I. Vision and Mission of the Institute

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 innovative activities in collaboration with industry and institute of repute
- Ensuring the academic process to uphold culture, ethics and social responsibility

II. 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

III. Program Educational Objectives (PEOs)

The graduates of mechanical engineering will

PEO1: Have a successful professional career in the field of computer aided design and manufacturing to meet the changing needs of the industry.

PEO2: Involve in technology and research advancements through continuing education.

PEO3: Provide innovative solutions to industrial design and manufacturing problems using computer aided tools.

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IV. Program Outcomes (POs)

Graduates will be able to:

PO1: Identify, formulate and solve engineering problems using modern engineering and computer aided tools

PO2: Conduct experiments, analyze and interpret data in the area of design and manufacturing using engineering and software tools

PO3: Demonstrate skills to provide solutions for multidisciplinary problems using modern technologies

PO4: Independently carry out research /investigation and development work to solve practical problems

PO5: Write and present a substantial technical report/document effectively

PO6: Develop the art of self learning and ability for life–long learning

V. PEO/PO Mapping

PEO/PO	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	3	3	3	3	2	2
PEO2	3	3	3	3	2	3
PEO3	3	3	3	3	3	3

1: Low, 2: Medium, 3: High

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VI. MAPPING OF COURSE OUTCOMES WITH PROGRAM OUTCOMES

Year	SEM	Subject	PO1	PO2	PO3	PO4	PO5	PO6
I Year	SEM I	P21CC101 – Computer Aided Engineering	✓	✓	—	✓	—	✓
		P21CC102 – Mechatronics System Design	✓	✓	✓	—	✓	—
		P21CC103 – Computer Aided Process Planning	✓	—	✓	—	—	—
		P21RMC01 – Research Methodology & IPR	—	—	—	✓	✓	✓
		P21CC104 – Geometric Modelling Laboratory	✓	✓	—	✓	✓	✓
		P21CC105 – Automation Laboratory	✓	✓	—	✓	✓	✓
	SEM II	P21CC201 – Finite Element Analysis in Manufacturing	✓	✓	—	✓	—	✓
		P21CC202 – Additive Manufacturing and Tooling	✓	✓	✓	—	—	—
		P21CC203 – Product Life Cycle Management	✓	—	✓	✓	—	✓
		P21CC204 – Design for Sustainability	✓	✓	—	—	—	✓
		P21CC205 – Simulation Laboratory	✓	✓	—	✓	✓	✓
		P21CC206 – Technical Seminar						
II Year	SEM III	P21CC301 – Project Work – Phase I	✓	✓	✓	✓	✓	✓
	SEM IV	P21CC401 – Project Work – Phase II	✓	✓	✓	✓	✓	✓
PE		P21CCP01 – Design of Material Handling Systems	✓	—	—	—	—	✓
		P21CCP02 – Mechanical behaviour of materials	✓	✓	—	✓	—	✓
		P21CCP03 – Optimization Techniques in Design	✓	✓	—	✓	—	✓
		P21CCP04– Quality Engineering	✓	✓	—	—	—	✓
		P21CCP05 – Embedded System Design	✓	✓	✓	—	—	✓

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		P21CCP06 – Sensors and Instrumentation	✓	—	✓	—	—	✓
		P21CCP07 – Supply Chain Management	✓	—	—	—	—	✓
		P21CCP08 – Composite Materials and Mechanics	✓	—	—	—	—	✓
		P21CCP09 – Design for Manufacturing Systems	✓	—	✓	—	—	✓
		P21CCP10 – Performance Modelling and Analysis of Manufacturing Systems	✓	✓	—	—	—	✓
		P21CCP11 – Industrial Robotics	✓	—	✓	—	—	—
		P21CCP12 – MEMS and NEMS	✓	—	✓	—	—	✓
		P21CCP13 – Computational Fluid Dynamics	✓	—	✓	—	—	✓
		P21CCP14 – Reliability in Engineering Systems	✓	✓	—	—	—	✓
		P21CCP15 – Project Management	✓	—	✓	✓	✓	✓
		P21CC202 – CNC Technology and Programming	✓	✓	—	—	—	—
		P21CCP17 – Micro and Smart Systems	✓	✓	✓	✓	—	✓
		P21CCP18 – Internet of things in manufacturing	✓	✓	✓	—	—	—
		P21CCI01 – Industrial Training/Internship	✓	✓	✓	✓	✓	✓

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M.E. CAD/CAM ENGINEERING

REGULATIONS – 2021

CHOICE BASED CREDIT SYSTEM

CURRICULUM FOR I TO IV SEMESTERS

SEMESTER I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P21CC101	Computer Aided Engineering	FC	3	0	0	3
2	P21CC102	Mechatronics System Design	PCC	3	0	0	3
3	P21CC103	Computer Aided Process Planning	PCC	3	0	0	3
4	P21RMC01	Research Methodology& IPR	RMC	3	0	0	3
5	–	Professional Elective – I	PEC	3	0	0	3
6	–	Professional Elective – II	PEC	3	0	0	3
PRACTICALS							
7	P21CC104	Geometric Modelling Laboratory	PCC	0	0	4	2
8	P21CC105	Automation Laboratory	PCC	0	0	4	2
			TOTAL	**18**	**0**	**8**	**22**

SEMESTER II

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
THEORY							
1	P21CC201	Finite Element Analysis in Manufacturing	PCC	3	0	0	3
2	P21CC202	Additive Manufacturing and Tooling	PCC	3	0	0	3
3	P21CC203	Product Life Cycle Management	PCC	3	0	0	3
4	P21CC204	Design for Sustainability	PCC	3	0	0	3
5	–	Professional Elective – III	PEC	3	0	0	3
6	–	Professional Elective – IV	PEC	3	0	0	3
PRACTICALS							
7	P21CC205	Simulation Laboratory	PCC	0	0	4	2
8	P21CC206	Technical Seminar	PCC	0	0	4	2
			TOTAL	**18**	**0**	**8**	**22**

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SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
		THEORY					
1	–	Professional Elective – V	PEC	3	0	0	3
2	–	Professional Elective – VI	PEC	3	0	0	3
		PRACTICALS					
5	P21CC301	Project Work – Phase I	EEC	0	0	12	6
			TOTAL	0	0	12	12

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
		PRACTICALS					
1	P21CC401	Project Work – Phase II	EEC	0	0	24	12
2	P21CCI01	Industrial Training/Internship	EEC	0	0	0	2
			TOTAL	0	0	0	14

LIST OF COURSES BASED ON ITS CATEGORY

FOUNDATION COURSES (FC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P21CC101	Computer Aided Engineering	FC	3	0	0	3

PROFESSIONAL CORE COURSES (PCC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
		THEORY					
1	P21CC102	Mechatronics System Design	PCC	3	0	0	3
2	P21CC103	Computer Aided Process Planning	PCC	3	0	0	3
3	P21CC201	Finite Element Analysis in Manufacturing	PCC	3	0	0	3
4	P21CC202	Additive Manufacturing and Tooling	PCC	3	0	0	3
5	P21CC203	Product Life Cycle Management	PCC	3	0	0	3
6	P21CC204	Design for Sustainability	PCC	3	0	0	3
7	P21CC104	Geometric Modelling Laboratory	PCC	0	0	4	2
8	P21CC105	Automation Laboratory	PCC	0	0	4	2
9	P21CC205	Simulation Laboratory	PCC	0	0	4	2

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PROFESSIONAL ELECTIVES COURSES (PEC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
		Elective I & II					
1	P21CCP01	Design of Material Handling Systems	PEC	3	0	0	3
2	P21CCP02	Mechanical behaviour of materials	PEC	3	0	0	3
3	P21CCP03	Optimization Techniques in Design	PEC	3	0	0	3
4	P21CCP04	Quality Engineering	PEC	3	0	0	3
5	P21CCP05	CNC Technology and Programming		3	0	0	3
6	P21CCP06	Sensors and Instrumentation	PEC	3	0	0	3
		Elective III & IV					
7	P21CCP07	Supply Chain Management	PEC	3	0	0	3
8	P21CCP08	Composite Materials and Mechanics	PEC	3	0	0	3
9	P21CCP09	Design for Manufacturing Systems	PEC	3	0	0	3
10	P21CCP10	Performance Modelling and Analysis of Manufacturing Systems	PEC	3	0	0	3
11	P21CCP11	Industrial Robotics	PEC	3	0	0	3
12	P21CCP12	MEMS and NEMS	PEC	3	0	0	3
		Elective V & VI					
13	P21CCP13	Computational Fluid Dynamics	PEC	3	0	C	3
14	P21CCP14	Reliability in Engineering Systems	PEC	3	0	0	3
15	P21CCP15	Project Management	PEC	3	0	0	3
16	P21CCP16	Embedded System Design	PEC	3	0	0	3
17	P21CCP17	Micro and Smart Systems	PEC	3	0	0	3
18	P21CCP18	Internet of things in manufacturing	PEC	3	0	0	3

RESEARCH METHODOLOGY & IPR COURSES (RMC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P21RMC01	Research Methodology& IPR	RMC	3	0	0	3

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	C
1	P21CC206	Technical Seminar	EEC	0	0	4	2
2	P21CC301	Project Work – Phase I	EEC	0	0	12	6
3	P21CC401	Project Work – Phase II	EEC	0	0	24	12
4	P21CCI01	Industrial Training / Internship	EEC	0	0	0	2

VIII. Scheme of Credit distribution – Summary

S.No	Stream	Credits/Semester				Credits	%	Suggested by AICTE
		I	II	III	IV			
1.	Foundation Courses (FC)	3	—	—	—	3	4.28	—
2.	Professional Core Courses (PCC)	10	16	—	—	26	37.14	32.35
3.	Professional Elective Courses (PEC)	6	6	6	—	18	25.71	26.47
4.	Research Methodology & IPR Courses (RMC)	3	—	—	—	3	4.28	2.94
5.	Employability Enhancement Courses (EEC)	—	—	6	14	20	28.57	38.23
Total		22	22	12	14	70	100	100

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SEMESTER I

P21CC101	COMPUTER AIDED ENGINEERING	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- Enrich knowledge in fundamentals of CAE and geometric modelling
- Impart basic knowledge of machine learning
- Impart knowledge on automated production and assembly lines

UNIT I 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 II 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 III MACHINE LEARNING 9

Introduction to machine learning – Examples and applications – Designing learning system – perspectives and issues of learning system – Concept learning – Decision learning – tree representation – Appropriate probes for decision tree – Introduction artificial neural network – Perceptions.

UNIT IV 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 V 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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REFERENCES:

1. Zeid, Ibrahim Zlid, "CAD/CAM theory and practice", 2rd edition, McGraw Hill Education, New Delhi, 2010.
2. Groover, Michell .P. "CAD/CAM computer aided design and manufacturing", 3rd edition, Pearson, 2012.
3. Groover, Michell .P. "Automation production systems and computer integrated manufacturing", 2rd edition, Pearson, 2015.
4. Mitchell, Tom M. "Machine Learning", 1st edition, McGraw Hill Education, New Delhi, 2013.
5. Alpaydin, Ethem. "Introduction to Machine Learning", 2rd edition, PIH learning, 2019.

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	Understand
CO2	Discuss the various geometric modelling concepts	Understand
CO3	Explain the machine learning principles and its applications	Understand
CO4	Explain the various components of automated production lines	Understand
CO5	Explain the concepts of assembly automation	Understand

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	—	1	—	1
CO2	3	1	—	1	—	1
CO3	3	1	—	1	—	1
CO4	3	1	—	1	—	1
CO5	3	1	—	1	—	1
CO	3	1	—	1	—	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER I

P21CC102	MECHATRONICS SYSTEM DESIGN	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT I 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 II 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 III 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 IV 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 V 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

REFERENCES:

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 2015.
3. Brian morriss, "Automated manufacturing Systems–Actuators Controls, sensors and Robotics",McGraw Hill International Edition, 2015.
4. Georg pelz, "Mechatronic Systems: Modeling and simulation" with HDL's, John Wiley and sons Ltd, 2013.

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5. Bolton, "Mechatronics – Electronic Control systems in Mechanical and Electrical Engineering" 7th Edition, Pearson Education., 2016

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

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

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	—	1	—
CO2	2	1	3	—	1	—
CO3	2	2	3	—	1	—
CO4	2	2	3	—	1	—
CO5	2	2	3	—	1	—
CO	2	2	3	—	1	—
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER I

P21CC103	COMPUTER AIDED PROCESS PLANNING	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

UNIT I INTRODUCTION 9

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

UNIT II COMPUTER AIDED POCESS PLANNING 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 III PART DESIGN PRESENTATION 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 IV PROCESS ENGINEERING AND PROCESS PLANNING 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 V 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

REFERENCES:

1. Leondes, Cornelius T. Computer aided and integrated manufacturing systems. Vol. 5. World Scientific, 2003.
2. Groover, M. P., Automation, production systems, and computer–integrated manufacturing. Pearson Education India, 2016.
3. Nanua Singh, Systems Approach to Computer Integrated Design and Manufacturing, John Wiley & Sons, 1996.
4. Tien–Chien Chang, Richard A.Wysk, An Introduction to automated process planning systems, Prentice Hall, 1985.
5. Rao, Computer Aided Manufacturing, Tata McGraw Hill Publishing Co., 2000.

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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	Understand
CO2	Develop codes for the products using OPTIZ / MICLASS system	Apply
CO3	Elaborate the principles of process engineering	Understand
CO4	Develop process planning systems using computer aided tools	Apply
CO5	Explain the concepts of integrated process planning systems	Understand

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	–	1	–	–	–
CO2	2	2	1	–	–	–
CO3	2	–	1	–	–	–
CO4	2	2	1	–	–	–
CO5	2	–	1	–	–	–
CO	2	–	1	–	–	–
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER I

P21RMC01	RESEARCH METHODOLOGY AND IPR	Category: RMC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge in problem formulation, analysis and solutions
- To impart skills required for technical paper writing / presentation without violating professional ethics.
- To familiarize knowledge on patent drafting and filing patents.

UNITI RESEARCH PROBLEM FORMULATION **9**

Meaning of research problem – Sources of research problem – Criteria characteristics of a good research problem – Errors in selecting a research problem – Scope and objectives of research problem. Approaches of investigation of solutions for research problem – data collection – analysis – interpretation – necessary instrumentations

UNITII LITERATURE REVIEW AND DATA COLLECTION **9**

Effective literature studies approaches – analysis – plagiarism and research ethics. Method of data collection – Types of data – Primary Data – Scales of measurement – Source and collection of data observation method – Secondary data

UNITIII TECHNICALWRITING / PRESENTATION **9**

Effective technical writing : How to write report – paper – developing a research proposal – format of research proposal – presentation and assessment by a review committee

UNITIV INTRODUCTION TO INTELLECTUALPROPERTY RIGHTS (IPR) **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.

UNITV INTELLECTUAL PROPERTYRIGHTS(IPR) **9**

Patent Rights : Scope of Patent Rights – Licensing and transfer of technology – Patent information and databases – Geographical Indications – New Developments in IPR – Administration of Patent System – IPR of Biological Systems – Computer Software etc.

Contact Periods:

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

REFERENCES:

1. Ranjit Kumar, "Research Methodology: AStep–by–Step Guidefor beginners"2nd Edition,2010.
2. Cooper, DR and Schindler, P S., "Business Research Methods", Tata McGraw Hill, 9th Edition, 2014.
3. Robert P.Merges, Peter S, Menell, Mark A.Lemley, "Intellectual Property" in New Technological age, 2016

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K–Level
CO1	Formulate research problem	Apply
CO2	Carryout research analysis	Analyze
CO3	Develop research proposal	Evaluate
CO4	Draft process of patenting	Apply
CO5	File and publish patents in R&D	Evaluate

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	–	–	–	1	3	1
CO2	–	–	–	1	3	1
CO3	–	–	–	1	3	1
CO4	–	–	–	1	3	1
CO5	–	–	–	1	3	1
CO	–	–	–	1	3	1
Correlation levels:		1: Slight (Low)	2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER I

		Category: PCC			
P21CC104	GEOMETRIC MODELLING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

LIST OF EXPERIMENTS

1. Feature manipulation – Copy – Edit – Pattern – Suppress – History operations etc., using Solid Modeling Software
2. Solid modeling using Extrude – Revolve – Sweep etc.
3. Surface modeling – Mesh of curves and Free form using Solid Modeling Software
4. Sheet metal Design – creation of thin feature and manipulation
5. Assembly of the developed components – Exploded Views – Interference check – Geometric dimensioning and Tolerances.
6. Drafting – Layouts – Standard & Sectional Views – Detailing & Plotting
7. CAD data Exchange formats – IGES – PDES – PARASOLID – DXF and STL
8. Weldment design – Design and creating the chassis of an automobile
9. Casting Design – create casting design with allowances – positioning of runner and riser – Core prints.
10. Design of straight – helical gears and analyzing the kinematics of gear train using motion study.
11. 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.

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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	Apply
CO2	Model a 3D component using solid and surface modelling techniques.	Apply
CO3	Assemble the individual parts into a component and generate pictorial views	Apply
CO4	Create weldments and casting design using modelling Software	Apply
CO5	Perform motion study on simple mechanisms.	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	–	2	3	1
CO2	2	3	–	2	3	1
CO3	2	3	–	2	3	1
CO4	2	3	–	2	3	1
CO5	2	3	–	2	3	1
CO	2	3	–	2	3	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER I

P21CC105	AUTOMATION LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

LIST OF EXPERIMENTS

1. Control of Single & Dual Acting Cylinders using Pneumatics
2. Actuating multiple cylinders sequentially by cascade method
3. Develop electro pneumatic circuits using multiple actuators
4. Speed control of AC servo Motors using PLC
5. Water level controller using PLC
6. Cascading circuit design using PLC
7. Temperature & Pressure Control using computerized Data Acquisition Systems
8. Control of velocity and direction of fluids using software
9. Control of temperature and pressure of liquid flow using software
10. Interfacing PID controller with computer
11. Control of physical variables such as temperature, pressure, speed and vibration using PID controllers
12. Perform AND & OR logical circuits for forward stroke of a double acting cylinder using two manual control
13. 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.	Apply
CO2	Control a physical variable using PLC system.	Apply
CO3	Measure and control physical variable using Data Acquisition System.	Apply
CO4	Interface and control physical variables using PID controllers.	Apply
CO5	Perform AND, OR logic and counter operation using pneumatic circuit	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	1	3	1
CO2	2	3	3	1	3	1
CO3	2	3	3	1	3	1
CO4	2	3	3	1	3	1
CO5	2	3	3	1	3	1
CO	2	3	3	1	3	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P21CC201	FINITE ELEMENT ANALYSIS IN MANUFACTURING	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III 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 IV 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 V 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

REFERENCES:

1. Seshu.P, "Textbook of Finite Element Analysis", 2rd edition, PHI education, 2016.
2. Reddy. J.N., "An Introduction to the Finite Element Method", 3rd edition, McGraw Hill Education, New Delhi, 2012.
3. Chandrupatla, Belagundu, "Introduction to Finite Elements in Engineering", 4th edition, Pearson, 2009.
4. Reddy, J.N., "Introduction to nonlinear finite element analysis", 1st edition, Oxford University Press, 2013.
5. Daryl L Logan, "A First Course in the Finite Element Method", 4th edition, Thomson, 2012.

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COURSE OUTCOMES (CO)

Upon completion of the course, the student will be able to

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

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	–	1	–	1
CO2	2	3	–	1	–	1
CO3	2	3	–	1	–	1
CO4	2	3	–	1	–	1
CO5	2	3	–	1	–	1
CO	2	3	–	1	–	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P21CC202	ADDITIVE MANUFACTURING AND TOOLING	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III 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 IV 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 V 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

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REFERENCES:

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; 2rd edition.2015 .
4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press,2011.
5. J Nagendra Ms, Ganesh Prasad, P.F., "Rapid Prototyping and Allied Manufacturing Technologies", Air walk Publications, 2016.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

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

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	–	–	–
CO2	3	1	2	–	–	–
CO3	3	1	2	–	–	–
CO4	3	1	2	–	–	–
CO5	3	1	2	–	–	–
CO	3	1	2	–	–	–
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P21CC203	PRODUCT LIFE CYCLE MANAGEMENT	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III 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 IV 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 V 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

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REFERENCES:

1. Ivica Crnkovic, Ulf Asklund and AnnitaPerssonDahlqvist, "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).
4. Stark, John "Product Lifecycle Management (Volume 1)21st Century Paradigm for Product Realisation", Springer, 2020
5. Michael Grieves, "Product Life Cycle Management", Tata McGraw Hill, 2016.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K–Level
CO1	Explain history, concepts and terminology of PLM	Understand
CO2	Explain the functions and features of PLM	Understand
CO3	Discuss the features of PDM	Understand
CO4	Correlate the role of PLM in industries	Understand
CO5	Integrate PLM/PDM with other applications with case studies	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	–	1	1	–	2
CO2	3	–	1	1	–	2
CO3	3	–	1	1	–	2
CO4	3	–	1	1	–	2
CO5	3	–	3	2	–	2
CO	3	–	2	2	–	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P21CC204	DESIGN FOR SUSTAINABILITY	Category: PCC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III 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 IV 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 V 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

REFERENCES:

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

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4. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
5. GraedelT.Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

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

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	–	–	–	1
CO2	3	2	–	–	–	1
CO3	3	2	–	–	–	1
CO4	3	2	–	–	–	1
CO5	3	2	–	–	–	1
CO	3	2	–	–	–	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P21CC205	SIMULATION LABORATORY	Category: PCC			
		L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

- 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

1. Basics of MATLAB – Dealing with matrices – Graphing – Functions of one variable and two variables
2. Solve simple vibration problems using Matlab
3. Simulate process line using MATLAB and SIMULINK
4. Static analysis of typical industrial components using 3D elements
5. Stress analysis of axis – symmetric components
6. Stress analysis of plates and shells
7. Kinematic and dynamic analysis of mechanism using mechanism analysis software.
8. Modal and Harmonic analysis of mechanical parts like turbine blade – aircraft wing – etc.
9. Vibration analysis of spring – mass systems.
10. Steady state thermal analysis of IC engine components – boiler – etc.
11. Transient thermal analysis of elements such as fins – engine parts – electronic parts – etc.
12. Thermo–mechanical analysis of components such as spindle – brake – etc.
13. Analysis of internal and external fluid flow (pipes – ducts – aerofoil etc.) using CFD software
14. FEA for sustainable design using a Modeling & Simulation software.
15. 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	Apply
CO2	Analyze the stresses in the machine components using FEM	Analyze
CO3	Conduct dynamic analysis for the given problems	Analyze
CO4	Conduct thermal for the given problems	Analyze
CO5	Analyse fluid flow using CFD	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	—	2	2	1
CO2	3	2	—	2	2	1
CO3	3	2	—	2	2	1
CO4	3	2	—	2	2	1
CO5	3	2	—	2	2	1
CO	3	2	—	2	2	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER II

P21CC206	TECHNICAL SEMINAR	Category: PCC			
		L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

To enrich the communication skills of the student and presentations of technical topics of interest, this course is introduced. In this course, a student has to present three Technical papers or recent advances in engineering/technology that will be evaluated by a Committee constituted by the Head of the department.

COURSE OUTCOME (CO)

Acquired the basic skills to for performing literature survey, paper presentation and communication.

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	–	–	–	–	3	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER III

P21CC301	PROJECT WORK PHASE –I	Category: ECC			
		L	T	P	C
		0	0	12	6

COURSE OBJECTIVES

- 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

STRATEGY

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.

Contact Periods:

Lecture: 0 Periods   Tutorial: 0 Periods   Practical: 360 Periods   Total: 360 Periods

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

Cos	Statements	K–Level
CO1	Identify, formulate and solve engineering problems	Apply
CO2	Carry out detailed literature review for the engineering problem	Analyze
CO3	Prepare a methodology to conduct a research	Analyze
CO4	Conduct experiments as per the methodology	Analyze
CO5	Prepare technical report and oral presentation	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	3
CO2	3	3	3	3	3	3
CO3	2	3	3	3	3	3
CO4	2	3	3	3	3	3
CO5	3	3	2	3	3	3
CO	3	3	3	3	3	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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SEMESTER IV

P21CC401	PROJECT WORK PHASE –II	Category: ECC			
		L	T	P	C
		0	0	24	12

COURSE OBJECTIVES

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

STRATEGY

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

Contact Periods:

Lecture: 0 Periods   Tutorial: 0 Periods   Practical: 360 Periods   Total: 360 Periods

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

Cos	Statements	K–Level
CO1	Identify ,formulate and solve engineering problems	Apply
CO2	Develop experiment methodology for the identified engineering problem	Analyze
CO3	Conduct experiments as per the methodology	Analyze
CO4	Analyze the results and interpret the data	Evaluate
CO5	Prepare technical report, publication and oral presentation	Analyze

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	3
CO2	3	3	3	3	3	3
CO3	2	3	3	3	3	3
CO4	2	3	3	3	3	3
CO5	3	3	2	3	3	3
CO	3	3	3	3	3	3
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE I & II

P21CCP01	DESIGN OF MATERIAL HANDLING SYSTEMS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- Familiarize the various material handling equipment's
- Enable to design various material handling equipment's
- Enable to design various drives in material handling equipment's

UNIT I 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 II 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 III 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 IV CONVEYORS 9

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

UNIT V 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

REFERENCES:

1. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981
2. Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
3. Lingaiah. K. and Narayanalyengar, "Machine Design Data Hand Book", Vol. 1 & 2, Suma Publishers, Bangalore, 1983.
4. Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.
5. Siddhartha Ray, "Introduction to Materials Handling", New Age International Pvt. Ltd., 19th edition, 2017.

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COURSE OUTCOMES:

Upon completion of the course, the student will be able to

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

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	–	–	–	–	1
CO2	3	–	–	–	–	1
CO3	3	–	–	–	–	1
CO4	3	–	–	–	–	1
CO5	3	–	–	–	–	1
CO	3	–	–	–	–	1
Correlation levels:	1: Slight (Low)					

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ELECTIVE I & II

P21CCP02	MECHANICAL BEHAVIOUR OF MATERIALS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- 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 I BASIC CONCEPTS OF MATERIAL BEHAVIOR 9

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 – Super plasticity – Griffith's theory – Ductile – brittle transition in steel – High temperature fracture – creep – Larson Miller parameter – Deformation and fracture mechanism maps.

UNIT II BEHAVIOR UNDER DYNAMIC LOADS AND DESIGN APPROACHES 9

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 III SELECTION OF MATERIALS 9

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.

UNIT IV MODERN METALLIC MATERIALS 9

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 V BIOMATERIALS 9

Metallic implants – Stainless steel – co – based alloys, Tic– based alloys – Common polymeric materials – PMMA – PGA – PCL – Bioceramics – Zirconia – carbon – calcium phosphates – hydroxyapatite – Natural biomaterials – collagen – elastin – cellulose – coral – alginate.

Contact Periods:

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

REFERENCES:

1. Geroge E.Dieter, "Mechanical Metallurgy", 3rd edition, McGraw Hill Education, New Delhi, 2009.
2. Thomas H.Courtney, "Mechanical behavior of Materials". 3rd edition, McGraw Hill Education, New Delhi, 2015.
3. Balasubramaniam. R, "Callister's Materials Science and Engineering", 2rd edition, Wiley India Pvt. Ltd, India, 2014.
4. Mauil Agrawal.C, Joo L. Ong, Mark R. Appleford, and Gopinath Mani "Introduction of Biomaterials Basic Theory with Engineering Applications", 1st edition, Cambridge University Press, UK, 2016.

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5. Marc Andr'e Meyers, Krishan Kumar Chawla, "Mechanical behaviour of materials", 2rd edition, Cambridge University Press, UK, 2009.

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	Understand
CO2	Discuss the behaviour of materials under various loads	Apply
CO3	Select materials for different industrial applications	Understand
CO4	Discuss the characteristics and mechanical properties of Metallic Materials	Understand
CO5	Discuss the characteristics and mechanical properties of Non– Metallic Materials	Understand

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	–	1	–	1
CO2	3	1	–	1	–	1
CO3	3	1	–	1	–	1
CO4	3	1	–	1	–	1
CO5	3	1	–	1	–	1
CO	3	1	–	1	–	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE I & II

P21CCP03	OPTIMIZATION TECHNIQUES IN DESIGN	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II CONSTRAINED OPTIMIZATION TECHNIQUE **9**

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

UNIT III 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 IV 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 V 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

REFERENCES:

1. Kalyanamoy Deb, "Optimization for Engineering Design Algorithms and Examples", Prentice Hall of India. 2016.
2. Douglas. C. Montgomery., "Response Surface Methodology: Product and Process optimization using designed experiments", Wiley,1995.
3. Rao, Singaresu, S., "Engineering Optimization –Theory & Practice", New Age International (P) Limited, New Delhi, 2000.
4. Goldberg, D.E., "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson, 2008.

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5. Yang, X. S. (2018). Optimization techniques and applications with examples. John Wiley & Sons.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

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

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	–	2	–	2
CO2	3	2	–	2	–	2
CO3	3	2	–	2	–	2
CO4	3	2	–	2	–	2
CO5	3	2	–	2	–	2
CO	3	2	–	2	–	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE I & II

P21CCP04	QUALITY ENGINEERING	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III 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 IV 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 V 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

REFERENCES:

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

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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	Understand
CO2	Discuss the basic concepts of lean production system	Understand
CO3	Apply statistical tools to control the quality of the products in industry	Apply
CO4	Distinguish the techniques to improve the quality of the products in an industry	Understand
CO5	Design experimental trails to conduct experiments with multiple inputs	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	–	–	–	2
CO2	3	1	–	–	–	2
CO3	3	2	–	–	–	2
CO4	3	1	–	–	–	2
CO5	3	2	–	–	–	2
CO	3	2	–	–	–	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE I & II

P21CCP05	EMBEDDED SYSTEM DESIGN	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III PIC MICROCONTROLLERS 9

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

UNIT IV EMBEDDED PROGRAMMING 9

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

UNIT V 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

REFERENCES:

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.
5. Raj Kamal, Embedded Systems Architecture Programming and Design II edition, Tata MC Graw–Hill, 2016.

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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	Understand
CO2	Apply the principle of ARM architecture in Real time operating systems	Apply
CO3	Discuss the basic principles and architecture of PIC microcontrollers	Understand
CO4	Develop embedded system programmes for various applications	Apply
CO5	Apply the principle of IoT in embedded systems	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	–	–	1
CO2	1	1	3	–	–	1
CO3	1	1	3	–	–	1
CO4	1	1	3	–	–	1
CO5	1	1	3	–	–	1
CO	1	1	3	–	–	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE I & II

P21CCP06	SENSORS AND INSTRUMENTATION	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III 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 IV 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 V 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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REFERENCES:

1. Jain.R.K, "Mechanical and Industrial Measurements (Process Instrumentation and Control)", 2rd edition, Khanna Publishers, 1995.
2. Sawhney, A.K. "A Course in mechanical measurements and instrumentation and control", 12th edition, Dhanpat Rai, 2014.
3. Beckwith, Thomas.G, "Mechanical measurements", 5th edition, Pearson, 2004.
4. Sinclair, Ian, "Sensors and transducers", 1st edition, Springer, 2011.
5. Patranabis .D, "Sensors and transducers", 2rd edition, Prentice–Hall of India, 2008.

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	Understand
CO2	Apply the principle of ARM architecture in Real time operating systems	Apply
CO3	Discuss the basic principles and architecture of PIC microcontrollers	Understand
CO4	Develop embedded system programmes for various applications	Apply
CO5	Apply the principle of IoT in embedded systems	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	–	3	–	–	1
CO2	2	–	3	–	–	1
CO3	2	–	3	–	–	1
CO4	2	–	3	–	–	1
CO5	2	–	3	–	–	1
CO	2	–	3	–	–	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE III & IV

P21CCP07	SUPPLY CHAIN MANAGEMENT	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III 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 IV 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 V 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

REFERENCES:

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.
3. Martin Christopher, "Logistics and Supply chain Management", 5th Edition, FT Publishers, 2016.
4. Michaell H. Hugos, "Essentials of Supply Chain Management"3rd Edition, John Wiley & Sons, 2011.
5. Myerson, Paul, "Lean Supply Chain and Logistics Management", McGraw–Hill Education, 2012.

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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	Understand
CO2	Explain the components of supply chain	Understand
CO3	Design systems for logistics management	Apply
CO4	Implement inventory control practices in an industry	Apply
CO5	Discuss the recent developments in six sigma	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	—	—	—	—	1
CO2	3	—	—	—	—	1
CO3	3	—	—	—	—	1
CO4	3	—	—	—	—	1
CO5	3	—	—	—	—	1
CO	3	—	—	—	—	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE III & IV

P21CCP08	COMPOSITE MATERIALS AND MECHANICS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

UNIT I 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 II MANUFACTURING OF COMPOSITES 9

Manufacturing of Polymer Matrix Composites (PMCs) – hand lay – 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 III 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 IV 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 V 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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1. Autar K. Kaw., "Mechanics of Composite Materials", 2nd Edition, Taylor & Francis, 2006.
2. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
3. Chung, Deborah D.L., "Composite Materials: Science and Applications", Ane Books Pvt. Ltd./Springer, New Delhi, 1st Indian Reprint, 2009.
4. Madhujit Mukhop, "Mechanics of FRP Composite Materials &Structure "Universities Press 2004.
5. 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	Understand
CO2	Discuss the manufacturing processes of composite materials.	Understand
CO3	Discuss the equation that governs the mechanics of composites	Apply
CO4	Evaluate the strength of the laminates	Apply
CO5	Make use of equipment's to measure the properties of composites	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	–	–	–	–	1
CO2	3	–	–	–	–	1
CO3	3	–	–	–	–	1
CO4	3	–	–	–	–	1
CO5	3	–	–	–	–	1
CO	3	–	–	–	–	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE III & IV

P21CCP09	DESIGN FOR MANUFACTURING SYSTEMS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III ENTERPRISE RESOURCE PLANNING 9

Role ofEnterprise 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 IV MANUFACTURING SYSTEMS & CONTROL 9

Automated Manufacturing Systems – Modelling – Role of performance modelling – 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 networks – Factory networks – Open systems interconnection model – Net work to network interconnections – Manufacturing automation protocol – Database management system.

UNIT V 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

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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.
5. Pascal Dennis, "Lean Production Simplified: A plain Language Guide to the World's Most Powerful Production System", Productivity Press, 2017.

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	Understand
CO2	Implement the concept of Flexible Manufacturing Systems in industrial process	Apply
CO3	Apply the concept of ERP in an industry	Apply
CO4	Ensure the quality of a product by adopting appropriate manufacturing systems	Apply
CO5	Explain on the tools and procedures in implementing six sigma concept	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	–	2	–	–	2
CO2	3	–	2	–	–	2
CO3	3	–	2	–	–	2
CO4	3	–	2	–	–	2
CO5	3	–	2	–	–	2
CO	3	–	2	–	–	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE III & IV

P21CCP10	PERFORMANCE MODELLING AND ANALYSIS OF MANUFACTURING SYSTEMS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III 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 IV 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 V 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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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.
3. Mikell P. Groover , "Automation, Production Systems, and Computer–Integrated Manufacturing (4th Edition)" 4th Edition. Pearson, 2014.
4. MorHarchol–Balter, "Performance Modeling and Design of Computer Systems: Queueing Theory in Action". Cambridge, 2013.
5. Alasdair Gilchrist., "Industry 4.0: The Industrial Internet of Things", Apress, 2016.

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	Understand
CO2	Explain the methodologies to simplify the manufacturing processes	Understand
CO3	Apply the queuing models in manufacturing processes	Apply
CO4	Apply the queuing networks in manufacturing processes	Apply
CO5	Apply Petrinetsin manufacturing processes	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	–	–	–	2
CO2	2	2	–	–	–	2
CO3	3	2	–	–	–	2
CO4	3	2	–	–	–	2
CO5	3	2	–	–	–	2
CO	3	2	–	–	–	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE III & IV

P21CCP11	INDUSTRIAL ROBOTICS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

UNIT I 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 II 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 III 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 IV 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 V ARTIFICIAL INTELLIGENCE FOR ROBOT 9

Introduction to AI – State space search – generate and test – simple search – Depth First Search (DFS) – Breadth First Search (BFS) – comparison of DFS and BFS – quality solutions – Heuistic search – heuristic functions – best first search – hill climbing – local maxima – solution space search.

Contact Periods:.

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

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1. R.K.Mittal and I.J.Nagrath, Robotics and Control, Tata McGraw Hill, New Delhi,4th Reprint, 2011.
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, 2014.
4. B.K.Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 2015.
5. Deepak Khemain, "A first course in Artificial Intelligence", Tata McGraw Hill, New Delhi, 2013.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K–Level
CO1	Summarize the fundamentals of industrial robots	Understand
CO2	Execute the kinematic motions of robot for some specific	Apply
CO3	Carry out the motion and velocity studies on some specific	Apply
CO4	Implement the dynamic motions of robot for some specific	Apply
CO5	Summarize the basic concepts of artificial intelligence for robot	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	–	3	–	–	–
CO2	3	–	3	–	–	–
CO3	3	–	3	–	–	–
CO4	3	–	3	–	–	–
CO5	3	–	3	–	–	–
CO	3	–	3	–	–	–
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE III & IV

P21CCP12	MEMS AND NEMS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

UNIT I 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 II 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 III 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 IV 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 V 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

REFERENCES:

1. Tai Ran Hsu,"MEMS and Microsystems Design and Manufacture", 3rd edition, McGraw Hill Education, New Delhi, 2002.
2. Chang Liu, "Foundations of MEMS", 1st edition, Pearson education India limited, 2006.
3. Mahalik, Nitaigour Premchand, "MEMS", 2nd edition, McGraw Hill Education, New Delhi, 2007.

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4. Rai Choudhury. P, "MEMS and MOEMS technology and application", 2rd edition, PHI Learning, 2011.
5. Adams, Thomas.M, "Introductory MEMS: fabrication and applications" 1st edition, Springer, 2014.

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	Understand
2	CO2	Discuss the fabrication processes in MEMS and NEMS	Understand
3	CO3	Select appropriate sensors for MEMS and NEMS	Understand
4	CO4	Select appropriate actuators for MEMS and NEMS	Understand
5	CO5	Explain the mechanics involved in MEMS and NEMS	Understand

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	–	3	–	–	1
CO2	2	–	3	–	–	1
CO3	2	–	3	–	–	1
CO4	2	–	3	–	–	1
CO5	2	–	3	–	–	1
CO	2	–	3	–	–	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE V & VI

P21CCP13	COMPUTATIONAL FLUID DYNAMICS	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I 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 II 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 III 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 IV FLOW PROCESSES: FINITE VOLUME METHOD 9

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

UNIT V 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 – $k - \omega$ models – Standard and High and Low Reynolds number models.

Contact Periods:

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

REFERENCES:

1. John D. Anderson. JR. "Computational Fluid Dynamics the Basics with Applications" McGraw–Hill International Editions, 2017.
2. Versteeg and Malalasekera, N, "An Introduction to Computational Fluid Dynamics the Finite Volume Method," Pearson Education, Ltd., SecondEdition,2014.
3. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", TataMcGraw HillPublishingCompanyLtd.,1998.

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5. Suhas V. Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation,2017.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

S.No	COs	Statements	K–Level
1	CO1	Derive the governing equations and boundary conditions for Fluid dynamics	Understand
2	CO2	Analyze Finite difference and Finite volume methods for Diffusion	Apply
3	CO3	Analyze Finite volume method for Convective diffusion	Apply
4	CO4	Analyze Flow field problems based on Pressure based algorithms, SIMPLE, SIMPLER &PISO algorithms	Apply
5	CO5	Solve the Turbulence models and simple chemical reacting system	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	–	2	–	–	1
CO2	3	–	2	–	–	1
CO3	3	–	2	–	–	1
CO4	3	–	2	–	–	1
CO5	3	–	2	–	–	1
CO	3	–	2	–	–	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE V & VI

		Category: PEC			
21CCP14	RELIABILITY IN ENGINEERING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

UNIT I 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 II 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 III 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 IV 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 V MACHINE LEARNING FOR RELIABILITY 9

Basic machine – learning modelling – Classification: predicting in to buckets – Regression: predicting numerical values – Model generalization: assessing predictive accuracy for new data– Evaluation of classification models – regression models – Model optimization through parameter tuning.

Contact Periods:

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

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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,2005.
4. Birolini, Alessandro., "Reliability Engineering: Theory and Practice." Springer, 2017.
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COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

S.No	COs	Statements	K–Level
1	CO1	Explain the fundamental probability and reliability concepts	Understand
2	CO2	Evaluate reliability by network modeling	Apply
3	CO3	Conduct failure analysis by various techniques	Apply
4	CO4	Perform various life testing methods for reliability measurement	Apply
5	CO5	Optimize the Reliability of a system using machine learning	Apply

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	–	–	–	2
CO2	3	2	–	–	–	2
CO3	3	2	–	–	–	2
CO4	3	2	–	–	–	2
CO5	3	2	–	–	–	2
CO	3	2	–	–	–	2
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE V & VI

P21CCP15	PROJECT MANAGEMENT	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

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

UNIT I 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 II 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 III 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 IV 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 V 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

REFERENCES:

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,
3. Michael D. Whitt, "Successful Instrumentation & Control Systems Design", 2nd Edition, 2012, ISA,

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4. Tapan B. Bagchi, "ISO– 9000 Concepts, Methods & Implementation", Wheeler pub., 1995.
5. Bela G Liptak, "Instrument Engineers Handbook: Process Control", CRC Press, 3rd ed., 1995

COURSE OUTCOMES:

Upon completion of the course, the student will be able to

COs	Statements	K–Level
CO1	Solve an electric network by applying basic laws and reduction methods	Apply
CO2	Apply the concept of network theorems for electric circuits	Apply
CO3	Explain the concepts of three phase circuits and its power measurement	Understand
CO4	Analyze the transient response of electric circuits and to infer two port network parameters	Analyze
CO5	Interpret the resonance phenomenon and coupled circuits	Apply

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	–	1	2	2	1
CO2	3	–	1	2	2	1
CO3	3	–	1	2	2	1
CO4	3	–	1	2	2	1
CO5	3	–	1	2	2	1
CO	3	–	1	2	2	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE V & VI

P21CC202	CNC TECHNOLOGY AND PROGRAMMING	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- 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 I CONSTRUCTIONAL FEATURES OF CNC MACHINE TOOLS 9

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

UNIT II 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 III 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 IV 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 V 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.

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Contact Periods:

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

REFERENCES:

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
5 Rao P.N., CAD/CAM, Tata McGraw–Hill Publishing Company Limited, New Delhi, 2015.

COURSE OUTCOMES (CO)

Upon completion of the course, the student will be able to

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

COURSE ARTICULATION MATRIX:

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	–	–	–	–
CO2	3	2	–	–	–	–
CO3	3	2	–	–	–	–
CO4	3	2	–	–	–	–
CO5	3	2	–	–	–	–
CO	3	2	–	–	–	–
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE V & VI

		Category: PEC			
P21CCP17	MICRO AND SMART SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- 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 I INTRODUCTION 9

Miniaturization – Micro systems versus MEMS – microfabrication – smart materials – structures and systems – integrated Micro systems – applications of smart materials and Microsystems – Requirements of resource management.

UNIT II 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 III 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 IV 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 V 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. Sustainability in Smart systems.

Contact Periods:

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

REFERENCES:

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. DevadasShetty and Richard A. Kolk, "Mechatronics Systems Design", PWS publishing company, 2007.

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5. Zheng You, Qing–An Huang, "Micro Electro Mechanical Systems", Springer;1st edition,2018.

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

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

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	1	–	1
CO2	1	1	3	1	–	1
CO3	1	1	3	1	–	1
CO4	1	1	3	1	–	1
CO5	1	1	3	1	–	1
CO	1	1	3	1	–	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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ELECTIVE V & VI

P21CCP18	INTERNET OF THINGS IN MANUFACTURING	Category: PEC			
		L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Study the basics of IoT – cloud computing– smart manufacturing
- Familiarize on the various internet protocols for manufacturing system
- Impart knowledge on communication and information system in manufacturing

UNIT I IOT AND CLOUD COMPUTING **9**

Introduction – Physical design of IoT – Logical design of IoT – IoT enabling technologies – Domain specific IoTs – IoT design methodology – logical design – IoT physical devices (such as Raspberry Pi – pcDuino – Beaglebone black – Cubieboard) – Introduction to cloud computing: cloud models – cloud service examples – cloud based services & applications – Cloud service and platforms

UNIT II UNDERSTANDING INTERNET PROTOCOLS **9**

Simplified osi model – network topologies – standards – types of internet networking – Ethernet – WiFi – local networking – Bluetooth – bluetooth low energy (BLE) – Zigbee – 6LoWPAN – Sub 1 GHz – RFID – NFC – proprietary protocols – simplicity – networking design – push – pull and polling – network api

UNIT III APPLIED MACHINE TO MACHINE COMMUNICATION **9**

Introduction to M2M – description of M2M market – segments / applications – automotive – smart telemetry – surveillance and security – M2M industrial automation – M2M terminals and modules.

UNIT IV INFORMATION SYSTEMS IN MANUFACTURING **9**

Manufacturing organizations – management– and the networked enterprises – globalization challenges and opportunities – dimensions of information systems – approaches to study information system – technical and behavioral approach – information technology infrastructure.

UNIT V INTRODUCTION TO SMART MANUFACTURING **9**

Smart applications online predictive modeling – monitoring and intelligent control of machining / manufacturing and logistics/supply chain processes – smart energy management of manufacturing processes and facilities/

Contact Periods:

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

REFERENCES:

1. Boswarthick .D, Elloumi. O and Hersent.O, "M2M communications: A systems approach", Wiley, 1st edition, 2012.
2. Laudon.K, Laudon.J, "Management Information Systems", 14th edition, Pearson Higher Education, 2016.
3. Rajaraman. A, Leskovec .J, Ullmann. J, "Mining of Massive Data sets", Cambridge University Press, 2011.
4. Khandpur.R.S, "Handbook of Analytical Instruments", 2rd edition, Tata McGraw–Hill Publications, 2006.

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5. Edward Carryer.J, "Introduction to Mechatronic Design", Prentice Hall, 1st edition, 2010,

COURSE OUTCOMES (CO)

Upon completion of the course, students will be able to

COs	Statements	K–Level
CO1	System Design knowledge of Internet of Things.	Understand
CO2	Ensuring IOT with Security and Privacy as applicable.	Understand
CO3	Implement the M2M Communication protocols in a prototype.	Apply
CO4	Understand computer models of common engineering information types.	Understand
CO5	Understand the basic principle smart manufacturing	Understand

COURSE ARTICULATION MATRIX:

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	3	–	–	1
CO2	1	1	3	–	–	1
CO3	1	1	3	–	–	1
CO4	1	1	3	–	–	1
CO5	1	1	3	–	–	1
CO	1	1	3	–	–	1
Correlation levels:	1: Slight (Low)		2: Moderate (Medium)		3: Substantial (High)	

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