Department of Production Engineering & Industrial Management
College of Engineering Pune

2018-19

B.Tech Structure

[M- Group: Mechanical, Civil, Metallurgy & Material Science, Production S/W]

(w.e.f. 2015-16)

List of Abbreviations:

Abbreviation	Title	No of courses	Credits	% of Credits	
BSC	Basic Science Course	12/13	30/33	18-20	Approx. 40-45 %
EFC	Engineering Foundation Course	9	22	13	
MLC	Mandatory Learning Course	4	0	0	
ILOE	Institute Level Open Elective Course	2	6	3.5	
SLC	Self Learning Course	1	3	2	
HSMC	Humanities/Social Sciences/Management Course	5/6	8/11	4.5 / 6.5	
LLC	Liberal Learning Course	1	1	1.18	
SBC	Skill Based Course	5	23	13.5	Approx. 55- 60 %
PCC	Program Core Course	16	51	30	
DEC	Department Elective Course	2	6	3.5	
LC	Laboratory Course	19	41	24.11	

First Year B. Tech (All Branch)
Curriculum Structure
(w.e.f. 2015-16)

Semester I [M-Group]

Sr. No.	Course Type	Course Code	Course Name	TeachingScheme			Credits
				L	T	P	
1	BSC		Linear Algebra	2	1	0	3
2	BSC		Optics and Modern Physics	3	0	0	3
3	EFC		Basic Electrical Engineering	3	0	0	3
4	EFC		Computer Aided Engineering Drawing	2	0	2	3
5	EFC		Engineering Mechanics	3	0	0	3
6	LC		Mechanical Fab Shop	0	0	3	2
7	LC		Optics and Modern Physics Laboratory	0	0	2	1
8	LC		Electrical Engineering Laboratory	0	0	2	1
9	HSMC		Professional Communication	1	1	0	2
10	LC		Engineering Mechanics Laboratory	0	0	2	1
				14	**2**	**11**	**22**
			Total Academic Engagement and Credits	**27**			**22**

Semester II [M-Group]

Sr. No.	Course Type	Course Code	Course Name	TeachingScheme			Credits
				L	T	P	
1	BSC		Univariate Calculus	2	1	0	3
2	BSC		Solid State Physics and Statistical Thermodynamics	3	0	0	3
3	BSC		Applied Chemistry	3	0	0	3
4	EFC		Basic Electronics Engineering	3	0	0	3
5	EFC		Computer Programming	3	0	0	3
6	LC		Solid State Physics Laboratory	0	0	2	1
7	LC		Computer Programming Laboratory	0	0	4	2
9	LC		Applied Chemistry Laboratory	0	0	2	1
10	LC		Electronics and Computer Workshop	0	0	2	1
				14	1	10	20
			Total Academic Engagement and Credits	**22**			**20**

Second Year B. Tech (Production S/w)
Curriculum Structure (w.e.f. 2016-17)
Semester III [Odd Term]

Sr. No.	Course Type	Course Name	Teaching Scheme			Credits
			L	T	P	
1	BSC	Ordinary Differential Equations and Multivariate Calculus	2	1	-	**3**
2	BSC	Science of Living Systems	3	-	-	**3**
3	SBC	Innovation	1	-	-	**1**
4	PCC1	Strength of Materials	2	1	-	**3**
5	PCC2	Fundamentals of Metallurgy	3	-	-	**3**
6	PCC3	Theory of Machines	3	-	-	**3**
7	PCC4	Production Processes	3	1	-	**4**
8	LC1	Fundamentals of Metallurgy Laboratory	-	-	2	**1**
9	LC2	Theory of Machines Laboratory	-	-	2	**1**
10	LC3	Production Processes Laboratory	-	-	2	**1**
11	LC4	Product and System Graphics Laboratory	-	-	2	**1**
			17	**3**	**8**	**24**
		Total Academic Engagement and Credits	**28**			**24**

Semester IV [Even Term]

Sr. No.	Course Type	Course Name	Teaching Scheme			Credits
			L	T	P	
1	BSC	Vector Calculus and Partial Differential Equations	2	1	-	**3**
2	MLC	Environmental Studies	2	-	-	**-**
3	ILOE	Production Processes and Metrology	3	-	-	**3**
4	HSMC	Professional Ethics and Value Education	2	-	-	**0**
5	HSMC	Entrepreneurship Development	1	-	-	**1**
6	PCC1	Engineering Thermodynamics and Heat Transfer	3	-	-	**3**
7	PCC2	Fluid Power	3	-	-	**3**
8	PCC3	Design of Machine Elements	3	1	-	**4**
9	PCC4	Machining Science and Technology	3	1	-	**4**
10	LC1	Industrial Electronics and Electrical Drive Systems Laboratory	-	-	2	**1**
11	LC2	Engineering Thermodynamics and Heat Transfer Laboratory	-	-	2	**1**
12	LC3	Fluid Power Laboratory	-	-	2	**1**
			22	3	6	**24**
		Total Academic Engagement and Credits	**31**			**24**

Semester III (For Direct Second Year Admitted Diploma Students)

Sr. No.	Course Type	Course Name	Teaching Scheme			Credits
			L	T	P	
1	BSC	Linear Algebra and Univariate Calculus	4	1	-	**5**
2	BSC	Foundation of Physics	3	-	-	**3**
3	BSC	Science of Living Systems	3	-	-	**3**
4	SBC	Innovation	1	-	-	**1**
5	PCC1	Strength of Materials	2	1	-	**3**
6	PCC2	Fundamentals of Metallurgy	3	-	-	**3**
7	PCC3	Theory of Machines	3	-	-	**3**
8	PCC4	Production Processes	3	1	-	**4**
9	LC1	Fundamentals of Metallurgy Laboratory	-	-	2	**1**
10	LC2	Theory of Machines Laboratory	-	-	2	**1**
11	LC3	Production Processes Laboratory	-	-	2	**1**
12	LC4	Product and System Graphics Laboratory	-	-	2	**1**
			22	**03**	**8**	**29**
		Total Academic Engagement and Credits	**33**			**29**

Semester IV (For Direct Second Year Admitted Diploma Students)

Sr. No.	Course Type	Course Name	Teaching Scheme			Credits
			L	T	P	
1	BSC	Multivariate Calculus and Differential Equations	4	1	-	**5**
2	MLC	Environmental Studies	2	-	-	**-**
3	ILOE	Production Processes and Metrology	3	-	-	**3**
4	HSMC	Professional Ethics and Value Education	2	-	-	**0**
5	HSMC	Entrepreneurship Development	1	-	-	**1**
6	PCC1	Engineering Thermodynamics and Heat Transfer	3	-	-	**3**
7	PCC2	Fluid Power	3	-	-	**3**
8	PCC3	Design of Machine Elements	3	1	-	**4**
9	PCC4	Machining Science and Technology	3	1	-	**4**
10	LC1	Industrial Electronics and Electrical Drive Systems Laboratory	-	-	2	**1**
11	LC2	Engineering Thermodynamics and Heat Transfer Laboratory	-	-	2	**1**
12	LC3	Fluid Power Laboratory	-	-	2	**1**
			24	**3**	**6**	**26**
		Total Academic Engagement and Credits	**33**			**26**

Third Year B. Tech (Production S/w)
Curriculum Structure
(w.e.f. 2017-18)

Semester V

Sr. No.	Course Type	Course Code	Course Name	TeachingScheme			Credits
				L	T	P	
1	SBC		Industrial In-plant Training	0	0	0	10
2	LC		Seminar-I	0	0	0	2
3	SLC		Basics of Kinematics and Dynamics of Machines (MOOC)	0	0	0	3
				0	**0**	**0**	**15**
			Total Academic Engagement and Credits	**Max. 0**			**15**

Semester VI

Sr. No.	Course Type	Course Code	Course Name	TeachingScheme			Credits
				L	T	P	
1	DEC		Department Elective –I	3	0	0	3
2	PCC		Metrology and Quality Control	3	0	0	3
3	PCC		Kinematics and Dynamics of Machines	3	1	0	4
4	PCC		Tool and Die Design	3	0	0	3
5	PCC		Material Forming	3	0	0	3
6	LC		Metrology and Quality Control Laboratory	0	0	2	1
7	LC		Kinematics and Dynamics of Machines Laboratory	0	0	2	1
8	LC		Tool and Die Design Laboratory	0	0	2	1
9	SBC		Modelling and Simulation Lab	0	0	4	2
10	BSC		Numerical Methods Lab	0	1	2	2
11	MLC/SLC		Constitution of India	2	0	0	0
12	HSMC		Industrial Engineering and Engineering Economics	3	0	0	3
				20	2	12	26
			Total Academic Engagement and Credits	**Max. 34**			**26**

Final Year B. Tech (Production S/w)
Curriculum Structure
(w.e.f. 2018-19)

Semester VII

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	OEC		ILOE-II (Engg./Science/Technology)	3	0	0	3
2	PCC		Machine Tool Design	3	0	0	3
3	PCC		CAD / CAM / CIM	2	1	0	3
4	PCC		Manufacturing Automation	3	0	0	3
5	DEC		Department Elective -II	3	0	0	3
6	PSM		Operations Research	3	0	0	3
7	LC		CAD / CAM / CIM Laboratory	0	0	2	1
8	LC		Manufacturing Automation Laboratory	0	0	2	1
9	SBC		Software Laboratory	0	1	2	2
10	LC		Process Planning and Tool Selection Laboratory	0	0	2	1
11	MLC/SLC		Intellectual Property rights	1	0	0	0
12	LLC		Liberal Learning Course	1	0	0	1
				19	2	8	24
			Total Academic Engagement and Credits	**Max.29**			**24**

Semester VIII

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	SBC		Industrial In-plant Training	0	0	0	10
2	LC		Seminar-II	0	0	0	2
3	SLC		Project and Production Management / Equivalent MOOC's Course	0	0	0	3
	LLC			0	0	0	15
			Total Academic Engagement and Credits	**Max. 0**			**15**

Select Any one from below list of Department Elective Course-I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	DEC		Product Design and Manufacture	3	0	0	3
2	DEC		Total Quality Management	3	0	0	3
3	DEC		Micro electro mechanical systems	3	0	0	3
4	DEC		Tribology in manufacturing	3	0	0	3
5	DEC		Mechatronics	3	0	0	3
6	DEC		Robotics	3	0	0	3
7	DEC		Artificial Intelligence	3	0	0	3
8	DEC		Advanced Joining Technology	3	0	0	3

Minors- Manufacturing Technology (Mechanical)

Semester	Course offered	Teaching Scheme			Credits
		L	T	P	
V	Metrology and Quality Control	3	-	-	3
VI	Engineering Economics and Operations Research	3	-	-	3
VII	Manufacturing Automation	3	-	-	3
VIII	Industrial Design of Products	3	-	-	3

Minors- Manufacturing Technology (Civil/ENTC/Electrical/Instru/Comp/IT/Meta)

Semester	Course offered	Teaching scheme			Credits
		L	T	P	
V	Production Processes	3	-	-	3
VI	Engineering Economics and Operations Research	3	-	-	3
VII	Manufacturing Automation	3	-	-	3
VIII	Industrial Design of Products	3	-	-	3

Honors- Manufacturing Systems Engineering

Semester	Course offered	Teaching scheme			Credits
		L	T	P	
V	Precision Engineering	3	-	-	3
VI	Reliability and Maintenance Engineering	3	-	-	3
VII	Performance Modeling Of Production Systems	3	-	-	3
VIII	Machine Tool Systems	3	-	-	3

Honors- Mechatronics

Semester	Course offered	Teaching scheme			Credits
		L	T	P	
V	Principles of Electronics	3	-	-	3
VI	Industrial Instrumentation and Control	3	-	-	3
VII	Fluid Power Systems and Factory Automation	3	-	-	3
VIII	Mechatronics System Design	3	-	-	3

MACHINE TOOL DESIGN

Teaching Scheme	Examination Scheme
Lectures : 3 hrs/week	100 marks: Continuous evaluation- Assignments
Tutorial :	/Quiz/T1/T2 - 40 Marks, End Sem Exam- 60 marks

Course Objectives:

1. To understand kinematic structure of conventional machine tool.
2. To understand basic design of various elements of machine tool.
3. To learn basic design of stepped speed gear box and step less speed of machine tools.
4. To get knowledge of different control system in machine tool.
5. To get acquainted with characteristics of machine tool like reliability, rigidity etc.

Syllabus Contents:

Unit 1 **(10 hrs)**

Introduction and Drives

Recent trends in machine tool design, Classification and kinematic structure of machine tool, Consideration for machine tool speed drive, Structural and ray diagram etc., Electric motor selection, Feed drive types, Friction variator- Principle and types.

Unit 2 **(14 hrs)**

Elements of machine tool

Design of bed- Optimum design criteria, Cross sections, stiffness, Materials, Column design methodology for radical drilling and milling machine.

Design of guides-materials, Requirements, Types, Average pressure, stability, wear and it's compensation, Combination guide, stick-slip.

Design of spindle- Material, spindle ends and supports, Spacing between supports.

Design of power screws-Design methodology, Pitch error, Specific pressure on thread, Recirculating ball screw, Axial load and dynamic load carrying capacity, Rigidity etc.

Unit 3 **(4 hrs)**

Rigidity of machine tool

Static and dynamic rigidity, Source of vibration, chatter, static compliance of lathe, Dynamic rigidity analysis.

Unit 4 **(4 hrs)**

Control system in machine tool

Electrical control- Push button system, selective and pre selective control.

Adaptive control- ACO/ACC etc. control involving thermal relay, Directional control valves, Quick braking etc., Hydraulic control, use of stepper motor and servo motor.

Unit 5 **(6 hrs)**

NC- CNC AND FMS

Introduction, Block diagram of NC, Tool motion, Axes designation, CNC block diagram, Open/ Close loop control, Sensors, FMS- definition, Classification, Automatic tool changer, Machining centres.

Unit 6 **(4 hrs)**

Micro movement and reliability of machine tool

Micro movement method- Magnetostrictine, Thermodynamic etc, Reliability of component, Condition based maintenance and reliability centric maintenance.

Text Books:

- D.K. Pal and S.K.Basu, Design of Machine Tools (6th Revised Ed), Oxford-IBH 2014.
- A. Bhattacharya and G.C. Sen, Principles of Machine Tools, New Central Book Agency, Calcutta

Reference Books:

- Acherkan, N.S. et al Machine Tools Vol. I to Vol. IV, :, MIR Publications
- Martin, S.J. NC Machine Tools,: ELBS
- Koenigsburger, A., Design Principles of MCMT Pergamon press, 1964.
- Mehta, N.K., Machine Tool Design, Tata McGraw Hill
- T Kundra, Rao, P.M., Tiwari, N.K. Numerical Control and Computer Aided Manufacturing, Tata McGraw Hil

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Knowledge about Design of various elements of machine tools and their structures.
2. Knowledge of drives in machine tools.
3. Learn the methods of acceptance tests for machine tools.
4. Knowledge of NC-CNC machine & their controls.
5. Information about recent trends in machine tools

CAD /CAM /CIM

Teaching Scheme	Examination Scheme
Lectures: 2 hrs/week	T1 and T2 – 20 marks each, End-Sem Exam - 60
Tutorial: 1 hrs/week	

Course Objectives:

1. The aim of this course is to develop an understanding of the basic principles underlying Computer aided tools used in engineering and to develop students' awareness in the application of CAD and CAM systems in the context of developing engineering products.
2. To provide the students with a foundation in computer aided design.
3. To produce knowledgeable users of CAD systems.
4. To understand the basic concept of Computer Integrated manufacturing and its Industrial applications using Modern Production Techniques.
5. To understand the concepts of CAD/CAM within the scope of CIM.

Syllabus Contents:

Unit 1 **(4 hrs)**

Introduction to CAD/CAM

Introduction: Trends in Modern Manufacturing, Product Cycle and CAD/CAM, Functional relationship, Elements of CAD Hardware.

Computer Graphics: Transformation- Introduction, Formulation, Translation, Rotation, Scaling, Reflection, Homogenous Representation, Concatenated Transformation, Inverse Transformations.

Unit 2 **(7 hrs)**

Modelling

Curves:- Introduction, Analytic Curves, Parametric representation, Line, Circle, Parabolas, Hyperbolas, Ellipses, Conics. Geometric continuity (C0, C1, C2) and Visual continuity (G0, G1, G2), Synthetic Curves, Hermite Cubic Spline, Bezier Curve, B-Spline Curve and NURB

Surface:- Introduction, Surface Representation, Analytic Surface, Synthetic Surfaces, Hermite bicubic Surface, Bezier surfaces, B-spline Surfaces, Coons Surface, Reverse Engineering

Solids:-Introduction, Geometry & Topology, Solid Representation, Boundary Representation, Constructive Solid Geometry, Sweeps, Solid Manipulations, Feature Based Modelling**.**

Unit 3 **(7 hrs)**

Rapid Prototyping

Importance and overview of Rapid Prototyping, Classification of Rapid Prototyping (RP) Process (FDM, LOM, SLA, SLS, Stereolithography etc.), Typical Process Chain for RP, Introduction to CAD and Data exchange format, data format details, conversion, validation, repairing, Part Slicing and Orientation and its importance, application and case studies**.**

Unit 4 **(6 hrs)**

NC Programming

Machine Tool Co-ordinate System, Machine zero, Job zero, Cutter Programming, Tool Offsets, Programming Steps, NC Programming Languages, G-codes and M-codes. Turning Center programming, Machining Center programming, Advance features of Controller.

Unit 5 **(6 hrs)**

Computer Integrated Manufacturing (CIM)

Computer application in manufacturing, computer aided inspection and quality control. Computer integrated production management system, inventory material requirement planning, manufacturing resource planning, enterprise resource planning

Computer aided process planning (CAPP): Retrieval CAPP, generative CAPP and computer assisted shop floor control.

Unit 6 (**2 hrs)**

Group Technology

Part Families, Part classification and coding, production flow analysis, Rank Order Clustering Algorithm, machine cell design and Cellular manufacturing.

Text Books:

- Mikel P. Groover and Emory W. Zimmers: Computer Aided Design and Manufacturing, Prentice Hall.
- T. Kundra, Rao P.M., Tiwari N.K. : Numerical Control and Computer Aided Manufacturing, Tata McGraw Hill
- Nanua Singh: Systems Approach to Computer-Integrated Design and Manufacturing, John Wiley and Sons, Inc.
- P. Radhakrishnan and Subramaniam: CAD / CAM / CIM, Wiley Eastern Ltd.
- Venuvinod, PK., MA. W., Rapid Prortotyping – Laser Based and Other Technologies, Kluwer, 2004.

Reference Books:

- Paul C. Bave: CAD Principles and Applications
- Mikell P. Groover: Automation, Production systems & Computer Integrated Manufacturing, Prentice Hall.
- Ibrahim Zeid: Mastering in CAD-CAM, Tata McGraw Hill Publication.

Course Outcomes:

The student will show their ability at a professional level to:

1. Describe the principles of Computer Aided Designing systems and the concepts of Transformation, Geometric modeling, solid modeling, and feature-based design modeling.
2. Create and design and manufacturing of mechanical parts using state of the art CAD System and Rapid Prototyping techniques.
3. Compare and distinguish the difference between the operation and programming of a CNC machine tool using manual programming and the operation and programming of CNC machine

tool using CAM systems. Apply practices (manually) to develop the G-code program.

4. Exposure of different types of manufacturing available today such as the Special manufacturing System, the Manufacturing Cell, and the Flexible Manufacturing System (FMS), basic concepts of Group Technology and Computer Aided Process Planning.

(PE 407) MANUFACTURING AUTOMATION

Teaching Scheme	Examination Scheme
Lectures : 3 hrs/week	100 marks: Continuous evaluation- Assignments
Tutorial: -	T1-20, T2 – 40, ESE- 60 marks

Course Objectives:

- To provide the student a comprehensive technical knowledge of the important topics in production automation and related systems.
- To provide information about manufacturing operations and technologies that have been developed to automate manufacturing operations and industrial control systems
- To provide the student with a sound, basic background in the vast field of fluid power and automation
- To aware the students about basics of Mechatronics System Design related to automation of manufacturing operations

Syllabus Contents:

Unit 1 **(8 hrs)**

Overview of Manufacturing:

Introduction to Production Systems, Automation in Production Systems, Overview of Manufacturing, Manufacturing Operations, Manufacturing Models and Metrics

Automation, Mechatronics and Control Technologies:

Introduction to Automation, Definition of Mechatronics, Mechatronics in Manufacturing, Industrial Control Systems, Hardware Components for Automation, Mechatronics and Process Control (Data Conversion Devices, Sensors, Microsensors, Transducers, Signal Processing Devices, Relays, Contactors and Timers), Data Acquisition, Actuators and Mechanisms

Unit 2 **(8hrs)**

Material Handling and Identification Technologies

Introduction to Material Handling, Principles of Material Handling, Material Transport Systems, Automated Guided Vehicle System (AGVS), Conventional and Automated Storage Systems, Engineering Analysis of Storage Systems, Automatic Identification and Data Capture

Manufacturing Systems

Introduction to Manufacturing Systems, Single Station Manufacturing Cells, Manual Assembly Lines: Single Model and Mixed Assembly Line Balancing, Automated Production Lines, Automated Assembly Systems

Unit 3 **(6 hrs)**

Automation and Principle of Hydraulic and Pneumatic Circuit Design and Analysis

Hydraulic and Pneumatic Controls, Application in Machine Tools and other Mechanical Fields, Hydraulic and Pneumatic Circuit Design Considerations, Functional Diagram in

Circuit Design, Pneumatic Circuit Analysis, Electrical Controls for Fluid Power Circuits, Fluid Logic Control Systems, Fluid Power Maintenance and Safety, Synthesis of circuits, circuit optimization techniques.

Unit 4 **(6 hrs)**

Programmable Automation

(Processor)

Overview of Microcomputer systems, Microcontroller, 8051 Microcontroller Architecture, 8051 Instruction set and interfacing, applications and assembly language programming of microcontroller

Unit 5 **(8 hrs)**

Control System and Controllers

Transfer function and block diagram, Block Diagram Reduction, Controller Principles, Process Characteristics, Control System Parameters, Controller Modes, Control Actions

Discrete Control

Programmable Logic Controllers, Basic Structure, Ladder Logic Programming, Types and Selection of PLC

Unit 6 **(6 hrs)**

Mechatronic Systems – Control Architectures, Design Strategy and Case Studies

Introduction, Control Architecture, Traditional and Mechatronics Designs, Possible Mechatronic Design Solutions, Case Studies of Mechatronic Systems

Text Books:

- Mikell P. Groover, Automation, Production Systems, and Computer Integrated Manufacturing, Third Edition, Prentice-Hall of India Private Limited.
- W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education Limited
- S. R. Majumdar, Pneumatic Systems: Principles and Maintenance, Tata McGrawHill

Reference Books:

- N. P. Mahalik, Mechatronics: Principles, Concepts and Applications, Tata McGraw Hill
- S. R. Majumdar, Oil Hydraulic Systems: Principles and Maintenance, Tata McGraw Hill
- HMT Ltd. Mechatronics, Tata McGraw-Hill
- Joji P. Pneumatic Controls, Wiley India

Course Outcomes:

At the end of the course, student will be able to:

1. Enumerate the overview of manufacturing operations in the perspective of automation in production system
2. Identify the elements of mechatronics and automation in manufacturing systems.
3. Choose automation and control technology for implementation of automation in manufacturing
4. Analyze the material handling technologies used in factory automation
5. Evaluate various manufacturing systems of industrial environment
6. Build basic logical circuit for fluid power systems used in factory automation

(DEC) PRODUCT DESIGN AND MANUFACTURE

Teaching Scheme
Lectures : 3 hrs/week
Tutorial: -

Examination Scheme
100 marks: Continuous evaluation- Assignments /Quiz/T1/T2 - 40 Marks , End Sem Exam- 60 marks

Course Objectives:

1. Gain an understanding and appreciation of the breadth and depth of the field of Product design and manufacturing.
2. Understand the various basics of Product design phases, design morphology, considerations in different manufacturing processes and value engineering.
3. Learn how to apply optimization, ergonomics and anthropometry for product design and manufacturing.
4. Learn to design, develop and manufacturing of a product.

Syllabus Contents:

Unit 1 **(5 hrs)**

Introduction To Product Design

Asimow's Model: Definition of Product Design, Design by Evolution, Design by Innovation, Essential Factors of Product Design, Production-Consumption Cycle, Flow and Value Addition in the Production-consumption Cycle, The Morphology of Design (The sever phases), Primary Design Phases and flowcharting, Role of Allowance Process Capability, and. Tolerance in Detailed Design and Assembly.

Unit 2 **(8 hrs)**

Product Design Practice and Industry

Introduction, Product Strategies Time to Market, Analysis of the Product, The Three S's, Standardization Renard Series (Preferred Numbers), Simplification, The Designer and it's Role, The Designer: Myth and Reality, The Industrial Design Organization Basic Design Considerations, Problems faced by Industrial Designer. Procedure adopted by Industrial Designers, Types of Models designed by Industrial Designers, What the Designer contributes, Role of Aesthetics in Product Design, Functional Design Practice.

Review of Strength, Stiffness and Rigidity Considerations in Product Design

Principal Stress Trajectories (Force - Flow Lines), Balanced Design, Criteria and Objectives of Design, Material Toughness: Resilience, Designing for Uniform Strength, Tension vis-à-vis Compression.

Unit 3 **(8 hrs)**

Design for Production - Metal Parts

Producibility Requirements in the Design of Machine Components, Forging Design, Pressed Components Design, Casting Design, Design for Machining Ease, The Role of Process Engineer, Ease of Location and Clamping, Some Additional Aspects of Production Design, Die Casting and Special Castings, Design for Powder Metallurgical Parts, Expanded Metals and Wire Forms.

Designing with Plastics, Rubber, Ceramics and Wood

Approach to Design with Plastics, Plastic Bush Bearings, Gears in Plastic, Fasteners in Plastic, Rubber Parts, Design Recommendations for Rubber Parts, Distortion in Rubber, Dimensional Effects, Tolerances, Ceramics and Glass Parts, Production Design Factors for Ceramic Parts, Special Considerations for Design of Glass Parts, Dimensional Factors and Tolerances, Wood. Design for assembly and disassembly.

Unit 4 **(8 hrs)**

Optimization in Design

Introduction, Siddal's Classification of Design Approaches, Optimization by Differential Calculus, Lagrange Multipliers, Simplex search Method, Geometric Programming, Johnson's Method of Optimum Design.

Unit 5 **(8 hrs)**

Economic Factors Influencing Design

Product Value, Design for Safety, Reliability and Environmental Considerations, Manufacturing Operations in relation to Design, Economic Analysis, Profit and Competitiveness, Break- even Analysis, Economics of a New Product Design (Samuel Eilon Model).

Human Engineering Considerations in Product Design

Introduction, Human being as Applicator of Forces, Anthropometry: Man as Occupant of Space, The Design of Controls, The Design of Displays, Man/Machine Information Exchange.

Unit 6 **(8 hrs)**

Value Engineering and Product Design

Introduction, Historical& Perspective, What is Value? Nature and Measurement of Value, Maximum Value, Normal Degree of Value, Importance of Value, The Value Analysis, Job Plan, Creativity, Steps to Problem-solving and Value Analysis, Value Analysis Tests, Value Engineering Idea Generation Cheek-list, Cost Reduction through Value Engineering Case Study on Tap Switch Control Assembly, Material and Process Selection in Value Engineering.

Modern Approaches to Product Design

Concurrent Design, Quality Function Deployment (QFD) for design.

Text Books:

- A.C. Chitale and R.C. Gupta, Product Design and Manufacturing by PHI.
- Karl T. Ulrich & Steven D., Product Design & Development Eppinger Tata McGraw Hill, 3rd Edition, 2003

Reference Books:

- Tim Jones, Butterworth Heinmann, New Product Development by Oxford, *TAC*- 1997.
- Roland Engene Y.,Inetoviez, New Product Development: Design & Analysis, John Wiley and Sons Inc., N.Y. 1990.
- Geofferry Boothroyd, Peter Dewhurst and Winston Knight. Product Design for

Manufacture and Assembly, Amherst, 1983.
- Bill Hollins, Stwout Pugh, Butterworth, Successful Product Design by London 1990.
- Boothroyod & DewburstP.,Design for Assembly, a Designer's Hand book, University of Massachusets, Amherst, 1983.
- Keyinotto & Kristini Wood, Product Design Pearson Education 2004.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Learn basics of product design process and morphology of design.
2. Students are exposed to Concept design, detail design, manufacturing, marketing, Introduction strategy of new product. Students learn about process of design for production of metal components.
3. Understand producibility requirements in the Design of Machine Components.
4. To understand optimization tools and ergonomic principles applied on typical product design as well as concept of value engineering in new product design.
5. To prepare a brief presentation on design morphology of at least one product as well as assignments is given to students to evaluate manufacturability and design for production.
6. At the end of course students should aware of different stages of product design.

() TOTAL QUALITY MANAGEMENT

Teaching Scheme
Lectures : 3 hrs/week
Tutorial: -

Examination Scheme
Test 1 – 20, Test 2 – 20, End-Sem Exam- 40.

Course Objectives:

- To develop the quality consciousness among the students by teaching modern quality management techniques and to make them competitive in global quality scenario.

Syllabus Contents:

Unit 1 **(6 Hrs)**

Introduction To Quality Management

Definitions – TOM framework, benefits, awareness and obstacles. Quality – vision, mission and policy statements. Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality. Historical review, Ten principles of quality management. Overview of the contributions of Deming, Juran, Crosby, Masaaki Imai, Feigenbaum, Ishikawa, PDSA cycle, Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio. Concepts of Quality circle, Japanese 5S principles and 8D methodology.

Unit 2 **(9 Hrs)**

Statistical Process Control and Process Capability

Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed. Process capability – meaning, significance and measurement. Acceptance Sampling by variables, some aspects of specifications and tolerances, Process capability. Sampling inspection, OC Curves and Sampling Plan, 100% Inspection and Selective Inspection, Statistics in Selective inspection. Measurement system capability, Gauge R&R study, Machine Capability study, statistical tolerances. Control charts for individual measurements, X chart, Moving average and moving range charts, exponential weighted moving average chart, cumulative sum chart.

Unit 3 **(9 Hrs)**

Quality Improvement Through Design of Experiments

Data analysis, Analysis of variance, t test, f test, Normal probability plot, box plot, full factorial experiments, main effects of a factor, two factor experiments. Regression, Taguchi method, Design of orthogonal experiments, data analysis by response graph method and analysis of variance

Unit 4 **(5 Hrs)**

Six Sigma Approach to Quality and Concepts Of Reliability

Six sigma introduction, Sigma Quality level, Six sigma methodology, DMAIC, DMADV, tools used in six sigma projects. Sigma case Six studies. Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve, maintainability

Unit 5 **(6 Hrs)**

Tools and Techniques For Quality Management

Quality functions development (QFD) – Benefits, Voice of customer, information organization, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process and documentation. Seven old (statistical) tools. Seven new management tools. Zero defect concept, Bench marking and POKA YOKE. Selection of sources of supply, evaluation of suppliers. Kaizen, JIT

Unit 6 **(5 Hrs)**

Quality Systems Organizing and Implementation

Total productive maintenance (TMP) – relevance to TQM, Terrotechnology. Business process re-engineering (BPR) – principles, applications, reengineering process, benefits and limitations. Introduction to IS/ISO 9001:2015 – quality management systems – guidelines for performance improvements. Quality Audits. TQM culture, Leadership – quality council, employee involvement, motivation, empowerment, recognition and reward- Benefits of implementing ISO 9000 standard.

Text Books:

- Dale H. Besterfield et al, Total Quality Management, Third edition, Pearson Education (First Indian Reprints 2004).
- L Suganthi, Anand A. Samuel, Total Quality Management, PHI learning Pvt. Ltd., Sixth Edition 2010.
- K. Krishnaiah, Applied Statistical Quality Control and Improvement, PHI learning Pvt. Ltd., First Edition 2014.

Reference Books:

- Roger C. Swanson, "The Quality Improvement Hand Book", Publisher Vanity Books International, New Delhi.
- Williarn. C. Johnson and Richard J. Chavia, "Encyclopaedia of Total Quality Management", New Delhi.

Course Outcomes:

1. Understanding of quality management philosophies and frameworks.
2. In-depth knowledge on various tools and techniques of quality management.
3. Learn the applications of quality tools and techniques in both manufacturing and service industry.
4. Develop strategies for continuous process improvement.

MICRO ELECTRO MECHANICAL SYSTEMS

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
100 marks: Continuous evaluation- Assignments /Quiz/T1/T2 - 40Marks, End Sem Exam- 60 marks

Course Objectives:

1. To gain and understand the scope, importance and applications of MEMS products and devices
2. To study and assimilate the materials for MEMS devices fabrication as well as the materials for indirect use.
3. To learn the principles, design, working and applications of microsensors and microactuators.
4. To understand and select packaging method for a MEMS product.

Syllabus Contents:

Unit 1 **(6 hrs)**

Introduction

Overview of MEMS & Microsystems: Evolution of microsensors, MEMS & microfabrication – typical MEMS and Microsystems and miniaturization – applications of Microsystems.
Materials demand for Extreme conditions of operation, material property mapping, Processing, strengthening methods, treatment and properties

Unit 2 **(6 hrs)**

MEMS materials: Overview of Smart Materials, Structures and Products Technologies Smart Materials (Physical Properties) Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Magneto electric Materials, Magneto rheological Fluids Electro rheological Fluids, Shape Memory Materials, Bio-Materials, metal matrix composites (MMC), their applications in aerospace and automobiles, Super-plastic materials

Unit 3 **(4 hrs)**

Design
Design consideration – process design – mechanical design

Unit 4 **(8 hrs)**

Micro manufacturing/Micro fabrication
Preparation of the substrate, Physical Vapour Deposition, Chemical Vapour Deposition, Ion Implantation, Coatings for high temperature performance, Electrochemical and spark discharge and Plasma coating methods, electron beam and laser surface processing, Organic and Powder coatings, Thermal barrier coating, LIGA process

Unit 5 **(6 hrs)**

Micro sensors
Smart Sensor, Actuator and Transducer Technologies, Smart Sensors: Accelerometers; Force

Sensors; Load Cells; Torque Sensors; Pressure Sensors; Microphones; Sensor Arrays

Unit 6 **(6 hrs)**

Micro actuators

Smart Actuators: Displacement Actuators; Force Actuators; Power Actuators; Vibration Dampers; Shakers; micro Fluidic Pumps; micro Motors Smart Transducers: Ultrasonic Transducers; Sonic Transducers;

Text Books:

- MEMS & Microsystems: Design & Manufacture, Tai Ran Hsu, Tata McGraw Hill, 2002.
- Smart Materials and Structures, M.V. Gandhi and B.S. Thompson, Chapman & Hall, London;
- New York, 1992 (ISBN: 0412370107).

Reference Books:

- Intermetallic compounds VOL I & II, Westbrook J.H & Fleischer R.L., John Wiley, Chichester 1995.
- Micro sensors, MEMS and smart Devices, Julian W. Gardner & Vijay K. Varadan, John Wiley & Sons, 2001.
- Smart Structures: Analysis and Design, A.V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).
- Smart Structures and Materials, B. Culshaw, Artech House, Boston, 1996 (ISBN: 0890066817).

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Understand the scope, importance and application of miniaturized products
2. Analyse and Demonstrate design skills of MEMS devices and products
3. Select a relevant microfabrication/ micromachining technique
4. Select an appropriate microsensor and microactuator in a given application.
5. Recommend a suitable packaging technique or method for a MEMS product.

TRIBOLOGY IN MANUFACTURING

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1 and T2 – 20 marks each, End-Sem Exam - 60

Course Objectives:

1. To impart knowledge and importance of Tribology in Design, friction, wear and lubrication aspects of machine components
2. To know the material properties which influence the tribological characteristics of surfaces.
3. To know the performance of different types of bearings and analytical/theoretical analysis thereof of different types bearings and design of bearings
4. To know different metal forming processes from tribological point of view.

Syllabus Contents:

Unit 1 **(8 hrs)**

Tribology

Introduction, Importance of Tribology in Design, Tribology in Industry, Economic Considerations, effects of surface preparation on Tribology.

Friction

Introduction, Laws of friction, kinds of friction, causes of friction, area of contact, friction measurement, theories of friction.

Wear

Types of wear, various factors affecting wear, cutting tool wear & coating, measurement of wear, wear between solids and flowing liquids, theories of wear.

Unit 2 **(6 hrs)**

Lubricants and Lubrication

Introduction, Lubricant properties- physical and chemical, basic modes of lubrication, types of lubricants, Seals-Static and dynamic.

Unit 3 **(8 hrs)**

Hydrostatic and Aerostatic Lubrication

Basic concept, operations, advantages and limitations. Flow of viscous fluid through rectangular slot, Circular pad bearing and conical bearing, load carrying capacity and flow of lubricants. Bearing power, energy losses in bearing and film thickness, bearing temperature. Optimum design of step bearing, Introduction to Aerostatic Bearing and its application.

Unit 4 **(10 hrs)**

Hydrodynamic Lubrication

Theory of hydrodynamic lubrication. Mechanism of pressure development in oil film. Two-dimensional Reynolds equation, pressure distribution in journal bearings - long & short, Load Carrying capacity, Somerfield number, importance of radial clearance, eccentricity

ratio minimum oil film thickness etc., Heat Balance equations.

Hydrodynamic Thrust Bearing

Introduction, flat plate thrust bearing, pressure distribution equation, load, centre of pressure. Tapered land thrust bearing, step-thrust bearing, and tilting pad thrust bearing. Friction in tilting pad thrust bearing, Heat Balance equations.

Unit 5 **(6 hrs)**

Hydrostatic Squeeze Film

Introduction, parallel rectangular plate, Circular plate approaching each other and cylinder near plane, pressure distribution, squeeze load and time of approach.

Unit 6 **(4 hrs)**

Lubrication in metal processing

Lubricants in Forging, wire drawings, drawing, extrusion, rolling etc. Lubricants used for wire ropes, pulley and chains, introduction to Nano-Tribology.

Text Books:

- Basu S.K., Sengupta S. N. and Ahuja B.B. “Fundamentals of Tribology” PHI Learning, Ltd. India.
- Majumdar B. C. "Introduction to Tribology and Bearings", S. Chand and Company Ltd., New Delhi.

Reference Books:

- Bharat Bhushan, “Principles and Applications of Tribology”, John Wiley and Sons.
- Sahu P., “Engineering Tribology”, PHI Learning, Ltd. India
- Fuller D.D. "Theory and Practice of Lubrication for Engineers". John Wiley and Sons.
- Neale M. J. "Tribology hand Book", Butterworths. London.
- Orlov P., "Fundamentals of Machine Design", Vol. IV, MIR Publication.
- Cameron A. "Basic Lubrication Theory", Wiley Eastern Ltd.
- 'Hailing J., "Principles of Tribology", McMillan Press Ltd., 1975.
- Ghosh M.K., Majumdar B.C. and Sarangi M., “Theory of lubrication”, Tata McGraw Hill Education Pvt. Ltd., New Delhi.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. The course will enable the students to know the importance of Tribology in Industry.
2. The course will enable the students to know the basic concepts of Friction, Wear, Lubrications and their measurements.
3. This course will help students to know the performance of different types of bearings and analytical analysis thereof.
4. This course will help students to learn and discuss different metal forming processes from tribological point of view.

PE-461 MECHATRONICS

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1 and T2 – 20 marks each, End-Sem Exam – 60

Course Objectives :

1. To acquire a mix of skills in mechanical engineering, electronics and computing which is necessary to comprehend and design mechatronics system.
2. To help the student to become capable of operating and communicating across the range of engineering disciplines necessary in Mechatronics.

Syllabus Contents:

Unit 1 **(8 hrs)**

Mechatronics:
Introduction to Mechatronics, Application areas of Mechatronics, Mechatronic Design Concept, Introduction to Measurement Systems, Control Systems

System Response: Introduction, Input-Output model equation and system characterization, Instantaneous, Lagging and Delay Response, Transient Response Specification, Test Signals, Signals, Bandwidth and Frequency Response, Dynamic Characteristics of Measurement Frequency Response of a System,

Signal Conditioning and Signal Processing:
Signal conditioning, Digital Signals, Data Acquisition, Digital Signal Processing, Pulse-modulation. Analog Signal Processing, Analog to Digital Conversion.

Unit 2 **(8 hrs)**

Digital Logic, Circuits, Systems and Hardware:
Digital Logic, Boolean Algebra, Karnaugh Maps, Combinational Logic and Circuits, Timing Diagrams, Design of Logic Networks, Sequential Logic, Devices and Circuits, Integrated Circuit System Design.

Microprocessors, Microcomputers and Microcontrollers:
Introduction, Microprocessor-based Digital Control, Microcomputer Organization, Microprocessor Architecture, Memory, Input/Output Hardware, Microcontrollers, General Requirements for control and their implementation in Microcontrollers, Classifications, Applications.

Unit 3 **(7 hrs)**

Assembly Language:
Languages, Instruction Sets, Assembly Language Programs, Subroutines, Look-up Tables.

Input/Output Systems:
Interfacing, Input/Output Addressing, Interface Requirements, Peripheral Interface Adapters, Serial Communications Interface, Examples of Interfacing.

Unit 4 **(8 hrs)**

Programmable Logic Controllers:

Introduction, Basic Structure, PLC Hardware, Ladder Diagrams, Input/Output Processing, Programming, Selection of a PLC.

Sensors and Transducers:

Introduction to Sensors and Transducers, Performance Terminology, Sensor working Principles, Selection of sensors,

Unit 5 **(7 hrs)**

Actuators:

Introduction to actuation system, Pneumatic and Hydraulic Actuation Systems, Mechanical Actuation Systems, Electromagnetic Principles, Electrical Actuation Systems, Piezoelectric actuators.

Data Acquisition:

Introduction, Elements of a Data Acquisition and Control System, Overview of the Input/Output Process, Analog to Digital (A/D) Conversion, Digital to Analog (D/A) Conversion, Data Acquisition Case Studies, Data Acquisition and Control Case Studies.

Unit 6 **(7 hrs)**

Mechatronics System Design:

Integrated design issues in Mechatronics, Mechatronics Key Elements, Traditional and Mechatronics designs, The Mechatronics Design Process, Possible Mechatronics Design Solutions, Advanced approaches in Mechatronics, Control architectures, Advanced Applications in Mechatronics: Sensors for Condition Monitoring, Mechatronic Control in Automated Manufacturing, AI in Mechatronics, Fuzzy Logic Applications in Mechatronics, Micro sensors in Mechatronics, Case studies in Mechatronics.

Text Books

- W. Bolten : Mechatronics : Electronic Control Systems in Mechanical and Electrical Engineering, Third Edition, Pearson Education (Low Price Edition).
- Michael B. Histand and David G. Alciatore : Introduction to Mechatronics and Measurement Systems, McGraw-Hill International Edition.
- Devdas Shetty and Richard A. Kolk : Mechatronics System Design, PWS Publishing Company (An International Thomson Publishing Company).
- Nitaigour Premchand Mahalik : Mechatronics : Principles, Concepts and Applications, Tata McGraw Hill Publishing Company Limited, New Delhi

Reference Books

- Clarence W. De Silva : Mechatronics : An Integrated Approach, CRC Press.
- Lawrence J. Kamm : Understanding Electro-Mechanical Engineering : An Introduction to Mechatronics, Prentice – Hall of India Private Limited, New Delhi.
- HMT Limited : Mechatronics, Tata McGraw Hill Publishing Company Limited, New Delhi

Course Outcomes:

1. To know key elements of Mechatronics system and classification of Mechatronics Products.
2. To be familiar with the Mechatronics System Design Process.
3. To learn concept of transfer function, block diagram representation of control systems, reduction and analysis of block diagrams.
4. To be aware of various control actions and controllers used for developing Mechatronics Systems.
5. To know the concept of PLC based system, PLC programming techniques and industrial applications of PLC.
6. To gain knowledge of various principles of sensors, its characteristics, and interfacing with acquisition systems

ROBOTICS

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1 and T2 – 20 marks each, End-Sem Exam - 60

Course Objectives:

- To enable students to understand the basic concepts and principles in robotics.
- To enable students to classify the robot structures, grippers, drives and their design and selection
- To enable students about kinematics of robot manipulator and transformation analysis.
- To enable students to understand robot programming and write the programs.
- To enable students to analyze the trajectory planning of robot joints.
- To select robotsfor various applications and perform economic analysis

Syllabus Contents:

Unit 1 **(8 hrs)**

Basic Concepts in Robotics:

Automation and robotics, robot anatomy, basic structure of robots, resolution, accuracy and repeatability. Classification and Structure of Robotics System: Point to point and continuous path systems. Control loops of robotic system, manipulators, wrist motions and grippers.

Robot End Effectors / Grippers:

Grippers and tools, Types of end effectors-mechanical, magnetic and vacuum, gripper force analysis and gripper design considerations.

Unit 2 **(8 Hrs)**

Drives and Control Systems: Basic control systems, concepts and models, types of drive system- Hydraulic systems, pneumatic and electrical, DC servo motors, control system analysis, robot activation and feedback components, types of controllers- P, PI, PID controllers.

Sensors in Robotics

Sensors, internal-external sensors, contact and non-contact sensors, position and velocity sensors, Touch and slip sensors, Force and torque sensors, tactile sensors, Proximity and range sensors. Vision Systems: Vision equipment, line scan and area scan sensor, Charge Coupled Device , image processing, and analysis, preprocessing, segmentation and feature recognition, smoothening of binary image

Unit 3 **(8 Hrs)**

Robot Arm Kinematics and Dynamics:

Homogenous coordinates and homogenous transformations, Forward and Inverse kinematics in robot, Denavit Hartenberg convention and its applications Lagrange-Euler formation, Robot dynamics control

Unit 4 **(6 Hrs)**

Interfacing: Interfacing robot with PC, RS232C serial interface

Robot Programming: Methods of robot programming, lead through programming methods, a robot program for generating a path in space, motion interpolation, WAIT, SIGNAL and DELAY commands, branching capabilities and limitations of lead through methods. Robot Language: The textual robot languages, generations of robot programming languages, variables, motion commands, end effectors and sensor commands, computations and operations, Introduction to artificial intelligence

Unit 5 **(6 Hrs)**

Trajectory Planning

Introduction, Joint Space Scheme, Cubic Polynomials with via points, Blending scheme

Unit 6 **(6 Hrs)**

Robot Applications in Manufacturing:

Material transfer and machine loading/unloading, processing operations assembly and inspection. Concepts of safety in robotics, social factors in use of robots, economics of robots.

Introduction to Telechirs & Futuristic Topics in Robotics:

Telechiric machines and its application - handling radioactive materials, work in space mining& under sea operations, Telechiric surgery, collaborative robotics, calibration.

Reference Books:

- S. R. Deb.: Robotics Technology And Flexible Automation, Tata McGraw Hill Publishing Co. Ltd.
- P.A. Janakiraman, Robotics and Image Processing, Tata Mcgraw Hill, 1995

Reference Books:

- Yoren Koren: Robotics for Engineers, McGraw Hill Book Co., ISBN 0-07-035341-7.
- M. P. Grover, M. Weiss, R. N. Nagel, N. G. Odrey, : Industrial Robotics Technology, ISBN 0-07-100442-4.
- K. S. Fu, C. G. S. Lee, R. C. Gonzaler, Robotics Control, Sensing, Vision and Intelligence, Tata McGraw Hill. 2008, ISBN 13: 9780070226258

Course Outcomes:

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

1. Define basic terms, classify and analyze the robot structure & gripper designs
2. Select the drive system with feedback control and sensors.
3. Apply the knowledge of kinematics for link transformation.
4. Write a program for robotic application
5. Analyze the trajectory planning of joints of robot manipulator. ·
6. Select the robots on the basis of application areas and perform economic analysis.

Artificial Intelligence

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1 and T2 – 20 marks each, End-Sem Exam - 60

Course Objectives:

They should be able to:

- Choose the appropriate representation for an AI problem or domain model, and construct domain models in that representation
- Choose the appropriate algorithm for reasoning within an AI problem domain
- Implement and debug core AI algorithms in a clean and structured manner
- Design and analyze the performance of an AI system or component
- Describe AI algorithms and representations and explain their performance, in writing and orally.

Syllabus Contents:

Unit 1 **(6 hrs)**

Overview: foundations, scope, problems, and approaches of AI.

Intelligent agents: reactive, deliberative, goal-driven, utility-driven, and learning agents, Artificial Intelligence programming techniques.

Unit 2 **(8 Hrs)**

Problem-solving through Search: forward and backward, state-space, blind, heuristic, problem-reduction, alpha-beta pruning, minimax, constraint propagation, neural, stochastic, and evolutionary search algorithms, sample applications.

Unit 3 **(8 Hrs)**

Knowledge Representation and Reasoning: ontologies, foundations of knowledge representation and reasoning, representing and reasoning about objects, relations, events, actions, time, and space; predicate logic, situation calculus, description logics, reasoning with defaults, reasoning about knowledge, sample applications.

Unit 4 **(6 Hrs)**

Planning: planning as search, partial order planning, construction and use of planning graphs.

Representing and Reasoning with Uncertain Knowledge: probability, connection to logic, independence, Bayes rule, bayesian networks, probabilistic inference, sample applications.

Unit 5 **(8 Hrs)**

Decision-Making: basics of utility theory, decision theory, sequential decision problems, elementary game theory, sample applications.

Machine Learning: basic concepts, linear models, perceptron, K nearest neighbors, advanced models, neural networks, SVMs, decision trees and unsupervised learning

Unit 6 **(4 Hrs)**

Applications of AI(vision/robotics etc.), student project presentations

Text Books:

- Russell, Stuart and Norvig, Peter, "Artificial Intelligence: A Modern Approach" Prentice Hall, 2003.

Reference Books:

- Aleksander, Igor and Burnett, Piers "Thinking Machines" Oxford, 1987.
- Bench-Capon, T. J. M., "Knowledge Representation: An approach to artificial intelligence" Academic Press, 1990.
- Genesereth, Michael R. and Nilsson, Nils J. "Logical Foundations of Artificial Intelligence", Morgan Kaufmann,1987.
- Michael Negnevitsky, Artificial Intelligence: A Guide to Intelligent Systems (3rd Edition),
- VINOD CHANDRA S.S., ANAND HAREENDRAN S, " ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING"
- Luger " Artificial Intelligence", Edition 5, Pearson, 2008

Course Outcomes:

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

- Knowledge of what constitutes "Artificial" Intelligence and how to identify systems with Artificial Intelligence.
- Ability to apply Artificial Intelligence techniques for problem solving.
- Implement classical Artificial Intelligence techniques, such as search algorithms, minimax algorithm, neural networks, tracking, robot localization.
- Ability to apply Artificial Intelligence techniques for problem solving.

(DEC) ADVANCED JOINING TECHNOLOGY

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1 and T2 – 20 marks each, End-Sem Exam - 60

Course Objectives:

- Make students aware of various conventional & advanced Welding Processes.
- Students should select the appropriate welding process for a given material and application
- Learn various defects of weld and able to obtain quality welds for different materials.

Syllabus Contents:

Unit I :Gas and Arc welding processes: (7 hrs)
Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electroslag welding processes - advantages, limitations and applications

Unit II : Resistance Welding Processes: **(7 hrs)**
Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes - advantages, limitations and applications.

UNIT III : **Solid State Welding Processes**: **(7 hrs)**
Cold pressure welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll welding and Hot pressure welding processes - advantages, limitations and applications, Advances in adhesive bonding, Brazing and soldering, cladding.

UNIT IV : **Advanced Welding Processes**: **(9 hrs)**
Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding - principle, working and applications, Friction stir welding, Cold Metal Transfer - concepts, processes and applications, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles, Robotic Welding.

UNIT V : **Testing and Design of Weldments: (6 hrs)**
Design and quality control of welds. Edge preparation types of joints, weld symbols. Stresses in butt and fillet welds - weld size calculations. Design for fatigue. Destructive and non destructive testing of weldments. Weldability Testing - tensile, bend hardness. Impact, notch and fatigue tests. Visual examination - liquid penetration test, magnetic particle examination. Radio graphs, ultrasonic testing. Life assessment of weldments. IS codes.

UNIT VI : **Weld Metallurgy: (6 hrs)**

Weld thermal cycles and their effects, effects of pre and post weld heat treatments, concept of HAZ, concept of weldability and its assessment. Welding of different materials, defects in welds, their causes and remedies.

Text Books:

- Parmer R.S., "Welding Engineering and Technology", Khanna Publishers, New Delhi, 2008.
- Little R.L., "Welding and Welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.
- Kalpakjian S. "Manufacturing Engineering and Technology" Prentice Hall Pearson Education India; 4th edition, 2002.

References :

- Schwartz M.M. "Metals Joining Manual". McGraw Hill Books, 1979.
- Tylecote R.F. "The Solid Phase Welding of Metals". Edward Arnold Publishers Ltd. London, 1968.
- AWS- Welding Hand Book. 8th Edition. Vol- 2. "Welding Process"
- Nadkarni S.V. "Modern Arc Welding Technology", 1st edition, Oxford IBH Publishers, 2005.
- Christopher Davis. "Laser Welding- Practical Guide". Jaico Publishing House, 1994.
- Davis A.C., "The Science and Practice of Welding", Cambridge University Press, Cambridge, 1993.
- Mishra. R.S and Mahoney. M.W, Friction Stir Welding and Processing, ASM,2007.

Course Outcomes:

Students should be able to:

1. Explain the working of various conventional & advanced Welding Processes.
2. Understand advantages & limitations of welding processes and select the appropriate welding process based on application; customer requirement and specifications.
3. Demonstrate an ability of inspection and testing of welded components and apply remedial measures to minimize defects in welding.

() OPERATIONS RESEARCH

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
100 marks: Continuous evaluation- Assignments /Quiz/T1/T2- 40 Marks, End Sem Exam- 60 marks

Course Objectives:

1. Understand the mathematical modelling of real life optimization problems.
2. Learn how to identify, formulate and solve optimization problem.
3. Learn simulation techniques.
4. Learn project management techniques.

Syllabus Contents:

Unit 1 **(4 hrs)**

Introduction

Operations Research: Development, history, definitions, objectives, characteristics, limitations, phases, and applications. Optimization models and their classifications

Linear Programming

Formulation of LP problem, Simplex method (minimization / maximization cases). Degeneracy in LP, Duality in LP, Sensitivity analysis.

Unit 2 **(7 hrs)**

Transportation

Introduction. Methods for finding initial solution. Test of optimality Maximization Transportation problem. Tran-shipment problem. Degeneracy.

Assignment Problem

Introduction. Solution methods. Variations of the assignment problem. Traveling Salesman Problem.

Unit 3 **(6 hrs)**

Sequencing Models

Scheduling and sequencing. Assumptions in sequencing models. Processing "n" jobs on "m" machines.

Inventory Control System (Quantitative Approach)

Introduction. Meaning of Inventory Control. Functional classifications of Inventories. Advantages of Inventory Control. Deterministic Inventory Models: economic lot size with instantaneous replenishment with and without shortage costs, economic lot size models with quantity discount.

Unit 4 **(7 hrs)**

Queuing Theory

Queuing Systems : Introduction, cost associated with, Classification of queuing models.

Kendall's notations. Models : {(M/M/1) : (α / FSFS)}. Single server models.

Simulation

Introduction to discrete event Simulation. Monte -Carlo Simulation. Problems related to Monte-Carlo Simulation.

Dynamic Programming

Distinguishing characteristics of D.P. Deterministic DP problems.

Unit 5 **(6 hrs)**

Replacement Models

Replacement of capital equipment that deteriorates with time, Replacement of items that fail without deteriorating.

Theory of Games

Introduction, two–person zero-sum game. Minimax and Maximin principle. Saddle point. Methods for solving game problems with mixed strategies. Introduction to graphical, and iterative methods for solving game problems.

Unit 6 **(4 hrs)**

Network Models

Introduction to PERT / CPM. Concepts and construction of network diagrams. Critical path and project duration, floats, network crashing, optimum project duration and cost, PERT activity, time estimate, probability of completion of a project on before specified time, Resource allocation and load smoothening.
Minimal Spanning tree , Shortest route and Maximal Flow problems.

Text Books:

- Gupta P. K. and Hira D. S. : Operations Research, S Chand & Company Ltd.
- Sharma S. D., KedarNath : Operations Research, Ram Nath& Co.

Reference Books:

- Sharma J. K. : Mathematical Models in Operations Research, Tata McGraw – Hill Publishing Company Limited.
- Taha H. A. : Operations Research : An Introduction, Prentice Hall of India Pvt. Ltd.
- Wagner H. N. : Principles of Operations Research with applications to Managerial Decisions, Prentice Hall of India Pvt. Ltd.
- R. Panneerselvam : Operations Research, Prentice Hall of India Pvt. Ltd
- Wiest J. D. & Levy F. K.: Managerial Guide to PERT/CPM, Prentice Hall of India Pvt. Ltd.
- Srinath L.S "PERT & CPM principles & Applications" Affiliate East West Press (P) Ltd.,

New Delhi, 1975.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Develop a general understanding of the Operational Research (OR) approach to decision making
2. Develop network planning procedures for solving logistic and scheduling problems.
3. Formulate inventory and queuing problems and generate optimal solutions.
4. Identify best techniques to solve a specific problem

() CAD / CAM / CIM LABORATORY

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term Work: -- 50 Marks
Oral:--50 Marks

Course Objectives:

- To understand the basic procedure required to develop the solid model using solid modeler.
- To understand the concept of Rapid Prototyping Techniques using Additive Manufacturing Technology. Actual use of FDM Technology Machines to study the additive manufacturing technology and its applications
- To understand the concept of N.C machines and part programming, Simulation of tool path and generation of part program using CAM package.
- To provide the fundamental concepts of the theory of the finite element method
- To develop proficiency in the application of the finite element method (modeling, analysis and interpretation of results) to realistic engineering problems based on structural analysis through the use of FEA packages.
- To demonstrate the ability to create models for trusses, frames, plate structures, machine parts, and components using ANSYS software.

Syllabus Contents:

1. To Study of Solid Modeler and Modeling of Simple machine parts
2. Study of Rapid Prototyping Techniques by Using Additive Manufacturing Technologies as FDM Technology
3. To study Simulation of cutting/milling operations using CAM packages
4. Introduction to FEA, Advantages & Disadvantages of FEA & its Applications, What is FEA, Functional Approximation method, Finite Difference Method, Steps involved in FEA, Stiffness matrix & its properties, Derivation of Stiffness matrix, Types of Elements.
5. Introduction to ANSYS, ANSYS Interface & Environments, Problem solving methodology in ANSYS.
6. Analysis of various problems using ANSYS software.

Note: Oral shall be based on above assignments.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

- Understand how CAD technology can be leveraged in the design & manufacturing process
- Understand and use the advance technologies like Additive Manufacturing Technology to solve complex real life problems
- Compare and distinguish the difference between the operation and programming of a CNC machine tool using manual programming and the operation and programming of CNC machine tool using CAM systems. Apply practices (manually) to develop the G-code program
- Understand the concept of FEA and its requirement in design and manufacturing phase.
- Evaluate and interpret FEA analysis results for design and evaluation purposes to solve complex real life problems
- Develop a basic understanding of the limitations of the FE method and understand the possible error

sources in its use.

(PE 497) MANUFACTURING AUTOMATION LABORATORY

Teaching Scheme	Examination Scheme
Practical: 2 hrs/week	Term Work : 50 Marks, Oral : 50 Marks

Course Objectives:

- To know the fluid power systems employed in manufacturing industry.
- To learn how to design and analyse the fluid power systems required in automated environment.
- To be able to design the circuits for different operating requirements of an automated or mechatronics system.
- To know the basics of PLC programming and its applications in industrial fluid power.

Syllabus Contents:

The term work shall consist of record of any eight assignments on following topics:

1. Study & Design of basic hydraulic and pneumatic circuits: such as Standard ON-OFF and Pneumatic Latch.
2. Study & Design of Pneumatic or Hydraulic circuit for Two Push Button Control and Clamping of Work piece.
3. Study & Design of Pneumatic or Hydraulic circuit for material handling.
4. Study & Experiments in 8051 Microcontroller & its applications in Production Engineering.
5. Study & experiments in Programmable Logic Controllers (PLC).
6. Study of Displacement, Level, Pressure controls.
7. Measurements & Design of circuit for Speed & Temperature measurements.
8. Study & Design of Simple Hydraulic or Pneumatic and Electro-Hydraulic or Electro-Pneumatic Automatic Control Circuit Problem.
9. Study & Design of Electro-hydraulic or Electro-pneumatic Control Circuit Problem.
10. Study of Maintenance and Troubleshooting of Fluid Power Systems.

Note: Oral shall be based on above assignments.

Course Outcomes:

1. To have an overview of manufacturing, manufacturing operations and automation technologies
2. To study the definition and elements of mechatronics and automation system
3. To learn how to apply the principles of mechatronics and automation for the development of productive and efficient manufacturing systems.
4. To study the hydraulic and pneumatic systems employed in manufacturing industry.
5. To study material handling technologies for their identification in automated material control purposes.
6. To learn the integration of automation technologies and material handling technologies into manufacturing systems.

SOFTWARE LABORATORY

Teaching Scheme
Practical : 2hrs/week
Tutorial : 1 hr/wk

Examination Scheme
Term Work : 50 Marks
Oral/Practical Exam : 50 Marks

Course Objectives:

- To schedule tasks, generate Work Breakdown Structure and estimate critical activities to the project.
- To Assign Work Resources to Tasks, to track progress on tasks and to compare multiple projects.
- To build Multi capacity and Multi Location layouts to generate optimum facility planning and layout design using Witness software.
- To generate and evaluate what-ifs scenarios for finalizing layout.
- To understand fundamentals of object oriented programming in Java such as defining classes, invoking methods, variables, conditional an iterative execution, etc
- To be able to use the Java SDK environment to create, debug and run simple Java Programs
- To design a module structure to solve a problem and evaluate alternatives

Syllabus Contents:

1 . Introduction to scheduling of a project in MS Project 2010, Fine-Tuning Task Details, Fine-Tuning the Project Plan, Creating Summary tasks and Milestones, defining Task Dependencies, Constraint types and Task types, Studying Gantt Chart view.

2. Introduction to CPM/PERT using MS Project 2010, Assigning resources, Resource Levelling, cash flow and Project overview analysis by generating reports.

3. Introduction to production facility planning and scheduling using WITNESS software, Defining Location, Entities, Arrivals, Processing and Attributes related to the facility, introduction to What-If scenarios, Assigning Machine downtimes and setup times.

4. Introduction to WITNESS software. Simulating multiple iterations of a layout and comparative analysis of different layouts using WITNESS Manufacturing Edition software.

5. Overview to Java Platform
Compiler Vs Interpreter, JVM and Byte code concept, JNI concept, Security in Java.

6. Basic Language components of Java
Variable, operators, Expressions, Statements and Block, Control structures, Arrays, Functions.

7.Object Oriented Concepts in Java
Creating Classes, Managing Inheritance, Polymorphism and other COP concepts, Interfaces and Packages, Enumerated Types, Annotations, Nested Classes, Inner classes and Anonymous classes

8. Essential Java Classes
String class, Other classes in java.lang, Classes for mathematical operations, Exception

Handling, Collections

9. File and other I/O Handling

Overview of I/O streams, java.io package classes overview, Reading/Writing standard I/O, Reading/Writing in File

10. GUI programming

AWT Classes, Event Handling, Introduction to SWING, Introduction to Advanced Core Java: Threads, Socket Programming, 2D-3D programming, Image Handling API, RMI, Reflection, JNI programming, Applets

List of Assignments

1. Write programs for
   a. Fibonacci Series up to given number of terms.
   b. Prime Number within a given range.
   c. That reads a String from the command line and writes it backward

2. Write a program that continues to read a line from user and print all the characters back in reveres. The program terminates when the user write "End'

3. Write a program to count the number of tokens, given a string and a separator.

4. Number Generator is class that generates random numbers continuously while Running Average class calculates the average of a set of numbers generated. Write These Classes. Write a program that uses tile piped stream to pipe the number generator with the average calculator.

5. Create a Circle class that contains a radius field. Give it a constructor where you pass in the radius. Have your test routine create a few circles, assign a value to the radius, then print out some information about the circles. Give your Circle a getArea method that calculates its area, and a printInfo method that prints out the radius and area. Make a program that creates an array of 100 circles, each with a random radius. Print out the sum of the areas of the 100 circles. Also print the biggest and smallest areas.

6. Write a program for rectangle as in Assignment 5. Have your Circle and Rectangle inherit from a common Shape class. Change all your existing classes so that the fields are private and you have getXxx and setXxx methods to lookup and change the values of the fields. If you haven't already made a Square class, do so. Make your Square inherit from Rectangle, but still enforce the restriction that the width and the height are the same. Hint: override some method(s). Make a method that will take an array of Shape objects and sum their areas. Where is the best place to put this method? Make a test case consisting of an array of mixed shapes.

7. Write a program to count the numbers of characters entered through stdin. The program exits upon entering Ctrl+Z. Also write all these characters in to given file.

8. Write a program to append a set of files to a given file.

9. Design a calculator in AVVT and SWING.

Note: Oral shall be based on above assignments.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

- Develop a basic understanding of the Java platform
- Able to develop classes for mathematical operators
- Assign Work Resources to Tasks, Assign Material Resources to Tasks and Assign Cost Resources to Tasks, track progress on tasks usage and resource utilization and monitor project execution compared with the planned schedule.
- Simulate Processes and Networks regarding production facility to reduce the work in process inventory and optimize resource optimization
- To select the layout having optimum productivity and resources.

PROCESS PLANNING AND TOOL SELECTION LAB

Teaching Scheme	Examination Scheme
Practical : 2 hrs/week	Term Work : 50 Marks
Tutorial: -	Oral : 50 Marks

Course Objectives:

- To study the part print analysis.
- To learn how to select and arrange various manufacturing processes to machine a component.
- To understand how to select and assign various tools and tooling to machine a component
- To learn how to prepare process plan and process flow diagram for machining of a workpiece.

Syllabus Contents:

The term work shall consist of record of any Six assignments on following topics:

1. Preliminary part print analysis for given components which includes study of part, its dimensions and tolerances and control of its features of parts.
2. Preparation of tolerance chart for any two components also students have to describe handling, basic processes for manufacturing, sequence of operations. Study of Special processes if necessary, related surfaces to be machined, Assembly Process if any for the given parts.
3. Analysis of Part Dimensions of given component: Shape of part as flatness, straightness, roundness, geometrical shapes, symmetry, job requirement of finish on part.
4. Drawing of arrangement of locators, for standard shaped components like rectangular prism, pyramids, cylinder, tube, cones and any one non standard component for good geometric control Manufacturing Processes:
5. Identification and list our sequence of various manufacturing processes to be performed on a given component/workspiece, from a drawing such as Basic Processes, Principal Processes, Major Operations and Auxiliary Processes, Supporting Operations.
6. Study and Selection of Tooling: Standard and Special Tooling. Use of Jigs and Fixtures, Selection of Equipment, Tooling. Economics of Tooling.
7. Study of conventional tooling methods for commonly Machined Surfaces, Tooling ideas for Typical features on a job. Multi tooling setups, New tools and tooling methods
8. Study of the machined parts and initial data required for process design from the point of manufacture :
    a. Planning the sequence of machining operations along with selection of machining operations along with selection of machine tools, cutting tools, jigs and fixtures, cutting variables as well as fixing in process dimensions and gauging.
    b. Datum features/surfaces and their selection.
    c. Stock preparations and blank selection with material estimate.
    d. Time estimate and time standards.
    e. Process sheet design for the complete manufacture of the machined parts.

Note: Oral shall be based on above assignments

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Analyze the dimensions, tolerances and control of various features of parts.
2. Students can able to select and assign sequence of machining processes from basic to principal processes.
3. Students can identify and select the appropriate tools and toolings for major machining operations to be performed on workpiece.
4. Students can Prepare process plan and flow diagram for given component.

Minors – Manufacturing Technology (Mechanical)

SEMESTER-VII

MNUFACTURING AUTOMATION

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
100 marks: Continuous evaluation- Assignments /Quiz/T1/T2- 40 Marks, End Sem Exam- 60 marks

Course Objectives:

1. To explain the production performance of manufacturing systems
2. To realize the importance of Mechatronics in Factory Automation
3. To get acquainted with the automation and control technologies
4. To identify the requirement of material handling and identification technologies
5. To carry out performance analysis of various manual and automated manufacturing systems
6. To identify, build and design fluid power systems required in factory automation

Syllabus Contents:

UNIT 1: Overview of Manufacturing (8 hrs)

Introduction to Production Systems, Automation in Production Systems, Overview of Manufacturing, Manufacturing Operations, Manufacturing Models and Metrics
Automation, Mechatronics and Control Technologies:
Introduction to Automation, Definition of Mechatronics, Mechatronics in Manufacturing, Products and Design, Review of Fundamentals of Electronics Industrial Control Systems, Hardware Components for Automation, Mechatronics and Process Control (Data Conversion Devices,
Sensors, Micro-sensors, Transducers, Signal Processing Devices, Relays, Contactors and Timers), Data Acquisition, Actuators and Mechanisms

UNIT 2: Material Handling and Identification Technologies (8 hrs)

Introduction to Material Handling, Principles of Material Handling, Material Transport Systems, Conventional and Automated Storage Systems, Engineering Analysis of Storage Systems, Automatic Identification and Data Capture
Manufacturing Systems
Introduction to Manufacturing Systems, Single Station Manufacturing Cells, Manual Assembly Lines: Single Model and Mixed Assembly Line Balancing, Automated Production Lines, Automated Assembly Systems

UNIT 3:Automation and Principle of Hydraulic and Pneumatic Circuit Design and Analysis (6 hrs)

Hydraulic and Pneumatic Controls, Application in Machine Tools and other Mechanical Fields, Hydraulic and Pneumatic Circuit Design Considerations, Functional Diagram in Circuit Design, Pneumatic Circuit Analysis, Electrical Controls for Fluid Power Circuits, Fluid Logic Control

Systems, Fluid Power Maintenance and Safety, Synthesis of circuits, circuit optimization techniques.

UNIT 4: **Programmable Automation (Processors)** **(6 hrs)**

Overview of Microcomputer systems, Microcontroller, 8051 Microcontroller Architecture, 8051 Instruction set and interfacing, applications and assembly language programming of microcontroller

UNIT 5: Control System and Controllers **(8 hrs)**

Transfer function and block diagram, Block Diagram Reduction, Controller Principles, Process Characteristics, Control System Parameters, Controller Modes, Control Actions
Discrete Control
Programmable Logic Controllers, Basic Structure, Ladder Logic Programming, Types and Selection of PLC

UNIT 6:**Mechatronic Systems : Control Architectures, Design Strategy and Case Studies** **(6 hrs)**

Introduction, Control Architecture, Traditional and Mechatronics Designs, Possible Mechatronic Design Solutions, Case Studies of Mechatronic Systems

Text Books:

- Mikell P. Groover, Automation, Production Systems, and Computer Integrated Manufacturing, Third Edition, Prentice-Hall of India Private Limited.
- W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education Limited

Reference Books:

- N. P. Mahalik, Mechatronics: Principles, Concepts and Applications, Tata McGrawHill
- S. R. Majumdar, Oil Hydraulic Systems: Principles and Maintenance, Tata McGrawHill
- HMT Ltd. Mechatronics, Tata McGrawHill
- Joji P. Pneumatic Controls, Wiley India
- S. R. Majumdar, Pneumatic Systems: Principles and Maintenance, Tata McGrawHill

Course Outcomes:

- To have an overview of manufacturing, manufacturing operations and automation technologies
- To study the definition and elements of mechatronics and automation system
- To learn how to apply the principles of mechatronics and automation for the development of productive and efficient manufacturing systems.
- To study the hydraulic and pneumatic systems employed in manufacturing industry.
- To study material handling technologies for their identification in automated material

Control purposes.

- To learn the integration of automation technologies and material handling technologies Into manufacturing systems.

Minros – Manufacturing Technology (Non - Mechanical)

SEMESTER-VII
MANUFACTURING AUTOMATION

Teaching Scheme
Lectures : 3 hrs/week
Tutorial: hr/week

Examination Scheme
100 marks: Continuous evaluation- Assignments /Quiz/T1/T2- 40 Marks, End Sem Exam- 60 marks

Course Objectives:

1. To explain the production performance of manufacturing systems
2. To realize the importance of Mechatronics in Factory Automation
3. To get acquainted with the automation and control technologies
4. To identify the requirement of material handling and identification technologies
5. To carry out performance analysis of various manual and automated manufacturing systems
6. To identify, build and design fluid power systems required in factory automation

Syllabus Contents:

UNIT 1: Overview of Manufacturing (8 hrs)

Introduction to Production Systems, Automation in Production Systems, Overview of Manufacturing, Manufacturing Operations, Manufacturing Models and Metrics
Automation, Mechatronics and Control Technologies:
Introduction to Automation, Definition of Mechatronics, Mechatronics in Manufacturing, Products and Design, Review of Fundamentals of Electronics Industrial Control Systems, Hardware Components for Automation, Mechatronics and Process Control (Data Conversion Devices,
Sensors, Micro-sensors, Transducers, Signal Processing Devices, Relays, Contactors and Timers), Data Acquisition, Actuators and Mechanisms

UNIT 2: Material Handling and Identification Technologies (8 hrs)

Introduction to Material Handling, Principles of Material Handling, Material Transport Systems, Conventional and Automated Storage Systems, Engineering Analysis of Storage Systems, Automatic Identification and Data Capture
Manufacturing Systems
Introduction to Manufacturing Systems, Single Station Manufacturing Cells, Manual Assembly
Lines: Single Model and Mixed Assembly Line Balancing, Automated Production Lines, Automated Assembly Systems

UNIT 3:**Automation and Principle of Hydraulic and Pneumatic Circuit Design and Analysis (6 hrs)**

Hydraulic and Pneumatic Controls, Application in Machine Tools and other Mechanical Fields,

Hydraulic and Pneumatic Circuit Design Considerations, Functional Diagram in Circuit Design,

Pneumatic Circuit Analysis, Electrical Controls for Fluid Power Circuits, Fluid Logic Control Systems, Fluid Power Maintenance and Safety, Synthesis of circuits, circuit optimization techniques.

UNIT 4:**Programmable Automation (Processors) (6 hrs)**

Overview of Microcomputer systems, Microcontroller, 8051 Microcontroller Architecture, 8051 Instruction set and interfacing, applications and assembly language programming of microcontroller

UNIT 5:**Control System and Controllers (8 hrs)**

Transfer function and block diagram, Block Diagram Reduction, Controller Principles, Process

Characteristics, Control System Parameters, Controller Modes, Control Actions

Discrete Control

Programmable Logic Controllers, Basic Structure, Ladder Logic Programming, Types and Selection of PLC

UNIT 6: Mechatronic Systems – Control Architectures, Design Strategy and Case Studies (06 hrs)

Introduction, Control Architecture, Traditional and Mechatronics Designs, Possible Mechatronic Design Solutions, Case Studies of Mechatronic Systems

Text Books:

- Mikell P. Groover, Automation, Production Systems, and Computer Integrated Manufacturing, Third Edition, Prentice-Hall of India Private Limited.
- W. Bolton, Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, Pearson Education Limited

Reference Books:

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- S. R. Majumdar, Oil Hydraulic Systems: Principles and Maintenance, Tata McGrawHill
- HMT Ltd. Mechatronics, Tata McGrawHill
- Joji P. Pneumatic Controls, Wiley India
- S. R. Majumdar, Pneumatic Systems: Principles and Maintenance, Tata McGrawHill

Course Outcomes:

- To have an overview of manufacturing, manufacturing operations and automation technologies
- To study the definition and elements of mechatronics and automation system
- To learn how to apply the principles of mechatronics and automation for the
- development of productive and efficient manufacturing systems.
- To study the hydraulic and pneumatic systems employed in manufacturing industry.
- To study material handling technologies for their identification in automated material control purposes.
- To learn the integration of automation technologies and material handling technologies into manufacturing systems.

Honors – Manufacturing Systems Engineering

SEMESTER-VII

PERFORMANCE MODELING OF PRODUCTION SYSTEMS

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Objective:

1. To understand concept of automation.
2. To familiarize the students assembly line balancing using algorithm.
3. To familiarize the students parts of the automation.
4. To understand how AGV are used in the production systems.
5. Use of Petri Nets in the production systems.

UNIT 1 **(8 hrs)**

Dedicated manufacture versus Flexible manufacture, mechanization versus automation, semi automatic versus automatic systems using 'in-line' transfer, rotary transfer, Balancing of assembly line using available algorithms. Transfer line-monitoring system (TLMS) using Line Status, Line efficiency. Buffer stock Simulation.

UNIT 2 **(7 Hrs)**

Hard automation using relays, solenoid operated valves, magnetic selectors, hydraulic and pneumatic systems in automation. 'In travel' control, 'centralized travel' control and 'time sequence' control.

UNIT 3 **(6 Hrs)**

Automatic inspection of parts and loading unloading using Robots and Vision systems with CCD cameras, LED's for three-dimensional On-line inspection.

UNIT 4 **(6 Hrs)**

AGV and its various guiding technologies.

UNIT 5 **(8 Hrs)**

Markov chain analysis for production systems with discrete time and continuous time analysis. Markov chain analysis with zero or with one or more repair facility, Reversible Markov chains in manufacturing, Use of analytical hierarchy process in Cellular Manufacturing Systems.

UNIT 6 **(7 Hrs)**

Uses of Petri Nets. Generalized timed Petri Nets, Extended stochastic Petri Nets and their applications in Production systems.

References Books:

- N. Viswanadhan & Y. Narahari, "Performance Modelling of Automated Manufacturing Systems", Prentice Hall of India (Eastern Economy Edition) 1992.
- Mikell P. Groover, "Automation, Production Systems & Computer Integrated Manufacturing" Prentice Hall India Learning Pvt. Ltd.3rdEdition. 2008
- Benjamin S. Blanchand, "Logistics Engineering and Management (5th Edn.) - Pearson Education Asia - Indian Reprint 2001

Course Outcomes:

- Identify the type of Production system and its modelling.
- Perform line balancing and buffer stock simulation.
- Analyse the production system using Markov chain & Petri Net.

Honors –Mechatronics
SEMESTER-VII
(PCC) FLUID POWER SYSTEMS AND FACTORY AUTOMATION

Teaching Scheme	**Examination Scheme**
Lectures : 3 hrs/week	T1/T2/ Assignments/ Quiz -40 End-Sem Exam- 60 marks

Course Objectives:

1. To know the importance and industrial applications of fluid power.
2. To explain the desirable of properties of fluid and its selection based on application requirements.
3. To learn applications of governing principles and laws for fluid power.
4. To implement distribution of fluid power by selecting appropriate components.
5. To evaluate energy losses in fluid power systems
6. To build and analyse fluid power circuits for various industrial applications.
7. To carry out logical and functional design along with control components for industrial fluid power applications.

Syllabus Contents

Hydraulic Power Generators - Selection and specification of pumps, pump characteristics.

Linear and Rotary Actuators - selection, specification and characteristics.

Pressure - direction and flow control valves - relief valves, non return and safety valves - actuation systems.

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits – press circuits - hydraulic milling machine - grinding, planning, copying, forklift, earth mover circuits - design and selection of components - safety and emergency mandrels.

Pneumatic fundamentals - control elements, position and pressure sensing

Pneumatic logic circuits - switching circuits -fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods – step counter method - compound circuit design - combination circuit design.

Pneumatic equipments - selection of components - design calculations -application - fault finding – hydro pneumatic circuits –

Use of microprocessors/microcontrollers for sequencing - PLC, Low cost automation - Robotic circuits.

Reference Books:

- Antony Esposito, "Fluid power with Applications", Prentice Hall India, 7th Edition, 2014.
- Dudleyt, A.Pease and John J.Pippenger, "Basic Fluid Power", Prentice Hall, 1987.

- Andrew Parr, "Hydraulic and Pneumatics", Jaico Publishing House, 1999.
- Bolton. W. “Pneumatic and Hydraulic Systems", Butterworth - Heinemann, 1997.
- Anthon H. Hehn, “Fluid Power Troubleshooting”, 2nd Edition, Marcel Dekker.
- S. R. Majumdar, “Pneumatic Systems: Principles and Maintenance”, Tata McGrawHillPublishing Company Limited, 1995.

Course Outcomes

At the end of the course, students will be :

1. Aware of the importance and the scope of hydraulics and pneumatics in the modern industry.
2. Able to select and size the different components required to design a fluid power system.
3. Able to select a control system to control the operation of designed fluid power system.
4. Able to design and implement low cost automation system.

SEMESTER VIII

PE-402 INDUSTRIAL INPLANT TRAINING

Teaching Scheme
Contact Hours: 2 hrs/week/student
Duration of Training in Industry : 6 months

Examination Scheme
Term Work : 50 Marks
Oral Exam : 50 Marks

Course Outcomes:

1. Learning the environment of Industry and its organization chart.
2. Learning of Manufacturing Machine Tools: Principles and Operations.
3. Exposure to different departments of plant which gives them to conceptualize Design, Manufacturing, Production Planning, Quality Control etc.
4. Learning about process of Supply Chain Management, Vendor Development, Product Design, concept of Value Engineering in New Product Development etc.
5. Comprehensive report writing skills based on his/her observations, training received and assignments completed.

General guidelines to the institutions running production - Sandwich degree course and to the students opting for sandwich course. Students are expected to learn following things during the Industrial Inplant Training of 6 months:
He shall be given training in large or medium size manufacturing unit in various departments.

1. Orientation / Rotational Training :
Organizational Structure of the Company, scale and type of production, types of products, functional departments like Manufacturing, Process Planning & Control, Quality Assurance, Assembly, Testing, Maintenance, Stores, Purchase, Marketing, Human Resources Department, Design and Drawing Department, General Administration, Packing and Dispatching. Tool Engineering, Materials & Material Handling etc.

2. Industrial Design and Drawing Practice:
Design and Drawing standards, study of Mechanical components and mechanical components and introduction to machine element design such as gears, gear boxes, chain and belt drives, electric motor selection, couplings, shafts, keys, bearings, brackets, bolted and welded connections. Sub - assembly and assembly design and drawings. Various ISO and BIS standards for design. Simple assignments based on the above items, selection of materials, material specification, beat treatment, and properties of materials.

3. Study of Manufacturing Processes:
Study of Processes such as casting, forging, sheet metal working, plastic moulding, extrusion, rolling and machining operations on various machines. Study of finishing processes like grinding, lapping, honing, burnishing, buffing, etc. Chipless manufacturing processes.

4. Study of Various Manufacturing Machine Tools such as lathes, capstan and turret lathes, planer, shaper and milling. Mechanical and Hydraulic Presses, Gear hobbing, shaping and grinding machines.

5. Study of special purpose machines, jig boring machines, NCICNC machines, work centers and transfer lines and automatic machines.

6. Study of single point cutting tools and multipoint tools, form tools, jig and fixtures, special purpose machine tools and Press tools, Tool material and tool selection, study of cutting parameters.
7. Study of material handling methods and equipment.

8. Introduction to Quality and Quality Policy, need for Quality Control, National and International Standards on Quality and Reliability. Study of various inspection gauges, selection of gauges, comparators, calibration of gauges, Standards Room, etc. Product Performance Test Procedures.

9. Study of various Production Planning and Control functions. Process and Operation Planning, Yearly and Monthly Planning, Forecasting, Scheduling, Planning.
10. Study of various Industrial Engineering functions, Work Study, (Motion Study and Time analysis), Ergonomic considerations, Plant Layout, Safety aspects of working, Safety gadgets used on machines and Personal Safety Equipment.

The students shall be asked to do simple assignments in various departments where he is undergoing training.
Industries shall be requested to prepare training program before hand, covering as much as possible from above mentioned topics depending upon the type of industry.

Term Work :
Term Work will consist of a comprehensive report based on his observation, training received and assignments completed during 6 months of training. The report shall also include good drawing figure, process sheets and machine and product specifications.
Students should maintain training project diary and report to internal guide every week. For writing project report, students must follow the format given in the project diary.

Oral Examination
Oral examination will be based on In-plant Training Report (Term Work), which will be conducted jointly by internal examiner from within the institute and external examiner from the industry.

Outcomes:

- At the end of the programme, successful trainees will be able to understand different manufacturing methods and their applications.

- Assessments and application of different management options for optimal production.
- To acquire skills to deal with public policy issues at the interface of science, government, industry and civil society.
- Students will understand different management tools and their applications.

PE-404 SEMINAR – II

Teaching Scheme
Practical:- 2 hrs/week

Examination Scheme
Oral: -- 50 Marks
Term Work: -- 50 Marks

Seminar shall be based on deep study of any topic related to production engineering; format of the report shall be as follows:
1. Title Page (Refer format given)
2. Certificate (Refer format given)
3. Acknowledgements:- There should not be any mistake in name and initials.
4. Abstract:- A page explaining the Seminar topic in maximum 150 words.
5. Content / Index (Refer format given in the Project Diary)
6. List of Tables/Figures or Nomenclature and Symbols:- List of Tables, Figures, Graphs etc. with respective page numbers.
7. Introduction:- 2-3 pages.
8. Seminar Report:- Description of topic about 12-15 pages.
9. Conclusion
10. References (Refer format given in the Project Diary)

Instructions regarding Seminar Report Printing:-
Page size :- A4.
Page Format :- Left-1.25", Right-1", Top & Bottom 1" – No Border / Frame.
Font :- Arial Regular.
Font Size and Colour :- 12, Black.
Line Spacing :- 1.5
Printing / Typing :- On one side of the paper only.
(No blank sheet be left any where in the report.)
Paragraph :- Justified.
Paragraph Indent :- Nil.
Page numbers :- Right bottom, starting from „Contents" page.
Printing :- Laser.
Binding :- Spiral with front and back cover of card paper neatly cut to size.

Number of Copies of the Seminar Report: - **Two**.

Instructions for figures and tables:-

i. Figures should be drawn on separate sheets or inserted on the page on which the text is typed. The figures are drawn in either permanent black ink or printed on paper. The figures should be numbered.
ii. Tables shall be typed in text. A separate sheet may be used, if necessary. The table shall be numbered.
iii. Mathematical portion of the text shall be preferably typed. If this is not possible, it should be written in permanent black ink. Lengthy Mathematical derivations shall not be included. Only the important steps and expressions shall be given.

iv. Discussions and conclusions shall form the last paragraph of the text.

Outcomes:
A Students should:

1. Explore seminar topic and its importance.
2. Acquire excellent presentation & communication skills.
3. Develop interest towards research oriented fields with ability to search the literature from the available resources.
4. Develop technical writing skills.

Certificate Page: -

DEPARTMENT OF PRODUCTION ENGINEERING & INDUSTRIAL MANAGEMENT

COLLEGE OF ENGINEERING, PUNE

(An Autonomous Institute of Government of Maharashtra)

CERTIFICATE

This is to certify that Mr./Miss_____ has completed the Seminar entitled _____in partial fulfillment of the requirement of the VIII semester Production Engineering (Sandwich) Course at the Department of Production Engineering of COLLEGE OF ENGINEERING, PUNE – 411005, during the academic term 20 - 20 .

(Name of Guide)

Date:- dd/mm/yyyy Guide

(Name of HOD)

Place:- Pune-411005. Prof. & Head

Department of Production Engg. & Industrial Management ,

College of Engineering, Pune:- 411005.

(Examiner)

Term Work

Term Work shall comprise of Seminar report. Topic of seminar should be pre-approved by guide.

Oral Examination

Seminar Presentation / Oral examination will be assessed by guide and one internal examiner from within the institute.

PROJECT AND PRODUCTION MANAGEMENT

Teaching Scheme	Examination Scheme
Self study	End Semester Exam-100 Marks

Course Objectives:

1. Understand the basic concepts of Project & Production Management.
2. Implement Project Planning in their Industrial In-Plant Training Project work
3. Apply concept of Facility Location & Layout and implement in their Industrial In-Plant Training Project work
4. Identify and tackle the medium and short-term planning decisions in the industry.

Syllabus Contents:

Unit 1

Project Conception and Appraisal: Project Identification, Idea Screening, Project Appraisal, Project Selection

Unit 2

Project Planning

Development of Project Network – Work Breakdown Structure, Project Representation – AOA and AON Networks, Project Scheduling –Critical Path Method, Project Scheduling with Probabilistic Activity Times - PERT , Time/ Cost Trade-offs in Projects Linear Time-Cost Trade-offs in Projects: A Heuristic Approach, Resource Considerations in Projects, Resource Profiles and levelling ,Limited Resource Allocation

Unit 3

Project Implementation & Complementation

Project Monitoring and Control with PERT / Cost, Team Building and Leadership in Projects Project Completion, Review and Future Directions

Unit 4

Production Management

Introduction to Production Systems and a Generalized Model of Production, Life cycle of a Production System and Major managerial Decisions

Financial Evaluation of Production Related Decisions

Performance Measures of a Production System, Financial Evaluation of Capital Decisions, Decision Trees and evaluation of risk.

Designing Products & Services

Introducing New Products and Services, Product Mix Decisions

Unit 5

Facility Location and Layout

Plant Location, Process Layouts, Product Layouts and Assembly Line Balancing, Cellular Layouts, Layouts for Advanced Manufacturing Systems.

Unit 6

Production Planning Over Medium Term Horizon

Demand Forecasting, Aggregate Production Planning

Operational Decisions Over the Short Term

Inventory related Decisions, Material Requirements Planning, Sequencing and Scheduling

References:

- Arun Kanda, S. G. Deshmukh. Project and Production Management (Video Course) From NPTEL, IITD, http://www.nptel.ac.in/video.php?subjectId=112102106
- Prasanna Chandra, Projects Planning, Analysis, Selection, Financing, Implementation, and Review, sevent Edition, Mc Graw Hill Education (India) Pvt. Ltd.
- Martand Telsang, Industrial Engineering and Production Management
- R. L. Francis, John A. White, Facility layout and location:an analytical approach, Prentice-Hall, 1974
- Stephen N Chapman, Fundamentals of Production Planning and Control, Pearson Education, 2006
- William Bolton, Production Planning and Control- Longman Scientific & Technical 1994Geofferry Boothroyd, Peter Dewhurst and Winston Knight. Product Design for Manufacture and Assembly, Amherst, 1983.
- Bill Hollins, Stwout Pugh, Butterworth, Successful Product Design by London 1990.
- Boothroyod & DewburstP.,Design for Assembly, a Designer's Hand book, University of Massachusets, Amherst, 1983.
- Keyinotto & Kristini Wood, Product Design Pearson Education 2004.

Course Outcomes:

- To enable students to learn the basic concepts of Project & Production Management
- To enable students to implement Project Planning in their Industrial In-Plant Training Project work
- To get capable of self-education and clearly understand the value of achieving perfection in Project implementation & completion.
- To study concept of Facility Location & Layout and implement in their Industrial In-Plant Training Project work
- To develop analytical mind for solving demand forecasting and Inventory decisions

Minors – Manufacturing Technology (Mechanical)
SEMESTER-VIII

INDUSTRIAL DESIGN OF PRODUCTS

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
100 marks: Continuous evaluation- Assignments /Quiz/T1/T2 - 40 Marks, End Sem Exam- 60 marks

Course Objectives:

1. Graduates will apply concepts of design and modeling for manufacturing to solve product design related engineering problems.
2. Graduates understand manufacturing technologies like Rapid prototyping for modeling.
3. Graduates understand product design optimization methods for better design.
4. Graduates will take hands on experience on live problem statements.

Syllabus Contents:

Unit 1 : Introduction to Product Design (5 hrs)

Asimow's Model: Definition of Product Design, Design by Evolution, Design by Innovation, Essential Factors of Product Design, Production-Consumption Cycle, Flow and Value Addition in the Production-consumption Cycle, The Morphology of Design (The sever phases), Primary Design Phases and flowcharting, Role of Allowance Process Capability, and. Tolerance in Detailed Design and Assembly.

Unit 2 : Product Design Practice and Industry (8 hrs)

Introduction, Product Strategies Time to Market, Analysis of the Product, The Three S's, Standardization Renard Series (Preferred Numbers), Simplification, The Designer and their Role, The Designer: Myth and Reality, The Industrial Design Organization Basic Design Considerations, Problems faced by Industrial Designer. Procedure adopted by Industrial Designers, Types of Models designed by Industrial Designers, What the Designer contributes, Role of Aesthetics in Product Design, Functional Design Practice. Review of Strength, Stiffness and Rigidity Considerations in Product Design Principal Stress Trajectories (Force - Flow Lines), Balanced Design, Criteria and Objectives of Design, Material Toughness: Resilience, Designing for Uniform Strength, Tension vis-à-vis Compression.

Unit 3 : Design for Production -Metal Parts (8 hrs)

Producibility Requirements in the Design of Machine Components, Forging Design, Pressed Components Design, Casting Design, Design for Machining Ease, The Role of Process Engineer, Ease of Location and Clamping, Some Additional Aspects of Production Design, Die Casting and Special Castings, Design for Powder Metallurgical Parts, Expanded Metals and

Wire Forms.

Designing with Plastics, Rubber, Ceramics and Wood

Approach to Design with Plastics, Plastic Bush Bearings, Gears in Plastic, Fasteners in Plastic, Rubber Parts, Design Recommendations for Rubber Parts, Distortion in Rubber, Dimensional Effects, Tolerances, Ceramics and Glass Parts, Production Design Factors for Ceramic Parts, Special Considerations for Design of Glass Parts, Dimensional Factors and Tolerances, Wood. Design for assembly and disassembly.

Unit 4 : Rapid Prototyping (8 hrs)

Importance and overview of Rapid Prototyping, Classification of Rapid Prototyping (RP) Process (FDM, LOM, SLA, SLS, Stereo lithography etc.), Typical Process Chain forRP, Introduction to CAD and Data exchange format, data format details, conversion, validation, repairing, Part Slicing and Orientation and its importance, application and case studies.

Unit 5 : Economic Factors Influencing Design (8 hrs)

Product Value, value analysis, design for Safety, Reliability and Environmental Considerations, Manufacturing Operations in relation to Design, Economic Analysis, Profit and Competitiveness, Break-even Analysis, Economics of a New Product Design (Samuel Eilon Model).

Human Engineering Considerations in Product Design

Introduction, Human being as Applicator of Forces, Anthropometry: Man as Occupant of Space, The Design of Controls, The Design of Displays, Man/Machine Information Exchange.

Unit 6: Modern Approaches to Product Design (6 hrs)

Concurrent Design, Quality Function Deployment (QFD) for design, product design optimization methods.

Text Books:

- A.C. Chitale and R.C. Gupta, Product Design and Manufacturing by PHI.
- Karl T. Ulrich & Steven D., Product Design & Development Eppinger Tata McGraw Hill, 3rdEdition, 2003

Reference Books:

- Tim Jones, Butterworth Heinmann, New Product Development by Oxford, TAC-1997.
- Roland Engene Y.,Inetoviez, New Product Development: Design & analysis, John Wiley and Sons Inc., N.Y. 1990.
- Geofferry Boothroyd, Peter Dewhurst and Winston Knight. Product Design for Manufacture and Assembly, Amherst, 1983.
- Bill Hollins, Stwout Pugh, Butterworth, Successful Product Design by London 1990.
- Boothroyod & DewburstP.,Design for Assembly, a Designer's Hand book, University of Massachusets, Amherst, 1983.

- Keyinotto and Kristini Wood, Product Design Pearson Education 2004.
- Venuvinod, PK., MA. W., Rapid Prortotyping –Laser Based and Other Technologies, Kluwer,2004.

Course Outcomes:

- Students learn basics of product design process and morphology of design.
- Students are exposed to Concept design, detail design, manufacturing, marketing, Introduction strategy of new product. Students learn about process of design for production of metal components.
- To understand optimization tools and ergonomic principles applied on typical product design as well as concept of value engineering in new product design.
- To understand all phases of product. Concept to final manufacturing.

Minros – Manufacturing Technology (Non - Mechanical)

SEMESTER-VIII

INDUSTRIAL DESIGN OF PRODUCTS

Teaching Scheme	**Examination Scheme**
Lectures : 3 hrs/week	100 marks: Continuous evaluation- Assignments /Quiz/T1/T2 - 40 Marks, End Sem Exam- 60 marks

Course Objectives:

1. Graduates will apply concepts of design and modeling for manufacturing to solve product design related engineering problems.
2. Graduates understand manufacturing technologies like Rapid prototyping for modeling.
3. Graduates understand product design optimization methods for better design.
4. Graduates will take hands on experience on live problem statements.

Syllabus Contents:

Unit 1 Introduction to Product Design **(5 hrs)**

Asimow's Model: Definition of Product Design, Design by Evolution, Design by Innovation, Essential Factors of Product Design, Production-Consumption Cycle, Flow and Value Addition in the Production-consumption Cycle, The Morphology of Design (The sever phases), Primary Design Phases and flowcharting, Role of Allowance Process Capability, and. Tolerance in Detailed Design and Assembly.

Unit 2 Product Design Practice and Industry **(8 hrs)**

Introduction, Product Strategies Time to Market, Analysis of the Product, The Three S's, Standardization Renard Series (Preferred Numbers), Simplification, The Designer and their Role, The Designer: Myth and Reality, The Industrial Design Organization Basic Design Considerations, Problems faced by Industrial Designer. Procedure adopted by Industrial Designers, Types of Models designed by Industrial Designers, What the Designer contributes, Role of Aesthetics in Product Design, Functional Design Practice. Review of Strength, Stiffness and Rigidity Considerations in Product Design Principal Stress Trajectories (Force - Flow Lines), Balanced Design, Criteria and Objectives of Design, Material Toughness: Resilience, Designing for Uniform Strength, Tension vis-à-vis Compression.

Unit 3: Design for Production -Metal Parts **(8 hrs)**

Producibility Requirements in the Design of Machine Components, Forging Design, Pressed Components Design, Casting Design, Design for Machining Ease, The Role of Process Engineer, Ease of Location and Clamping, Some Additional Aspects of Production Design, Die Casting and Special Castings, Design for Powder Metallurgical Parts, Expanded Metals and Wire Forms.

Designing with Plastics, Rubber, Ceramics and Wood

Approach to Design with Plastics, Plastic Bush Bearings, Gears in Plastic, Fasteners in Plastic, Rubber Parts, Design Recommendations for Rubber Parts, Distortion in Rubber, Dimensional Effects, Tolerances, Ceramics and Glass Parts, Production Design Factors for Ceramic Parts, Special Considerations for Design of Glass Parts, Dimensional Factors and Tolerances, Wood. Design for assembly and disassembly.

Unit 4: Rapid Prototyping (8 hrs)

Importance and overview of Rapid Prototyping, Classification of Rapid Prototyping (RP) Process (FDM, LOM, SLA, SLS, Stereo lithography etc.), Typical Process Chain forRP, Introduction to CAD and Data exchange format, data format details, conversion, validation, repairing, Part Slicing and Orientation and its importance, application and case studies.

Unit 5: Economic Factors Influencing Design (8 hrs)

Product Value, value analysis, design for Safety, Reliability and Environmental Considerations, Manufacturing Operations in relation to Design, Economic Analysis, Profit and Competitiveness, Break-even Analysis, Economics of a New Product Design (Samuel Eilon Model).

Human Engineering Considerations in Product Design

Introduction, Human being as Applicator of Forces, Anthropometry: Man as Occupant of Space, The Design of Controls, The Design of Displays, Man/Machine Information Exchange.

Unit6 : Modern Approaches to Product Design (6 hrs)

Concurrent Design, Quality Function Deployment (QFD) for design, product design optimization methods.

Text Books:

- A.C. Chitale and R.C. Gupta, Product Design and Manufacturing by PHI.
- Karl T. Ulrich & Steven D., Product Design & Development Eppinger Tata McGraw Hill, 3rdEdition, 2003

Reference Books:

- Tim Jones, Butterworth Heinmann, New Product Development by Oxford, TAC-1997.
- Roland Engene Y.,Inetoviez, New Product Development: Design & analysis, John Wiley and Sons Inc., N.Y. 1990.
- Geofferry Boothroyd, Peter Dewhurst and Winston Knight. Product Design for Manufacture and Assembly, Amherst, 1983.
- Bill Hollins, Stwout Pugh, Butterworth, Successful Product Design by London 1990.
- Boothroyod & DewburstP.,Design for Assembly, a Designer's Hand book, University of Massachusets, Amherst, 1983.
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- Venuvinod, PK., MA. W., Rapid Prortotyping –Laser Based and Other Technologies, Kluwer, 2004.

Course Outcomes:

- Students learn basics of product design process and morphology of design.
- Students are exposed to Concept design, detail design, manufacturing, marketing, Introduction strategy of new product. Students learn about process of design for production of metal components.
- To understand optimization tools and ergonomic principles applied on typical product design as well as concept of value engineering in new product design.
- To understand all phases of product. Concept to final manufacturing.

Honors – Manufacturing Systems Engineering

SEMESTER-VIII
MACHINE TOOL SYSTEMS

Teaching Scheme	Examination Scheme
Lectures : 3 hrs/week	100 marks: Continuous evaluation- Assignments /Quiz/T1/T2- 40 Marks, End Sem Exam- 60 marks

Course Objectives:

1. To understand machine tool configuration & their structure
2. To understand different important elements in machine tool system.
3. To get to know recent development in machine tool system.
4. To understand basic design principles of macro/micro elements of system.
5. To understand machine tool utilization to increase effective productivity.

Syllabus Contents:

Unit1: Machine tool configuration (6 hrs)

Recent development in machine tool field, Basic concepts and requirements, types of machine tool, structure of machine tool system, Design approach by matrix method, Introduction to CNC and machining centre configuration.

Unit2: Drive system review (6 hrs)

Elements of machine tool system, their requirements and design criteria-drive system viz speed/ feed drive, power transmission screw etc

Unit 3: Supporting elements and design analysis (8 hrs)

Supporting elements in machine tool-like bed, guides and lubrication, and stick slip, spindle, Machine column etc.

Unit 4: Rigidity & reliability of machine tool (6 hrs)

Rigidity of machine tool-static and dynamic, dynamic characterization analysis of cutting process, vibration and chatter, Machine compliance estimation, Tobius curve etc. Reliability of machine tool, Availability etc.

Unit 5: Automation and feedback (6 hrs)

Open loop and closed loop control, pre-selective and selective control, micro movements of elements, micro sensors, electrical/electronic control of motor, hydraulic controls, in-process gauging etc.

Unit 6: Introduction to modern machine tool **(8 hrs)**

Principle of automation, multi-axis machining centres, additive manufacturing machines, super finishing machines etc., machine tool power utilization with full tool life, Machine tool performance(Coefficient of merit).

Text Books:

- S K Basu, D. K. Pal - *Design of Machine Tools*, Oxford & IBH Pub., 1995
- Gopal Chandra Sen, Amitabha Bhattacharyya - *Principles of Machine Tools*, New Central Book Agency, 1967
- N. Ignatyev, N. Acherkan et al - *Machine Tool Design*, Volume 4, University Press of the Pacific, 2000.

Reference Books:

- N K Mehta - *Machine tool design and Numerical control*, third edition, Tata McGraw hill publications limited, 2012
- Stanley John Martin-*Numerical Control of Machine Tools*, Hodder and Stoughton, 1970
- T.K. Kundra- *Numerical Control and Computer-Aided Manufacturing*, McGraw-Hill Education, 1987
- JW Gardner, F Udrea- *Microsensors: principles and applications*,2nd John Wiley & Sons, 2009.
- A Gebhardt, A Gebhardt- *Understanding additive manufacturing*,CarlHanserVerlag GmbH & Co.,2012.
- RS Schmid, S Kalpakjian- *Manufacturing engineering and technology*, Pearson Prentice Hall, 2006.
- B Lu, D Li, X Tian- *Development Trends in Additive Manufacturing and 3D Printing*,Engineering, vol-1,issue-1,2015
- Menz et al - *Microsystem technology* - wileyvch verlag,2000

Course Outcomes:

- To learn machine tool structure and their elements
- To understand basic design features of machine elements
- To get upto-date knowledge in machine tool development field

Honors –Mechatronics
SEMESTER-VIII

(PCC) MECHATRONICS SYSTEM DESIGN

Teaching Scheme	**Examination Scheme**
Lectures : 3 hrs/week	T1/T2/ Assignments/Quiz -40
	End-Sem Exam- 60. marks

Course Objectives:

1. To be aware of integration of knowledge from different disciplines into Mechatronics.
2. To realize existence of Mechatronics in engineering and consumer products those are useful in everyday life.
3. To impart theoretical knowledge and make students familiar to select suitable sensors and actuators while designing electro-mechanical systems.
4. To demonstrate technical requirement while working with Mechatronics Systems.

Syllabus Contents:

- **Rotational drives** - Pneumatic Motors: continuous and limited rotation - Hydraulic Motors: continuous and limited rotation - Brushless DC Motors - Motion convertors, Fixed ratio, invariant motion profile, variators, remotely controlled couplings Hydraulic Circuits and Pneumatic Circuits.
- **Mechanical Systems and Design** - Mechatronics approach - Control program control, adaptive control and distributed systems - Design process - Types of Design - Integrated product design - Mechanisms, load conditions, design and flexibility Structures, load conditions, flexibility and environmental isolation – Man machine interface, industrial design and ergonomics, information transfer from machine from machine to man and man to machine, safety.
- **Real time interfacing** - Introduction Elements of data acquisition and control Overview of I/O process-Installation of I/O card and software - Installation of application software- Over framing.
- **Case studies on Data Acquisition** - Transducer calibration system for Automotive applications Strain Gauge weighing system - Solenoid force - Displacement calibration system - Rotary optical encoder - Inverted pendulum control - Controlling temperature of a hot/cold reservoir -Pick and place robot - Carpark barriers.
- **Case studies on Data Acquisition and Control** - Thermal cycle fatigue of a ceramic plate - pH control system - De-Icing Temperature Control System - Skip control of a CD Player - Autofocus Camera, exposure control.
- **Case studies on design of Mechatronics products** - Motion control using D.C. Motor, A.C. Motor & Solenoids - Car engine management - Barcode reader.

References :

- W. Bolton, Mechatronics - Electronic Control systems in Mechanical and Electrical Engineering-, 2nd Edition, Addison Wesley Longman Ltd., 1999.

- Devdas Shetty, Richard A. Kolk, Mechatronics System Design, PWS Publishing company, 1997
- Bradley, D.Dawson, N.C. Burd and A.J. Loader, Mechatronics: Electronics in Products and Processes, Chapman and Hall, London, 1991.
- Brian Morris, Automated Manufacturing Systems - Actuators, Controls, Sensors and Robotics, Mc Graw Hill International Edition, 1995.
- Gopal, Sensors- A comprehensive Survey Vol I & Vol VIII, BCH Publisher.

Course Outcomes:

- Demonstrate how mechatronics integrates knowledge from different disciplines in order to realize engineering and consumer products that are useful in everyday life.
- Application of theoretical knowledge: understanding selection of suitable sensors and actuators; designing electro-mechanical systems.
- Technical work: working with mechanical systems that include digital and analogue electronics as a data acquisition model.