Unit – III)	L1	2	2	1								
04	List the advantages of acceptance sampling techniques. – (Unit – IV)	L2	2	1									
05	Explain the characteristics of good sampling plan –(Unit –IV)	L2	2	2	3								
06	Define reliability –(Unit – V)	L1	2	3									

1-Low, 2-Moderate, 3-High

Course Title: Industrial Engineering Laboratory			
Course Code: P13IPL67	**Sem: VI**	**L-T-P-H: 0-0-3-3**	**Credits: 1.5**
Contact Period: Lecture:39Hr Exam: 3Hr		**Weightage: CIE:50; SEE:50**	

Prerequisites: Students should have studied the Work Study.

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.

Course Learning Objectives (CLO):

After completion of lab the student should be able to:

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

Course Contents.

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

Scheme of Examination:

2 Experiments		: 40 Marks
Viva – Voce		: 10 Marks

	Total	**: 50 Marks**

Course Title: Machine Tools Laboratory			
Course Code: P13IPL68	**Sem: VI**	**L-T-P-H: 0-0-3-3**	**Credits: 1.5**
Contact Period: Lecture:39Hr Exam: 3Hr		**Weightage: CIE:50; SEE:50**	

Prerequisites: Students should have studied Production Technology and theory of metal cutting.

Course objective: To train the students with the practical knowledge of components of machine tools, the various parameters that can be influence on machining characteristics.

Course Learning Objectives (CLO):

After completion of lab the student should be able to

- Distinguish the parts of machine tools
- To identify the various parameters that can be influence machine tools
- Learn the effect of chips on tool life
- Evaluate the forces acting on different machine tools with conditions
- Asses to select right tools, materials for the machining process

Course contents

1. Acceptance tests on Lathe.
2. Acceptance tests on drilling machine.
3. Acceptance tests on milling machine.
4. Determination of Cutting forces during milling using milling tool dynamometer.
5. Determination of chip reduction co-efficient in lathe
6. Measurement of cutting tool temperature using thermo-couples.
7. Disassembly and assembly of the following machine parts.
   - Lathe tool stock
   - Swivel vice
   - Screw jack
   - Tool head of a shaper
   - Indexing heads

Scheme of Examination:

2 Experiments		: 40 Marks
Viva – Voce		: 10 Marks

	Total	**: 50 Marks**

Course Title: Value Engineering & Industrial Best Practice			
Course Code: P13IP661	**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 Quality Assurance and Reliability, Manufacturing and Management.

Course Learning Objectives (CLO) :

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

- Define the concept of Value Analysis and Value Engineering.
- Understand the scope and objectives of Value Management.
- Understand the difference between Value Engg and Value Analysis.
- Understand types of Values and their effect in cost reduction.
- Define the rules for functional definition and types of functions.
- Define the MISS technique and numerical evaluation of functional relationships.
- Understand the problem solving system.
- 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,

- Value Analysis and Value Engineering.
- Value Management.
- Types of Values and the effect of Cost reduction.
- MISS techniques.
- Problem solving systems.

Course Content

UNIT – I

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

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

UNIT – II

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

PROBLEM SETTING & SOLVING SYSTEM: A problem solvably stated is half solved, Steps in problem setting system, Identification, Separation and Grouping of functions. Case studies. **10 Hours**

UNIT – III

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

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

10 Hours

UNIT – IV

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

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

UNIT – V

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

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

TEXT BOOKS:

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

REFERENCE BOOKS:

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

Unit wise Plan

Unit-I

Introduction to Value Analysis and types of Values. Planned Hours:12hrs

Learning Objectives :

The Students should be able to,

1. Define the concept of Value Analysis and Value Engineering [L1].
2. Understand the scope and objectives of Value Management[L2].
3. Understand the difference between Value Engg and Value Analysis[L2].
4. Define the Advantages and limitations of Value Analysis [L1].
5. Understand types of Values and their effect in cost reduction [L2].

Unit-II

Functional Cost and its evaluation Problem setting and Solving systems.

Planned Hours:10hrs

Learning Objectives :

The Students should be able to,

1. Define the concept of Functional Cost[L1].
2. Define the rules for functional definition and types of functions [L1].
3. Define the MISS technique and numerical evaluation of functional relationships[L1].
4. Understand the problem solving system [L1].

Unit-III

Problem Setting & Solving systems and Value Engineering Job Plan Planned Hours:10

Learning Objectives :

The Students should be able to,

1. Understand the various stems involved in problem solving [L2].
2. Define the meaning and importance of value engineering job plan [L1].
3. Understand the concept of information phase, analysis phase and creative phase [L2].
4. Define the different methods of Performance appraisal process [L1].
5. Understand the cost reduction programmes [L2].

Unit-IV

Value Engineering Techniques and Advanced Value Analysis Techniques.

Planned Hours:10

Learning Objectives :

The Students should be able to,

1. Define the new value engineering techniques [L1].
2. Understand the role of techniques in Value Engineering [L2].
3. Define the Functional analysis system technique of Advanced Value Analysis [L1].

Unit-V

Advanced Value Analysis techniques and Application of Value Analysis.

Planned Hours:10

Learning Objectives :

The Students should be able to,

1. Understand the importance of Value Analysis of Management Practice [L2].
2. Define the steps involved in VAMP and application of VAMP in Government [L1].
3. Define the concept of Value Engineering, Cost reduction and Manufacturing [L1].

Lesson Plan

Unit-I

	Portion covered per Hour (An Estimate)
1	Introduction to Value Analysis : Definition of Value.
2	Value Analysis, Value Engg and Value Management.
3	Value analysis versus value engg, Value analysis v/s traditional cost reduction techniques.
4	Uses, application of value analysis.
5	Advantages and limitations of Value analysis.
6	Symptoms to apply value analysis, Coaching of Champion concept.
7	**TYPE OF VALUES:** Reasons for unnecessary cost of product.
8	Peeling cost Onion concept, unsuspected areas responsible for higher cost.
9	Value Analysis Zone, attractive features of value analysis.
10	Meaning of Value and types of value.
11	Their effect in cost reduction.
12	Value analysis procedure by simulation and detailed case studies of simple products.

Unit-II

1. **FUNCTIONAL COST AND ITS EVALUATION:** Meaning of Function and Functional cost.
2. Rules for functional definition, Types of functions.
3. Primary and secondary functions using verb and Noun, Function evaluation process.
4. Methods of function evaluation. Evaluation of function by comparison.
5. Evaluation of Interacting functions, Evaluation of function from available data, matrix technique.
6. MISS technique, Numerical evaluation of functional relationships and case studies.
7. **PROBLEM SETTING & SOLVING SYSTEM:** Introduction.
8. A problem solvably stated is half solved.
9. Steps in problem setting system.
10. Identification, Separation and Grouping of functions. Case studies.

Unit-III

1. **PROBLEM SETTING & SOLVING SYSTEM:** Introduction.
2. Goods system contains everything the task requires.
3. Various steps in problem solving, case studies.
4. **VALUE ENGINEERING JOB PLAN:** Introduction.
5. Meaning and Importance of Value Engineering Job plan.
6. Phases of job plan proposed by different value engineering experts.
7. Information phase, Analysis phase, Creative phase,
8. Judgement phase, Development planning phase, and case studies.
9. Cost reduction programs, criteria for cost reduction program,
10. Value analysis change proposal.

Unit-IV

1. **VALUE ENGINEERING TECHNIQUES:** Introduction.
2. Result Accelerators.
3. New Value Engineering Techniques.
4. Listing,
5. Role of techniques in Value Engineering,
6. Role of techniques in Value Engineering.
7. Details with Case examples for each of the Techniques.
8. **ADVANCED VALUE ANALYSIS TECHNIQUES:** Introduction
9. Functional analysis system technique.
10. Case Studies.

Unit-V

1. **ADVANCED VALUE ANALYSIS TECHNIQUES:** Introduction.
2. Value analysis of Management practice (VAMP).
3. Steps involved in VAMP and application of VAMP to Government.
4. University and Colleges.
5. Hospitals, School Problems etc., (service type problems).
6. **APPLICATION OF VALUE ANALYSIS:** Introduction.
7. Application of Value analysis in the field of Accounting and Appearance Design.
8. Cost reduction, Engineering and Manufacturing.
9. Management, Purchasing, Quality Control, Sales, marketing, Material Management Etc.,
10. Comparison of approach of Value analysis & other management techniques.

Review Questions

1. Define Value and Value Analysis.
2. Explain Value Engineering and Value Management.
3. Differentiate between Value Analysis and Value Engineering.
4. Differentiate between Value Analysis and Traditional cost reduction techniques.
5. Mention the applications of Value Analysis.
6. Write a note on Advantages and limitations of Value Analysis.
7. Explain Peeling cost onion concept.
8. Explain Value Analysis Zone.
9. Write a note on attractive features of Value Analysis.
10. Mention the different types of Value and their effect in cost reduction.
11. Explain Value analysis procedure by simulation.
12. Define meaning of function and functional cost.
13. Mention the rules for functional definition.
14. Explain the different types of functions.
15. Explain Primary and Secondary functions.
16. Explain Function evaluation process.
17. Explain the different methods of function evaluation.
18. Explain the steps involved in problem setting system.
19. Explain Identification, separation and grouping of functions.
20. Explain Matrix technique of functions.
21. Explain evaluation of interacting functions.
22. Explain various steps involved in problem solving.
23. What is problem setting?
24. What is problem solving system?
25. Mention the meaning and importance of Value engineering job plan.
26. Explain the phases of job plan proposed by different value engineering experts.
27. What is information phase?
28. What is Analysis phase?
29. Define Creative and Judgement phase.
30. Write a note on development planning phase.
31. Write a note on cost reduction programs.
32. Explain criteria for cost reduction program.
33. Mention the different value engineering techniques.
34. What are new value engineering techniques?
35. Mention the role of different techniques in value engineering.
36. What are Advanced Value analysis techniques?
37. Write a note on functional analysis system technique.
38. What is Value analysis of Management practice?
39. Mention the steps involved in Value analysis of Management practice.
40. Mention the application of VAMP to government.
41. Write a note on application of VAMP to University and colleges.
42. Write a note on application of VAMP to Hospitals and Schools.
43. Mention the application of VAMP in the field of Accounting.
44. What is Appearance Design?
45. What is Cost reduction?
46. Compare approaches of value analysis with management techniques.
47. What is Management?
48. What is purchasing?
49. Define Quality Control.
50. Explain in brief the other management techniques used in application of value analysis.

Course Title: Mechanical Vibrations			
Course Code: P13IP662	**Sem: VI**	**L-T-P-H: 4-0-0-4**	**Credits: 4**
Contact Period: Lecture:52Hr Exam: 3Hr		**Weightage: CIE:50; SEE:50**	

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

Course Content

UNIT – 1

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

UNIT – 2

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

UNIT – 3

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

UNIT – 4

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

UNIT – 5

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

TEXT BOOKS

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

REFERENCES BOOKS

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

Course Outcomes

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

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

Unit wise Plan

Unit-I

Learning Objectives

By the end of the topic, student will be able to

1 Classify the vibratory systems.
2 Formulate the governing differential equations of motion for the single degree of freedom undamped-free vibrating systems using Newton's second law or Energy methods and **Express** their natural frequencies.
3 Sketch an equivalent spring-mass vibratory system for a single dof system having multi masses and springs.
4 Formulate governing differential equations of motion to the single dof damped-free vibratory systems and **Express** their solutions.
5 Use logarithmic decrement curve to **Estimate** the actual damping present in the vibratory system.

Unit II

Learning Objectives :

By the end of the topic, student will be able to

1 Formulate the expression for transient and steady state vibration of a system subjected to harmonic excitation or excitation due to unbalanced force.
2 Determine force and motion transmissibility of vibratory system.
3 Estimate the spring stiffness and damping coefficients to minimize force and/or motion transmissibility of the system.
4 Estimate the frequency ratios to minimize steady state amplitude of vibration and/or force and motion transmissibility of the system.

Unit III

Learning Objectives :

By the end of the topic, student will be able to

1 Explain the working principle of vibrometer, velocity pick up and accelerometer.
2 Determine whirling speed of shaft and its maximum deflection under whirling or operating speeds.
3 Estimate dynamic force transmitted from the vibrating shaft to bearings.
4 Estimate maximum and minimum bending stress developed in the shaft due to its deflection.
5 Compute harmonics of general forcing functions using Fourier series.

Unit IV

Learning Objectives :

By the end of the topic, student will be able to

1 Formulate governing differential equations of motion for Two degree of freedom systems.
2 Solve governing differential equations of motion of free vibration of two dof systems in terms of initial conditions and **Express** their equation of motion.
3 Estimate natural frequencies and corresponding mode shapes of two degree of freedom systems having rectilinear and angular modes as well as combined rectilinear and angular modes.
4 Design undamped vibration absorber.
5 Determine influence coefficients of mechanical systems.

Unit V
Learning Objectives :
By the end of the topic, student will be able to

1 Estimate fundamental natural frequency of multi degree freedom systems using Rayleigh's, Dunkerley's and stodola's numerical methods.
2 Estimate all natural frequencies and corresponding mode shapes of multi degree freedom systems using Holzer's numerical method.
3 Formulate equation of motion using influence coefficients and **Estimate** natural frequencies of multi degree freedom systems from matrix iteration method.

Lesson Plan

Unit I

1 Introduction to mechanical vibration causes of vibration, effects of vibration, basic concepts of vibration, Simple harmonic motion, types of vibration.
2 Elements of vibrating system, definition of the terms: periodic motion, time period, frequency, amplitude, natural frequency, resonance, damping and degree of freedom, etc.
3 Single degree of freedom systems, determination of natural frequency using Newton's law and energy methods.
4 Numerical problems on determination of natural frequency/time period of single dof systems.
5 Numerical problems on determination of natural frequency/time period of single dof systems.
6 Numerical problems on determination of natural frequency/time period of single dof systems.
7 Introduction to damped free vibration, types of damping, derivation of governing differential equation of motion of spring-mass-damper system.
8 Solution of governing differential equation of under damped, critical damped and over damped systems.
9 Logarithmic decrement and Derivation of expressions for the logarithmic decrement.
10 Numerical problems.
11 Numerical problems.
12 Numerical problems.

Unit II

1 Introduction to forced vibration, Derivation of expression for equation of motion of a spring-mass-damper subjected to harmonic excitation.
2 Magnification factor and its variation with frequency ratio, Phase angle and its variation with frequency.
3 Derivation of expression for steady state amplitude of spring-mass-damped system subjected to rotating and reciprocating unbalance.
4 Vibration isolation-force and motion isolation, derivation of expression for force transmissibility.

5 Derivation of expression for force transmissibility.
6 Derivation of expression for motion transmissibility- absolute and relative motion.
7 Numerical problems
8 Numerical problems
9 Numerical problems
10 Numerical problems

Unit III

1 Introduction to vibration measuring instruments, Seismic instrument, working principles of vibrometer and accelerometer.
2 Numerical problems
3 Numerical problems
4 Introduction to whirling of shafts, critical speed of a light shaft having a single disc without damping, critical speed of a light shaft having a single disc with damping.
5 Numerical problems
6 Numerical problems
7 Introduction to Fourier series and Harmonic analysis.
8 Examples on representation of periodic motion into harmonic series.

Unit IV

1 Introduction to Two degree of freedom system, generalized and principal co-ordinates, principle and normal modes of vibration, coordinate coupling.
2 Determination of natural frequencies and mode shape for spring-mass system.
3 Derivation of equation of motion of undamped-free vibration of two dof system in terms of initial conditions.
4 Determination of natural frequencies and mode shape for double pendulum and string problems.
5 Natural frequencies of a system having combined rectilinear and angular modes.
6 Introduction to undamped vibration absorber.
7 Example problems on determination of natural frequencies and mode shapes.
8 Example problems on determination of natural frequencies and mode shapes.
9 Introduction to influence coefficients, Maxwell's reciprocal theorem.
10 Example problems on determination of influence coefficients.

Unit V

1 Introduction to multi-degree of freedom systems, Numerical methods in the determination of natural frequencies of multi-dof systems, Rayleigh's method.
2 Dunkerley's method, Example problems on determination of fundamental natural frequency using Rayleigh's and Dunkerley's methods.
3 Introduction to Stodola's method, an example problem on determination of fundamental natural frequency using Stodola's method.
4 Example problems on determination of fundamental natural frequency using Stodola's method.
5 Introduction to Holzer's method, an example problem on determination of natural frequencies using Holzer's method.
6 Example problem on determination of natural frequencies using Holzer's method.
7 Example problem on determination of natural frequencies using Holzer's method.
8 Example problem on determination of natural frequencies using Holzer's method.
9 Introduction to orthogonality principle, formation of equation of motion in terms of influence coefficients, Matrix iteration method.
10 Example problem on determination of natural frequencies using matrix iteration method.
11 Example problem on determination of natural frequencies using matrix iteration method.
12 Example problem on determination of natural frequencies using matrix iteration method.

Review Questions

1 Define the following:
(a) Free vibrations (b) Forced vibration (c) Damped vibration
(d) Degrees of freedom (e) Critical damping (f) Coulomb damping
(g) Viscous damping (h) Solid damping (i) Logarithmic damping
(j) Natural frequency (k) Damped natural frequency

2 Distinguish between the followings:
(i) Natural frequency and damped natural frequency
(ii) Free and forced vibrations (iii) Damped and undamped vibrations.

3 What are the different methods used to determine the expressions for natural frequency of a spring-mass system? Explain them.

4 Determine the natural frequency of the system shown in Fig. 1 using (i) Newton's second law method (ii) Energy method.

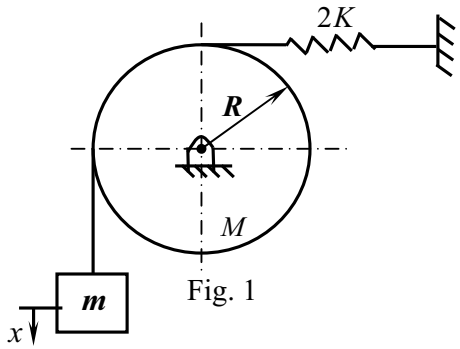


Fig. 1

5 A 20 kg mass is resting on a spring of 750 N/m and dash pot of 50 N-sec/m. If a velocity of 2 m/sec is applied to the mass at rest position, what will be its displacement at the end of 1 sec.

6 Derive an expression for the logarithmic decrement.

7 A body of mass 70 kg is suspended from a spring which deflects 2 cm under the load. It is subjected to a damping effect adjusted to a value 0.23 times that required for critical damping. Find the natural frequency of the undamped and damped vibrations and ratio of successive amplitudes for damped vibrations.

8 A vibrating system is defined by the following parameters:
$m = 3kg, k = 100N/m, C = 3N - \sec/m$.
Determine,
(i) the damping factor (ii) the natural frequency of damped vibration (iii) logarithmic decrement (iv) the ratio of two consecutive amplitudes and (v) the number of cycles after which the original amplitude is reduced to 20 percent.

9 The mass *M* of a machine is mounted on an elastic foundation modelled as a spring of stiffness *k* in parallel with a viscous damper of damping coefficient *C*. The machine is subjected to a harmonic excitation of $F_o \sin \omega t$. **Derive** the differential equation governing the machine's displacement and **Express** its steady-state amplitude.

10 An electric motor is supported on a spring and a dashpot. The spring has the stiffness 6.4 N/mm and the dashpot offers resistance of 500 N at velocity of 250 mm/sec. The unbalanced mass of 0.5 kg rotates at 50 mm radius and the total mass of vibratory system is 20 kg. The motor runs at 400 rpm. Determine (a) damping factor (b) amplitude of vibration and phase angle (c) force exerted by the spring and dashpot on the motor.

11 Explain the principles of operation of vibrometer and accelerometer.

12 The static deflection of the vibrometer mass is 20 mm. The instrument when attached to a machine vibrating with a frequency of 125 cpm records a relative amplitude of 0.3mm. find out for the machine, (i) Amplitude of vibration.

(ii) Maximum velocity of vibration and
(iii) Maximum acceleration.

13 A rotor of mass 14 kg is mounted at mid point of a steel shaft of 25 mm diameter supported between two bearings which are 40 cm apart. The rotor has an unbalance of 0.25 kg-cm. If the rotor runs at 6000 rpm, determine: (1) critical speed of the shaft (2) The maximum and minimum stress developed in the shaft (3) the dynamic load transmitted on each bearing. Take *E= 210 Gpa* and density of shaft material $\rho = 8gm/cc$.

14 Define the following (i) Generalized and principle coordinates (ii) Principla mode and normal mode of vibrations.

15 Determine the natural frequencies and the corresponding modes of vibration of the system shown in Fig. 2. The string is stretched with a large tension T. Also draw the mode shapes.

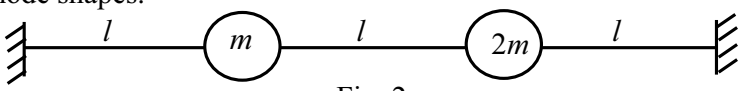


Fig. 2

16 With the derivation of necessary expressions, explain the principle of vibration absorber.

17 Determine the influence coefficients of the triple pendulum shown in Fig.3.

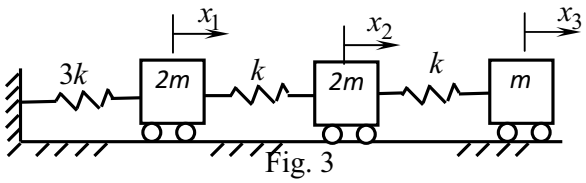


Fig. 3

18 Determine the fundamental natural frequency of transverse vibration of the system shown in Fig. 4 using Rayleigh's method and verify it using Dunkerley's method. Take $EI = 8\times10^4\ Nm^2$.

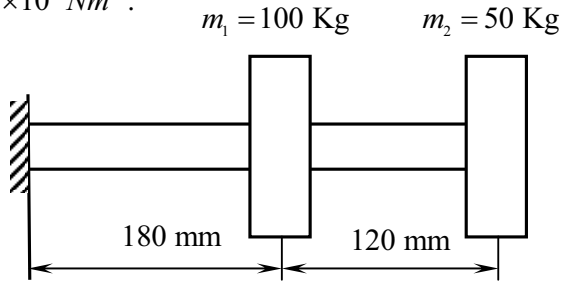


Fig. 4

19 Determine the natural frequencies of the system shown in Fig. 3. Use Holzer's method

20 Using matrix iteration method, determine first two natural frequencies of the system shown in Fig. 3

Course Articulation Matrix

Course Outcomes	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
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	M	H	M									
Determine the response of simple single degree of freedom systems subjected to forced vibration. **Design** mechanical systems with vibration isolation.	H	H	H									
Explain the working principle of vibration measuring instruments. **Determine** the whirling speed of shafts. **Compute** harmonics of general forcing functions using Fourier series.	L	M	H									
Formulate mathematical models and **Solve** vibration problems related to Two degrees of freedom. **Determine** influence coefficients.	M	H	H									
Solve multi degree of freedom systems using Rayleigh and Dunkerley, Stodola, Holzer and Matrix iteration methods.	H	L	L									

Course Title: Finite Element Methods			
Course Code: P13IP663	**Sem: VI**	**L-T-P-H: 4-0-0-4**	**Credits: 4**
Contact Period: Lecture:52Hr Exam: 3Hr		**Weightage: CIE:50; SEE:50**	

Course objective: The course aims to provide an introductory approach to finite element method as a basic numerical tool for solving mechanical engineering problems.

Unit -1

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

Unit -2

INTERPOLATION MODELS: Displacement function, selection of the order of displacement function, convergence criteria, geometric isotropy, Pascal's triangle for 2D polynomial, Different co-ordinate systems used in FEM, Interpolation or shape functions for 1D linear and quadratic bar elements and 2D linear triangular (CST) element in cartesian and natural co-ordinate systems. Lagrangian polynomial – Shape functions for linear quadrilateral element (QUAD 4) and quadratic quadrilateral element (9-noded), Iso-parametric, sub-parametric and super-parametric elements, Concept of Jacobian matrix, Jacobian matrix for CST. **12 hrs**

Unit -3

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. **10 hrs**

Unit -4

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

Unit -5

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

TEXT BOOKS

1 **Introduction to the Finite Element Method:** C. S. Desai and J.F. Abel, EWP an East-West Edition
2 **Introduction to Finite Elements in engineering:** T R Chandrupatla and A D Belegundu, PHI.
3 **The Finite Element Method in engineering:** S S Rao, Elsevier.

REFERENCES BOOKS

1 **The FEM its basics and fundamentals**: O.C.Zienkiewicz, Elsevier, 6e.
2 **Finite Element Method**: J.N.Reddy, McGraw –Hill International Edition.
3 **Finite Element Methods:** by Daryl. L. Logon, Thomson Learning 3rd edition.
4 **Fundamentals of Finite Element Analysis:** David V. Hutton,–Tata McGraw Hill

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** isoparametric 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.

Unit wise Plan

Topic Learning Objectives

Unit I

By the end of the topic, student will be able to

1 Explain FEM, its advanatages, disadvanatages and applications.
2 Explain different types of elements.
3 Apply Gauss elimination method to solve system of algebraic equations.
4 Apply Gauss quadrature rule for numerical integration.
5 Explain principle of minimum potential energy and derive potential energy functional for a three dimensional elastic body.
6 Explain the concept of plane stress and plane strain.

Unit II

By the end of the topic, student will be able to

1 Explain the convergence criteria for interpolation functions.
2 Derive shape functions for bar elements, CST and QUAD elements.
3 Explain iso-parametric formulation and its advantage.
4 Explain the concept of Jacobian matrix.

Unit III

By the end of the topic, student will be able to

1 Derive strain-displacement, element stiffness matrices and load vectors for bar and CST elements.
2 Explain special characteristics of stiffness matrix.
3 Explain the treatment of boundary conditions by elimination and penalty approach.
4 Solve problems on axially loaded bars.

Unit IV

By the end of the topic, student will be able to

1 Explain the concept of local and global coordinate systems.
2 Derive stiffness matrix for truss element.
3 Derive shape functions, stiffness matrix and load vectors for beam element.
4 Solve problems on truss and beam elements.

Unit V

1 Derive governing FE equation for 1D heat transfer problem using functional approach. and Galerkin's method.
2 Explain boundary conditions used in heat transfer problems.
3 Solve problems on 1D heat transfer.

Lesson Plan

Unit I

1	Need for use of FEM, Advantages and disadvantages of FEM, Engineering Applications of FEM, Steps involved in FEM
2	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.
3	Gauss elimination method, numericals
4	Numericals
5	Numerical integration by Gaussian quadrature (one point and two point formula).
6	Numericals
7	Numericals
8	Basic elastic equations – body force and traction force, strain-displacement relations.
9	Basic elastic equations – contd.
10	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.

Unit II

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

Unit III

1	Strain displacement matrix, Stiffness matrix for 1D bar element – Cartesian coordinates.
2	Strain displacement matrix, Stiffness matrix for 1D quadratic bar element – Natural coordinates.
3	Load vectors for 1D linear bar element.
4	Load vectors for 1D quadratic bar element.
5	Strain displacement matrix, Stiffness matrix for CST element.
6	Load vectors for CST element.
7	Assembly of elements by direct stiffness method, special characteristics of stiffness matrix.
8	Treatment of boundary conditions- elimination method
9	Treatment of boundary conditions- penalty method
10	Numericals
11	Numericals
12	Numericals

Unit IV

1	Local and global coordinate systems, stiffness matrix for plane truss element.
2	Numericals

3 Numericals
4 Numericals
5 Shape functions for beam element.
6 Stiffness matrix and load vectors for beam element.
7 Element shear force and bending moment diagrams for beam element.
8 Numericals
9 Numericals
10 Numericals

Unit V

1 Steady state heat transfer, 1D heat conduction- governing equation, boundary conditions.
2 1D heat transfer element, shape functions, gradient heat flux relations.
3 Element conduction matrix by functional approach.
4 Element conduction matrix by Galerkin's method.
5 Load vectors.
6 Numericals with conduction through composite walls.
7 Numericals with conduction and convection from thin fins.
8 Numericals with heat generation.
9 Numericals.
10 Numericals.

Review Questions

1 List the advantages and disadvantages of FEM over other numerical methods.

2 Explain the steps involved in FEM

3 Giving suitable example, explain the following:
(i) Essential and nonessential boundary conditions and (ii) Boundary value and initial value problems

4 Write note on node numbering scheme for the minimization of bandwidth of stiffness matrix

5 Solve the following system of simultaneous equation by Gaussian elimination method:
$2x_1 + x_2 + 3x_3 = 10;\ 4x_1 + x_2 + x_3 = 5;\ 3x_1 + 2x_2 + x_3 = 3$

6 What is meant by body force and surface force? Give examples.

7 With examples explain Plane stress and Plane strain. Give stress-strain relations.

8 Derive equilibrium equation for a 3D body subjected to surface forces.

9 Evaluate $\int_{-1}^{+1}\int_{-1}^{+1}(\xi^2 + 2\xi\eta + \eta^2)d\xi d\eta$ using two-point Gauss quadrature formula.

10 Write a note on convergence criteria and explain Pascal's triangle for 2D polynomial

11 What are the properties of shape functions? Derive the shape functions for a quadratic bar element in terms of natural coordinate system

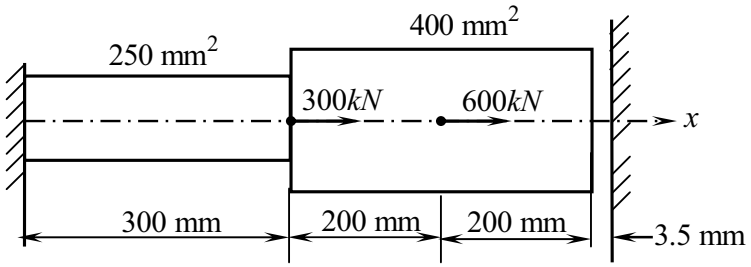
12 Derive strain-displacement matrix B for a quadratic bar element. If the length of the element is 30 mm, obtain B matrix at point P located at 1/4 of the element length.

13 With necessary proof, discuss elimination method used to apply boundary conditions.

14 Calculate the strain displacement matrix *B* and determine the *strains* $\varepsilon_x, \varepsilon_y$ and γ_{xy}, if the nodal displacements of a triangle are given by $u_i = 3mm; u_j = 4mm; u_k = 2mm;$ $v_i = 2mm; v_j = 3mm; v_k = 4mm$

Nodes i, j and k of the triangle are given by the coordinates (1,1), (4,1) and (1,5) respectively.

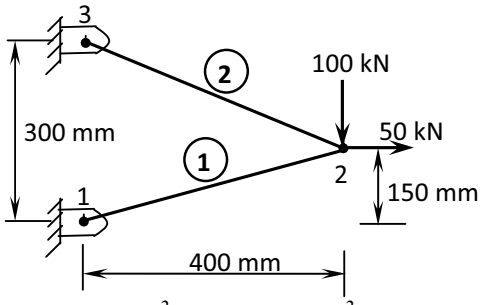
15 For the stepped bar shown in Fig. 1, determine the nodal displacement, stresses and support reactions.



E_1 = 70 GPa; E_2= 200 GPa

Fig. 1

16 For the two-bar truss member shown in Fig. 2, determine the displacement at load point and stresses in each member.



E=200 GPa, A_1=1500 mm^2, A_2=2000 mm^2

Fig. 2

17 Explain the concept of Iso, Sub and Super Parametric elements.

18 The beam shown in Fig. 3, determine the unknown deflections and slopes. Also determine the vertical deflection at the mid-point of the beam having distributed load of 12kN/m. Assume *E=200 GPa and* $I = 4\times10^6 mm^4$.

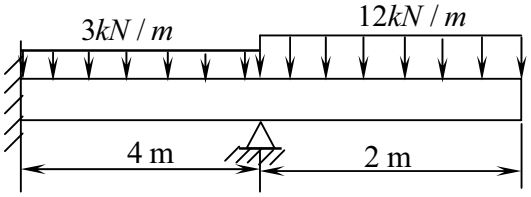


Fig. 3

19 Derive element conductivity and convection matrices for a 1D heat transfer problem using Galerkin's method.

20 The left surface of the plane wall of thickness 1.2 m is maintained at a constant temperature of 200°C and the right side surface is exposed to cold air at -15°C. The heat transfer coefficient associated with the outside surface is h=40W/m^{2o}C. The thermal conductivity is $K_{xx} = 25W/m^oC$ and there is a uniform generation of heat inside the wall of $Q = 400W/m^3$. Determine the temperature distribution through the wall using two elements of equal length.

Course Articulation Matrix

Course Outcomes	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
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.	**H**									**H**		
2. **Develop** interpolation models for different types of elements that satisfy convergence criteria and geometric isotropy. **Use** isoparametric concept in the finite element analysis.	**H**	**H**										
3. **Formulate** element stiffness matrices and load vectors for different elements by **applying** variational principle.	**H**	**H**										
4. **Use** developed finite element models in the **determination** of stresses, strains and reactions of axially loaded bars, trusses and transversely loaded beams.	**H**	**H**										
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.	**H**	**H**										

Course Title: Human Resource Management			
Course Code: P13IP664	**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 Management and Entrepreneurship.

a) Course Learning Objectives (CLO) :

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

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

b) 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: Evolution of HRM, Objectives, Functions and Policies.

HUMAN RESOURCE PLANNING: Uses and benefits, Man Power Inventory, Man Power Forecasting, Methods of Man Power Forecasting, job Description, Job Specification.

10 Hours

Unit – II

RECRUITMENT: Sources of Man power, Advertisement, Short Listing of Candidates calling Candidates for selection Process.

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

Unit – III

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

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

Unit – IV

COUNSELLING AND HUMAN RESOURCE ACCOUNTING: Characteristics, Need, Function, Types, Suggestions for personneldevelopment, communication function, communication process, effectivecommunication. Human resource records, Advantages of HR accounting,Various methods of accounting. **10 Hours**

Unit – V

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

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

TEXT BOOKS:

1. Dr. K Ashwathappa, "Human Resources Management", Tata McGraw Hill, Edition 1999.
2. Hersey and Blanchard, "Management of Organisations Behaviour", Prentice Hall of India Edn – 1998.
3. ArunMonappa , "Industrial Relations", TMH, ISBN – 0-07- 451710-8

REFERENCES BOOKS:

1. Decenoz and robbins, "Personnel / Human resource Management", PHI, 2002.
2. CB Mamoria, "Management of Human Resources", Himalaya Publication House, 2003

Unit wise Plan

Unit-I

Introduction and Human Resource Planning **Planned Hours:10hrs**

Learning Objectives

The Students should be able to,

1. Define the concept of Human Resource Management [L1].
2. Understand the scope and objectives of HRM[L2].
3. Understand the process of HRP [L2].
4. Define the different internal and external factors which affects HRP [L1].
5. Understand the concept of Job Analysis [L2].

Unit-II

Recruitment and Selection. **Planned Hours:12hrs**

Learning Objectives

The Students should be able to,

1. Define the concept of Recruitment [L1].
2. Define the different methods of Recruitment [L1].
3. Define the different methods used in selection process [L1].
4. Understand the advantages and limitations of different methods of Selection process [L1].

Unit-III

Training and Development and Performance Appraisal. **Planned Hours:12hrs**

Learning Objectives

The Students should be able to,

1. Define the concept Training, Development and Performance appraisal [L1].
2. Understand the importance of Identification of Training needs [L2].
3. Understand the importance of Training evaluation and Training budget [L2].
4. Define the different methods of Performance appraisal process [L1].
5. Understand the limitations of different methods of Performance appraisal process [L2].

Unit-IV

Counselling and Human Resource Accounting. Planned Hours:10hrs

Learning Objectives

The Students should be able to,

1. Define the characteristics, need and functions of Counselling [L1].
2. Define the different methods of Counselling [L2].
3. Understand the communication process [L2].
4. Define the advantages of HR accounting and different methods of accounting [L1].

Unit-V

Industrial Relations, Industrial Disputes and Settlement. Planned Hours:08hrs

Learning Objectives

The Students should be able to,

1. Understand the different acts such as Standing Order Act, Indian Factory Act, ESI Act., etc., [L2].
2. Define the causes for Industrial Disputes. [L1].
3. Understand Board of Conciliation, Voluntary Arbitration, Industrial tribunal and Adjudication [L2].

Lesson Plan

Unit-I

	Portion covered per Hour (An Estimate)
1	HRM : Introduction.
2	HRM – Definition and Evolution of HRM.
3	Objectives of HRM – Societal, Organizational, Functional and Personal.
4	Scope of HRM.
5	Principles, Policies and Functions of HRM.
6	HRP : Introduction and factors affecting HRP.
7	Human Resource Planning Process.
8	Forecasting Techniques.
9	Job Description.
10	Job Specification.

Unit-II

1.	Recruitment : Introduction.
2.	Factors affecting Recruitment process.
3.	Recruitment process.
4.	Advertisement.
5.	Advantages of Advertisement.
6.	Selection : Introduction.
7.	Factors affecting Selection process.
8.	Selection procedure.
9.	Internal and External methods of recruitment.
10.	Psychological testing – Advantages and limitations.
11.	Induction procedure, transfers and promotion.
12.	Interview – Written Test and Group discussion.

Unit-III

1. Training and Development : Introduction.
2. Identification of Training needs.
3. Training process.
4. On-Job and Off-Job training methods.
5. Training Evaluation and Training Budget.
6. Development : Executive development approaches.
7. Development : Non-executive development methods.
8. Performance appraisal : Introduction.
9. Performance appraisal process.
10. Different methods of Performance appraisal process.
11. Advantages and limitations of different methods of performance appraisal process.
12. Personal Counselling based on Annual Confidential Reports.

Unit-IV

1. Counselling : Introduction.
2. Characteristics of Counselling.
3. Functions and types of Counselling.
4. Suggestions for Personal development.
5. Communication Process.
6. Functions of Communication.
7. Effective communication process and its barriers.
8. Human Resource Records.
9. Advantages of HR Accounting.
10. Various methods of accounting.

Unit-V

Portion covered per Hour (An Estimate)

1. Industrial Relations : Introduction.
2. Indian Trade Union Act and Standing Orders Act.
3. ESI Act.
4. Industrial Disputes and Settlement : Introduction.
5. Indian Industrial Disputes Act and Industrial Disputes settlement Machinery.
6. Works committee and Board of Conciliation.
7. Voluntary Arbitration and Compulsory arbitration.
8. Court of Inquiry, Industrial Tribunal and Adjudication.

Review Questions

1. Define Human Resource Management.
2. Explain the Evolution of HRM.
3. With a block diagram explain the objectives of HRM.
4. Mention the Functions of HRM.
5. Define the principles of HRM.
6. Mention the uses and benefits of HRP.
7. Briefly explain the different forecasting techniques.
8. Define Job Description and Job Specification.
9. With a block diagram explain the process of HRP.
10. Mention the Internal and External Factors which affects HRP process.
11. Explain in brief the different external factors which affect HRP.
12. Define Recruitment process.
13. Explain different factors which affect Recruitment process.
14. Write a note on Advertisement.
15. With a block diagram explain the process of recruitment.
16. Explain Voluntary retirement scheme.
17. Explain in brief different methods of Recruitment process.
18. With a block diagram explain the process of Selection.
19. Write a note on Induction program.
20. Write a note on Transfers, Promotion and Interview.
21. Explain the Internal methods of recruitment process.
22. Explain in brief different external methods of recruitment process.
23. Explain Group discussion.
24. Write a note on Training and development.
25. Write a note on Identification of Training needs.
26. Explain Training Evaluation.
27. What is Executive development?
28. Explain different non-executive development methods.
29. With a block diagram explain the training process.
30. What is Performance appraisal?
31. Mention the advantages and limitations of performance appraisal process.
32. What is Personal counselling?
33. Explain the different methods of Training process.
34. Mention the advantages and limitations of Internal Training process.
35. Mention the disadvantages of External Training process.
36. Mention the need of Counselling.
37. Mention the functions of Counselling and Human Resource accounting.
38. What is Communication?
39. Briefly explain the different methods of communication.
40. What is effective communication?
41. With a block diagram explain the communication process.
42. What is the barrier for effective communication?
43. Mention the advantages of HR Accounting.
44. Briefly explain the different methods of Accounting.
45. Write a note on Indian Trade Union Act.
46. Write a note on Standing Order Act.
47. Write a note on ESI Act.
48. Write a note on Indian Factories Act.
49. What is Industrial Disputes?
50. Write a note on Industrial Tribunal and Adjudication.