KPRIET
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KPR INSTITUTE OF ENGINEERING AND TECHNOLOGY
Coimbatore – 641407
DEPARTMENT OF MECHANICAL ENGINEERING

1. Vision and Mission of the Institution

Vision

To become a premier institute of academic excellence by imparting technical, intellectual and professional skills to students for meeting the diverse needs of the industry, society, the nation and the world at large.

Mission

- Commitment to offer value based education and enhancement of practical skills
- Continuous assessment of teaching and learning process through scholarly activities
- Enriching research and innovation activities in collaboration with industry and institute of repute
- Ensuring the academic process to uphold culture, ethics and social responsibility

2. Vision and Mission of the Department

Vision

To produce globally competent mechanical engineers to meet the changing needs of industries through innovative academic processes, research and value based education

Mission

The Department of Mechanical Engineering is committed to,

- Provide fundamental and skill based education in mechanical engineering through innovative practices in teaching and learning
- Collaborate with reputed industries, professional bodies and research laboratories for establishing Centre of Excellence
- Imbibe ethical behavior and morality for social upliftment to uphold human values

3. Programme Educational Objectives (PEOs)

The graduates of mechanical engineering will

PEO1: have a successful professional career in their related field of engineering to meet the changing needs of various stakeholders.

PEO2: involve in technology advancements through continuing education.

PEO3: practice their profession with good leadership skills and ethical values.

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4. Program Outcomes (POs)

Engineering Graduates will be able to:

PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering Fundamentals and an engineering specialization to the solution of complex engineering problems
PO2	**Problem analysis**	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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5. Program Specific Outcomes (PSOs)

A graduate of Mechanical Engineering should

PSO 1: Apply mechanical engineering principles to design, develop and implement advanced machine/mechanical systems or process for better performance and less human effort.

PSO 2: Ensure quality by applying quality tools, maintenance principles and managerial skills to comprehend the mechanical engineering processes, products and services.

6. Mapping of POs and PEOs

Subject Code	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
PEO1	√	-	√	-	√	-	-	-	-	-	√	-
PEO2	-	√	-	√	-	√	√	√	-	-	-	√
PEO3	-	-	-	-	-	√	-	√	√	√	-	-

7. Mapping of Course Outcomes (COs) with Program Outcomes (POs) (Fundamental & Professional Core Subjects)

Subject Code	Subject Name	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
P19ME101	Computer Aided Engineering	√	√	-	-	√	-	-	-	-	-	√	-	√	√
P19ME102	Mechatronics System Design	√	√	√	√	√	-	-	-	-	-	√	-	√	√
P19ME103	Computer Aided Process Planning	√	√	√	√	√	-	-	-	-	√	√	-	√	√
P19ME104	Additive Manufacturing and Tooling	√	√	√		√	-	-	-	-	-	√	-	√	√
P19ME201	Finite Element Analysis in Manufacturing	√	√	√	√	√	-	√	-	-	-		√	√	√
P19ME202	CNC Technology and Programming	√	√	√	√	√	-	√	-	-	√	√		√	√
P19ME203	Product Life Cycle Management	√	√	√	√	-	-	√	-	-	-	√	√	√	√
P19ME204	Design for Sustainability	√	√	√	√	-	-	√	-	-	-	√	√	√	√

8. Mapping of Course Outcomes (COs) with Program Outcomes (POs) (Professional Elective Subjects)

Subject Code	Subject Name	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
P19MEP01	Design of Material Handling Systems	√	√	√	√	-	-	-	-	-	-	-	-	√	-
P19MEP02	Mechanical behaviour of materials	√	√	√		-	-	-	-	-	-	-	√	√	√
P19MEP03	Optimization Techniques in Design	√	√	√	√	√	-	-	-	-	-	-	√	√	√
P19MEP04	Quality Engineering	√	√	√	-	√	√	-	-	-	-	-	√	√	√

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P19MEP05	Embedded System Design	√	√	√	√	√	-	-	-	-	-	-	-	√	√
P19MEP06	Sensors and Instrumentation	√	√	√	-	-	-	-	-	-	-	-	-	√	√
P19MEP07	Supply Chain Management	√	√	√	√	-	√	-	-	-	-	√	√	√	√
P19MEP08	Composite Materials and Mechanics	√	√	√	-	-	-	-	-	-	-	-	-	√	√
P19MEP09	Design for Manufacturing Systems	√	√	√	-	-	-	-	-	-	-	√	√	√	√
P19MEP10	Performance Modelling and Analysis of Manufacturing Systems	√	√	√	√	√	--	-	-	-	-	√	√	√	√
P19MEP11	Industrial Robotics	√	√	√	√	√	-	-	-	-	-	√	√	√	√
P19MEP12	MEMS and NEMS	√	√	-	-	-	-	-	-	-	-	-	-	√	√
P19MEP13	Computational Fluid Dynamics	√	√	√	-	-	-	-	-	-	-	-	-	√	√
P19MEP14	Reliability in Engineering Systems	√	√	√	√	-	-	-	-	-	-	-	-	√	√
P19MEP15	Project Management	√	√	√	√	-	-	-	-	-	-	√	-	√	√
P19MEP16	Research Methodology	√	√	√	√	√	-	-	-	-	-	√	√	√	√
P19MEP17	Micro and Smart Systems	√	√	√	-	-	-	-	-	-	-	-	-	√	√
P19MEP18	Real Time Systems	√	√	-	-	-	-	-	-	-	-	-	-	√	√

9. Mapping of Course Outcomes (COs) with Program Outcomes (POs) (Employability Enhancement Courses)

Subject Code	Subject Name	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
P19ME105	Geometric Modelling Laboratory	√	√	√	√	√	-	√	-	√	√	√	√	√	√
P19ME106	Automation Laboratory	√	√	√	√	√	-	√	-	√	√	√	√	√	√
P19ME205	Simulation Laboratory	√	√	√	√	√	-	-	-	-	√	√	√	√	√
P19ME206	Computer Aided Manufacturing Laboratory	√	√	√	√	√	-	√	-	-	√	√	√	√	√
P19ME301	Project work Phase – I	√	√	√	√	√	√	√	√	√	√	√	√	√	√
P19ME401	Project work Phase II	√	√	√	√	√	√	√	√	√	√	√	√	√	√

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Curriculum I to IV Semesters

SEMESTER – I

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C
THEORY							
1	P19ME101	Computer Aided Engineering	FC	3	0	0	3
2	P19ME102	Mechatronics System Design	PC	3	0	0	3
3	P19ME103	Computer Aided Process Planning	PC	3	0	0	3
4	P19ME104	Additive Manufacturing and Tooling	PC	3	0	0	3
5	-	PE – I	PE	3	0	0	3
6	-	PE – II	PE	3	0	0	3
PRACTICALS							
7	P19ME105	Geometric Modelling Laboratory	EEC	0	0	4	2
8	P19ME106	Automation Laboratory	EEC	0	0	4	2
			TOTAL	**18**	**0**	**10**	**22**

SEMESTER – II

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C
THEORY							
1	P19ME201	Finite Element Analysis in Manufacturing	PC	3	0	0	3
2	P19ME202	CNC Technology and Programming	PC	3	0	0	3
3	P19ME203	Product Life Cycle Management	PC	3	0	0	3
4	P19ME204	Design for Sustainability	PC	3	0	0	3
5	-	PE – III	PE	3	0	0	3
6	-	PE – IV	PE	3	0	0	3
PRACTICALS							
7	P19ME205	Simulation Laboratory	EEC	0	0	4	2
8	P19ME206	Computer Aided Manufacturing Laboratory	EEC	0	0	4	2
			TOTAL	**18**	**1**	**8**	**22**

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SEMESTER – III

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C
THEORY							
1	-	PE – V	PE	3	0	0	3
2	-	PE – VI	PE	3	0	0	3
PRACTICALS							
3	P19ME301	Project work Phase – I	EEC	0	0	12	6
			TOTAL	6	0	12	12

SEMESTER – IV

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C
PRACTICALS							
1	P19ME401	Project work Phase II	EEC	0	0	24	12
			TOTAL	0	0	24	12

PROFESSIONAL ELECTIVE COURSES
SEMESTER I (Elective I and II)

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C
1	P19MEP01	Design of Material Handling Systems	PE	3	0	0	3
2	P19MEP02	Mechanical behaviour of materials	PE	3	0	0	3
3	P19MEP03	Optimization Techniques in Design	PE	3	0	0	3
4	P19MEP04	Quality Engineering	PE	3	0	0	3
5	P19MEP05	Embedded System Design	PE	3	0	0	3
6	P19MEP06	Sensors and Instrumentation	PE	3	0	0	3

SEMESTER II (Elective III and IV)

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C
1	P19MEP07	Supply Chain Management	PE	3	0	0	3
2	P19MEP08	Composite Materials and Mechanics	PE	3	0	0	3
3	P19MEP09	Design for Manufacturing Systems	PE	3	0	0	3
4	P19MEP10	Performance Modelling and Analysis of Manufacturing Systems	PE	3	0	0	3
5	P19MEP11	Industrial Robotics	PE	3	0	0	3
6	P19MEP12	MEMS and NEMS	PE	3	0	0	3

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SEMESTER III (Elective V and VI)

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C
1	P19MEP13	Computational Fluid Dynamics	PE	3	0	0	3
2	P19MEP14	Reliability in Engineering Systems	PE	3	0	0	3
3	P19MEP15	Project Management	PE	3	0	0	3
4	P19MEP16	Research Methodology	PE	3	0	0	3
5	P19MEP17	Micro and Smart Systems	PE	3	0	0	3
6	P19MEP18	Real Time Systems	PE	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.NO	COURSE CODE	COURSE NAME	CATEGORY	L	T	P	C
1	P19ME105	Geometric Modelling Laboratory	EEC	0	0	4	2
2	P19ME106	Automation Laboratory	EEC	0	0	4	2
3	P19ME205	Simulation Laboratory	EEC	0	0	4	2
4	P19ME206	Computer Aided Manufacturing Laboratory	EEC	0	0	4	2
5	P19ME301	Project work Phase – I	EEC	0	0	12	6
6	P19ME401	Project work Phase II	EEC	0	0	24	12

10. Components of Curriculum and Credit Structure

COURSE CATEGORY	SEMESTER				TOTAL CREDITS
	I	II	III	IV	
FC	3				3
PC	10	13			21
PE	6	6	6		18
EEC	4	4	6	12	26
Total	23	23	12	12	68
Internship Credit					01
Total Credits					69

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P19ME101	COMPUTER AIDED ENGINEERING	Category: FC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Enrich knowledge in CAE strategies for effective manufacturing.
- Impart knowledge on geometric modelling and machine learning
- Impart knowledge on automated production and assembly lines

Unit 1 FUNDAMENTALS OF CAE 9

Introduction to CAE - CAD, CAM, FEA and CFD, CAE process, benefits of CAE, Tools of CAE- CATIA, Solid Works, Unigraphics, Hypermesh, Ansys, Nastran, LS Dyna, EDGE cam, CAE simulations, optimal Design techniques.

Unit 2 GEOMETRIC MODELLING 9

Introduction, engineering applications - criteria for evaluating representations, mathematical models for representing geometry - 2D simple shapes, curves, simple surfaces and regular shaped solids, representing complex solids. Primitive instancing, mesh, sweep, boundary, decomposition models and CSG. Applications of geometric modelling- estimation of volume.

Unit 3 MACHINE LEARNING 9

Introduction - learning algorithms: roll learning, statistical learning, detective learning, exploration and discovery. Introduction to ANN - Types of neural network, learning in neural networks

Unit 4 AUTOMATED PRODUCTION LINES 9

Comparison of manual and automated production lines, criteria for designing manual and automated production lines, automated production line-system configurations, work part transfer mechanisms, part delivery at workstations, applications of automated lines, analysis of transfer lines. Automated Guided Vehicles (AGV) - Types of AGV and applications, vehicle guidance technology, vehicle management and safety. Conventional storage methods and equipment, Automated storage/Retrieval system and carousel storage system

Unit 5 AUTOMATED ASSEMBLY SYSTEMS 9

Overview of generic material handling equipment, The 10 principles of Material handling. Conveyor systems, types of conveyors, operations and features, basics of automated assembly systems, planning for single and mixed model systems, quantitative analysis of assembly systems with case studies. Assembly Automation - types and configurations – parts delivery at workstations - product design for automated assembly - Case study.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS

1 B. Raphael and IFC Smith, "Fundamentals of Computer aided Engineering", 3rd Edition, Wiley, June 2013
2 Cornelius Leondes, "Manufacturing systems processes (volume 4), CRC press, NY, 2001

REFERENCE BOOKS

1 Kant Vajpayee. S, "Principles of Computer Integrated Manufacturing", Prentice Hall of India, 1999
2 Daniel Hunt.V, "Computer Integrated Manufacturing Hand Book", Chapman & Hall, 1989
3 Yoram Koren, "Computer Control of Manufacturing System", McGraw Hill, 1986
4 Jha, N.K, "Handbook of Flexible Manufacturing Systems", Academic Press Inc., 1991.

WEB SOURCES

1 https://nptel.ac.in/courses/112103174/module1/lec2/3.html
2 https://nptel.ac.in/courses/112104230/47

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

Cos	Statements	K-Level
CO1	Discuss the tools and terminologies that are associated with computer aided engineering.	Understanding
CO2	Discuss the various geometric modelling concepts	Understanding
CO3	Explain the machine learning principles and its applications	Understanding
CO4	Explain the various components of automated production lines	Understanding
CO5	Explain the concepts of assembly automation	Understanding

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	2	-	-	-	-	-	2	-	3	2
CO2	3	1	-	-	2	-	-	-	-	-	2	-	3	2
CO3	3	1	-	-	3	-	-	-	-	-	2	-	3	2
CO4	3	1	-	-	3	-	-	-	-	-	2	-	3	2
CO5	3	2	-	-	2	-	-	-	-	-	2	-	3	2
CO	3	2	-	-	3	-	-	-	-	-	2	-	3	2
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)						3: Substantial (High)			

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P19ME102	MECHATRONICS SYSTEM DESIGN	Category: PC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Provide fundamental knowledge on mechatronics systems.
- Enhance knowledge on mechatronics system modelling and control.
- Impart knowledge on practical applications of Mechatronics systems.

Unit 1 INTRODUCTION TO MECHATRONICS SYSTEM **9**

Key elements – mechatronics design process – types of design – traditional and mechatronics designs – advanced approaches in mechatronics - man machine interface, industrial design and ergonomics, safety.

Unit 2 REAL TIME INTERFACING **9**

Introduction - elements of data acquisition and control - overview of I/O process, analog signals, discrete signals and frequency signals – over framing.

Unit 3 MECHATRONICS SYSTEM MODELLING **9**

Introduction - model categories - model development - simulation using software - verification and validation. Mathematical modelling: Basic system modelling - mechanical electrical, fluid and thermal systems. Engineering systems: Rotational - translational, electro - mechanical, pneumatic-mechanical, hydro-mechanical, micro electro mechanical system - dynamic responses of system: first order, second order system – performance measures.

Unit 4 DATA ACQUISITION AND CONTROL **9**

Introduction – thermal cycle fatigue of a ceramic plate – pH control system – DC- Icing temperature control system – skip control of a CD Player – autofocus camera, exposure control. Case studies in design of mechatronic products – motion control using DC Motor and solenoids – car engine management systems.

Unit 5 ADVANCED APPLICATIONS IN MECHATRONICS **9**

Advanced applications of mechatronics systems: Sensors for condition monitoring – mechatronics control in automated manufacturing – Artificial intelligence in mechatronics – Fuzzy Logic applications in mechatronics – Microsensors for mechatronics applications.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Devdas shetty, Richard A. Kolk, "Mechatronics System Design", Cengage Education , 2013.

2 Bolton, -Mechatronics - Electronic Control systems in Mechanical and Electrical Engineering-, 7th Edition, Pearson Education., 2016.

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REFERENCE BOOKS

1 De Silva,"Mechatronics: A Foundation Course", Taylor & Francis, Indian Reprint, 2013

2 Bradley, D.Dawson, N.C. Burd and A.J. Loader,"Mechatronics: Electronics in Products and Processes", CRC Press 1991 , First Indian print 2010.

3 Brian morriss, "Automated manufacturing Systems–Actuators Controls, sensors and Robotics",McGraw Hill International Edition, 2011

4 Georg pelz,"Mechatronic Systems: Modeling and simulation" with HDL's, John Wiley and sons Ltd, 2013

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Define the basic concepts and elements of the mechatronics system.	Understanding
CO2	Apply data acquisition system modules to interface the components of mechatronics systems.	Applying
CO3	Apply mechatronics system modelling for engineering applications.	Applying
CO4	Apply the concept of mechatronics to automate processes in the manufacturing industry.	Applying
CO5	Apply advanced tools like ANN, Fuzzy logic in mechatronics systems.	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	2	1	-	-	-	-	-	1	-	3	2
CO2	2	2	1	2	1	-	-	-	-	-	1	-	3	2
CO3	2	2	2	2	2	-	-	-	-	-	1	-	3	2
CO4	2	2	2	2	2	-	-	-	-	-	1	-	3	2
CO5	2	2	2	2	2	-	-	-	-	-	1	-	3	2
CO	2	2	2	2	2	-	-	-	-	-	1	-	3	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19ME103	COMPUTER AIDED PROCESS PLANNING	Category: PC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Understand the importance of process planning role in manufacturing
- Understand the process engineering methods
- Apply computer aided process planning in the manufacturing industry.

Unit 1 INTRODUCTION 9

Process planning in manufacturing cycle - process planning and production planning – process planning and concurrent Engineering, Group Technology (GT)

Unit 2 PART DESIGN PRESENTATION 9

Design drafting - dimensioning - conventional tolerance - geometric tolerance - input / output devices - topology - geometric transformation - perspective transformation - data structure - Geometric modelling for process planning. GT coding - the Opitz system -the MICLASS system - case studies.

Unit 3 PROCESS ENGINEERING AND PROCESS PLANNING 9

Experience based planning - decision table and decision trees - process capability analysis - process planning - variant process planning - generative approach - forward and backward planning, input format, AI.

Unit 4 COMPUTER AIDED PROCESS PLANNING SYSTEMS 9

Logical design of a process plan - Implementation considerations - manufacturing system components, production Volume, number of production families - CAM-I, CAPP, MIPLAN, APPAS,AUTOPLAN and PRO, CPPP.

Unit 5 INTEGRATED PROCESS PLANNING SYSTEM 9

Totally integrated process planning systems - overview - modulus structure -data structure, operation - report generation - expert process planning

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Chang, T.C., " An Expert Process Planning System ", Prentice Hall, 1985.

2 Gideon Halevi and Roland D. Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1995.

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REFERENCE BOOKS

1 Nanua Singh, " Systems Approach to Computer Integrated Design and Manufacturing ", John Wiley & Sons, 1996.

2 Rao, "Computer Aided Manufacturing ", Tata McGraw Hill Publishing Co., 2000.

3 Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985.

WEB SOURCES

1 http://claymore.engineer.gusu.edu/jackh/eod/automate/capp/capp.htm

2 http://Estraj.ute.sk/journal/engl/027/027.htmED5071

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Discuss the process planning cycle and group technology	Understanding
CO2	Develop codes for the products using OPTIZ / MICLASS system.	Applying
CO3	Elaborate the principles of process engineering	Understanding
CO4	Develop process planning systems using computer aided tools.	Applying
CO5	Explain the concepts of integrated process planning systems.	Understanding

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	2	1	-	2	2
CO2	3	2	2	-	2	-	-	-	-	2	1	-	2	2
CO3	3	2	2	1	-	-	-	-	-	2	1	-	2	2
CO4	3	2	2	1	2	-	-	-	-	2	1	-	2	2
CO5	3	2	2	1	-	-	-	-	-	2	1	-	2	2
CO	3	2	2	1	-	-	-	-	-	2	1	-	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

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P19ME104	ADDITIVE MANUFACTURING AND TOOLING	Category: PC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Impart knowledge on fundamental and advanced technologies in additive manufacturing and its application
- Impart knowledge on the other technologies related to additive manufacturing
- Understand the applications of additive manufacturing in tooling

Unit 1 INTRODUCTION 9

Need –Development of AM systems –AM process chain –Impact of AM on product development - Virtual Prototyping - Rapid Tooling– RP to AM - Classification of AM processes - benefits -limitations - applications.

Unit 2 REVERSE ENGINEERING AND CAD MODELING 9

Reverse Engineering: Basics of reverse engineering, need for reverse engineering in additive manufacturing, Methodologies for Reverse Engineering. Digitization techniques – model reconstruction – data processing for rapid prototyping: CAD model preparation, data requirements, solid modeling – data formats - data interfacing, part orientation and support generation, support structure design, model Slicing, tool path generation - software for AM- case studies

Unit 3 LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, advantages, disadvantages and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

Unit 4 POWDER BASED ADDITIVE MANUFACTURING SYSTEMS AND 3D-PRINTING TECHNIQUES 9

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS - powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications, Electron beam melting, Printing technologies : Binder jetting and material jetting - Processes, materials, advantages, limitations and applications.

Unit 5 TOOLING 9

Classification, soft tooling, production tooling, bridge tooling, direct and indirect tooling, fabrication processes, applications - Case studies; automotive, aerospace and electronics industries.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 J Nagendra Ms, Ganesh Prasad, P.F., "Rapid Prototyping and Allied Manufacturing Technologies", Air walk Publications, 2016.
2 D.I Wimpenny, P.M. Pandey. Kumar., "3D Printing and Additive Manufacturing Technologies." Springer; 1st ed. 2019

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REFERENCE BOOKS

1 M. Adithan, "Rapid Prototyping." Atlantic Publishers and Distributors Pvt. Ltd, 2015.

2 Chua, C.K., LeongK.F. and LimC.S., "Rapid prototyping: Principles and applications", World Scientific Publishers,2010

3 Ian Gibson, "Additive Manufacturing Technologies." Springer Nature; 2nd ed.2015 edition.

4 Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press,2011

WEB SOURCES

1 M. Balaji, "Fused Deposition Modelling"Link: https://www.youtube.com/watch?v=WFi9JUV-SQU

2 K.V.Wong,"A Review of Additive Manufacturing"DOI:http://dx.doi.org/10.5402/2012/208760

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Describe the concepts and terminology of additive manufacturing.	Understanding
CO2	Explain reverse engineering concepts and its importance in additive manufacturing.	Applying
CO3	Explain the liquid and solid based additive manufacturing techniques.	Applying
CO4	Discuss about the powder based additive manufacturing techniques with current industrial application.	Applying
CO5	Explain the types of tooling in additive manufacturing.	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	3	-	-	-	-	-	1	-	3	2
CO2	2	2	2	-	3	-	-	-	-	-	1	-	3	2
CO3	2	2	2	-	3	-	-	-	-	-	1	-	3	2
CO4	2	2	2	-	3	-	-	-	-	-	1	-	3	2
CO5	2	2	2	-	3	-	-	-	-	-	1	-	3	2
CO	2	2	2	-	3	-	-	-	-	-	1	-	3	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19ME105	GEOMETRIC MODELLING LABORATORY	Category :EEC			
		L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

The objective of this course is to

- Model 3D view of the given orthographic projections.
- Convert 3D part models to 2D drawings
- Assemble the developed product.

LIST OF EXPERIMENTS

- Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc., using Solid Modeling Software
- Solid modeling using Extrude, Revolve, Sweep etc.
- Surface modeling – Mesh of curves and Free form using Solid Modeling Software
- Sheet metal Design- creation of thin feature and manipulation
- Assembly of the developed components - Exploded Views, Interference check, Geometric dimensioning and Tolerances.
- Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting
- CAD data Exchange formats-IGES, PDES, PARASOLID, DXF and STL
- Weldment design- Design and creating the chassis of an automobile
- Casting Design- create casting design with allowances, positioning of runner and riser, Core prints.
- Design of straight, helical gears and analyzing the kinematics of gear train using motion study.
- Usage of standard package for designing fasteners.

Contact Periods:

Lecture: - Periods Tutorial: - Periods Practical: 60 Periods Total: 60 Periods

REFERENCES

1 Radhakrishnan P, Subramanian S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

Cos	Statements	K-Level
CO1	Draw 2D drawing in a CAD modelling software	Applying
CO2	Model a 3D component using solid and surface modelling techniques.	Applying
CO3	Assemble the individual parts into a component and generate pictorial views	Applying
CO4	Create weldments and casting design using modelling Software	Applying
CO5	Perform motion study on simple mechanisms.	Applying

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COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	1	3	-	1	-	2	2	2	2	3	2
CO2	1	2	2	1	3	-	1	-	2	2	2	2	3	2
CO3	1	2	2	1	3	-	1	-	2	2	2	2	3	2
CO4	1	2	2	1	3	-	1	-	2	2	2	2	3	2
CO5	1	2	2	1	3	-	1	-	2	2	2	2	3	2
CO	1	2	2	1	3	-	1	-	2	2	2	2	3	2
Correlation levels: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)														

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Learn Beyond

19ME106	AUTOMATION LABORATORY	Category: EEC			
		L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

The objective of this course is to

- Develop pneumatic and electro pneumatic circuits using PLC
- Model and simulate the physical systems using software
- Interface PID controller with computer
-

LIST OF EXPERIMENTS

- Control of Single & Dual Acting Cylinders using Pneumatics
- Actuating multiple cylinders sequentially by cascade method.
- Develop electro pneumatic circuits using multiple actuators
- Speed control of AC servo Motors using PLC
- Water level controller using PLC
- Cascading circuit design using PLC
- Temperature & Pressure Control using computerized Data Acquisition Systems
- Control of velocity and direction of fluids using software
- Control of temperature and pressure of liquid flow using software
- Interfacing PID controller with computer
- Control of physical variables such as temperature, pressure, speed and vibration using PID controllers
- Perform AND & OR logical circuits for forward stroke of a double acting cylinder using two manual control.
- Demonstrate auto reset of a counter after 'n' cycles using double solenoid valve.

Contact Periods:

Lecture: - Periods Tutorial: - Periods Practical: 60 Periods Total: 60 Periods

REFERENCES

1 Mikell.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2008

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COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Develop and test a pneumatic and electro-pneumatic circuit.	Applying
CO2	Control a physical variable using PLC system.	Applying
CO3	Measure and control physical variable using Data Acquisition System.	Applying
CO4	Interface and control physical variables using PID controllers.	Applying
CO5	Perform AND, OR logic and counter operation using pneumatic circuit	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	1	3	-	1	-	2	2	2	2	3	2
CO2	1	2	2	1	3	-	1	-	2	2	2	2	3	2
CO3	1	2	2	1	3	-	1	-	2	2	2	2	3	2
CO4	1	2	2	1	3	-	1	-	2	2	2	2	3	2
CO5	1	2	2	1	3	-	1	-	2	2	2	2	3	2
CO	1	2	2	1	3	-	1	-	2	2	2	2	3	2
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)						3: Substantial (High)			

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P19ME201	FINITE ELEMENT ANALYSIS IN MANUFACTURING	Category: PC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Introduce the concepts of mathematical modeling for engineering problems.
- Equip students with fundamentals of finite element principles.
- Select appropriate elements to solve physical and engineering problems with emphasis on structural and thermal engineering applications.

Unit 1 ONE DIMENSIONAL ANALYSIS 9

Steps in FEA – Discretization, function – derivation of element characteristics matrix, shape function, assembly and imposition of boundary conditions – solution and post processing – One dimensional analysis in solid mechanics and heat transfer.

Unit 2 NON-LINEAR PROBLEMS 9

Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – ViscoPlasticity – Geometric Non linearity – large displacement Formulation –Solution procedure–Application in Metal Forming Process and Contact Problems.

Unit 3 DYNAMIC PROBLEMS 9

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis – Houbolt, Wilson, Newmark – Methods – Explicit & Implict Methods- Lanchzos, Reduced method for large size system equations.

Unit 4 FLUID MECHANICS AND HEAT TRANSFER PROBLEMS 9

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation – Steady and Transient Solution.

Unit 5 ANALYSIS OF PRODUCTION PROCESSES 9

FE Analysis of metal casting – Special considerations, latent heat incorporation, gap element – time stepping procedures – Crank – Nicholson algorithm – Prediction of grain structure – Basic concepts of plasticity – Solid and flow formulation – small incremental deformation formulation – FE Analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 P.Seshu. "Textbook Of Finite Element Analysis", PHI education, 2015.
2 Reddy. J.N., "An Introduction to the Finite Element Method", 4th Edition, Tata McGraw-Hill, 2018
3 Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 1990.

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REFERENCE BOOKS

1. J. N. Reddy, "Introduction to nonlinear finite element analysis", Oxford University Press, 2015
2. Daryl L Logan, "A First Course in the Finite Element Method", Global Engineering, 2012
3. Paul Kurowski, "Finite element analysis for design engineers", SAE, 2004
4. Javier Garcia de Jalon, "Kinematic and Dynamic Simulation of Multibody Systems: The Real-Time Challenge" Springer- Verlag, 1993
5. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990.

WEB SOURCES

1. https://nptel.ac.in/courses/112104116/
2. https://www.open.edu/openlearn/science-maths-technology/introduction-finite-element-analysis/content-section-0?active-tab=description-tab

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Apply finite element formulations to solve one dimensional Problems.	Applying
CO2	Gain knowledge in material & geometric non- linearity and plasticity	Applying
CO3	Solve the problems under dynamic conditions by applying various techniques.	Applying
CO4	Formulate the finite element equation to arrive at the solutions for fluid mechanics and heat transfer problems.	Applying
CO5	Interpret the finite element formulation of different production processes and its applications.	Applying

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	2	2	-	1	-	-	-	-	2	3	2
CO2	2	3	3	2	2	-	1	-	-	-	-	2	3	2
CO3	2	3	3	2	2	-	1	-	-	-	-	2	3	2
CO4	2	3	3	2	2	-	1	-	-	-	-	2	3	2
CO5	2	3	3	2	2	-	1	-	-	-	-	2	3	2
CO	2	3	3	2	2	-	1	-	-	-	-	2	3	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19ME202	CNC TECHNOLOGY AND PROGRAMMING	Category: PC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Impart knowledge on the working principle and parts of CNC machines.
- Enhance knowledge on the control systems and their interface with CNC machines
- Enhance the programme skills for operating a CNC machine

Unit 1 CONSTRUCTIONAL FEATURES OF CNC MACHINE TOOLS 9

Evolution of Computerized control in manufacturing, Components, Working principle of CNC, DNC and Machining centers. Constructional features of CNC machines: Introduction, spindle drives, transmission belting, axes feed drives, slide ways, ball screws, torque transmission, guideways.

Unit 2 ACCESSORIES AND FEEDBACK DEVICES 9

ACCESSORIES: Work tables, Spindles, Spindle heads, Beds and Columns, Tooling – Automatic Tool changer (ATC). Feedback devices: Introduction, digital/incremental displacement measuring systems, incremental rotary encoders, Moire fringes, feedback measurement systems and sensors, digital / absolute measuring system, tool and work holding devices.

Unit 3 CONTROL SYSTEM AND INTERFACE 9

Electro-magnetic Analogue Position Transducers: Principle, advantages, characteristics, Synchros, Synchro-Resolvers, Inductors, Laser interferometer. Control Systems And Interface: Open and closed loop systems, Microprocessor based CNC systems, block diagram of typical CNC system, description of hardware and soft interpolation systems, standard and optional features of CNC control systems, adaptive control.

Unit 4 PART PROGRAMMING 9

Manual part programming : G-codes and M-Codes, Programming for machining simple components- Job offset, tool offset, machine setting. APT language structure, APT geometry, Definition of point, time, vector, circle, plane, patterns and matrices. APT motion commands: setup commands, point-to point motion commands, continuous path motion commands, post processor commands, control commands, macro subroutines, part programming preparation for typical examples

Unit 5 ECONOMICS AND MAINTENANCE OF CNC MACHINE TOOLS 9

Introduction, factors influencing selection of CNC machines, cost of operation of CNC machines, maintenance features of CNC machines, preventive maintenance, documentation, spare parts, training in maintenance.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Radhakrishnan P "Computer Numerical Control Machines", New Central Book Agency, 2012.
2 Rao P.N., CAD/CAM, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2015.

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REFERENCE BOOKS

1 Pabla, B.S. & Adithan, M. "CNC Machines", New Age Publishers, New Delhi 2016.
2 Warren.S.Seames, Computer Numerical Control: Concepts and Programming, 4th edition, Delmar Thomson Learning Inc., 2002.
3 James Madison, "CNC Machining Hand Book", Industrial Press Inc., 1996.
4 Peter Smid, "CNC Programming Handbook", Industrial Press Inc., 2000

WEB SOURCES

1 https://www.udemy.com/fusion-360-tutorial-for-cnc-machinists/
2 https://ncviewer.com/

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Explain the constructional features of the CNC and its operation	Understanding
CO2	Discuss the different accessories and feedback systems in CNC machines.	Understanding
CO3	Discuss on the different control systems in the CNC machines	Understanding
CO4	Develop CNC part programs for simple components	Applying
CO5	Assess costing of the machine and develop maintenance schedule for CNC machine.	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	-	2	-	-	2	1	-	2	2
CO2	3	2	2	1	2	-	2	-	-	2	1	-	2	2
CO3	3	2	2	1	2	-	2	-	-	2	1	-	2	2
CO4	3	2	3	1	3	-	2	-	-	2	1	-	2	2
CO5	3	2	2	1	2	-	2	-	-	2	1	-	2	2
CO	3	2	2	1	2	-	2	-	-	2	1	-	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19ME203	PRODUCT LIFE CYCLE MANAGEMENT	Category: PC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Know the functions and features of PLM/PDM
- Impart knowledge on product data management
- Emphasize on the different modules of PLM/PDM tools and its implementation approaches

Unit 1 HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9

Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (PDM), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM). PLM/PDM Infrastructure – Network and communications, data management, Heterogeneous data sources and applications.

Unit 2 PLM FUNCTIONS AND FEATURES 9

User Functions – data vault and document management, workflow and process management, product structure management, product classification and programme management. Utility Functions – communication and notification, data transport, data translation, image services, system administration and application integration.

Unit 3 PRODUCT DATA MANAGEMENT (PDM) TECHNOLOGY 9

Product Data Management -An Introduction to concepts, benefits and terminology, CIM Data. PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation.

Unit 4 ROLE OF PLM IN INDUSTRIES 9

Case studies on PLM selection and implementation (like auto, aero, electronic) -other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance.

Unit 5 CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9

Applications of soft computing in product development process - Advanced database design for integrated manufacturing. PLM Customization, use of EAI technology (Middleware), Integration with legacy database, CAD, SLM and ERP. Case studies based on top few commercial PLM/PDM tools: Sun micro systems, ABB Automation products, Siemens PLM software for Mahindra vehicles and Ford vehicles, PLM of Xerox machine, PLM for cam maintenance and repair setup.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

Stark, John "Product Lifecycle Management (Volume 1)21st Century Paradigm for Product Realisation", Springer, 2020.

Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2016.

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REFERENCE BOOKS

1 Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, "Implementing and Integrating Product Data Management and Software Configuration Management", Artech House Publishers, 2003.

2 John Stark, "Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question", Springer Publisher, 2007.

3 John Stark, "Product Lifecycle Management: 21st Century Paradigm for Product Realisation", Springer Publisher, 2011 (2nd Edition).

WEB SOURCES

1 https://training.plm.automation.siemens.com/country/en-ams/ilt/live.shtml

2 https://nptel.ac.in/courses/112107217/2

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

Cos	Statements	K-Level
CO1	Explain history, concepts and terminology of PLM.	Understanding
CO2	Explain the functions and features of PLM.	Understanding
CO3	Discuss the features of PDM	Understanding
CO4	Correlate the role of PLM in industries	Understanding
CO5	Integrate PLM/PDM with other applications with case studies.	Applying

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	2	-	-	-	1	2	2	2
CO2	3	2	1	1	-	-	2	-	-	-	1	2	2	2
CO3	3	2	1	1	-	-	2	-	-	-	1	2	2	2
CO4	3	2	1	1	-	-	2	-	-	-	1	2	2	2
CO5	3	2	3	2	-	-	2	-	-	-	1	2	2	2
CO	3	2	2	2	-	-	2	-	-	-	1	2	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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<table>
<tr><td rowspan="3">P19ME204</td><td rowspan="3">DESIGN FOR SUSTAINABILITY</td><td colspan="4">Category: PC</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

COURSE OBJECTIVE

Objective of this course is to

- Understand the concept of design for manufacturing, assembly and environment.
- Impart knowledge on the factors influencing sustainability
- Emphasis on the role of computer application in design for manufacturing and assembly.

Unit 1 INTRODUCTION 9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits - Datum features - Tolerance stacks.

Unit 2 FACTORS INFLUENCING FORM DESIGN 9

Working principle, material, manufacture, design - Possible solutions - materials choice – Influence of materials on form design - form design of welded members, forgings and casting.

Unit 3 COMPONENT DESIGN AND MACHINING CONSIDERATION 9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, countersunk screws - reduction of machined area - simplification by separation -simplification by amalgamation - design for machinability - design for economy - design for clamping – design for accessibility - design for assembly – product design for manual assembly -product design for automatic assembly – robotic assembly.

Unit 4 COMPONENT DESIGN - CASTING CONSIDERATION 9

Redesign of castings based on parting line considerations - minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - modifying the design -group technology - computer Applications for DFMA.

Unit 5 DESIGN FOR ENVIRONMENT 9

Introduction – Environmental objectives – Global issues – Regional and local issues –Basic DFE methods – design guidelines – application – Life cycle assessment – basic method – AT&T's environmentally responsible product assessment -Weighted sum assessment method – Life cycle assessment method -Techniques to reduce environmental impact - design to minimize material usage – design for disassembly – design for recyclability – design for manufacture – design for energy efficiency – design to regulations and standards

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS

1 Boothroyd, G, Design for Assembly Automation and Product Design. New York, Marcel Dekker, 2016

2 Harry Peck , Designing for manufacture, Pitman–19738.Kevin Otto and Kristin Wood, Product Design. Pearson Publication, (Fourth Impression) 2009.

REFERENCE BOOKS

1 Bralla, Design for Manufacture handbook, McGraw hill, 1999.Fixel, J. Design for the Environment McGraw Hill.1996

2 Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.

3 Graedel T.Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Outline the appropriate design principles for sustainable manufacturing.	Understanding
CO2	Elaborate on the factors influencing form design of a product.	Understanding
CO3	Design a product by considering the machining requirements.	Applying
CO4	Design a component to be manufactured by casting	Applying
CO5	Design an equipment considering the environmental factors.	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	2	-	-	-	1	2	2	2
CO2	3	2	1	1	-	-	2	-	-	-	1	2	2	2
CO3	3	2	1	1	-	-	2	-	-	-	1	2	2	2
CO4	3	2	1	1	-	-	2	-	-	-	1	2	2	2
CO5	3	2	1	2	-	-	2	-	-	-	1	2	2	2
CO	3	2	1	2	-	-	2	-	-	-	1	2	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

N. [signature]

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Learn Beyond

P19ME205	SIMULATION LABORATORY	Category: EEC			
		L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

The objective of this course is to

- Analyze the stresses in the various machine components using Software Package.
- Simulate the working of the system and develop mathematical model for real time systems
- Analyse simple CFD problems

LIST OF EXPERIMENTS

- Basics of MATLAB- Dealing with matrices, Graphing - Functions of one variable and two variables
- Solve simple vibration problems using Matlab
- Simulate process line using MATLAB and SIMULINK
- Static analysis of typical industrial components using 3D elements.
- Stress analysis of axis–symmetric components
- Stress analysis of plates and shells
- Kinematic and dynamic analysis of mechanism using mechanism analysis software.
- Modal and Harmonic analysis of mechanical parts like turbine blade, aircraft wing, etc.
- Vibration analysis of spring-mass systems.
- Steady state thermal analysis of IC engine components, boiler, etc.
- Transient thermal analysis of elements such as fins, engine parts, electronic parts, etc.
- Thermo-mechanical analysis of components such as spindle, brake, etc.
- Analysis of internal and external fluid flow (pipes, ducts, aerofoil etc.) using CFD software
- FEA for sustainable design using a Modeling & Simulation software.
- Case study involving structural/thermal analysis of typical parts

Contact Periods:

Lecture: - Periods Tutorial: - Periods Practical: 60 Periods Total: 60 Periods

REFERENCES

1 P.Seshu, "Textbook Of Finite Element Analysis", PHI education, 2013.

2 Xu Han, "Numerical Simulation-based Design: Theory and Methods", Springer, 2018

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COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

Cos	Statements	K-Level
CO1	Use MATLAB and SIMULINK software's to solve simple problems	Applying
CO2	Analyze the stresses in the machine components using FEM.	Analyzing
CO3	Conduct dynamic analysis for the given problems	Analyzing
CO4	Conduct thermal for the given problems	Analyzing
CO5	Analyse fluid flow using CFD	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	3	-	-	-	-	2	2	2	2	2
CO2	2	3	3	3	3	-	-	-	-	2	2	2	2	2
CO3	2	3	3	3	3	-	-	-	-	2	2	2	2	2
CO4	2	3	3	3	3	-	-	-	-	2	2	2	2	2
CO5	2	3	3	3	3	-	-	-	-	2	2	2	2	2
CO	2	3	3	3	3	-	-	-	-	2	2	2	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

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P19ME206	COMPUTER AIDED MANUFACTURING LABORATORY	Category: EEC			
		L	T	P	C
		0	0	4	2

COURSE OBJECTIVE

The Objective of this Course is to

- Generate Numerical code for CNC machine operation.
- Simulate the tool path using a software package.

LIST OF EXPERIMENTS

- CL Data and Post process generation using CAM packages.
- Application of CAPP in Machining and Turning Centre.
- Part Programming - VMC- Linear Cutting. - simulation and machining
- Circular cutting. - simulation and machining
- Cutter Radius Compensation. -simulation and machining
- Canned Cycle Operations. - simulation and machining
- Part Programming - CNC Lathe -Straight, Taper and Radius Turning. -simulation and machining
- Thread Cutting. -simulation and machining
- Rough and Finish Turning Cycle. -simulation and machining
- Drilling and Tapping Cycle. -simulation and machining
- Operation of Contour milling using Vertical machining centre
- Demonstration on additive manufacturing - FDM/SLA
- Bed levelling and slicing in additive manufacturing process
- Case studies on industrial problems.

Contact Periods:

Lecture: - Periods Tutorial: - Periods Practical: 60 Periods Total: 60 Periods

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Generate the Numerical code for machining components in VMC	Applying
CO2	Generate the Numerical code for machining components in HMC	Applying
CO3	Generate the Process plan for any Operation.	Applying
CO4	Simulate the tool path for various operation of the NC machine and set the CNC machine for operation.	Applying
CO5	Fabricate simple components by additive manufacturing	Applying

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COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	3	-	1	-	-	2	2	2	2	2
CO2	2	3	3	3	3	-	1	-	-	2	2	2	2	2
CO3	2	3	3	3	3	-	1	-	-	2	2	2	2	2
CO4	2	3	3	3	3	-	1	-	-	2	2	2	2	2
CO5	2	3	3	3	3	-	1	-	-	2	2	2	2	2
CO	2	3	3	3	3	-	1	-	-	2	2	2	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19ME301	PROJECT WORK PHASE –I	Category: EEC			
		L	T	P	C
		0	0	12	6

COURSE OBJECTIVE

The Objective of this Course is

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To prepare project reports and to face reviews and viva-voce examination.

SYLLABUS	**Hours Req.**
The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of engineering design. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.	**180**

COURSE OUTCOMES (CO)

At the end of the course the students will have a clear idea of their area of work and they will be in a position to carry out the remaining phase II work in a systematic way.

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)					3: Substantial (High)				

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19ME301	PROJECT WORK PHASE –II	Category: EEC			
		L	T	P	C
		0	0	24	12

COURSE OBJECTIVE

The Objective of this Course is

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS	**Hours Req.**
The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including one external examiner	**360**

COURSE OUTCOMES (CO)

On completion of the project work students will be in a position to take up any challenging practical problem in the field of engineering design and find better solutions to it.

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)					3: Substantial (High)				

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P19MEP01	DESIGN OF MATERIAL HANDLING SYSTEMS	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Familiarize the various material handling equipments
- Enable to design various material handling equipments
- Enable to design various drives in material handling equipments

Unit 1 MATERIALS HANDLING EQUIPMENT **9**

Types of intraplant transporting facility, principal groups of material handling equipment, choice of material handling equipment, hoisting equipment, screw type, hydraulic and pneumatic conveyors, general characteristics of hoisting machines, surface and overhead equipment, general characteristics of surface and overhead equipment and their applications. Introduction to control of hoisting equipment.

Unit 2 DESIGN OF HOISTS **9**

Design of hoisting elements: Welded and roller chains -Hemp and wire ropes - design of ropes, pulleys, pulley systems, sprockets and drums, load handling attachments. Design of forged hooks and eye hooks - crane grabs -lifting magnets - grabbing attachments -design of arresting gear -brakes: shoe, band and cone types.

Unit 3 DRIVES OF HOISTING GEAR **9**

Hand and power drives -traveling gear - rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear -cogwheel drive -selecting the motor ratings.

Unit 4 CONVEYORS **9**

Types - description -design and applications of belt conveyors, apron conveyors and escalators, pneumatic conveyors, screw conveyors and vibratory conveyors.

Unit 5 ELEVATORS **9**

Bucket elevators: design - loading and bucket arrangements - cage elevators -shaft way, guides, counter weights, hoisting machine, safety devices - design of fork lift trucks

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981
2 Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.

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REFERENCE BOOKS

1. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Vol. 1 & 2, Suma Publishers, Bangalore, 1983
2. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970
3. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.
4. Boltzharol, A.,"Materials Handling Handbook", TheRonald press company 1958
5. Siddhartha Ray, "Introduction to Materials Handling", New Age International Pvt. Ltd., 19th edition, 2017.

STANDARDS

1. P.S.G. Tech., "Design Data Book", Kalaikathir Achchagam, Coimbatore, 2003

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Elaborate on the key parameters in design of material handling equipment	Understanding
CO2	Design hoist and cranes for industrial application.	Applying
CO3	Design the conveyer for transport of materials in industry	Applying
CO4	Design conveyors for various applications.	Applying
CO5	Design the elevators for industrial applications.	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	-	-	2	-
CO2	2	2	2	1	-	-	-	-	-	-	-	-	2	-
CO3	2	2	2	1	-	-	-	-	-	-	-	-	2	-
CO4	2	2	2	1	-	-	-	-	-	-	-	-	2	-
CO5	2	2	2	1	-	-	-	-	-	-	-	-	2	-
CO	2	2	1	1	-	-	-	-	-	-	-	-	2	-
Correlation levels:			1: Slight (Low)				2: Moderate (Medium)					3: Substantial (High)		

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P19MEP02	MECHANICAL BEHAVIOUR OF MATERIALS	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Study the mechanical behavior of materials under different loading and temperature conditions.
- Familiarize on the various metallic and non metallic materials
- Select the metallic and non metallic materials for various applications

Unit 1 BASIC CONCEPTS OF MATERIAL BEHAVIOR 10

Elasticity in metals and polymers - Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fiber and dispersion strengthening Effects of temperature, strain and strain rate on plastic behavior - superplasticity - Griffith's theory - Ductile - brittle transition in steel - High temperature fracture, creep - Larson Miller parameter - deformation and fracture mechanism maps.

Unit 2 BEHAVIOR UNDER DYNAMIC LOADS AND DESIGN APPROACHES 10

Stress intensity factor and fracture toughness - fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Safe life, stress life and fail safe design approaches - effects of surface and metallurgical parameters on fatigue - fracture of non metallic materials - failure analysis, sources of failure, procedure for failure analysis.

Unit 3 SELECTION OF MATERIALS 10

motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance - relationship between material selection and processing - Case studies in material selection with relevance to areo, auto, marine, machinery and nuclear applications - Computer aided materials selection

Unit 4 MODERN METALLIC MATERIALS 8

Dual phase steels, High strength low alloy (HSLA) steel, transformation induced plasticity (TRIP) steel, maraging steel, nitrogen steel - Intermetallics, Ni and Ti aluminides - smart materials, shape memory alloys, Metallic glasses and Nano crystalline materials.

Unit 5 NON METALLIC MATERIALS 7

Polymeric materials - Formation of polymer structure - Production techniques of fibers, foam, adhesives and coatings - structure, properties and applications of engineering polymers - Advanced structural ceramics, WC, TiC, TaC, Al_2O_3, SiC, Si_3N_4, CBN and diamond - properties, processing and applications.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Norman E., Dowling, Mechanical Behaviors of Materials, 4th Edition, Prentice Hall, Upper Saddle river, NJ, 2017

2 Thomas H. Courtney, Mechanical behavior of Materials (3rd edition), McGraw Hill, 2014

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REFERENCE BOOKS

1. Geroge E. Dieter, Mechanical Metallurgy (3rd edition), McGraw Hill, 2017
2. Kyriakos Komvopolus, Mechanical testing of Engineering Materials, Cognella Academic Publishing, San Diego, California, 2017.
3. Callister, Rethwisch, Material Science and Engineering: An introduction, 9th Edition, Wiley, 2013
4. Ashby M.F., "Materials selection in Mechanical Design" 2nd Edition, Butter worth 1999

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Explain the fundamental concepts of materials behavior	Understanding
CO2	Discuss the behaviour of materials under various loads	Applying
CO3	Select materials for different industrial applications	Understanding
CO4	Discuss the characteristics and mechanical properties of Metallic Materials	Understanding
CO5	Discuss the characteristics and mechanical properties of Non- Metallic Materials	Understanding

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	2	2	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2	2	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2	2	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2	2	2
CO5	3	2	2	-	-	-	-	-	-	-	-	2	2	2
CO	3	2	2	-	-	-	-	-	-	-	-	2	2	2

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

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P19MEP03	OPTIMIZATION TECHNIQUES IN DESIGN	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Impart knowledge on solving problems using linear programming.
- Master different optimization techniques using classical and numerical techniques.
- Equip with the concepts of genetic algorithms and neural networks

Unit 1 UNCONSTRAINED OPTIMIZATION TECHNIQUES **9**

Introduction to optimum design - General principles of optimization –Problem formulation & their classifications - single and multi variable optimization, techniques of unconstrained minimization – golden section, random, pattern and gradient search methods – Interpolation methods.

Unit 2 CONSTRAINED OPTIMIZATION TECHNIQUE **9**

Optimization with equality and inequality constraints - Direct and indirect methods using penalty functions, Lagrange multipliers - geometric programming

Unit 3 APPLICATIONS OF OPTIMIZATION TECHNIQUES **9**

Structural applications –Design of simple truss members - design applications – design of simple, axial, transverse loaded members for minimum cost, weight – design of shafts and torsionally loaded members – design of springs.

Unit 4 OPTIMIZATION OF DYNAMIC SYSTEMS **9**

Dynamic applications – optimum design of single, two degree of freedom systems, vibration absorbers. Application in mechanisms – optimum design of simple linkage mechanisms.

Unit 5 GENETIC ALGORITHM AND NEURAL NETWORKS **9**

GENETIC ALGORITHM (GA): Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, drawbacks of GA. NEURAL NETWORKS: Organization of the brain, biological and artificial neuron models, Characteristics of ANN, McCulloch-Pitts model, types of neuron activation function, ANN connectivity, learning strategies, learning rules. Introduction to nature inspired algorithms.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Kalyanamoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India. 2016

2 Johnson Ray, C., "Optimum design of mechanical elements", Wiley, John & Sons, 2014

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REFERENCE BOOKS

1 Douglas. C . Montgomery., "Response Surface Methodology: Product and Process optimization using designed experiments", Wiley,1995

2 Rao, Singaresu, S., "Engineering Optimization –Theory & Practice", New Age International (P) Limited, New Delhi, 2000.

3 Goldberg, D.E., "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson, 2008.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Explain in detail about single variable optimization techniques.	Understanding
CO2	Apply the principle of geometric Programming in Engineering Design	Applying
CO3	Apply Optimization techniques to design of simple mechanical elements.	Applying
CO4	Apply Optimization techniques to design of dynamic systems	Applying
CO5	Explain the concepts of neural networks and Genetic Algorithms in optimization problems.	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	2	-	-	-	-	-	-	2	3	2
CO2	2	2	3	2	2	-	-	-	-	-	-	2	3	2
CO3	2	2	3	2	2	-	-	-	-	-	-	2	3	2
CO4	2	2	3	2	2	-	-	-	-	-	-	2	3	2
CO5	2	2	3	2	2	-	-	-	-	-	-	2	3	2
CO	2	2	3	2	2	-	-	-	-	-	-	2	3	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)			3: Substantial (High)								

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P19MEP04	QUALITY ENGINEERING	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Understand the basic principles of quality management.
- Obtain knowledge on systematic procedure for maintaining records
- Identify the causes for defects in the production system.

Unit 1 QUALITY ENGINEERING AND ASSURANCE SYSTEMS **9**

Quality value and engineering: Definition of TQM, approaches, elements, principles, pillars, models. Crosby's 14 steps to quality improvement. Quality Assurance systems: Definition, objectives, major elements, manual, management principles, forms, quality planning. FMEA - types of FMEA, product and process risk, susceptibility, occurrence and Response capability, correction and prevention.

Unit 2 LEAN MANUFACTURING SYSTEMS **9**

Introduction to seven waste and their narration; Evolution of lean; Global competition, Lean Manufacturing, Value flow and Muda, Muri and Mura, Need for LM, Meeting the stakeholders requirement, Elements of LM. Fundamental blocks of lean manufacturing , concept of 5S, impact of 5S in lean manufacturing, Total Productive Maintenance (TPM), Pillars of TPM, Implementation of TPM. Workflow, Small lot sizes, Pull Method, Kanban, Just In Time.

Unit 3 STATISTICAL PROCESS CONTROL **9**

Process capability, old and new seven tools of quality, control charts for variables, control charts for attributes, problems on control charts, setting of product tolerances.

Unit 4 QUALITY IMPROVEMENT TECHNIQUES **9**

Definition, types, merits, models, phases. Business process re engineering - definition, 6 R's of business process, quality circles. Computer aided quality control

Unit 5 DESIGN OF EXPERIMENTS AND ANOVA **9**

Design of experiments: Introduction, task aids and responsibilities for DOE process steps, DOE process steps description. Analysis of variance (ANOVA): one-way ANOVA, two-way ANOVA, critique of F-test, ANOVA for four level factors, multiple level factors. Taguchi Methods – quadratic loss function, analysis, robust design.8-point approach.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Douglas C Montgomery, "Design and analysis of Experiments", 10th edition , wiley, 2018
2 Brue G, "Six Sigma for Managers", Tata-McGraw Hill, New Delhi, Second reprint, 2002

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REFERENCE BOOKS

1. De Feo J A and Barnard W W, "Six Sigma: Break trough and Be-yond", Tata McGraw-Hill, New Delhi, 2005.
2. Pyzdek T and Berger R W," Quality Engineering Handbook", Tata-McGraw Hill, New Delhi, 1996
3. Dale H. Besterfield, Carol Besterfield-Michna, Glen Besterfield, Mary Besterfield-Sacre, "Total Quality Management" Pearson, 2012.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Explain the pillars of quality and practice those principles to reduce the defects that occur in the manufacturing processes.	Understanding
CO2	Discuss the basic concepts of lean production system.	Understanding
CO3	Apply statistical tools to control the quality of the products in industry	Applying
CO4	Distinguish the techniques to improve the quality of the products in an industry.	Understanding
CO5	Design experimental trails to conduct experiments with multiple inputs.	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	1	1	-	-	-	-	-	2	3	3
CO2	3	2	1	-	1	1	-	-	-	-	-	2	3	3
CO3	3	2	3	-	2	1	-	-	-	-	-	2	3	3
CO4	3	2	1	-	1	1	-	-	-	-	-	2	3	3
CO5	3	2	3	-	2	1	-	-	-	-	-	2	3	3
CO	3	2	2	-	2	1	-	-	-	-	-	2	3	3
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

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P19MEP05	EMBEDDED SYSTEM DESIGN	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Provide an overview of embedded system design principles
- Understand the concepts of real time operating systems
- Provide exposure to embedded system development tools using basic programming techniques

Unit 1 INTRODUCTION TO EMBEDDED SYSTEMS 9

Overview of embedded systems, embedded system design process, challenges -common design metrics and optimization. Hardware - Software design, embedded product development

Unit 2 REAL TIME OPERATING SYSTEM 9

Real time operating systems architecture - tasks and task states - tasks and data - semaphore and shared data - message queues, mail boxes and pipes -encapsulating semaphores and queues -interrupt routines in an RTOS Environment. Introduction to Vx works, RTLinux

Unit 3 PIC MICROCONTROLLERS 9

Programmable Interrupt Controller (PIC) Architecture - instruction set - addressing modes - timers - interrupt logic - CCP modules - analog to digital convertor (ADC).

Unit 4 EMBEDDED PROGRAMMING 9

I/O Programming, interrupts and timer application. interfacing keypad. interfacing LCD. interfacing ADC/DAC

Unit 5 IOT REFERENCE ARCHITECTURE 9

Industrial Automation - Service oriented architecture based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Raj Kamal, Embedded Systems Architecture Programming and Design II edition, Tata MC Graw-Hill, 2016

2 Tim Wilmshurst, Designing Embedded Systems with PIC Microcontrollers: principles and applications Elsevier, 2015

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REFERENCE BOOKS

1 Steve Heath, Embedded Systems Design II edition, Newness publications, 2009

2 Tammy Noergaard, Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers Elsevier, 2015

3 David E. Simon, An embedded software primer, Pearson Education, 1995.

4 Raj Kamal, Microcontrollers Architecture Programming Interfacing and System Design, Pearson Education, 2010

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Define the basic principle of Embedded systems	Understanding
CO2	Apply the principle of ARM architecture in Real time operating systems.	Applying
CO3	Discuss the basic principles and architecture of PIC microcontrollers.	Understanding
CO4	Develop embedded system programmes for various applications.	Applying
CO5	Apply the principle of IoT in embedded systems.	Applying

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	-	-	-	-	-	-	-	3	2
CO2	3	2	3	1	2	-	-	-	-	-	-	-	3	2
CO3	3	2	2	1	1	-	-	-	-	-	-	-	3	2
CO4	3	2	3	1	2	-	-	-	-	-	-	-	3	2
CO5	3	2	3	1	2	-	-	-	-	-	-	-	3	2
CO	3	2	3	1	2	-	-	-	-	-	-	-	3	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

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P19MEP06	SENSORS AND INSTRUMENTATION	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Introduce the various sensor used in industries
- Analyze, design, build and troubleshoot variety of sensor circuits
- Explain the principles of operation of the major sensors

Unit 1 REVIEW OF MEASUREMENT AND INSTRUMENTATION **9**

Review of Static characteristics of Instrument systems, dynamic characteristics of Instrument systems. Review of Op - Amp Circuit, passive - and active – filters.

Unit 2 SIGNAL CONDITIONING **9**

Analog Signal Conditioning: Principles of analog signal conditioning, Signal-Level and Bias Changes. Linearization, Conversions, Filtering and Impedance Matching, Concept of Loading. Passive Circuits: Voltage Divider, Bridge Circuits, Bridge Resolution, Bridge Applications Digital Signal Conditioning: Review of Digital Electronics: Digital Information, Fractional Binary Numbers, Boolean Algebra, Digital Electronics Circuits: comparator, converter, Digital-to-Analog Converters (DACs), Analog-to-Digital Converters (ADCs): Flash-, SAR, Dual Slope.

Unit 3 THERMAL SENSORS **9**

Definition of Temperature: Thermal Energy, absolute and relative Temperature, Metal resistance versus temperature devices: Resistance versus Temperature Approximations, Resistance-Temperature Detectors (RTD) Thermistors: Semiconductor Resistance versus Temperature, Thermistor Characteristics, THERMOCOUPLES: Thermoelectric Effects, Thermocouple Characteristics, Thermocouple Sensors. Other thermal sensor: Bimetal Strips, Gas Thermometers, Vapor-Pressure Thermometers, Liquid-Expansion Thermometers Solid-State Temperature Sensors, Design considerations.

Unit 4 MECHANICAL SENSORS **9**

Displacement, Location, or Position Sensors: Resistive-, Capacitive-, and Inductive Sensors. Variable-Reluctance Sensors, LVDT. Level Sensors. Metal Strain Gauges and Semiconductor Strain Gauges (SGs). Load Cells. Motion sensors: Types of Motion, Accelerometer Principles, Types of Accelerometers. Pressure sensors: Pressure Principles, Pressure Sensors ($p > 1$ atmosphere), Pressure Sensors ($p < 1$ atmosphere). Flow sensors: Solid-Flow –and liquid flow measurement: Pipe Flow Principles, Restriction Flow Sensors, Obstruction Flow Sensor. Magnetic Flow Meter.

Unit 5 OPTICAL SENSORS **9**

Fundamentals of EM radiation. Nature of EM Radiation, Characteristics of Light, Photometry. Photodetectors: Characteristics, Photoconductive Detectors, Photovoltaic Detectors, Photodiode Detectors. Photo emissive Detectors. PYROMETRY: Thermal Radiation, Broadband Pyrometers, Narrowband Pyrometers

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS

1 Robert B. Northrop, "Introduction to Instrumentation and Measurement, 3rd Edition", CRC –Press – Taylor and Francis Group, 2012.
2 John G. Webster, "Measurement, Instrumentation, and Sensors Handbook", CRC –Press –Taylor and Francis Group, 2015

REFERENCE BOOKS

1 Curtis D. Johnson, "Process Control Instrumentation Technology, 6th Edition", Prentice Hall International Edition, 2000
2 E. O. Deoblin, D N Manik, "Measurement systems", 5th edition,2007,TMH.
3 K C Jain, Electronic Measurements and Instrumentation Jain Brothers pub, 2016
4 H S kalsi, Electronic Instrumentation 3rd edition, Mc. Graw Hill publication, 2011.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Explain the basic characteristics of the measurement system	Understanding
CO2	Apply analog/digital signals for various circuits	Applying
CO3	Select the sensors suitable for measuring the thermal variables	Understanding
CO4	Select the sensors suitable for measuring the mechanical variables	Understanding
CO5	Select the sensors that utilize optical principles	Understanding

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	-	-	-	-	-	-	-	-	2	2
CO2	2	2	2	-	-	-	-	-	-	-	-	-	2	2
CO3	2	2	2	-	-	-	-	-	-	-	-	-	2	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	2	2
CO5	2	2	2	-	-	-	-	-	-	-	-	-	2	2
CO	2	2	2	-	-	-	-	-	-	-	-	-	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19MEP07	SUPPLY CHAIN MANAGEMENT	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Impart knowledge on supply chain management and its importance
- To emphasise on the supply chain control process
- Update on the recent developments in supply chain management

Unit 1 BASICS OF SUPPLY CHAIN MANAGEMENT 9

Introduction, Definition of Supply Chain Management (SCM), Evolution Supply Chain Management, Key drivers of Supply Chain Management, Typology of Supply Chains, Cycle view of Supply Chain, Problems in SCM and Suggested Solutions

Unit 2 PLANNING DEMAND AND SUPPLY 9

Introduction, Components of SCM - Demand Management, Demand Forecasting, Supply Management - Evolution of ERP - Concept of ERP in SCM - Quick Response and Accurate Response System in SCM, use of other Planning Strategies

Unit 3 LOGISTICS MANAGEMENT 9

Definition of Logistics and Logistics Management - Types of Logistic Activities - Importance of Logistics Management - Integrated Logistics and its Support - Determinants of Designing Logistical System - Transportation, Warehousing, Packaging.

Unit 4 INVENTORY ANALYSIS AND CONTROL 9

Supply Chain Operations: Procurement Cycle - Inventory Management - Inventory Costs - Types of Inventory Models - Inventory Control Systems - Tools of Inventory Management. ABC inventory system - EOQ models for purchased parts - inventory order policies - EMQ models for manufactured parts - lot sizing techniques, inventory models under uncertainty.

Unit 5 RECENT TRENDS IN SUPPLY CHAIN MANAGEMENT 9

Introduction, New Developments in Supply Chain Management, Outsourcing Supply Chain Operations, Co-Maker ship, The Role of E-Commerce in Supply Chain Management, Green Supply Chain Management, Distribution Resource Planning, World Class Supply Chain Management

Contact Periods:

Lecture: 45 Periods   Tutorial: - Periods   Practical: – Periods   Total: 45 Periods

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TEXT BOOKS

1 Sunil Chopra, "Supply Chain Management: Strategy, Planning, and Operation", 6th Edition, Pearson Education, 2016.

2 Thomas Pyzdek Paul, A. Keller, "Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts, and Managers at All Levels" Tata McGraw Hill, 2017

REFERENCE BOOKS

1 Martin Christopher, "Logistics and Supply chain Management", 5th Edition, FT Publishers, 2016

2 Michaell H. Hugos, "Essentials of Supply Chain Management"3rd Edition, John Wiley & Sons, 2011

3 Coyle, John J., Supply Chain Management: A Logistics Perspective, 2016, Cengage Learning.

4 Myerson, Paul, "Lean Supply Chain and Logistics Management", McGraw-Hill Education, 2012

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Discuss the fundamentals of supply chain management	Understanding
CO2	Explain the components of supply chain	Understanding
CO3	Design systems for logistics management	Applying
CO4	Implement inventory control practices in an industry	Applying
CO5	Discuss the recent developments in six sigma	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	2	-	-	-	-	1	2	3	**2**
CO2	3	2	1	1	-	2	-	-	-	-	1	2	3	**2**
CO3	2	2	3	1	-	2	-	-	-	-	1	2	3	**2**
CO4	2	2	3	1	-	2	-	-	-	-	1	2	3	**2**
CO5	2	2	3	1	-	2	-	-	-	-	1	2	3	2
CO	2	2	3	1	-	2	-	-	-	-	1	2	3	2
Correlation levels:				1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)			

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P19MEP08	COMPOSITE MATERIALS AND MECHANICS	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Know the fundamentals of composite material and its behavior
- Have an insight on the analysis of fiber reinforced laminate design
- Familiarize on the thermo-mechanical behavior and residual stresses in laminates

Unit 1 INTRODUCTION TO COMPOSITE MATERIALS **9**

Definition- Matrix materials - polymers - metals - ceramics - reinforcements: Particles, whiskers, inorganic fibers, metal filaments - ceramic fibers - fiber fabrication - natural composite wood, jute Mechanical properties and applications of composites, particulate reinforced composites, dispersion - strengthened composites, fiber - reinforced composites - Rule of mixtures - Characteristics of fiber - reinforced composites.

Unit 2 MANUFACTURING OF COMPOSITES **9**

Manufacturing of Polymer Matrix Composites (PMCs)-handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-, bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) – Solid state, liquid state,vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs) – hot pressing-reaction bonding process-infiltration technique.

Unit 3 INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS **9**

Lamina Constitutive Equations: Assumptions – macroscopic viewpoint. Generalized Hooke's Law, Definition of stress and moment resultants. Basic assumptions of laminated anisotropic plates. Laminate constitutive equations – coupling interactions, balanced laminates, symmetric laminates, angle ply laminates, cross ply laminates. Laminate structural moduli. Evaluation of lamina Properties, Quasi - Isotropic laminates.

Unit 4 LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES **9**

Introduction - Maximum stress and strain criteria. Von - Misses yield criterion for Isotropic Materials. Generalized Hill's criterion for anisotropic materials. Tsai-Hill's failure criterion for composites. Prediction of laminate failure equilibrium equations of motion. Energy formulations, static bending analysis, buckling analysis, free vibrations – natural frequencies

Unit 5 TESTING OF COMPOSITES **9**

Mechanical testing of composites, tensile testing, Compressive testing, flexural testing, impact testing, Micro Vickers hardness testing, Inter-laminar shear testing, fatigue testing, moisture absorption testing, biodegradability testing, and Morphological analysis of composite laminates.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS

1 Autar K. Kaw., "Mechanics of Composite Materials", 2nd Edition, Taylor & Francis, 2006.

2 Composites Manufacturing" Materials, Product and Process Engineering by Sanjay K. Mazumdar, CRC Press, 2002

REFERENCE BOOKS

1 Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990

2 Chung, Deborah D.L., "Composite Materials: Science and Applications", Ane Books Pvt. Ltd./Springer, New Delhi, 1st Indian Reprint, 2009

3 Madhujit Mukhop, "Mechanics of FRP Composite Materials & Structure"Universities Press 2004.

4 Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 5th edition, 2009

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Explain the fundamentals of composite materials	Understanding
CO2	Discuss the manufacturing processes of composite materials.	Understanding
CO3	Discuss the equation that governs the mechanics of composites	Applying
CO4	Evaluate the strength of the laminates	Applying
CO5	Make use of equipments to measure the properties of composites	Applying

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	-	-	-	-	-	-	-	-	2	**2**
CO2	2	2	2	-	-	-	-	-	-	-	-	-	2	**2**
CO3	2	2	2	-	-	-	-	-	-	-	-	-	2	**2**
CO4	2	2	2	-	-	-	-	-	-	-	-	-	2	**2**
CO5	2	2	2	-	-	-	-	-	-	-	-	-	2	2
CO	2	2	2	-	-	-	-	-	-	-	-	-	2	**2**
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19MEP09	DESIGN FOR MANUFACTURING SYSTEMS	Category : PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Emphasise on the processes followed in industries
- Highlight the improvement in quality by implementing the industrial processes
- To impart knowledge on the manufacturing processes and control

Unit 1 LEAN MANUFACTURING AND VALUE STREAM MAPPING 9

Evolution of Mass production – Traditional vs. Mass production – Evolution of Toyota (Lean) Production System – Business Dynamics of Lean production – Principles of Lean production: Value, Value stream, Flow, Pull, Perfection. Need for Value Stream mapping – Steps involved in Value stream mapping – Choose value stream – PQ and PR analysis – Current State map – Lean Metrics – Future State Map – Kaizen plans

Unit 2 FLEXIBLE MANUFACTURING SYSTEMS 9

Group Technology: Introduction, objectives, part families, algorithms and models for G.T. - Rank order clustering, Bond energy, mathematical model for machine – component cell formation. Introduction to FMS - concepts, advantages, components of FMS and their integration in the data processing systems, FMS scheduling - examples of FMS installations. Distributed data processing in FMS

Unit 3 ENTERPRISE RESOURCE PLANNING 9

Role of Enterprise Resource Planning (ERP) in manufacturing, Materials Requirement Planning (MRP)- Master Production Schedule (MPS);Bill of Material (BOM);Inventory Records; Closed Loop MRP; Manufacturing Resource Planning (MRP-II), Manufacturing and Production Planning Module of an ERP System , Distribution Requirements Planning (DRP), Product Data Management (PDM)- Data Management, Process Management; functions of PDM; Benefits of PDM, Manufacturing Operations- Make-to-Order (MTO) and Make-to-Stock (MTS); Assemble-to-Order (ATO); Engineer-to-Order (ETO); Configure-to-Order (CTO)

Unit 4 MANUFACTURING SYSTEMS & CONTROL 9

Automated Manufacturing Systems - Modelling - Role of performance modelling -simulation modelsAnalytical models. Product cycle - Manufacturing automation -Economics of scale and scope - input/output model - plant configurations. Performance measures - Manufacturing lead-time - Work in process -Machine utilization - Throughput – Capacity - Flexibility - performability - Quality. Control Systems - Control system architecture - Factory communications - Local area networks - Factory net works - Open systems interconnection model - Net work to network interconnections - Manufacturing automation protocol - Database management system.

Unit 5 BENCHMARKING AND SIX SIGMA 9

Introduction, Understanding the Benchmarking Concept, Benchmarking Process, Benchmarking Procedure equipment, Additional control. Concept of six sigma, steps involved in implementing six sigma, advantages of six sigma.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1. Pascal Dennis, "Lean Production Simplified: A plain Language Guide to the World's Most Powerful Production System", Productivity Press, 2017.
2. Thomas E Vollmann, William I Berry, "Manufacturing Planning and Control Systems", Galgotia Publication (P) Ltd., New Delhi, 2013.

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REFERENCE BOOKS

1. Panneerselvam R., "Production and Operations Management", Prentice-Hall of India Pvt.Ltd., New Delhi, 2012.
2. Mike Rother and Rother Shook, "Learning to See: Value-Stream Mapping to Create Value and Eliminate Muda", The Lean Enterprise Institute, 2003.
3. James Womack and Daniel T. Jones, "Lean Thinking: Banish Waste and Create Wealth in Your Organization", Free Press, 2003.
4. James D Dilworth, "Production and Operations Management ", Tata McGraw Hill, Inc, New Delhi, 1993.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

Cos	Statements	K-Level
CO1	Explain the importance of lean manufacturing and value stream mapping	Understanding
CO2	Implement the concept of Flexible Manufacturing Systems in industrial process	Applying
CO3	Apply the concept of ERP in an industry	Applying
CO4	Ensure the quality of a product by adopting appropriate manufacturing systems	Applying
CO5	Explain on the tools and procedures in implementing six sigma concept	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	-	-	-	-	-	-	-	2	2	2	3
CO2	2	2	2	-	-	-	-	-	-	-	2	2	2	3
CO3	2	2	2	-	-	-	-	-	-	-	2	2	2	3
CO4	2	2	2	-	-	-	-	-	-	-	2	2	2	3
CO5	2	2	2	-	-	-	-	-	-	-	2	2	2	3
CO	2	2	2	-	-	-	-	-	-	-	2	2	2	3
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)						3: Substantial (High)			

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P19MEP10	PERFORMANCE MODELLING AND ANALYSIS OF MANUFACTURING SYSTEMS	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Instigate the importance of analyzing a manufacturing system
- Familiarize with the concepts involved in modeling a manufacturing system
- Emphasis the networking strategies in a manufacturing system

Unit 1 MANUFACTURING SYSTEMS & CONTROL 9

Automated Manufacturing Systems – modeling – role of performance modeling – simulation models-Analytical models. Product cycle – manufacturing automation – economics of scale and scope – input/output model – plant configurations. Performance measures – manufacturing lead-time – work in process – machine utilization – throughput – capacity – flexibility – performability – Quality Control systems –control system architecture – factory communications – local area network interconnections – manufacturing automation protocol – database management system.

Unit 2 MANUFACTURING PROCESSES 9

Poisson process - Discrete Time Markov (DTM) chain models – definition and notation – Sojourn times in states – Examples of DTMCs in manufacturing – Chapman – Kolmogorov equation – Steady-state analysis. Continuous Time Markov Chain Models – definitions and notation – Sojourn times in states – examples of CTMCs in manufacturing – equations for CTMC evolution – Markov model of a transfer line. Birth and Death Processes in Manufacturing – Steady state analysis of BD Processes – Typical BD processes in manufacturing.

Unit 3 QUEUING MODEL 9

Notation for queues – examples of queues in manufacturing systems – performance measures – Little's result – Steady state analysis of M/M/m queue, queues with general distributions, and queues with breakdowns – analysis of a flexible machine center.

Unit 4 QUEUING NETWORKS 9

Examples of QN models in manufacturing – Little's law in queuing networks – Tandem queue – an open queuing network with feedback – an open central server model for FMS – closed transfer line – Closed server model – Garden Newell networks.

Unit 5 PETRINETS 9

Classical Petri Nets – definitions – transition firing and reachability – representational power – properties – manufacturing models. Stochastic Petri Nets – Exponential timed Petri Nets – Generalized Stochastic Petri Nets – modeling of KANBAN systems – Manufacturing models.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

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TEXT BOOKS

1 Viswanadham, N and Narahari, Y. "Performance Modelling of Automated Manufacturing Systems", Prentice Hall of India, New Delhi, 1994

2 Trivedi, K.S. "Probability and Statistics with Reliability, Queuing and Computer Science Applications", Prentice Hall, New Jersey, 1982.

REFERENCE BOOKS

1 Mikell P. Groover , "Automation, Production Systems, and Computer-Integrated Manufacturing (4th Edition)" 4th Edition. Pearson, 2014

2 Mor Harchol-Balter, "Performance Modeling and Design of Computer Systems: Queueing Theory in Action". Cambridge, 2013.

3 Nicolas Privault, "Understanding Markov chains: Examples and Applications". Springer, 2013.

4 Alasdair Gilchrist., "Industry 4.0: The Industrial Internet of Things", Apress, 2016

WEB SOURCES

1 https://www.youtube.com/watch?v=Hda5tMrLJqc

2 https://www.youtube.com/watch?v=xGkpXk-AnWU

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Explain the importance of performance control of a manufacturing system	Understanding
CO2	Explain the methodologies to simplify the manufacturing processes	Understanding
CO3	Apply the queuing models in manufacturing processes	Applying
CO4	Apply the queuing networks in manufacturing processes	Applying
CO5	Apply Petrinets in manufacturing processes	Applying

COURSE ARTICULATION MATRIX:

Cos \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	-	-	1	1	2	2
CO2	3	2	2	2	2	-	-	-	-	-	1	1	2	2
CO3	2	3	2	2	2	-	-	-	-	-	1	1	2	2
CO4	2	3	2	2	2	-	-	-	-	-	1	1	2	2
CO5	2	3	2	2	2	-	-	-	-	-	1	1	2	2
CO	3	2	2	2	2	-	-	-	-	-	1	1	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19MEP11	INDUSTRIAL ROBOTICS	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Impart knowledge on fundamentals of robotics.
- Make the student to learn on robotic motions
- Familiarize with the actuators and sensors used in robots.

Unit 1 FUNDAMENTAL OF ROBOTICS 9

Introduction, definition of robot, classification of robots, History of robotics, robot components, degree of freedom, robot joints, robot coordinates, reference frames, programming modes, robot characteristics, robot work space, robot languages, advantages and disadvantages of robots, Robot as a mechanisms, matrix representation -representation of a point in a space, representation of a vector in space, representation of a frame in a reference frame, representation of rigid body.

Unit 2 ROBOT KINEMATICS 9

Homogeneous transformation matrices, representation of a pure translation, pure rotation about an axis, representation of combined transformations, transformations relative to the rotating, inverse of transformation matrices, forward and inverse kinematics of robots, forward and inverse kinematic equations for position and orientation.

Unit 3 DIFFERENTIAL MOTIONS AND VELOCITIES 9

Introduction, differential relationship, Jacobian differential motions of a frame-translations, rotation, rotating about a general axis, differential transformation of a frame, Differential changes between frames, calculation of jacobian, relation between jacobian and the differential operator, inverse jacobian, basics of trajectory planning, path Vs trajectory, joint space trajectory planning –third order polynomial trajectory planning.

Unit 4 ROBOT DYNAMICS AND APPLICATION 9

Lead through programming, robot programming as a path in space, motion interpolation Wait, Signal and Delay, branching capabilities and limitations, Robot Languages Textual robot languages, generations, Robot language structures, elements in functions, Applications –Material transfer, Machine loading/unloading, processing operations, assembly and inspections.

Unit 5 ROBOT ACTUATORS AND FEEDBACK COMPONENTS 9

Hydraulic actuators, Pneumatic actuators, electric actuators & stepper motors, Position sensors, potentiometers, resolvers, encoders, velocity sensors, tactile sensors, proximity sensors.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 James Perlberg, "Industrial Robotics", Cengage Learning, 2016.

2 M.P.Groover, M.Weiss, R.N. Nageland N. G.Odrej, Industrial Robotics, McGraw-Hill Singapore, 2016

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REFERENCE BOOKS

1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2005.
2. JohnJ.Craig ,Introduction to Robotics Mechanics and Control, Third edition, Pearson Education, 2009
3. R.D.Klafter, T.A.Chimielewski and M.Negin, Robotic Engineering–An Integrated Approach, Prentice Hall of India, New Delhi, 1994
4. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

S.No	Cos	Statements	K-Level
1	CO1	Summarize the fundamentals of industrial robots	Understanding
2	CO2	Execute the kinematic motions of robot for some specific applications.	Applying
3	CO3	Carry out the motion and velocity studies on some specific applications.	Applying
4	CO4	Implement the dynamic motions of robot for some specific applications.	Applying
6	CO5	Select the actuators and feedback components for a robot	Applying

COURSE ARTICULATION MATRIX:

POs / Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	2	-	-	-	-	-	1	1	2	2
CO2	3	2	2	1	2	-	-	-	-	-	1	1	2	2
CO3	3	2	2	1	2	-	-	-	-	-	1	1	2	2
CO4	3	2	2	1	2	-	-	-	-	-	1	1	2	2
CO5	3	2	2	1	2	-	-	-	-	-	1	1	2	2
CO	3	2	2	1	2	-	-	-	-	-	1	1	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19MEP12	MEMS AND NEMS	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Familiarize with the basic concepts of MEMS and NEMS.
- Impart knowledge on the manufacturing process, sensors and actuators involved in MEMS and NEMS

Unit 1 OVERVIEW AND INTRODUCTION 9

New trends in Engineering and Science: Micro and Nano scale systems - Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electromechanical Systems, Applications of Micro and Nano electro mechanical systems, Micro electromechanical systems, devices and structures Definitions, Materials for MEMS: Silicon, silicon compounds, polymers, metals

Unit 2 MEMS FABRICATION TECHNOLOGY 9

Microsystem fabrication processes: Photolithography, Ion Implantation, Diffusion, Oxidation.Thin film depositions: LPCVD, Sputtering, Evaporation, Electroplating; Etching techniques: Dry and wet etching, electrochemical etching; Micromachining: Bulk Micromachining, Surface Micromachining, High Aspect-Ratio (LIGA and LIGA-like) Technology; Packaging: Microsystems packaging, Essential packaging technologies, Selection of packaging materials

Unit 3 MICRO SENSORS 9

MEMS Sensors: Design of acoustic wave sensors, resonant sensor, Vibratory gyroscope, Capacitive and Piezoresistive Pressure sensors-engineering mechanics behind these Microsensors. Case study: Piezo-resistive pressure sensor

Unit 4 MICRO ACTUATORS 9

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces (Parallel plate, Torsion bar, Comb Drive actuators), Micromechanical Motors and pumps. Case study: Comb drive actuators

Unit 5 NANO SYSTEMS AND QUANTUM MECHANICS 9

Atomic Structures and Quantum Mechanics, Molecular and Nanostructure Dynamics: Shrodinger Equation and Wave Function Theory, Density Functional Theory, Nanostructures and Molecular Dynamics, Electromagnetic Fields and their quantization, Molecular Wires and Molecular Circuits.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1. Sergey Edward Lyshevski , "MEMS and NEMS: Systems, Devices, and Structures (Nano- and Microscience, Engineering, Technology and Medicine) ", CRC press 2002
2. Stephen D. Senturia," Micro system Design", Kluwer Academic Publishers,2001

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REFERENCE BOOKS

1 Tai Ran Hsu ,"MEMS and Microsystems Design and Manufacture" ,Tata Mcraw Hill, 2002.

2 Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006

3 Minhang Bao, "Analysis and Design Principles of MEMS Devices", 1st Edition, Elsevier Science-2005.

4 Luis Castañer, "Understanding MEMS: Principles and Applications ", Wiley, 2015.

WEB SOURCES

1 https://nptel.ac.in/courses/108105058/

2 https://nptel.ac.in/courses/105104099/

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

S.No	COs	Statements	K-Level
1	CO1	Summarize the fundamentals of MEMS and NEMS	Understanding
2	CO2	Discuss the fabrication processes in MEMS and NEMS	Understanding
3	CO3	Select appropriate sensors for MEMS and NEMS	Understanding
4	CO4	Select appropriate actuators for MEMS and NEMS	Understanding
5	CO5	Explain the mechanics involved in MEMS and NEMS	Understanding

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	1	2
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	1	2
CO5	3	2	-	-	-	-	-	-	-	-	-	-	1	2
CO	3	2	-	-	-	-	-	-	-	-	-	-	1	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19MEP13	COMPUTATIONAL FLUID DYNAMICS	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Introduce numerical modeling and its role in the field of heat, fluid flow and combustion
- Enable the students to understand the various discretization methods
- Solve complex problems in the field of heat transfer and fluid dynamics.

Unit 1 GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES 9

Basics of Heat Transfer, Fluid flow–Mathematical description of fluid flow and heat transfer Conservation of mass, momentum, energy and chemical species-Classification of partial differential equations–Initial and Boundary Conditions–Discretization techniques using finite difference methods– Taylor's Series-Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test

Unit 2 DIFFUSION PROCESSES: FINITE VOLUME METHOD 9

Steady one-dimensional diffusion, Two- and three-dimensional steady state diffusion problems, discretization of unsteady diffusion problems – Explicit, Implicit and Crank-Nicholson's schemes, Stability of schemes.

Unit 3 CONVECTION -DIFFUSION PROCESSES: FINITE VOLUME METHOD 9

One dimensional convection–diffusion problem, Central difference scheme, upwind scheme Hybrid and power law discretization techniques –QUICK scheme.

Unit 4 FLOW PROCESSES: FINITE VOLUME METHOD 9

discretization of incompressible flow equations– Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms.

Unit 5 MODELING OF COMBUSTION AND TURBULENCE 9

Mechanisms of combustion and Chemical Kinetics, Overall reactions and intermediate reactions, Reaction rate, Governing equations for combusting flows. Simple Chemical Reacting System (SCRS), Turbulence-Algebraic Models, One equation model, k–ω models- Standard and High and Low Reynolds number models.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Versteeg and Malalasekera, N," An Introduction to Computational Fluid Dynamics The Finite Volume Method," Pearson Education, Ltd., SecondEdition,2014.

2 Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", TataMcGraw HillPublishingCompanyLtd.,1998.

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REFERENCE BOOKS

1. Jiyuan Tu, Guan Heng Yeoh, Chaogun Liu, "Computational Fluid Dynamics A Practical Approach" Butterworth –Heinemann An Imprint of Elsevier, Madison, U.S.A.,2018
2. John D. Anderson. JR. "Computational Fluid Dynamics the Basics with Applications" McGraw-Hill International Editions, 2017.
3. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2014.
4. Suhas V. Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation,2017.

WEB SOURCES

1. Q/A Session on Fluid Dynamics by Prof. Balachandra Puranik, IIT Bombay. https://www.youtube.com/watch?v=9Rvn2kaMPM
2. Joseph J.S. Shang, Land marks and new frontiers of computational fluid dynamics. Advances in Aerodynamics, Edition 1, Article5 (2019). Doi: https://doi.org/10.1186/s42774-019-0003-x

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

Cos	Statements	K-Level
CO1	Derive the governing equations and boundary conditions for Fluid dynamics	Understanding
CO2	Analyze Finite difference and Finite volume methods for Diffusion	Applying
CO3	Analyze Finite volume method for Convective diffusion	Applying
CO4	Analyze Flow field problems based on Pressure based algorithms, SIMPLE, SIMPLER &PISO algorithms.	Applying
CO5	Solve the Turbulence models and simple chemical reacting system.	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	2	2
CO2	3	2	2	-	-	-	-	-	-	-	-	-	2	2
CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	2
CO4	3	2	2	-	-	-	-	-	-	-	-	-	2	2
CO5	3	2	2	-	-	-	-	-	-	-	-	-	2	2
CO	3	2	2	-	-	-	-	-	-	-	-	-	2	2
Correlation levels:		1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)				

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P19MEP14	RELIABILITY IN ENGINEERING SYSTEMS	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Impart knowledge on the reliability tools and its features
- Emphasise on the reliability testing methods
- Arrive at optimum solutions to improve reliability

Unit 1 Basic Probability and ReliabilityTheory 9

Elements of probability, probability distributions, Random variables, Density and Distribution functions-Expected value and standard deviation – Binomial distribution, Poisson distribution, normal distribution, exponential distribution, Weibull distribution. Definition of Reliability: Definition of terms used in reliability, Component reliability, Hazard rate, derivation of the reliability function in terms of the hazard rate.

Unit 2 Network Modeling and Reliability Evaluation 9

Evaluation of network Reliability / Unreliability – Series systems, Parallel systems, Series - Parallel systems, partially redundant systems – Types of redundancies - Evaluation of network Reliability / Unreliability using conditional probability method – Paths based and Cutset based approach – complete event tree and reduced event tree methods - Examples.

Unit 3 Time Dependent Probability 9

Reliability functions f(t), F(t), R(t), h(t) – Relationship between these functions – Baths tubs curve – Exponential failure density and distribution functions - Expected value and standard deviation of Exponential distribution – Measures of reliability – MTTF, MTTR, MTBF – Evaluation of network reliability / Unreliability of simple Series, Parallel, Series-Parallel systems - Partially redundant systems - Examples.

Unit 4 Reliability Life Testing Methods 9

Reliability Life Testing - Test time calculations, Burn-in testing, Acceptance testing, accelerated life testing and Experimental Design - Reliability Growth Testing - Growth process, Idealized growth curve and other growth models. Goodness of Fit tests - Chi-square goodness of fit test, Bartlett's test for the exponential distribution, Mann's test for the weibull distribution, kolmogorov smirnov test for normal and lognormal distributions and tests for the power law process model.

Unit 5 Optimization of System Reliability 9

Optimization techniques for system reliability with redundancy – heuristic methods applied to optimal system reliability- redundancy allocation by dynamic programming – reliability optimization by non linear programming.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Charles E. Ebeling, "An introduction to Reliability and Maintainability engineering", TMH,2017.
2 Reliability Engineering by E. Balagurusamy, Tata McGraw Hill, 2003.

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REFERENCE BOOKS

1 G. Haribaskaran, Probability, Queuing Theory & Reliability Engineering, Laxmi publications, Second Edition, 2006.

2 Mohit S.Moheshworkar, Pallavi. Moheshworkar," Text book of Reliability and Maintenance Engineering" SK Kataria & Sons-New Delhi; 2014 edition, 2014.

3 Patrick D.T. O'Connor, Andre Kleyner, "Practical Reliability Engineering" John Wiley; 5thedition,2012

4 Birolini, Alessandro., "Reliability Engineering: Theory and Practice." Springer,2017.

WEB SOURCES

1 Wiki Books, "Computer Systems Engineering/ Reliability models."
Link: https://en.wikibooks.org/wiki/Computer_Systems_Engineering/Reliability_models

2 Failure Analysis and Prevention- IIT Roorkee, "Industrial engineering tool for failure analysis". Link: https://www.youtube.com/watch?v=ElxgxrGumhc

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Explain the fundamental probability and reliability concepts	Understanding
CO2	Evaluate reliability by network modeling	Applying
CO3	Conduct failure analysis by various techniques	Applying
CO4	Perform various life testing methods for reliability measurement	Applying
CO5	Optimize the Reliability of a system	Applying

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	2	-	-	-	-	-	-	-	-	2	2
CO2	2	2	3	2	-	-	-	-	-	-	-	-	2	2
CO3	2	2	3	2	-	-	-	-	-	-	-	-	2	2
CO4	2	2	3	2	-	-	-	-	-	-	-	-	2	2
CO5	2	2	3	2	-	-	-	-	-	-	-	-	2	2
CO	2	2	3	2	-	-	-	-	-	-	-	-	2	2
Correlation levels:	1: Slight (Low)				2: Moderate (Medium)					3: Substantial (High)				

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P19MEP15	PROJECT MANAGEMENT	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Inculcate knowledge on the basics of project management
- Explore the criteria and processes for project management
- Make aware of the project management standards

Unit 1 INTRODUCTION TO PROJECT MANAGEMENT **9**

Definition of project purpose - Scope, time, quality and organization structure. Basic and detailed engineering: Degree of automation, Project S curves, manpower considerations, inter-department and inter-organization interactions, Multi agency interaction. Types of projects and types of contracts e.g. EPC, BOOT etc.

Unit 2 PROJECT COST ESTIMATION **9**

Types and estimates, pricing process, salary and other overheads, man-hours, materials and support costs. program evaluation and review techniques (PERT) and critical path method (CPM), estimating activity time and total program time, total PERT/CPM planning crash times, software's used in project management.

Unit 3 ENGINEERING DESIGN CRITERIA **9**

Project engineering documents and drawing: Process flow sheets, Mechanical flow sheets, Instrument index sheets, loop wiring diagram, panel drawings and specifications, plot plans, installation details, special drawings, purchase requisition, other documents. Pneumatic versus electronics system Transmission systems: Pneumatic & Electronic – Materials, Distribution, Terminations and Identification

Unit 4 MAINTENANCE AND SERVICE **9**

Organizing: Documents, schedule, cost control Ordering and Receiving equipment and Material: Purchase orders, Material status, storage Installing instrument systems: Procedures, Coordination, Good installation practices. Startup: Placing instruments in service, Tuning loop controls, evaluating process upsets and disturbances, Repairing or replacing defective equipment, special equipment, Additional control.

Unit 5 PROJECT MANAGEMENT SOFTWARE **9**

Introduction, software tools such as Microsoft Project, Primavera Project Planner, Crystal Ball and ProChain, Advantages of using Project Management Software, Common Features in the Project Management Software, Illustration- case studies.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Harlod Kerzner and Van Nostrand "Project management: A systems approach to planning scheduling and controlling" , John Wiley & Sons, 11th ed., 2013,

2 W.G. Andrew and H.B. Williams "Applied Instrumentation in Process Industries", Gulf Professional Publishing, 3rd ed. 2008,

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REFERENCE BOOKS

1 Michael D. Whitt, "Successful Instrumentation & Control Systems Design", 2nd Edition, 2012, ISA,
2 Tapan B. Bagchi, "ISO- 9000 Concepts, Methods & Implementation", Wheeler pub., 1995.
3 Bela G Liptak, "Instrument Engineers Handbook: Process Control", CRC Press, 3rd ed., 1995,

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Discuss the basics of project management	Understanding
CO2	Estimate the cost of a project using the tools	Applying
CO3	Identify the design criteria in a project	Applying
CO4	Carry the maintenance and services activities of a project	Applying
CO5	Implement the Standards in a project	Applying

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	-	-	-	-	-	-	2	-	2	2
CO2	2	2	2	2	-	-	-	-	-	-	2	-	2	2
CO3	2	2	2	2	-	-	-	-	-	-	2	-	2	2
CO4	2	2	2	2	-	-	-	-	-	-	2	-	2	2
CO5	2	2	2	2	-	-	-	-	-	-	2	-	2	2
CO	2	2	2	2	-	-	-	-	-	-	2	-	2	2
Correlation levels:				1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)			

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Learn Beyond

P19MEP16	RESEARCH METHODOLOGY	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- impart knowledge on research problem formulation.
- analyze research related information
- provide exposure on intellectual property rights

Unit 1 FOUNDATION OF RESEARCH 9

Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method –Understanding the language of research –Concept, Construct, Definition, Variable. Research Process. Problem Identification & Formulation –Research Question– Investigation Question –Measurement Issues –Hypothesis –Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing –Logic & Importance

Unit 2 QUANTITATIVE AND QUALITATIVE RESEARCH 9

Qualitative research –Quantitative research –Concept of measurement, causality, generalization, replication. Merging the two approaches. Concept of measurement–what is measured? Problems in measurement in research –Validity and Reliability. Levels of measurement –Nominal, Ordinal, Interval, Ratio. Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non-Response. Characteristics of a good sample. Probability Sample –Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample –Practical considerations in sampling and sample size.

Unit 3 RESEARCH DESIGN AND DATA ANALYSIS 9

Concept and Importance in Research –Features of a good research design –Exploratory Research Design –concept, types and uses, Descriptive Research Designs –concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Data Preparation –Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis –Cross tabulations and Chi-square test including testing hypothesis of association.

Unit 4 INTELLECTUAL PROPERTY RIGHTS 9

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit 5 PATENT RIGHTS AND NEW DEVELOPMENTS IN IPR 9

Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Kothari CR. "Research methodology: Methods and techniques." New Age International; 2004.
2 Khushdeep Dharni and Neeraj Pandey, "Intellectual property rights", PHI, 2014.

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REFERENCE BOOKS

1. "Introducing Research Methodology: A Beginner's Guide to Doing a Research Project"
2. Creswell JW, Poth CN. "Qualitative inquiry and research design: Choosing among five approaches". Sage publications; 2017.
3. Denzin NK, Lincoln YS, editors. The Sage handbook of qualitative research. Sage; 2011
4. John Palfrey, "Intellectual Property Strategy", The MIT press, 2012.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Explain the various stages of research methodologies	Understanding
CO2	Apply the qualitative and quantitative techniques to carry a research	Applying
CO3	Apply Design of Experiments technique co carry out research effectively research	Applying
CO4	Discuss the process of making a Patent.	Understanding
CO5	Discuss the IPR tools and procedure and apply for a patent	Understanding

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	-	-	-	-	-	3	2	2	2
CO2	3	3	3	3	3	-	-	-	-	-	3	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	3	2	2	2
CO4	3	2	2	2	2	-	-	-	-	-	2	2	2	2
CO5	3	2	2	2	2	-	-	-	-	-	2	2	2	2
CO	3	3	3	3	2	-	-	-	-	-	3	2	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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P19MEP17	MICRO AND SMART SYSTEMS	Category: PE			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVE

Objective of this course is to

- Understand the basic concepts involved in device architecture and interface engineering. Understand different types of conventional and novel nano electronic devices
- Understand the physical processes governing the operation of Microscopic devices.

Unit 1 INTRODUCTION **9**

Miniaturization, Micro systems versus MEMS, microfabrication, smart materials, structures and systems, integrated Micro systems, applications of smart materials and Microsystems

Unit 2 MICROSENSORS, ACTUATORS, SYSTEMS AND SMART MATERIALS **9**

Silicon capacitive accelerometer, piezoresistive pressure sensor, as sensor, an electrostatic combo-drive, a magnetic micro relay, portable blood analyzer, piezoelectric, ink jet, print head, micro mirror array for video projection, smart materials and systems

Unit 3 MICRO MACHINING TECHNOLOGIES **9**

Silicon as a material for micro machining, thin film deposition, lithography, etching, silicon micro machining, specialized materials for Microsystems, advanced processes for micro fabrication.

Unit 4 MODELLING OF SOLIDS IN MICROSYSTEMS **9**

Bar, beam, energy methods for elastic bodies, heterogeneous layered beams, bimorph effect, residual stress and stress gradients, Poisson effect and the anti-elastic curvature of beams, torsion of beams and shear stresses, dealing with large displacements, In-plane stresses. electrostatics, Coupled Electro-mechanics: statics, stability and pull-in phenomenon, dynamics. Squeezed film effects in electro mechanics

Unit 5 INTEGRATION OF MICRO AND SMART SYSTEMS **9**

Integration of Micro systems and microelectronics, Micro systems packaging, case studies of integrated Microsystems, case study of a smart-structure in vibration control. SCALING EFFECTS IN MICRO SYSTEMS: scaling in mechanical domain, electro static domain, magnetic domain, diffusion, effects in the optical domain, biochemical phenomena.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Zheng You, Qing-An Huang, "Micro Electro Mechanical Systems", Springer;1sted.2018edition.

2 B. Ekwall, M. Cronquist, "Micro Electro Mechanical Systems (MEMS): Technology, Fabrication Processes & Applications (Nanotechnology Science and Technology).", Nova Science Publishers Inc., 2011.

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REFERENCE BOOKS

1 Kanni Raj, "Micro mechatronics: Micro Electro Mechanical Systems." Create space Independent Pub, 2016.

2 Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print, 2013

3 Smaili. A and Mrad.F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.

4 Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", PWS publishing company, 2007.

WEB SOURCES

1 System Model of Electro Mechanical Systems.
Link: https://www.youtube.com/watch?v=dNlyB9k2Xtl

2 M. Hautefeuille, B. O' Flynn, Frank H.; C. O' Mahony, Development of a micro electro-mechanical system(MEMS) based multi sensor platform for environmental monitoring.
DOI : http://dx.doi.org/10.3390/mi2040410

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Discuss about smart materials and Microsystems	Understanding
CO2	Explain the various sensors and actuators for microsystems	Understanding
CO3	Explain the various micro machining processes	Understanding
CO4	Create microsystems solid models	Applying
CO5	Integrating of microsystems with microelectronics	Understanding

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	2	-	-	-	-	-	-	-	-	-	2	2
CO2	2	1	2	-	-	-	-	-	-	-	-	-	2	2
CO3	2	1	2	-	-	-	-	-	-	-	-	-	2	2
CO4	2	1	2	-	-	-	-	-	-	-	-	-	2	2
CO5	2	1	2	-	-	-	-	-	-	-	-	-	2	2
CO	2	1	2	-	-	-	-	-	-	-	-	-	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)				3: Substantial (High)				

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P19MEP18	**REAL TIME SYSTEMS**	**Category: PE**			
		L	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVE

Objective of this course is to

- Impart knowledge on the basics of scheduling and related programming
- Emphasise on the real time communications and data base
- Analyze evaluation techniques and reliability models for Hardware Redundancy

Unit 1 INTRODUCTION TO TASK SCHEDULING 9

Introduction-Issues in Real Time Computing, Structure of a Real Time System, Task classes, Performance Measures for Realtime Systems, Task Assignment and Scheduling–Classical uniprocessor scheduling algorithms, RM algorithm with different cases-Priority ceiling-precedence constraints-using of primary and alternative tasks.

Unit 2 UNI AND MULTIPROCESSOR SCHEDULING 9

Uni processor scheduling of IRIS tasks, Task assignment, Utilization balancing – Next fit – Bin packing - Myopic off – line – Focused addressing and bidding – Buddy strategy – Fault Tolerant Scheduling. - Aperiodic scheduling – Spring algorithm, Horn algorithm - Bratley.- Sporadic scheduling.

Unit 3 REAL TIME COMMUNICATIONS 9

Introduction – VTCSMA – PBCSMA - Deterministic collision resolution protocol - DCR for multipacket messages – dynamic planning based – Communication with periodic and aperiodic messages.

Unit 4 REAL TIME DATABASES 9

Basic Definition, Realtime Vs General purpose databases, Main Memory Databases, Transaction priorities, Transaction Aborts, Concurrency control issues, Disk Scheduling Algorithms, Two-phase Approach to improve Predictability, Maintaining Serialization Consistency, Databases for Hard Real Time System.

Unit 5 REAL TIME MODELLING AND CASE STUDIES 9

Petri nets and applications in real time modeling, Air traffic controller system–Distributed air defense system - case studies.

Contact Periods:

Lecture: 45 Periods Tutorial: - Periods Practical: – Periods Total: 45 Periods

TEXT BOOKS

1 Ronald G Askin, "Modelling and Analysis of Manufacturing systems", John Wiley and Sons, Inc, 1993.

2 Viswanathan N and Narahari Y "Performance Modelling of Automated Manufacturing systems" Prentice Hall Inc, 1992

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REFERENCE BOOKS

1. Meng chu Zhou, "Modelling, Simulation and Control of Flexible Manufacturing systems: A Petri Net Approach", World Scientic Publishing Company Pvt. Ltd., 2000.
2. Jean Marie Proth and Xiaolan Xie, "Petri Net: A Tool for Design and Management of Manufacturing Systems", John Wiley and Sons, New York, 1996.
3. Brandimarte P and Villa A, "Modelling Manufacturing Systems" Springer Verlag, Berlin,1999.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K-Level
CO1	Understand issues in real-time systems and task scheduling algorithms	Understanding
CO2	Know various types of processor scheduling algorithm	Understanding
CO3	Compare real time and general-purpose database	Understanding
CO4	Understand database maintenance algorithms	Understanding
CO5	Review about Petri nets and its applications	Understanding

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO2	2	2	-	-	-	-	-	-	-	-	-	-	2	2
CO3	2	2	-	-	-	-	-	-	-	-	-	-	2	2
CO4	2	2	-	-	-	-	-	-	-	-	-	-	2	2
CO5	2	2	-	-	-	-	-	-	-	-	-	-	2	2
CO	2	2	-	-	-	-	-	-	-	-	-	-	2	2
Correlation levels:			1: Slight (Low)			2: Moderate (Medium)					3: Substantial (High)			

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