COEP Technological University
(Formerly, College of Engineering, Pune)

Department of Manufacturing Engineering and Industrial Management

Curriculum Structure & Detailed Syllabus (UG Program)

B. Tech. (Manufacturing Science and Engineering)
(Revision: A.Y. 2020-21, Effective from: A.Y. 2023-24)

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Program Education Objectives (PEOs):

The Undergraduate students will demonstrate:

I. **PEO1**: Advance professionally as a result of his/her ability to solve complex technical problems using the knowledge of mathematics, science, engineering and humanities and to work in multidisciplinary areas whose solutions lead to significant societal benefits.

II. **PEO2**: Demonstrate professional engineering competence to real life problems and compete successfully using principles of manufacturing and time and quality management in the design and manufacture of products and services.

III. **PEO3**: Exhibit professionalism, ethical attitude, communication skills, teamwork in their profession and adapt to current trends by engaging in lifelong learning.

Program Outcomes (POs):

The Undergraduate Students will demonstrate:

a. Graduates will apply the basic knowledge of mathematics, science, engineering and humanities to Production Engineering field
b. Graduates will have the ability to define the problems and provide solutions by designing and conducting experiments, interpreting, and analyzing data for manufacturing.
c. Graduates will design manufacturing systems that would encompass machining science and technology, production processes, metal forming, tool and die design with the fully acquaintance with engineering thermodynamics and heat transfer, theory of machines, strength of material and would meet specifications and requirements as demanded by the customers.
d. Graduates will apply design and tooling for manufacturing, Kinematics of Machine Elements, Quality Control, modeling of manufacturing systems to solve production engineering problems.
e. Graduates understand manufacturing technologies like computer-controlled processes and Industrial Engineering, production management, SCLM, and Total Quality Management concepts.
f. Graduates will have the confidence to apply engineering solutions in global and societal contexts.
g. Graduates will understand quantitative modeling and analysis of a broad array of systems-level decision problems concerned with economic efficiency, work design, productivity and quality with environmental focus.
h. Graduates should be capable of self-education and clearly understand the value of achieving perfection in their professional endeavors.
i. Graduates will participate as members of engineering and science laboratory teams, as well as members of multidisciplinary design teams.
j. Graduates will be proficient in English language in both verbal and written forms which will enable them to compete with graduates of international engineering institutions.
k. Graduates will have the ability to choose and apply appropriate resource management technique/s so as to optimally utilize resources in manufacturing systems.

l. Graduates will be broadly educated and will have an understanding of the impact of engineering on society and demonstrate awareness of contemporary issues.

Correlation between the PEOs and PO's/PSO's

Program Objectives		Program Outcome												Program Specific Outcomes		
		a	b	c	d	e	f	g	h	i	j	k	l	PSO 1	PSO 2	PSO 3
PEO's	I	✓	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
	II	✓	✓	✓	✓	✓	✓					✓	✓	✓		
	III	✓	✓				✓		✓	✓	✓		✓			✓

Program Specific Outcomes:

After completion of the program, the graduates should be able to:

PSO1: Apply knowledge of manufacturing systems, industrial engineering and analytical techniques to solve real world problems.

PSO2: Apply knowledge of machine tool design, measurement systems, quality control and management systems to identify, formulate and solve complex engineering problems.

PSO3: Design, develop and manufacture innovative products using emerging manufacturing and computing technologies like CAD/CAM/CIM, rapid prototyping, machine learning, artificial intelligence etc.

UG Program Structure of
B. Tech. (Manufacturing Science and Engineering)

List of Abbreviations:

Abbreviation	Title	No of courses	Credits	% of Credits
BSC	Basic Science Course	9	27	16.26
ESC	Engineering Science Course	5	18	10.89
MLC	Mandatory Learning Course	4	0	0
SLC	Self Learning Course	2	5	3.02
HSMC	Humanities/Social Sciences/Management Course	7	9	5.4
LLC	Liberal Learning Course	1	1	0.6
SBC	Skill Based Course	7	17	10.24
IFC	Interdisciplinary Foundation Course	2	4	2.40
IOC	Interdisciplinary Open Course	3	6	3.61
DEC	Department Elective Course	2	6	3.61
PCC	Program Core Course	19	56	33.73
LC	Laboratory Course	17	17	10.24
		78	166	100

UG Program Structure [B.Tech.]
Manufacturing Science and Engineering

Semester I [M-Group]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Linear Algebra	2	1	0	3
2	BSC		Optics and Modern Physics	3	0	0	3
3	ESC		Basic Electrical Engineering	3	0	0	3
4	ESC		Engineering Graphics and Design	2	0	4	4
5	ESC		Engineering Mechanics	3	1	0	4
6	SBC		Mechanical Fab Shop	0	0	2	1
7	LC		Optics and Modern Physics Laboratory	0	0	2	1
8	LC		Basic Electrical Engineering Laboratory	0	0	2	1
9	LC		Engineering Mechanics Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**13**	**2**	**12**	**21**

Semester II [M-Group]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC		Uni-variate 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	ESC		Basic Electronics Engineering	3	0	0	3
5	ESC		Programming for Problem Solving	3	0	2	4
6	HSMC		Design Thinking	0	1	0	1
7	HSMC		Effective Communication Skills	0	0	2	1
8	SBC		Electronics and Computer Workshop	0	0	2	1
9	LC		Solid State Physics and Statistical Thermodynamics Laboratory	0	0	2	1
10	LC		Applied Chemistry Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**14**	**2**	**10**	**21**

Effective from A. Y. 2021-2022

III-Semester:

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC	MA-20001	Ordinary Differential Equations and Multivariate Calculus	2	1	0	3
2	BSC	AS-20001	Biology for Engineers	3	0	0	3
3	IFC	CE(IF)-20001	Strength of Material	2	0	0	2
4	SBC	PE-21001	Product and System Graphics	0	1	2	2
5	PCC	ME-20009	Theory of Machines	2	1	0	3
6	PCC	PE-21002	Manufacturing Processes	3	0	0	3
7	PCC	PE-21003	Material Science and Technology	3	0	0	3
8	LC	PE-21004	Manufacturing Processes Laboratory	0	0	2	1
9	LC	PE-21005	Material Science and Technology Laboratory	0	0	2	1
10	LC	ME-20011	Theory of Machines Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**15**	**03**	**8**	**22**

For other department

Sr. No.	Course Type	Course Code	**Interdisciplinary Foundation Course-I**	L	T	P	Credits
1	IFC	MFG(IF)-21001	Introduction to Manufacturing Processes	2	0	0	2

Semester III [For Direct Second Year Admitted Diploma Students]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC	MA-20002	Linear Algebra and Univariate Calculus	4	1	0	5
2	BSC	PH-20001	Foundation of Physics	3	0	0	3
3	BSC	AS-20001	Biology for Engineers	3	0	0	3
4	IFC	CE(IF)-20001	Strength of Material	2	0	0	2
5	SBC	PE-21001	Product and System Graphics	0	1	2	2
6	PCC	ME-20009	Theory of Machines	2	1	0	3
7	PCC	PE-21002	Manufacturing Processes	3	0	0	3
8	PCC	PE-21003	Material Science and Technology	3	0	0	3
9	LC	PE-21004	Manufacturing Processes Laboratory	0	0	2	1
10	LC	PE-21005	Material Science and Technology Laboratory	0	0	2	1
11	LC	ME-20011	Theory of Machines Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**20**	**8**	**8**	**27**

IV-Semester:

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC	MA-20004	Vector Calculus and Partial Differential Equations	2	1	0	3
2	MLC	ML-20004	Professional Laws, Ethics, Values and Harmony	1	0	0	0
3	HSMC	HS-20004	Innovation and Creativity	1	0	0	1
4	IFC	EE(IF)-20001	Industrial Electronics and Electrical Drives	1	0	2	2
5	SBC	PE-21006	Rapid Prototyping Practice (an "I-D-P: Ideate-Develop- Prototype" team Micro-project)	0	0	2	1
6	PCC	ME-20012	Engineering Thermodynamics and Heat Transfer	3	0	0	3
7	PCC	ME-20013	Fluid Power	2	1	0	3
8	PCC	ME-20010	Design of Machine Elements	3	0	0	3
9	PCC	PE-21007	Machining Science and Technology	3	0	0	3
10	LC	ME-20014	Engineering Thermodynamics and Heat Transfer Laboratory	0	0	2	1
11	LC	ME-20015	Fluid Power Laboratory	0	0	2	1
12	LC	PE-21008	Machining Science and Technology Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**16**	**02**	**10**	**22**

For other department

Sr. No.	Course Type	Course Code	Interdisciplinary Foundation Course-II	L	T	P	Credits
1	IFC	PE(IF)-21002	Industrial Engineering	2	0	0	2

Semester IV [For Direct Second Year Admitted Diploma Students]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC	MA-20005	Multi Variate Calculus and Differential Equations	4	1	0	5
2	MLC	ML-20004	Professional Laws, Ethics and Values	1	0	0	0
3	HSMC	HS-20004	Innovation and Creativity	1	0	0	1
4	IFC	EE(IF)-20001	Industrial Electronics and Electrical Drives	1	0	2	2
5	SBC	PE-21006	Rapid Prototyping Practice (an "I-D-P: Ideate-Develop- Prototype" team Micro-project)	0	0	2	1
6	PCC	ME-20012	Engineering Thermodynamics and Heat Transfer	3	0	0	3
7	PCC	ME-20013	Fluid Power	2	1	0	3
8	PCC	ME-20010	Design of Machine Elements	3	0	0	3
9	PCC	PE-21007	Machining Science and Technology	3	0	0	3
10	LC	ME-20014	Engineering Thermodynamics and Heat Transfer Laboratory	0	0	2	1
11	LC	ME-20015	Fluid Power Laboratory	0	0	2	1
12	LC	PE-21008	Machining Science and Technology Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**18**	**2**	**10**	**24**

Semester V [M-Group]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	MLC	ML-21002	Environmental Studies	1	0	0	0
2	IFC		Interdisciplinary Foundation Course-III	1	0	2	2
3	HSMC		Humanities Open Course – I • English Language Proficiency-I • Finance for Engineers-I • Engineering Economics-I • Industrial Psychology-I • Japanese Language-I • German Language-I • Spanish Language-1	2	0	0	2
4	SBC	MFG-22001	Advance Manufacturing and Simulation Laboratory	0	0	2	1
5	PCC	MFG-22002	Metrology and Quality Control	3	0	0	3
6	PCC	MFG-22003	Tool and Die Design	2	1	0	3
7	PCC	MFG-22004	Industrial Engineering and Management	2	0	0	2
8	PCC	MFG-22005	Product Design and Manufacturing	3	0	0	3
9	PCC	MFG-22006	Material Forming	3	0	0	3
10	PCC	MFG-22007	Kinematics and Dynamics of Machines	2	1	0	3
11	LC	MFG-22008	Process Planning and Tool Selection Laboratory	0	1	2	2
12	LC	MFG-22009	Metrology and Quality Control Laboratory	0	0	2	1
			Total Academic Engagement and Credits	**19**	**3**	**8**	**25**

For Other department

			Interdisciplinary Foundation Course-III	**L**	**T**	**P**	**Credits**
1	IFC	MFG(IF)-22001	Fundamentals of Robotics	2	0	0	2

Semester VI [M-Group]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	BSC	MA-21001	Probability and Statistics for Engineers	2	1	0	3
2	MLC	ML-21001	Constitution of India	1	0	0	0
3	HSMC		Humanities Open Course – II • English Language Proficiency-II • Finance for Engineers-II • Engineering Economics-II • Industrial Psychology-II • Japanese Language-II • German Language-II • Spanish Language-II	2	0	0	2
4	HSMC	HS-21001	Entrepreneurship Principles and Process	1	0	0	1
5	SBC	MFG-22010	Mini project [“D-S-P-T: Design-Simulate-Prototype-Test ”]	0	0	4	2
6	IOC		Interdisciplinary Open Course-I	2	0	0	2
7	DEC		Department Elective -I/Industry floated Course/Co-Taught Course	3	0	0	3
8	PCC	MFG-22011	Robotics and Intelligent Manufacturing	2	1	0	3
9	PCC	MFG-22012	Operations Research	3	0	0	3
10	PCC	MFG-22013	Manufacturing Automation	3	0	0	3
11	LC	MFG-22014	Manufacturing Automation Lab	0	0	2	1
			Total Academic Engagement and Credits	**19**	**2**	**6**	**23**

Department Elective-I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	DEC	MFG(DE)-22001	Supply Chain and Logistics Management	3	0	0	3
2	DEC	MFG(DE)-22002	Reliability and Maintenance	3	0	0	3
3	DEC	MFG(DE)-22003	Facility Planning and Design	3	0	0	3
4	DEC	MFG(DE)-22004	Micro and Nano Manufacturing	3	0	0	3
5	DEC	MFG(DE)-22005	Advanced Joining Technology	3	0	0	3
6	DEC	MFG(DE)-22006	Design of Experiments and Optimization	3	0	0	3

For Other department

			Interdisciplinary Open Course-I	L	T	P	Credits
1	IFC	MFG(IF)-22002	Reliability Engineering	2	0	0	2

Semester VII [M-Group]: Scheme B

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	MLC		Intellectual Property Rights	1	0	0	0
2	LLC		Liberal Learning Course	1	0	0	1
3	IOC		Interdisciplinary Open Course-III	2	0	0	2
4	DEC		Department Elective-II	3	0	0	3
5	SLC		Massive Open Online Course -I (Any One) Production Planning and Control/ Project and Production Management	3	0	0	3
7	PCC		CAD/CAM/CAE/CIM	2	1	0	3
8	PCC		Advanced and Additive Manufacturing Technology	3	0	0	3
9	PCC		Machine Tool and Manufacturing System	3	0	0	3
10	LC		CAD/CAM/CAE/CIM Lab	0	0	2	1
11	LC		Advanced Manufacturing Lab-II	0	0	2	1
			Total Academic Engagement and Credits	**20**	**1**	**4**	**20**

Department Elective-II [Option among minimum 3 courses]

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	DEC		Precision Engineering & In-process gauging	3	0	0	3
2	DEC		Total Quality Management and Six Sigma	3	0	0	3
3	DEC		Material Handling Equipments Design	3	0	0	3
4	DEC		Tribology in Design and Manufacturing	3	0	0	3
5	DEC		Mechatronics	3	0	0	3
6	DEC		Manufacturing Control Systems	3	0	0	3

Semester VIII [M-Group]: B Scheme

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1	SBC		Major Project with Industry/Corporate/Academia	0	0	18	9
2	SLC		Massive Open Online Course -I Internet of Things	3	0	0	3
			Total Academic Engagement and Credits	**0**	**0**	**20**	**12**

Semester Wise Credit Distribution	Teaching Scheme			Credits
	L	T	P	
I	13	2	12	21
II	14	2	10	21
III	16	2	08	22
IV	17	2	8	22
V	19	2	8	25
VI	18	2	10	23
VII	19	2	4	20
VIII	0	0	20	12
Total Academic Engagement and Credits	116	14	80	166

Minors- Manufacturing Technology (Mechanical)

Semester	Course offered	Teaching Scheme			Credits
		L	T	P	
V	Industrial Engineering	3	-	-	3
VI	Precision Engineering	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

Department Elective-II [Option among minimum 3 courses]

PRECISION ENGINEERING AND IN-PROCESS GUAGING

Teaching Scheme
Lectures: 3 hrs/week

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

Course Outcomes:

- Describe the General concept of accuracy, dimensional wear of cutting tools, location of rectangular prism alignment tests.
- Understand the Influence of static stiffness, thermal effects, compliance of work piece, Influence of vibration on accuracy.
- Interpret the overall performance with tolerance analysis.
- Compute errors due to compliance of machine-fixture-tool-work piece (MFTW) System
- Make use of measuring systems to check the dimensional quality and surface finish of the product.
- Analyse the process capability and tolerances of the system considering the functional aspects of product.

Unit 1 **(8 hrs)**

Accuracy concepts:

Introduction – Concept of Accuracy of Machine Tools – Spindle ad Displacement Accuracies – Accuracy of numerical Control Systems – Errors due to Numerical Interpolation Displacement Measurement System and Velocity Lags. Geometric Dimensioning and Tolerancing: Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums –Datum Feature of Representation – Form Controls, Orientation Controls – Logical Approach to Tolerancing.

Unit 2 **(8 hrs)**

Datum Systems: Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

Unit 3 **(8 hrs)**

Stiffness, thermal effects, and finish machining

Overall stiffness of Lathe – compliance of work piece errors caused by cutting forces, deformation in turning, boring, milling, heat sources , thermal effects, Finish Turning, boring, grinding, Surface roughness

Unit 4 **(8 hrs)**

Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

Unit 5 **(8 hrs)**

Tolerance Analysis: Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, Cp, Cpk, Cost aspects, Feature Tolerances, Geometric Tolerances.

Tolerance Charting Techniques-Operation Sequence for typical shaft type of components, Preparation of Process drawings for different operations, Tolerance worksheets and centrally analysis, Examples. Design features to facilitate machining; Datum Features – functional and manufacturing. Components design – Machining considerations, Redesign for manufactured, Examples

Unit 6 **(8 hrs)**

Sensors in Precision engineering

sources of error: thermal, static, dynamic and process related; precision machining processes and process model: diamond turning, fixed and free abrasive processes, sensors for process monitoring and control.

Text books

- Murthy. R. L, Precision Engineering in Manufacturing‖, New Age International, New Delhi, 2005.
- V. C. Venkatesh, Sudin Izman, Precision Engineering, McGraw Hill LLC, 2008
- David A. Dornfeld, Dae-Eun Lee,Precision Manufacturing, Springer US, 2007

References

- Precision Manufacturing, by David Dornfeld and Dae-Eun Lee, Springer, 2008.
- Dornfeld, D., and Lee, D. E., Precision Manufacturing, 2008, Springer. A. H. Slocum, Precision Machine Design, 1992, Prentice-Hall.
- H. Nakazawa, Principles of Precision Engineering, 1994, Oxford University Press.
- P. Seyfried, H. Kuntzmann, P. McKeown and M. Weck, eds., Progress in Precision Engineering, Springer-Verlag, 1991.
- C. Evans, Precision Engineering; An Evolutionary View, Cranfield Press, 1989.
- Tlusty, J., Manufacturing Processes and Equipment, Prentice-Hall, Upper Saddle River NJ, 2000.
- Thomas, T. Rough Surfaces, 2nd ed., Imperial College Press, London, 1999.
- Whitehouse, D. J., Handbook of Surface Metrology, Institute of Physics Publishing, Philadelphia PA, 1994.

PE-(DE) TOTAL QUALITY MANAGEMENT AND SIX SIGMA

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	Test 1 – 20, Test 2 – 20, End-Sem Exam- 40.

Outcomes:

After the completion of this course, students will be able to:

- Understand quality management philosophies, frameworks etc.
- Analysis of problems using various tools and techniques of quality management.
- Apply various quality tools and techniques in both manufacturing and service industry.
- Evaluate the current process using Six Sigma Methodology
- Develop strategies for continuous process improvement.

- Design the experiments for manufacturing and service industries to find out the effective solution.

UNIT I **(06 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 II **(06 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. Control charts for individual measurements, X chart, Moving average and moving range charts, exponential weighted moving average chart, cumulative sum chart.

UNIT III **(09 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 IV **(07 hrs)**

SIX SIGMA APPROACH TO QUALITY AND CONCEPTS OF RELIABILITY

Process capability analysis, Measurement system capability, Gauge R and R study, Machine capability study, Tolerance Analysis, Worst case and Statistical Tolerances, Six sigma introduction, Sigma Quality level, Six sigma methodology, DMAIC, DMADV, tools used in six sigma projects. Six Sigma case studies. Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve, maintainability

UNIT V **(07 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 , Value stream mapping

UNIT VI **(07 hrs)**

QUALITY SYSTEMS ORGANIZING AND IMPLEMENTATION

Total productive maintenance (TMP) – relevance to TQM, 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 9001 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.
- Montgomery, Douglas C. *Design, and analysis of experiments*, Eighth edition, Wiley student edition, 2008

Reference Books

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

PE(DE)- MATERIAL HANDLING EQUIPMENTS DESIGN

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:

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

- To get familiarized with various MH equipments.
- To learn basic design of MH equipment & system
- To learn methodology to select appropriate MH equipments.
- To learn safety related issues with MH system
- To design the bulk handling equipment using various components

Syllabus Contents:

Unit 1 **(6 hrs)**

Introduction

Introduction to material handling equipments, types, objectives, characteristics & classification of MH equipments, criteria for selection, various methods to analyse MH systems, requirements analysis.

Unit 2 **(6 hrs)**

Principles of MHS

Planning principle, system principle, material flow principle, gravity principle, space utilisation & aisle, unit size, mechanisation level, flexibility & expansion consideration, control principle, integration & automation, performance index, maintenance strategy.

Unit 3 **(4 hrs)**

Conveyor Design
Introduction to apron conveyor, pneumatic conveyor, Belt conveyor, screw conveyor, vibratory conveyor etc.

Unit 4 **(6 hrs)**

Hoist & bucket elevator design
Introduction, welded & roller chain, hemp & wire ropes, design of ropes, pulleys, sprocket, drum etc, design of hooks, lifting magnet and brakes -s hoe & cone type, types of bucket elecator, cage elevators, design of load & bucket arrangement.

Unit 5 **(8 hrs)**

Crane design
Hand propelled & EOT (electrically overhead travelling) crane, travelling mechanism of cantilever/monorails, jib crane, stability analysis etc.

Unit 6 **(10 hrs)**

Bulk handling equipment
Bulk materials, unit load concept, pallet, skids, containers, industrial truck, fork lifters, AGV, auxiliary equipments like gates, feeders, hoppers & chutes, automatic storage & retrieval system of fixed location bins, maintenance & safety of MHS.

Text Books:

- Material handling equipment, Alexander, Mir Publishers, 1981

Reference Books:

- Material Handling Equipment, Rudenko, Elnvee Pub , 1970.
- Material Handling System design, Heragu, Wiley Co, 2015.
- Material Handling System Design, Apple, Ronand Press , 1972.
- Material Handling Handbook, bolzharol, Ronald press, 1958.

PE(DE)-17003 TRIBOLOGY IN DESIGN AND MANUFACTURING

Teaching Scheme

Lectures: 3 hrs/week

Examination Scheme

Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:

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

- The course will enable the students to know the importance of Tribology in Industry.

- The course will enable the students to know the basic concepts of Friction, Wear, Lubrications and their measurements.
- This course will help students to know the performance of different types of bearings and analytical analysis thereof.
- This course will help students to learn and discuss 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.

PE(DE)-18003 MECHATRONICS

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

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

- Demonstrate how mechatronics integrates knowledge from different disciplines in order to realize engineering and consumer products that are useful in everyday life.
- Apply theoretical knowledge: understanding selection of suitable sensors and actuators; designing electro-mechanical systems.
- Work with mechanical systems that include digital and analogue electronics as a data acquisition model.
- Implement logic according to different scenarios
- Select suitable sensors, transducers and actuators given a specific problem
- Choose a specific connectivity method for a particular application

Syllabus Contents:

Unit 1 **(8 hrs)**

Mechatronics: Introduction to Mechatronics, Application areas of Mechatronics, Mechatronic Design Processes,

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.

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

Unit 3 **(7 hrs)**

Input/Output Systems:

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

Unit 4 **(8 hrs)**

Sensors, Transducers and Actuators

Introduction to Sensors and Transducers, Performance characteristics – static and dynamic, Sensor working Principles, Selection of sensors

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

Unit 5 **(7 hrs)**

Microcontrollers and Connectivity technologies: Introduction to use of open source hardware (Arduino & Raspberry Pi); shields/modules for GPS, GPRS/GSM, Bluetooth, RFID, and Xbee, integration with wireless networks, databases and web pages; web and mobile phone apps.

Unit 6 **(5 hrs)**

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

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.

Text Books

- Appu Kuttan, Introduction to MECHATRONICS, Oxford Univ Press, 2010
- Er R K Rajput, , A Textbook of Mechatronics, S Chand Publishing, 2007

Reference Books

- 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.
- Wolfgang Gopel, Sensors- A comprehensive Survey Vol I & Vol VIII, VCH, Wiley.

CAD / CAM / CAE/ CIM

Teaching Scheme	Examination Scheme
Lectures: 2 hrs/week	Test I - 20 Marks
Tutorial: 1 hrs/week	Test II - 20 Marks
	End Sem Exam - 60 marks

Course Outcomes:

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

- Solve the problems based on transformations of geometrical entities and develop its representation in a CAD system to validate the results.
- Represent the mathematical expression of geometrical entities to Evaluate and Validate developed curves, surfaces, and solids.
- Learn the concept of FEA and its implementation to evaluate and analyze FEA results for component design.
- Explain and Classify NC machines and its working principles to prepare NC programs using manual part programming techniques.
- Discuss the various concepts of CIM such as production planning and control, process planning, MRP, and ERP to solve the problems based on MRP during its implementation in large scale manufacturing.
- Explain the Group technology to apply the concepts of production flow analysis and rank order clustering to formulate machine cells

Syllabus Contents:

Unit 1: Introduction to CAD/CAM (4 hrs)

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: Modelling (7 hrs)

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: Finite Element Analysis (5 hrs)

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.

Unit 4: NC Programming (4 hrs)

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: Computer Integrated Manufacturing (CIM) (6 hrs)

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: Group Technology (2 hrs)

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

Textbooks:

- 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

Reference Books:

- 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**.** 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.

Advanced and Additive Manufacturing Technology

Teaching Scheme | **Examination Scheme**

Lectures: 3 hrs/week | T1 and T2 : 20 Marks each

Tutorial: - | End Sem Exam : 60 Marks

Course Outcomes:

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

1) Critique the effectiveness of different micro and nano manufacturing techniques for specific applications.
2) Analyse the impact of advanced manufacturing techniques on various industries, such as healthcare or electronics.
3) Students will be able to apply high-speed machining (HSM) techniques, precision grinding technology, to machine hard materials and super alloys for achieving improved material removal rates, surface finish and integrity, accuracy, and economic efficiency.
4) Learn the technological shift from conventional manufacturing techniques to additive manufacturing technology and understand the process chain of AM
5) Understand the process of classification of AM and their working principles.
6) Assess the quality of 3D printed parts based on surface finish and geometrical properties by application of post processing techniques.

Syllabus Contents:

Unit 1:

Micro & nano manufacturing technology (9 hrs)

Micro & nanotechnology, theory of miniature, MEMS , Fundamental of micro and nano technology, Micro and Nanofabrication, concepts of micro and Nano-systems and Microsystems Products, Microsystems and Microelectronics, Application of Microsystems, Standardisation and Commercialization Issues of Micro-Nano Systems.

Micro machining – Ultra Sonic Micro Machining, Abrasive Water Jet Micro Machining – Tool based Micro-machining, Chemical and Electro Chemical Micro Machining – Electric Discharge Micro machining. Electron and Laser Beam Micro Machining, Hybrid Micro machining, Electro Chemical Discharge micro machining, Machining of Micro gear, micro nozzle, micro pins and its applications. Tool based micromachining (TBMM).

Brief Overview of Novel Technologies with Impact in the Biomedical Device Industry, General Considerations for the Development of Biomedical Devices, Bio-fabrication Main Advances and Challenges Micro and Nano-manufacturing Technologies for Biodevices

Unit 2: **(6 hrs)**

Super finishing process

Micro and Nano manufacturing and Finishing: Focused Ion Beam Machining –Plasma Beam Machining – electrochemical nanomachining, Abrasive Flow finishing –- Magnetic Float polishing – Elastic Emission Machining – Chemo-Mechanical Polishing, Magnetic Abrasive Finishing – Magneto rheological finishing – Magneto Rheological abrasive flow finishing.

Advanced Surface Engineering including physical-chemical functionalisation, electro-deposition, CVD, PVD, tools/mould treatment, nano- and multi-layered coating.

Unit 3:

High-speed machining of Hard materials and super alloys

The machining of hard materials and super alloys, Hard machining using single point tools, high-speed machining, high performance machining of components. Application of HSM, improved material removal rate, surface finish and integrity, accuracy, economic considerations, precision grinding technology; ultra precision diamond turning and grinding technology.

Unit 4: **(10 hrs)**

Introduction to Additive Manufacturing (AM)

Introduction to AM, AM evolution, Distinction between AM and CNC machining, Advantages of AM, AM process chain: Pre-Processing, STL file manipulation, Classification of AM processes, post processing, Integration of Reverse Engineering and Rapid Prototyping.

Unit 5:

Design for AM **(05 hrs)**

Motivation, Design for manufacturing and Assembly concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.

Unit 6:

AM Applications: Rapid Tooling **(06 hrs)**

Convectional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling methods, Soft and Hard Tooling methods. Functional models, Pattern for investment and vacuum casting, medical models, art models, Engineering analysis models, new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries.

Text Books:

- Jain V.K., Introduction to Micro machining Narosa Publishing House, 2011.
- Daniel Dudzinski, Alain Molinari, H. Schulz, "Metal cutting and high speed machining" Kluwer Academic _ Plenum Publishers, 2002

Reference books:

- Helmi A. Youssef, "Machining of Stainless Steels and Super Alloys Traditional and Nontraditional Techniques" John Wiley & Sons, Ltd, 1st ed. 2016

- Chua Chee Kai, Leong Kah Fai, "Rapid Prototyping: Principles & Applications", World scientific, 2003.
- Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010
- Ali K. Kamrani, Emand Abouel Nasr, "Rapid Prototyping: Theory and Practice", Springer, 2006.
- Bhattacharyya B., "Electrochemical Micromachining for Nanofabrication, MEMS and Nanotechnology", William Andrew publications (Imprint of Elsevier) 2015.
- Bandyopadhyay. A.K., Nano Materials, New age international publishers, New Delhi, 2008, ISBN: 8122422578.
- Paul C. Bave: CAD Principles and Applications
- Understanding of Additive Manufacturing, Andreas Gebhardt, Hnaser Publishers, 2011.
- D.T. Pham, S.S. Dimov, Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer 2001

ME () Machine Tool and Manufacturing Systems

Teaching Scheme
Lectures: 2 hrs/week
Tutorial: 1 hrs/week

Examination Scheme
T1 and T2 : 20 Marks each
End Sem Exam : 60 Marks

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

- To understand machine tol and manufacturing system relationship.
- To get familiarised with machine tool elements and their functional requirement.
- To understand methodology of system analysis
- To understand machine tool configuration and dynamic characteristics relating manufacturing system.

Syllabus Contents:

Unit 1 **(6 hrs)**

Machine Tool System :

Introduction to m/c tool system, category of m/c tool, elements of system & configuration, analysis of requirement , kinematic structure of m/c tool.

Unit 2 **(8 hrs)**

Manufacturing & m/c tool system:

Block diagram of manufacturing system, system & engg. management, m/c tool system analysis-principle, purpose , approach , evaluation, modelling technique, validation & integration, m/c tool development requirement types, input-output of system , concurrent engineering concept.

Unit 3 **(6 hrs)**

Drive system: Power requirement, condition of reversibility , productivity loss concept, structure and ray diagram of gear-box design, layout diagram, motor selection, feed drive system etc.

Unit 4 **(8 hrs)**

System elements and dynamic characteristics, Supporting elements of m/c tool and requirement analysis , rigidity and vibration analysis , dynamic characterization of machining process.

Unit 5 **(6 hrs)**

Control system:

Basic control types, open and close loop control, adaptive control, automation and in-process inspection &control , sensors and micro-system.

Unit 6 **(6 hrs)**

Performance analysis of system elements and optimization. Multi-axes machining centres, additive mfg. tilting guide, stick-slip, sensitivity of rigidity , power utilization & tool life optimization, production process Optimization.

Text Books

- D.K. Pal and S.K.Basu, Design of Machine Tools (6th Revised Ed), Oxford-IBH 2014.
- 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 Hill
- Ring et al : Key issues in System Engineering.

CAD / CAE / CAM / CIM LABORATORY

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term Work: 50 Marks
Oral: 50 Marks

Course Outcomes:

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

- Understand the basic procedure required to develop the 3D model using CAD Modeling Software's. Build 3D CAD Models and Drawings of Industrial Parts, Assemblies etc.
- Learn the concept of FEA and its implementation to evaluate the stress and elongation on the component. Evaluate and analyze FEA analysis results for design and evaluation purposes to solve industry-based problems.
- Understand the concepts of CNC machine tools using CAM Programming. Develop the G-code program manually and using software.

Syllabus Contents:

1. To Study of CAD modeling software like INVENTOR to develop 3D CAD models, Assemblies and Drafting's.
2. Introduction to FEA, Advantages & Disadvantages of FEA & its Applications, Steps involved in FEA, Types of Elements etc.
3. Introduction to ANSYS, ANSYS Interface & Environments, Problem solving methodology in ANSYS,
4. Analysis of various problems in ANSYS software like simply supported beams, Chair etc.
5. To study Simulation of cutting/milling operations using CAM packages to develop CNC Programs.

Note: Oral shall be based on above assignments.

Advanced and Additive Manufacturing Laboratory

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Term Work: 50 Marks
Oral: 50 Marks

Course Outcomes:

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

- Understand the basic construction of additive manufacturing machines, different systems like Energy delivery, Material delivery, Nozzle and Heating Systems, suitable post processing techniques and its comparison by demonstrating on various 3D Printing and post processing machines.
- Learn the use of 3D printing software and Analyze the effect of various process parameters to evaluate the quality of 3d printed components.
- Develop the FDM based 3D printer by performing its assembly.

Understand the working principles of 3D scanners and its applications in the field of Additive Manufacturing.

Syllabus Contents:

1. **Experimental Investigation of Extrusion Based Additive Manufacturing technologies:** Machine Setup, Study of related Software, Hands-On Experience.
2. **Hands-On Experience on Liquid Polymer based Additive Manufacturing Technologies**: Machine Setup, Study of related Software, Actual Printing.
3. **Demonstration on Metal additive Manufacturing (Powder Based) Technologies:** Machine Setup, Study of related Software.
4. **Non Conventional Machine Tool** like ECM, EDM, Hybrid M/c Tool.
5. **Advanced Technology**- Atomic Force Microscopy, Scanning Tunnelling Microscope, Sensors, etc.

Note: Oral shall be based on above assignments.

Minors – Manufacturing Technology

SEMESTER-VII

PE(DE)-18001 MANUFACTURING AUTOMATION

Teaching Scheme	**Examination Scheme**
	Test I - 20 Marks
Lectures : 3 hrs/week	Test II - 20 Marks
	End Sem Exam - 60 marks

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.

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 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
- S. R. Majumdar, Pneumatic Systems: Principles and Maintenance, Tata McGraw Hill

Honors – Manufacturing Systems Engineering

SEMESTER-VII

PE(HO)-18001 PERFORMANCE MODELING OF PRODUCTION SYSTEMS

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

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.

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

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

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	Test I - 20 Marks
	Test II - 20 Marks
	End Sem Exam - 60 marks

Course Outcomes

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

- Understand the importance and the scope of hydraulics and pneumatics in the modern industry.
- Select and size the different components required to design a fluid power system.
- Analyze the fluid power circuits with control
- Design an electrical or PLC control logic system to control the operation of designed fluid power system.
- Design and implement low-cost fluid power automation system.

Syllabus Contents

Introduction to Fluid Power

Physical Properties of Hydraulic Fluids

Energy and Power in Hydraulic Systems

Frictional Losses in Hydraulic Pipelines

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.

Hydraulic Circuit Design and Analysis

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

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

Advanced Electrical Controls For Fluid Power Systems

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.

SEMESTER VIII

Scheme A
PE-18006 INDUSTRY PROJECT

Teaching Scheme	**Examination Scheme**
Contact Hours: 2 hrs/week/student	Term Work : 50 Marks
Duration of Training in Industry: 6 months	Oral Exam : 50 Marks

Course Outcomes:

- Understand different manufacturing methods and their applications.
- Assessments and application of different manufacturing options for optimal production.
- Accomplish objectives of the project work with efficient teamwork as well as resource management skills.
- Comprehensive report writing skills based on his/her observations, training received and assignments completed.
- Demonstrate professional ethics and values by solving engineering problems to benefit society or industry.

Student should undergo training in large or medium size manufacturing unit in various departments. Students are expected to learn following things during the Industrial Inplant Training of six months duration:

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, Design and development strategies.

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 assignments in various departments where he/she 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.

A report comprising preliminary literature review, objective, methodology and scope of the project work undertaken, duly signed by project guide(s) and head of the department, will be submitted for the end semester examination.

Evaluation: A committee comprising of guide and internal evaluation panel members shall assess the progress at mid-semester. Guide and appointed external examiner from industry shall jointly assess the progress/performance of the student based on In-plant Training Report, project presentation, and Q & A. This evaluation will be conducted at the end of the semester.

Scheme B

ACADEMIC PROJECT

Course Outcomes:

At the end of the project work, students will demonstrate the ability to

- Identify a problem statement from a rigorous literature survey or the industry requirements analysis in the domain of Manufacturing Science & Engineering
- Identify the methods/materials /solution strategies required for the project work.
- Accomplish all objectives of the project in allocated period with efficient teamwork.
- Demonstrate an ability to present project work through a comprehensive report and project presentation.
- Demonstrate professional ethics and values by solving engineering problems to benefit society or industry.

Academic Project envisages that a student during the final semester will acquire the ability of applying the engineering knowledge to a practical problem. A student is required to carry out the project work in the domain of Manufacturing Science and Engineering, under the guidance of a faculty member and/or the supervisor of the concerned industry/institute/organisation. The student can undertake the project individually or in a group of students. The project must cover at least any one area suggested below:

- Design and analysis of the machine tools/equipments/test rigs,
- Product design and development,
- Prototype/model development and Experimentation/Simulation using software/s environment,
- Advanced Manufacturing Processes
- Quality, Maintenance, Terotechnology and Reliability.
- Industrial Engineering and/or Ergonomics
- Robotics / Mechatronics/Automation System Design and development

Guidelines: After interactions with project guides experts, based on a comprehensive literature survey, the student shall identify the title and define the aim and objectives of a project.
These students are expected to work on details specifications, methodology, resources required, critical issues in design and implementation, and submit the project proposal. These students are also expected to work on the design, development, and testing of the proposed project work as per the planned schedule.

Deliverables: The project report is to be submitted at the end of the semester. This report includes a summary of the literature survey, detailed objectives, project specifications, design, proof of concept, developed system/Algorithm, results, contributions, and innovations in project work.
A report comprising preliminary literature review, objective, methodology and scope of the project work undertaken, duly signed by project guide(s) and head of the department, will be submitted for the end semester examination.

Evaluation: A committee comprising of guide and internal evaluation panel members shall assess the progress at mid-semester. Guide and appointed external examiner shall assess the progress/performance of the student based on a report, project presentation, and Q & A. This evaluation will be conducted at the end of the semester.

Massive Open Online Course -II
Internet of Things

Teaching Scheme	**Examination Scheme**
NPTEL Online mode	End Semester Exam-100 Marks

Course Outcomes:

- Understand, the need, importance and application of IoT and differentiate it with IIoT
- Apply networking methods to a given problem
- Select a communication protocol for an application
- Carry out analytics

Unit 1
Introduction to IoT: Origin, Definitions, Sensing, Actuation, Basics of Networking

Unit 2
Basics of Networking:, Communication Protocols

Unit 3
Communication Protocols: Sensor Networks: Machine-to-Machine Communications Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino

Unit 4
Introduction to Python programming, Introduction to Raspberry Pi, Implementation of IoT with Raspberry Pi

Unit 5
SDN for IoT, Data Handling and Analytics, Cloud Computing

Unit 6
Fog Computing, Smart Cities and Smart Homes, case studies on agriculture, healthcare etc.

References:

- "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", Pethuru Raj and Anupama C. Raman (CRC Press)
- "Internet of Things: A Hands-on Approach", Arshdeep Bahga and Vijay Madisetti (Universities Press)
- Research papers

Minors – Manufacturing Technology (Mechanical)
SEMESTER-VIII

INDUSTRIAL DESIGN OF PRODUCTS

Teaching Scheme	**Examination Scheme**
	Test I - 20 Marks
Lectures : 3 hrs/week	Test II - 20 Marks
	End Sem Exam - 60 marks

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.

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.
- GeofferryBoothroyd, Peter Dewhurst and Winston Knight. Product Design for Manufacture and Assembly, Amherst, 1983.
- Bill Hollins, Stwout Pugh, Butterworth, Successful Product Design by London 1990.
- BoothroyodDewburstP.,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.

Honors – Manufacturing Systems Engineering

SEMESTER-VIII
MACHINE TOOL SYSTEMS

Teaching Scheme	**Examination Scheme**
	Test I - 20 Marks
Lectures : 3 hrs/week	Test II - 20 Marks
	End Sem Exam - 60 marks

Course Outcomes:

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

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

Unit3: 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*, Carl Hanser Verlag 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

Honors –Mechatronics

SEMESTER-VIII
(PCC) MECHATRONICS SYSTEM DESIGN

Teaching Scheme

Lectures: 3 hrs/week

Examination Scheme

Test I - 20 Marks
Test II - 20 Marks
End Sem Exam - 60 marks

Course Outcomes:

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

- Understand the integration of knowledge from different disciplines into Mechatronics.
- Analyze existence of Mechatronics in engineering and consumer products those are useful in everyday life.
- Select suitable sensors and actuators while designing electro-mechanical systems.
- Create 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.