DEGREE OF MASTER

OF

ENGINEERING

M.E. CAD/CAM ROBOTICS CURRICULUM & SYLLABI

(2024 AND ONWARDS)

(REGULAR PROGRAMME)

Department of Mechanical Engineering

FACULTY OF ENGINEERING

Enable | Enlighten | Enrich
KARPAGAM
ACADEMY OF HIGHER EDUCATION
(Deemed to be University)
(Established Under Section 3 of UGC Act, 1956)

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University) Established Under Section 3 of UGC Act 1956

Accredited with A+ Grade by NAAC in Second Cycle

Pollachi Main Road, Eachanari Post,
Coimbatore – 641 021. INDIA

KARPAGAM ACADEMY OF HIGHER EDUCATION

(Deemed to be University Established Under Section 3 of UGC Act, 1956)
Accredited with A+ Grade by NAAC in Second Cycle
Eachanari Post, Coimbatore-641021. Tamilnadu, India.

FACULTY OF ENGINEERING
M.E. CAD/CAM ROBOTICS
CURRICULUM AND SYLLABI
(2024 Batch Onwards)

SEMESTER I

Course Code	Course title	Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		PSO	PO	L	T	P		CIA	ESE	Total	
								40	60	100	
24MECCR101	Applied Mathematics for Engineers	1	1,2,3,12	3	1	0	4	40	60	100	1
24MECCR102	Kinematics and Dynamics of Robotics	1, 2	1,2,3,4,5, 9,10,12	3	0	0	3	40	60	100	3
24MECCR103	Mechatronics	1	1,2,3,5, 10,12	3	0	0	3	40	60	100	5
24MECCR104	Product Design and Tooling	1	1,2,3,5,10, 12	3	0	0	3	40	60	100	7
24MECCR105	Industrial Automation and its Application	1	1,2,3,4,5,9,10, 11, 12	3	0	0	3	40	60	100	9
24MECCR1E*	Professional Elective I	-	-	3	0	0	3	40	60	100	-
24MECCR111	CAD/CAM Laboratory	1	1,2,3,5, 10,11,12	0	0	4	2	40	60	100	11
Total				**18**	**1**	**4**	**21**	**280**	**420**	**700**	

SEMESTER II

Course Code	Course title	Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		PSO	PO	L	T	P		CIA	ESE	Total	
								40	60	100	
24MECCR201	Advanced Finite Element Analysis	1	1,2,3,4,5,10,12	3	1	0	4	40	60	100	12
24MECCR202	Industrial Robotics and Expert Systems	1	1,2,9,10,12	3	0	0	3	40	60	100	14
24MECCR203	Vision System	1	1,2,3,10,12	3	0	0	3	40	60	100	16
24MECCR204	Emerging Materials for Robots	1	1,2,3,10,12	3	0	0	3	40	60	100	18
24MECCR205	Artificial Intelligence for Robotics	1,2	1,2,3,4,5,6,9,11, 12	3	0	0	3	40	60	100	20
24MECCR2E*	Professional Elective II	-	-	3	0	0	3	40	60	100	-
24MECCR211	Robotics Laboratory	2	1,2,3,5,6,9,10,11	0	0	4	2	40	60	100	22
Total				**18**	**1**	**4**	**21**	**280**	**420**	**700**	

SEMESTER III											
Course Code	Course title	Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		PSO	PO	L	T	P		CIA	ESE	Total	
								40	60	100	
24MECCR301	Research Methodology	1	1,2,5,8, 10,12	3	0	0	3	40	60	100	23
24MECCR3E*	Professional Elective III	-	-	3	0	0	3	40	60	100	-
24MECCR3E*	Professional Elective IV	-	-	3	0	0	3	40	60	100	-
24MECCR391	Project Work Phase I	1,2	1,2,3,4,5,6,10,11,12	0	0	12	6	80	120	200	25
Total				**9**	**0**	**12**	**15**	**200**	**300**	**500**	

SEMESTER IV											
Course Code	Course title	Outcomes		Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		PSO	PO	L	T	P		CIA	ESE	Total	
								40	60	100	
24MECCR491	Project Work Phase II	1,2	1,2,3,4,5,6,10,11,12	0	0	24	12	160	240	400	26
Total				**0**	**0**	**24**	**12**	**160**	**240**	**400**	

PROFESSIONAL ELECTIVE I

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
24MECCR1E01	Optimization Techniques	3	0	0	3	40	60	100	27
24MECCR1E02	Additive Manufacturing and Tooling	3	0	0	3	40	60	100	29
24MECCR1E03	Computer Application in Design	3	0	0	3	40	60	100	31
24MECCR1E04	Computer Integrated Manufacturing	3	0	0	3	40	60	100	33

PROFESSIONAL ELECTIVE II

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
24MECCR2E01	Modeling Simulation and Analysis	3	0	0	3	40	60	100	35
24MECCR2E02	Advanced Manufacturing Processes	3	0	0	3	40	60	100	37
24MECCR2E03	Control Systems in Robotics	3	0	0	3	40	60	100	39
24MECCR2E04	Vibration Analysis and Diagnosis	3	0	0	3	40	60	100	41

PROFESSIONAL ELECTIVE III

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
24MECCR3E01	Modern Material Handling Systems	3	0	0	3	40	60	100	43
24MECCR3E02	CAD for Smart Manufacturing	3	0	0	3	40	60	100	45
24MECCR3E03	Computer Aided Tooling for Manufacturing	3	0	0	3	40	60	100	47
24MECCR3E04	Computational Fluid Dynamics	3	0	0	3	40	60	100	49

PROFESSIONAL ELECTIVE IV

Course Code	Course title	Instruction Hours / Week			Credits	Maximum Marks			Pg. No.
		L	T	P		CIA	ESE	Total	
						40	60	100	
24MECCR3E05	Micro Electro Mechanical Systems (MEMS)	3	0	0	3	40	60	100	51
24MECCR3E06	Tribology in Design	3	0	0	3	40	60	100	53
24MECCR3E07	Design for Sustainability	3	0	0	3	40	60	100	55
24MECCR3E08	Design for Manufacturing, Assembly and Environment	3	0	0	3	40	60	100	57

Total Marks: 2300

Total number of credits: 69

PEO: Programme Educational Objectives **PO: Programme Outcomes**

L: Lecture Hour **T: Tutorial Hour** **CIA: Continuous Internal**

Assessment: Practical Hour **C: No. of Credits** **ESE: End Semester Examinations**

Note:

1. The passing minimum for Mandatory course is 50 marks out of 100 marks. There will be two tests,of which one will be class test covering 50% of syllabus for 50 marks and other for 50 marks.
2. A student will be eligible to get Post Graduate degree with Honors or additional Minor Engineering,if he/she completes an additional 6 credits. These could be acquired through MOOCs.

SEMESTER I

24MECCR101 APPLIED MATHEMATICS FOR ENGINEERS 4H-4C

Instruction Hours/week: L: 3 T:1 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is for the students;

- Introduce Fourier Transform, Laplace equation and Poisson equation which is central to many applications in Engineering apart from its use in solving one-dimensional heat conduction and wave equation problems.
- Acquaint the student with Fourier Transform method in solving Laplace equation and Poisson equations in various situations.
- Acquaint the student familiar with the concept of variation and functional through calculus of variations.

COURSE OUTCOMES

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

- Apply Fourier transform techniques for one dimensional heat flow equation and one-dimensional wave equation.
- Make use of Laplace and Fourier transforms in elliptic equations.
- Apply the concept of functional, strong, weak and Euler's equations in simple variation problems.
- Interpret the solutions for one-dimensional parabolic equation using finite difference method.
- Utilize finite difference method for one-dimensional parabolic equations.

UNIT I ONE DIMENSIONAL WAVE AND HEAT EQUATIONS 9

Fourier Transform methods – one-dimensional heat conduction problems, infinite and Semi-infinite rod – Laplace Equation – Poisson Equation.

UNIT II ELLIPTIC EQUATION 9

Laplace equation -Solution of Laplace's equation by means of Fourier transforms in a half-plane, in an infinite strip and in a semi-infinite strip-Solution of Poisson
equation by Fourier transform method.

UNIT II CALCULUS OF VARIATIONS 9

Concept of variation and its properties – Euler's equation – Functional dependent on first and higher order derivatives – Functionals dependent on functions of several independent variables

UNIT IV FINITE DIFFERENCE METHODS FOR ONE DIMENSIONAL PARABOLIC EQUATIONS 9

One dimensional parabolic equation – Explicit and Crank-Nicolson Schemes – Thomas Algorithm – Weighted average approximation.

UNIT V FINITE DIFFERENCE METHODS FOR TWO DIMENSIONAL PARABOLIC EQUATIONS 9

Dirichlet and Neumann conditions – Two Dimensional parabolic equations – ADI method. Applications of parabolic equations.

TOTAL: 45 HOURS

TEXT BOOK

1. Sankara Rao. K, Numerical Methods in Engineering, Khanna Publishers India Pvt. Ltd., New Delhi, 2011.
2. E Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, Tenth Edition, 2015.
3. M.K.Jain, S.R.K. Iyengar and R.K.Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, Fifth Edition, 2007.

REFERENCE BOOK

1. Andrews, L.C. and Shivamoggi, B.K. Integral Transforms for Engineers, Macmillan Publishing Company, New York,1999
2. Gupta, A.S., Calculus of Variations with Applications, Prentice Hall of India Pvt. Ltd., New Delhi, 2013
3. Spiegel, M.R., Theory and Problems of Complex Variables and its Application (Schaum's Outline Series), McGraw Hill Book Co., Singapore, 2017.
4. K. Sankara Rao, Introduction to Partial Differential Equations, 3rd edition, PHI Learning Private Ltd, New Delhi-110001, 2011.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C101.1	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C101.2	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C101.3	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C101.4	2	1	-	-	-	-	-	-	-	-	-	1	1	-
C101.5	3	2	1	-	-	-	-	-	-	-	-	1	1	-
C101	**2.8**	**1.8**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**1.0**	**-**

SEMESTER I

24MECCR102 KINEMATICS AND DYNAMICS OF ROBOTICS 3H-3C

Instruction Hours/week: L: 3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Apply kinematic principles to understand robotic motion.
- Solve direct kinematics problems for different robot types.
- Select joint angles using inverse kinematics for various robots.

COURSE OUTCOMES:

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

- Identify the robot position and orientation using rotation and angles.
- Explain the robot positions through direct kinematics for various designs.
- Summarize the inverse kinematics for different robotic setups.
- Plan motion paths, workspace limits, and execute pick-and-place actions.
- Examine robotic forces and motion equations, apply models to real cases.

UNIT I INTRODUCTION 9

Introduction, position and orientation of objects coordinates frame rotation matrix Euler angles roll, pitch and yaw angles coordinate transformations joint variables and position of each effectors

UNIT II DIRECT KINEMATICS 9

Dot and cross products coordinate frames rotations homogeneous co-ordinates link coordinates D-H representation the ARM equation. Direct kinematic analysis for four axis SCARA robot and six axis articulated robots.

UNIT III INVERSE KINEMATICS 9

The inverse kinematics problem general properties of solutions tool configuration inverse kinematic of four axis SCARA robot and six axis articulated robot.

UNIT IV WORKSPACE ANALYSIS AND TRAJECTORY PLANNING 9

Workspace analysis work envelope of a four axis SCARA robot and five axis articulated robot workspace fixtures the pick and place operations continuous path motion interpolated motion straight line motion

UNIT V MANIPULATOR DYNAMICS 9

Lagrange's equation kinetic and potential energy. Link inertia tensor link Jacobian manipulator inertia tensor. Gravity generalized forces, Lagrange- Euler dynamic model, dynamic model of a two-axis planar robot Newton Euler formulation. Lagrange Euler formulation problems

TOTAL: 45 HOURS

TEXT BOOKS:

1. Ghosal. A, “Robotics: Fundamental Concepts and Analysis,” McGraw Hill, 2008.
2. Reza N. Jazar, “Theory of Applied Robotics: Kinematics, Dynamics, and Control”, Springer, 2010.

REFERENCE BOOKS:

1. Robert J schilling, “Fundamentals of robotics analysis and control,” prentice hall of India Pvt. Ltd., 2000.
2. Sciavicco L., Siciliano B.: Modeling and control of robot manipulators, New York (N.Y.): McGraw-Hill, 1996.

WEBSITES:

1.https://u0011821.pages.gitlab.kuleuven.be/robotics/2009-HermanBruyninckx-robot-kinematics-and-dynamics.pdf
2. https://old.mu.ac.in/wp-content/uploads/2014/04/Robotics-IDOL.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C102.1	3	2	1	-	1	-	-	-	-	2	-	-	2	2
C102.2	3	2	1	-	1	-	-	-	-	2	-	-	2	3
C102.3	2	1	1	-	1	-	-	-	-	2	-	-	2	1
C102.4	3	2	1	-	1	-	-	-	1	-	-	-	1	2
C102.5	3	2	1	2	1	-	-	-	1	2	-	1	1	2
C102	**2.8**	**1.8**	**1.0**	**2.0**	**1.0**	**-**	**-**	**-**	**0.4**	**1.6**	**-**	**1.0**	**1.6**	**2.0**

SEMESTER I

24MECCR103	**MECHATRONICS**	**3H-3C**

Instruction Hours/week: L: 3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for students to;

- Provide an overview of actuation systems.
- Expose students to the fundamentals of microprocessors.
- Facilitate the understanding of the PLC program using ladder logic.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to;

- Explain the concepts of sensors and transducers.
- Develop the actuation systems.
- Apply interfacing concepts in microprocessors.
- Choose controllers for a given application.
- Model a mechatronics system.

UNIT I SENSORS AND TRANSDUCERS 9

Introduction to Mechatronics – Systems – Measurement Systems – Control Systems –Traditional design – Microprocessor-based Controllers. Introduction to sensors – Performance Terminology – Static and Dynamic characteristics – Displacement – Position and Proximity – Velocity and Motion – Fluid Pressure – Temperature Sensors – Light Sensors – Selection of Sensors – Signal processing – Servo systems.

UNIT II ACTUATORS 9

Pneumatic and Hydraulic Systems – Directional Control Valves – Rotary Actuators. Mechanical Actuation Systems – Cams – Gear Trains – Ratchet and pawl – Belt and Chain Drives – Bearings. Electrical Actuation Systems – Mechanical Switches – Solid State Switches – Solenoids – D.C Motors – A.C Motors – Stepper Motors.

Introduction to system models– Building block of Mechanical, Electrical, Fluid and Thermal Systems.

UNIT III MICROPROCESSORS 9

Introduction – Architecture – pin configuration Instruction set – Programming of Microprocessors using 8085 instructions – Interfacing. Input and output devices – interfacing D/A converters and A/D converters – Application – Temperature control – Stepper motor control.

UNIT IV CONTROLLERS 9

Introduction – Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode –Derivative Mode – Integral Mode – PID Controllers –Digital Controllers – Adaptive Control – Digital Logic Control – Micro Processors Control. Introduction to PLC – Basic Structure – Input / Output Processing – Programming – Mnemonics – Timers, Internal relays and counters – Data Handling – Analog Input / Output Selection of a PLC.

UNIT V MECHATRONIC SYSTEMS DESIGN 9

Stages in designing Mechatronics Systems – Traditional and Mechatronic Design – Possible Design Solutions - Case Studies of Mechatronics Systems, Pick and place robot – automatic Car Park Systems – Engine Management Systems – Introduction to MEMS.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Bolton W, Mechatronics (Anna University): A Multidisciplinary Approach, 1stedition, Pearson Prentice Hall, Delhi, 2008
2. Michael B. Histand David G. Alciatore, Introduction to Mechatronics and Measurement Systems, 4th edition, McGraw–Hill International Editions, New York, 2014

REFERENCE BOOKS

1. Nitaigour Prem chand Mahalik, Mechatronics: Principles, Concepts and Applications, 1st edition, McGraw–Hill Education, New Delhi, 2003
2. Ghosh P.K and Sridhar P.R, Introduction to Microprocessors for Engineers and Scientist, 3rd edition, Prentice Hall of India, New Delhi, 2009

WEBSITES:

1. https://archive.nptel.ac.in/courses/112/107/112107298/
2. https://nptel.ac.in/courses/112103174

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C103.1	2	1	-	-	2	-	-	-	-	1	-	2	2	-
C103.2	3	2	1	-	2	-	-	-	-	1	-	2	2	-
C103.3	3	2	1	-	2	-	-	-	-	1	-	2	2	-
C103.4	3	2	1	-	2	-	-	-	-	1	-	2	2	-
C103.5	3	2	1	-	2	-	-	-	-	1	-	2	2	-
C103	**2.8**	**1.8**	**1.0**	**-**	**2.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**2.0**	**-**

SEMESTER I

24MECCR104 PRODUCT DESIGN AND TOOLING 3H-3C

Instruction Hours/week: L: 3 T:0 P:0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for students to;

- Understand the entire product development lifecycle, from ideation to commercialization and gain knowledge of different product development models.
- Learn about various tooling techniques, materials, and machinery used in product manufacturing.
- Develop skills to create effective prototypes and optimize products for manufacturability with use of CAD/CAM tools and rapid prototyping technologies.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to;

- Apply design thinking principles to identify product opportunities.
- Develop and optimize product designs using CAD software.
- Select appropriate prototyping techniques based on project requirements.
- Identify appropriate tooling techniques for different manufacturing processes.
- Analyze emerging trends and their potential impact on product development.

UNIT I INTRODUCTION TO PRODUCT DEVELOPMENT 9

Overview of product development - The role of innovation and design thinking in product creation - Product lifecycle stages (concept, design, development, launch) - Market research and customer needs analysis - Introduction to product development methodologies (Waterfall, Agile, Lean).

UNIT II PRODUCT DESIGN AND CAD/CAM SYSTEMS 9

Fundamentals of product design - Introduction to CAD (Computer-Aided Design) and CAM (Computer-Aided Manufacturing) - Design for manufacturability (DFM) principles - Ergonomics and aesthetic considerations in design - Case studies of successful product designs.

UNIT III PROTOTYPING AND RAPID PROTOTYPING TECHNOLOGIES 9

Importance of prototyping in product development - Types of prototypes (physical vs. digital) - Rapid prototyping technologies: 3D printing, CNC machining, laser cutting - Advantages and limitations of various prototyping methods - Iterative prototyping and design refinement.

UNIT IV TOOLING AND MANUFACTURING PROCESSES 9

Introduction to tooling and its role in manufacturing - Types of tooling: injection molding, die casting, stamping, etc. - Tool design, selection of materials, and manufacturing methods - Quality control and inspection techniques in tooling - Cost analysis of tooling and its impact on product development.

UNIT V PRODUCT LAUNCH, COMMERCIALIZATION, AND FUTURE TRENDS 9

Preparing for product launch: testing, validation, and certification - Market entry strategies and commercialization techniques - Managing product lifecycles and product revisions - Emerging trends in product development: automation, AI-driven design, and Industry 4.0 - Sustainable product development and green manufacturing.

TOTAL: 45 HOURS

TEXT BOOKS

1. "Product Design and Development" by Karl T. Ulrich and Steven D. Eppinger.
2. "Manufacturing Processes for Design Professionals" by Rob Thompson
3. Journals and articles on emerging trends in product development and tooling
4. "Industrial Design: Materials and Manufacturing Guide" by Jim Lesko
5. "The Design of Everyday Things" by Don Norman (for understanding product usability and human-centered design)
6. "Prototyping for Designers: Developing the Best Digital and Physical Products" by Kathryn McElroy

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C104.1	3	2	1	-	1	-	-	-	-	1	-	1	2	-
C104.2	3	2	1	-	1	-	-	-	-	1	-	1	2	-
C104.3	3	2	1	-	1	-	-	-	-	1	-	1	2	-
C104.4	3	2	1	-	1	-	-	-	-	1	-	1	2	-
C104.5	3	2	2	1	1	-	-	-	-	1	-	1	2	-
C104	**3.0**	**2.0**	**1.2**	**1.0**	**1.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**2.0**	**-**

SEMESTER I

24MECCR105 INDUSTRIAL AUTOMATION AND ITS APPLICATION 3H-3C

Instruction Hours/week: L: 3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is for students;

- Gain a comprehensive understanding of the principles, strategies, and levels of industrial automation.
- Analyze the functions and components of advanced automation systems, including hydraulic actuators and intelligent systems.
- Apply knowledge of material handling and identification technologies to design efficient material transport and storage systems.

COURSE OUTCOMES

Upon the completion of this course, the students will be able to;

- Apply the basics of industrial automation, including hydraulic actuators and smart systems.
- Improve material handling and storage with automatic identification methods.
- Implement different manufacturing systems like manufacturing cells and FMS.
- Choose control solutions using industrial control, SCADA, and distributed control systems.
- Make use of programming and simulation for automation, shown through case studies.

UNIT I INTRODUCTION TO INDUSTRIAL AUTOMATION 9

Intelligent Systems, Hydraulic Actuators for Industrial Automation, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations. Flow lines & Transfer Mechanisms, Fundamentals of Transfer Lines. (SLE: Analysis of Transfer Lines)

UNIT II MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES 9

Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods. (SLE: Material Identification Methods)

UNIT III AUTOMATED MANUFACTURING SYSTEMS 9

Components, Classification and Overview of Manufacturing Systems, Manufacturing Cells, GT and Cellular Manufacturing, FMS, FMS and its Planning and Implementation. Quality Control Systems: Traditional and Modern Quality Control Methods, SPC Tools, Inspection Principles and Practices, Inspection Technologies. (SLE: Usage of SPC tools using excel or Minitab).

UNIT IV CONTROL TECHNOLOGIES IN AUTOMATION 9

Industrial Control Systems, Process Industries Versus Discrete-Manufacturing Industries, Continuous Versus Discrete Control, Computer Process and its Forms. Introduction & Automatic Process Control, Building Blocks of Automation Systems: LAN, Analog &Digital I/O Modules, SCADA Systems& RTU. Distributed Control System: Functional Requirements, Configurations & some popular Distributed Control Systems. (SLE: Display Systems in Process Control Environment.)

UNIT V AUTOMATION AND INDUSTRIAL CONTROL APPLICATIONS 9

Electric Drives, Sensors and Vision used for automation, Trajectory planning, Automation Algorithm, Programming and flow control for automation. Modeling and Simulation for Plant Automation:

Introduction, need for system Modeling, Building Mathematical Model of a Plant, Modern Tools & Future Perspective. Industrial Control Applications: Cement, Thermal, Water Treatment & Steel Plants. (SLE: Cases Studies minimum one for Cement, Thermal, Water Treatment & Steel Plants applications).

TOTAL: 45 HOURS

TEXT BOOKS

1. Automation, "Production Systems and Computer Integrated Manufacturing",M.P.Groover, Pearson Education.5th edition, 2009.
2. "Computer Based Industrial Control"- Krishna Kant, EEE-PHI,2nd edition,2010

REFERENCES

1. "An Introduction to Automated Process Planning Systems"- Tiess Chiu Chang & Richard A. Wysk.
2. "Performance Modeling of Automated Manufacturing Systems",-Viswanandham, PHI, 1st edition, 2009.
3. G.S. Hegde, "A Textbook on Industrial Robotics", University Science Press, Second Edition 2008, ISBN 978-81-318-051803

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C105.1	3	2	1	-	2	-	-	-	-	2	-	-	3	-
C105.2	3	2	1	1	2	-	-	-	2	3	-	-	3	-
C105.3	3	2	1	1	2	-	-	-	3	2	2	-	3	-
C105.4	3	2	1	1	2	-	-	-	3	3	2	-	3	-
C105.5	3	2	1	1	2	-	-	-	2	3	2	2	3	-
C105	**3.0**	**2.0**	**1.0**	**1.0**	**2.0**	**-**	**-**	**-**	**2.5**	**2.6**	**2.0**	**2.0**	**3.0**	**-**

SEMESTER I

24MECCR1E* **PROFESSIONAL ELECTIVE - I** **3H-3C**

Instruction Hours/week: L: 3 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

SEMESTER I

24MECCR111 **CAD/CAM LABORATORY** **4 H- 2 C**

Instruction Hours/week: L: 0 T:0 P: 4 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is for students to;

- Apply manual CNC part programming for turning machines using the SIEMENS system.
- Make use of manual CNC part programming for milling using the FANUC system
- Create part programs for milling and turning machines using CAM packages.

COURSE OUTCOMES

Students undergoing this course will be able to;

- Create 3D models of machine elements using SolidWorks.
- Construct 2D drawings from 3D models using SolidWorks.
- Compile the program using the FANUC coding system in a CNC machine.
- Compile the program using the FANUC coding system in a milling machine.
- Design part programs using CAM packages for milling and turning machines.

LIST OF EXERCISE

COMPUTER-AIDED DESIGN

1. 3D modelling of various machine elements using various options like protrusion, cut, sweep, draft, loft, blend, and rib.
2. Assembly – creating assembly from parts – assembly constraints
3. Conversion of 3D solid model to 2D drawing – different views, sections, isometric view and dimensioning.
4. Introduction to Surface Modeling.
5. Introduction to File Import, Export – DXF, IGES, STL, STEP

Note: Any one of the 3D MODELING software‘s like SOLIDWORKS, CREO, CATIA, NX Software, AutoCAD etc.

COMPUTER AIDED MANUFACTURING

1. Programming and simulation for various operations using canned cycle for CNC turning Centre.
2. Programming and simulation for machining of internal surfaces in CNC turning Centre.
3. CNC code generation using CAM software packages – Turning.
4. Programming and simulation for profile milling operations.
5. Programming and simulation for circular and rectangular pocket milling.
6. CNC code generation using CAM software packages – Milling
7. Study on Dimensional and geometric measurement of machined features using VMS and CMM.
8. Study on RDBMS and its application in problems like inventory control MRP.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C105.1	3	2	1	-	1	-	-	-	-	2	1	2	3	-
C105.2	3	2	1	-	1	-	-	-	-	2	1	2	3	-
C105.3	3	2	1	-	-	-	-	-	-	2	1	2	3	-
C105.4	2	1	-	-	-	-	-	-	-	2	1	2	3	-
C105.5	2	1	-	-	-	-	-	-	-	2	1	2	3	-
C105	**2.6**	**1.6**	**1.0**	-	**1.0**	-	-	-	-	**2.0**	**1.0**	**2.0**	**3.0**	-

SEMESTER II

24MECCR201 ADVANCED FINITE ELEMENT ANALYSIS 4H - 4C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to;

- Recognize and classify various types of physical problems that can be solved using FEA.
- Analyze one-dimensional problems related to bars, trusses, beams, and frames using appropriate finite element techniques.
- Synthesize information to select appropriate interpolation functions and shape functions for different types of finite elements.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to;

- Apply mathematical models and variational techniques to derive the weak form of governing equations for given physical problems.
- Analyze one-dimensional problems involving bars, trusses, beams, and frames using finite element techniques, considering dynamic and modal behavior.
- Construct finite element models, considering appropriate boundary conditions, constraints, and degrees of freedom.
- Evaluate numerical results from finite element analyses to draw engineering conclusions and make design recommendations.
- Apply finite element analysis to solve practical engineering problems, demonstrating problem-solving skills and critical thinking in diverse application areas.

UNIT I FUNDAMENTAL CONCEPTS AND PROBLEM CLASSIFICATION 9

Physical Problems and FEA in Computer-Aided Design - Stresses, Equilibrium, and Boundary Conditions - Strain-Displacement and Stress-Strain Relations - Linear and nonlinear material laws, Temperature Effects - Tensors, Indicial Notations, Deformation Gradients - Classification of Deformations, Degrees of Freedom - Solid Mechanics and Fluid Mechanics Problems.

UNIT II TECHNIQUES OF DISPLACEMENT-BASED FEA 9

Mathematical Models and Approximate Solutions - Minimization and Variational Procedures - Interpolation Polynomial and Nodal Approximations - Strong and Weak Forms, Galerkin's Approach

Shape and Interpolation Functions for 1D, 2D & 3D - Hermite, Lagrange, and Other Interpolation Functions.

UNIT III ONE-DIMENSIONAL PROBLEMS: BARS & TRUSSES 9

Introduction and Local-Global Coordinate Systems - Finite Element Stiffness and Load Matrix in Local Coordinates - Assembly of Global Stiffness Matrix and Load Vector - Boundary Conditions and Linear System Solution - Dynamic Analysis and Modal Frequencies - Example Problems in Trusses.

UNIT IV ONE-DIMENSIONAL PROBLEMS: BEAMS AND FRAMES 9

Finite Element Modeling of Beam Elements - Formulation of Element Matrices - Assembly of Global Stiffness Matrix, Mass Matrix, and Load Vector - Euler-Bernoulli and Timoshenko Beam Elements

Plane Frame and Space Frame Analysis - Solution Algorithms and Modal Frequencies.

UNIT V TWO-DIMENSIONAL AND VECTOR VARIABLE ANALYSIS 9

Formulation of 2D Problems with PDEs - Energy Principle Solution Algorithm - Constant Strain Triangles and Quadrilaterals - Modeling Boundary Conditions - Scalar Variable Problems (e.g., Heat Transfer) - Plane Stress, Plane Strain, Axisymmetric Elements - Isoparametric Elements and Higher Order Elements.

TOTAL: 45 HOURS

TEXTBOOKS:

1. Rao S.S, The Finite Element Method in Engineering, 4th Edition, Butter worth Heinemann imprint, USA, 2011
2. Daryl L. Logan, A First Course in the Finite Element Method, 5th Edition, Cengage Learning, Stamford, USA, 2011

REFERENCE BOOKS:

1. Tirupathi R. Chandrupatla, Ashok D. Belegundu, Introduction to Finite Elements in Engineering: International Edition, 4th Edition, Pearson Education Limited, 2014
2. David V Hutton, Fundamentals of Finite Element Analysis, 1st Edition, Tata McGraw–Hill Education, 2005.

WEBSITES:

1. https://www.academia.edu/39083992/Advanced_Finite_Element_Methods
2. https://www.iist.ac.in/sites/default/files/people/IN08026/FEM.pdf
3. https://mae.ufl.edu/nkim/egm6352/Chap0_Intro_2017.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C108.1	3	2	1	-	2	-	-	-	-	1	-	2	3	-
C108.2	3	3	2	1	2	-	-	-	-	1	-	2	3	-
C108.3	3	2	1	-	2	-	-	-	-	1	-	2	3	-
C108.4	3	3	2	1	2	-	-	-	-	1	-	2	3	-
C108.5	3	2	1	-	2	-	-	-	-	1	-	2	3	-
C108	**3.0**	**2.4**	**1.4**	**1.0**	**2.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**3.0**	**-**

SEMESTER II

24MECCR202 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The Goal of this course is for students;

- To learn about knowledge for Controlling the Robot motion.
- To understand the concepts of range sensors and Robotic vision system
- To gain about knowledge for design of robotics.

COURSE OUTCOMES

Upon completion of this course, the students will be able to;

- Outline the concepts of Robot Kinematics and robot programming.
- Summarize the design of drive systems and controlling the Robot motion
- Relate the concepts of range sensors and Robotic vision system
- Interpret the knowledge for the design of robotics.
- Explain about robot programming, artificial intelligence and expert systems.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 9

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT-II ROBOT DRIVES AND CONTROL 9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT-III ROBOT 9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system

UNIT-IV ROBOT CELL DESIGN AND APPLICATION 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial applications of Robots.

UNIT-V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 9

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

TOTAL: 45 HOURS

TEXT BOOKS

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", Mc Graw Hill, 1987.
2. Yoram Koren," Robotics for Engineers' Mc Graw-Hill, 1987.

REFERENCE BOOKS

1. Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering-An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
2. Timothy Jordanides et al, "Expert Systems and Robotics", Springer-Verlag, NewYork, May 1991.

WEBSITES

1. https://www.robotics.org/
2. https://roboticsandautomationnews.com

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C109.1	2	1	-	-	-	-	-	-	1	1	-	1	1	-
C109.2	2	1	-	-	-	-	-	-	1	1	-	1	1	-
C109.3	2	1	-	-	-	-	-	-	1	1	-	1	1	-
C109.4	2	1	-	-	-	-	-	-	1	1	-	1	1	-
C109.5	2	1	-	-	-	-	-	-	1	1	-	1	1	-
C109	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**1.0**	**-**	**1.0**	**1.0**	**-**

SEMESTER II

24MECCR203 **VISION SYSTEM** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Understand the characterizing and interpreting the information from images.
- Classify the basic preprocessing techniques
- Describe the object recognition techniques

COURSE OUTCOMES:

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

- Explain the extracting, characterizing and interpreting the information from images.
- Identify the basic preprocessing techniques
- Apply the Object recognition techniques for various applications
- Determine the holding site and gripper orientation based on collision fronts for robotics
- Estimate review of existing vision systems and a case study for Navigation.

UNIT I INTRODUCTION 9

Human vision - Machine vision and computer vision-benefits of machine vision -Block diagram and function of machine vision system implementation of industrial machine vision system.

UNIT II IMAGE ACQUISITION 9

Scene constraints-lighting sources, types and setups - Lighting parameters -working principle-Analog and Digital Cameras - General problem in capturing the image-selection of camera-optics in camera.

UNIT III IMAGE PROCESSING 9

Image formation - filtering technique - Pixel processing - Processing of binary and grey scale images-Operators-types-segmentation-edge detection-Morphology.

UNIT IV IMAGE ANALYSIS 9

Feature extraction-decision making pattern recognition - colour image processing -3D image processing.

UNIT V MACHINE VISION APPLICATION 9

Machine vision applications in manufacturing, electronics, printing, pharmaceutical, textile and Bio medical field - Case studies.

TOTAL: 45 HOURS

TEXT BOOKS:

1. P.A. Janaki Raman, “Robotics and Image Processing an Introduction,” Tata Mc Graw Hill Publishing company Ltd.,1995.
2. Richard.O.Duda, Peter.E.Hurt, “Pattern Classification and Scene,” Analysis Publishers. 2000.

REFERENCE BOOKS:

1. K.S. Fu, R.C., Gonzalez, C.S.G., Lee, "Robotics Control, Sensing Vision and Intelligence," Mc Graw Hill Book Company, 1987.
2. NelloZuech, "Understanding and Applying Machine Vision," Marcel dekker Inc., 2000.

WEBSITES:

1. https://onlinecourses.nptel.ac.in/noc19_cs58/preview
2. https://www.vision-systems.com/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C110.1	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C110.2	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C110.3	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C110.4	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C110.5	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C110	**2.6**	**1.6**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**2.0**	**-**

SEMESTER II

24MECCR204 EMERGING MATERIALS FOR ROBOTS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to;

- To impart knowledge on methods of synthesizing and modifying carbon nanomaterials including graphene, fullerenes, CNTs, Graphite whiskers, cones, and polyhedral crystals
- To understand methods of characterizing carbon nanomaterials
- To apply carbon nanomaterials in the fields of biosensors, biomedicine, water desalination, and photo-induced energy conversion.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to;

- Explain the methods of synthesizing and modifying carbon nanomaterials including graphene, and fullerenes.
- Identify the advanced Nanomaterials.
- Classify the engineering plastics
- Explain about the smart materials.
- Interpret the concept of composite materials

UNIT I CARBON NANOMATERIALS 9

Graphene: Synthesis, Properties, and Applications; Fullerene C60 Architectures in Materials Science; Graphite Whiskers, Cones, and Polyhedral Crystals; Epitaxial Graphene and Carbon Nanotubes on Silicon Carbide; Cooperative Interaction - Crystallization, and Properties of Polymer–Carbon Nanotube Nanocomposites; Carbon Nanotube Biosensors; Carbon Nanostructures in Biomedical Applications, Field Emission from Carbon Nanotubes; Nanocrystalline Diamond; Carbon Onions; Carbide-Derived Carbons; Templated and Ordered Mesoporous Carbons; Oxidation and Purification of Carbon Nanostructures;

UNIT II ADVANCED MATERIALS 9

Nanomaterials Fundamentals: Atomic Structure, molecules and phase, 0-D, 1-D, 2-D and 3-D nanomaterials, nanostructured metals, MOx, MSx, and nanocarbon; structure-property relationships – optical, catalytic, mechanical, thermal, electrical properties; MEMS and NEMS nanoscale Optoelectronics

UNIT III POLYMERS 9

Types, Commodity Plastics: PE, PP, PVC, PS; Engineering Plastics: PA, Fluoropolymers, Polyesters; Thermosets – Phenolics and Epoxy Resins; Rubbers: Natural and Synthetic, Additives; High-Performance Polymers: PEEK; Structure-Property Relationships: Chemical Properties, Solubility, Mechanical Properties, Calorimetric Properties, Electrical Properties, Optical Properties, Acoustic Properties, Processability.

UNIT IV SMART MATERIALS 9

Introduction to smart Materials, Shape Memory Alloys, Super Alloys, High Entropy Alloys, Magnetorheological and Electrorheological Fluids, Gels

UNIT V COMPOSITE MATERIALS 9

Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers,

TOTAL: 45 Hours

TEXT BOOKS:

1. Yury Gogotsi, Volker Presser, “Carbon Nanomaterials”, 2nd ed., CRC Press, 2013.
2. William D. Callister&David G. Rethwisch, Fundamentals of Materials Science and Engineering: An Integrated Approach, 5thedition, International Student Version, John Wiley & Sons, Inc., 2016.

REFERENCE BOOKS:

1. M. Wilson, K. Kannangara, G. Smith, M. Simmons and B. Raguse, “Nanotechnology: Basic Science and Emerging Technologies”, Chapman and Hall, 2012.
2. Nouailhat, “An Introduction to Nanosciences and Nanotechnology”, Wiley-ISTE, 2018.

WEBSITES:

1. https://www.cs.rochester.edu/users/faculty/nelson/courses/csc_robocon/robot_manual/materials.html
2. https://www.protolabs.com/en-gb/resources/blog/manufacturing-robotics-report-materials/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C111.1	2	1	-	-	-	-	-	-	-	1	-	1	1	-
C111.2	3	2	1	-	-	-	-	-	-	1	-	1	1	-
C111.3	2	1	-	-	-	-	-	-	-	1	-	1	1	-
C111.4	2	1	-	-	-	-	-	-	-	1	-	1	1	-
C111.5	2	1	-	-	-	-	-	-	-	1	-	1	1	-
C111	**2.2**	**1.2**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**1.0**	**-**

SEMESTER II

24MECCR205 ARTIFICIAL INTELLIGENCE FOR ROBOTICS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to;

- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and machine learning.

COURSE OUTCOMES:

Upon completion of this course the students will be able to;

- Identify problems that are amenable to solution by AI methods.
- Identify appropriate AI methods to solve a given problem.
- choose a given problem in the language/framework of different AI methods.
- Interpret the basic AI algorithms.
- Design and carry out an empirical evaluation of different algorithms on a problem formalization.

UNIT I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics Fundamentals of Robotics, Robot Kinematics: Position Analysis, Dynamic Analysis and Forces, Robot Programming languages & systems: Introduction, the three levels of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages.

UNIT II ARTIFICIAL INTELLIGENCE 9

Introduction to Artificial Intelligence. Applications- Games, theorem proving, natural language processing, vision and speech processing, robotics, expert systems. AI techniques- search knowledge, abstraction.

UNIT III PROBLEM SOLVING 9

State space search; Production systems, search space control: depth-first, breadth-first search. Heuristic search - Hill climbing, best-first search, branch and bound. Problem Reduction, Constraint Satisfaction End, Means-End Analysis. LA* Algorithm, L(AO*) Algorithm.

UNIT IV KNOWLEDGE REPRESENTATION 9

Knowledge Representation issues, first order predicate calculus, Horn Clauses, Resolution, Semantic Nets, Frames, Partitioned Nets, Procedural Vs Declarative knowledge, Forward Vs Backward Reasoning.

UNIT V EXPERT SYSTEM 9

Introduction to expert system, need and justification for expert systems, knowledge acquisition, Case studies: MYCIN,R1

TOTAL: 45 HOURS

TEXT BOOKS:

1. E. Rich and K. Knight, "Artificial intelligence", TMH, 2nd ed., 2012.
2. N.J. Nilsson, "Principles of AI", Narosa Publ. House, 2020.

REFERENCE BOOKS:

1. D.W. Patterson, "Introduction to AI and Expert Systems", PHI,2013.
2. Peter Jackson, "Introduction to Expert Systems", AWP, M.A., 2012.

WEBSITES:

1 . https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_robotics.htm
2. https://www.javatpoint.com/robotics-and-artificial-intelligence

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C112.1	3	2	1	2	2	2	-	-	2	-	2	2	2	2
C112.2	3	2	1	3	3	2	-	-	2	-	2	2	2	2
C112.3	3	2	1	2	2	2	-	-	2	-	2	2	2	2
C112.4	3	2	1	3	2	2	-	-	2	-	2	2	2	2
C112.5	3	2	1	2	2	2	-	-	2	-	2	2	2	2
C112	**3.0**	**2.0**	**1.0**	**2.4**	**2.2**	**2.0**	**-**	**-**	**2.0**	**-**	**2.0**	**2.0**	**2.0**	**2.0**

SEMESTER II

24MECCR2E* **PROFESSIONAL ELECTIVE II** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

SEMESTER II

24MECCR211 **ROBOTICS LABORATORY** **4 H - 2 C**

Instruction Hours/week: L: 0 T: 0 P: 4 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to;

- Apply logic principles to program basic AND, OR, and NOT solutions for robotic systems.
- Demonstrate understanding of latching concepts in PLC for efficient control.
- Execute mathematical operations and use timers/counters in robotic programming.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to;

- Develop logic-based programs for fundamental logic operations (AND, OR, NOT) in robotic applications.
- Apply latching concepts in PLC to enhance control and stability in robotic processes.
- Utilize timers, counters, and mathematical operations to create efficient robotic control routines.
- Model command programs enabling precise position control of robotic devices.
- Experiment with soft PLC techniques to achieve smooth and controlled velocity in robotic movements.

LIST OF EXPERIMENTS ON ROBOTICS

1. Programs on logic based on solutions of AND, OR, NOT.
2. Latching concepts in PLC
3. Timer counter/ Mathematical operations.
4. Position control through command program.
5. Velocity control through soft PLC
6. VFD speed control using commands
7. Movements of different robot axes.
8. Point to Point, LIN, CIRC Operations.
9. Sequencing and looping operations.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C114.1	3	2	1	-	1	-	-	-	-	2	-	-	-	3
C114.2	3	2	1	-	1	2	-	-	-	-	-	-	-	2
C114.3	3	2	1	-	1	-	-	-	2	-	-	-	-	2
C114.4	3	2	1	-	1	-	-	-	-	2	2	-	-	1
C114.5	3	2	1	-	1	2	-	-	2	2	-	-	-	3
C114	**3.0**	**2.0**	**1.0**	**-**	**1.0**	**2.0**	**-**	**-**	**2.0**	**2.0**	**2.0**	**-**	**-**	**2.2**

SEMESTER III

24MECCR301 RESEARCH METHODOLOGY 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students;

- To Understand Intellectual honesty and research integrity.
- To Understand the Publication ethics, standards and Identification of publication misconduct
- To Outline the authorship and Use of plagiarism software

COURSE OUTCOMES:

Upon Completion of this course, the students will be able;

- Identify the Research Methodology and Research & Publication Ethics.
- Summarize the concept of Intellectual honesty and research integrity
- Explain about Intellectual honesty and research integrity.
- Relate the Publication ethics, standards and Identification of publication misconduct
- Identify the Software tools for plagiarism

UNIT I PHILOSOPHY AND ETHICS 9

Introduction to Philosophy: Definition, nature and scope, concept, branches- Ethics: Definition, moral Philosophy, nature of moral judgments and reactions.

UNIT II SCIENTIFIC CONDUCT 9

Ethics with respect to science and research – Intellectual honesty and research integrity – scientific misconduct: Falsification – Fabrication and plagiarism (FFP) – Redundant Publications: duplicate and overlapping publications – salami slicing – Selective reporting and misrepresentation of date.

UNIT III PUBLICATION ETHICS 9

Publication Ethics: Definition, introduction and importance – Best practices / standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest -Publication Misconduct: definition, concept, problems that lead to unethical behavior and vice versa, type-Violation of publication ethics,
Authorship and contributorship – Identification of publication misconduct, complaints and appeals-Predatory publishers and journals

UNIT IV PUBLICATION MISCONDUCT 9

Group Discussions: Subject specific ethical issues, FFP, authorship- Conflicts of interest-Complaints and appeals: examples and Fraud from India and abroad.
Software tools: Use of plagiarism software like Tumitin, Urkund and other open source software tools

UNIT V DATABASE AND IPR 9

Database: Database –e-content Development. Indexing database-Citation database: Web of Science, Scopus, etc Research Metrics: Impact Factor of journal as per journal citation Report, SNP, SJR, IPP, Cite score- Metrics: h-index, 110 indexes, altmetrics. IPR: Patent-Copyrights-Trademark-Geographical Indication.

TOTAL: 45 HOURS

TEXT BOOKS

1. Best Practice Guidelines on Publishing Ethics: A Publisher's Perspective, Second Edition, 2014 John Wiley & Sons, Ltd.
2. Wager E. The Committee on Publication Ethics (COPE): Objectives and achievements 1997- 2012. Presse Med. 2012.

REFERENCE BOOKS

1. Carlson RV, Boyd KM, Webb DJ. The revision of the Declaration of Helsinki: Past, present and future. Br J Clin Pharmacol. 2004.
2. Kambadur Muralidhar, Amit Ghosh, & Ashok Kumar Singhvi "ETHICS in Science Education, Research and Governance",

WEBSITE:

1. https://bbamantra.com/research-methodology/
2. https://research-methodology.net/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C201.1	2	1	-	-	1	-	-	1	-	1	-	2	1	-
C201.2	2	1	-	-	-	-	-	1	-	1	-	2	1	-
C201.3	2	1	-	-	1	-	-	1	-	1	-	2	1	-
C201.4	2	1	-	-	-	-	-	1	-	1	-	2	1	-
C201.5	2	1	-	-	-	-	-	1	-	1	-	2	1	-
C201	**2.0**	**1.0**	**-**	**-**	**1.0**	**-**	**-**	**1.0**	**-**	**1.0**	**-**	**2.0**	**1.0**	**-**

SEMESTER III

24MECCR3E* **PROFESSIONAL ELECTIVE - III** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

SEMESTER III

24MECCR3E* **PROFESSIONAL ELECTIVE - IV** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

SEMESTER III

24MECCR391 **PROJECT WORK PHASE I** **12 H - 6 C**

Instruction Hours/week: L: 0 T: 0 P: 12 **Marks:** Internal:**80** External:**120** Total:**200**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Cultivate skills to innovate new ideas and select a suitable problem.
- Equip to apply subject knowledge to obtain solutions to real-world problems.
- Equip to explore the various solutions and propose a solution based on findings.

COURSE OUTCOMES:

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

- Summarize the literature survey.
- Identify the research gap
- Identify a suitable real-world problem.
- Choose the best methodology based on the research gap and problem.
- Analyze the data collected and interpret the findings/ solutions /improvements

COURSE DESCRIPTION

The individual student works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completingthe work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. The project work carried out in this semester may be a standalone project or part of the work of project work carried out in the fourth semester.

The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C204.1	2	1	-	-	1	1	-	-	-	3	2	2	2	1
C204.2	3	2	1	-	1	1	-	-	-	3	2	2	2	1
C204.3	3	2	1	-	1	1	-	-	-	3	2	2	2	1
C204.4	3	2	1	-	1	1	-	-	-	3	2	2	2	1
C204.5	3	3	2	1	1	1	-	-	-	3	2	2	2	1
C204	**2.8**	**2.0**	**1.0**	**1.0**	**1.0**	**1.0**	**-**	**-**	**-**	**3.0**	**2.0**	**2.0**	**2.0**	**1.0**

SEMESTER IV

24MECCR491 **PROJECT WORK PHASE II** **24 H - 12 C**

Instruction Hours/week: L: 0 T: 0 P: 24 **Marks:** Internal**:160** External**:240** Total**:400**

End Semester Exam: 3 Hours

COURSE OBJECTIVE

The goal of this course is for the students to;

- Cultivate skills to innovate new ideas and select a suitable problem.
- Equip to apply subject knowledge to obtain solutions to real-world problems.
- Equip to explore the various solutions and propose a solution based on findings.

COURSE OUTCOMES

Upon completion of this course, the students will be able to;

- Identify a suitable real-world problem.
- Apply subject knowledge to solve the problem.
- Analyze the data collected and interpret the findings/ solutions /improvements
- Choose the best solution based on the evaluation criteria.
- Summarize technical findings effectively.

COURSE DESCRIPTION

The individual student works on a topic approved by the head ofthe department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report and a research article related to the same work may be submitted and the same will accepted by WoS/SCI/SCIE indexed journals are required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C205.1	3	3	3	3	1	1	-	-	-	3	3	2	3	2
C205.2	3	3	3	3	1	1	-	-	-	3	3	2	3	2
C205.3	3	3	3	3	1	1	-	-	-	3	3	2	3	2
C205.4	3	3	3	3	1	1	-	-	-	3	3	2	3	2
C205.5	3	3	3	3	1	1	-	-	-	3	3	2	3	2
C205	**3.0**	**3.0**	**3.0**	**3.0**	**1.0**	**1.0**	**-**	**-**	**-**	**3.0**	**3.0**	**2.0**	**3.0**	**2.0**

PROFESSIONAL ELECTIVE I

24MECCR1E01 **OPTIMIZATION TECHNIQUES** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Use optimization techniques to solve complex engineering problems with nonlinear functions.
- Solve one-dimensional optimization problems using methods like Fibonacci and golden section.
- Apply interpolation methods and quadratic approaches for multivariable optimization.

COURSE OUTCOMES:

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

- Solve engineering optimization problems using nonlinear techniques.
- Apply methods like Fibonacci and golden section for one-dimensional optimization.
- Identify interpolation and quadratic methods for multivariable optimization.
- Analyze and select suitable methods for constrained nonlinear optimization.
- Apply integer programming and dynamic programming for real-world problems.

UNIT I NONLINEAR OPTIMIZATION 9

Introduction – unconstrained optimization - one-dimensional optimization – elimination methods – Fibonacci method, golden section methods – interpolation methods – quadratic, direct route method – multivariable optimization - direct search methods – pattern search methods – univariate method, hooks and Jeeves method, simplex method – descent methods – steepest descent, Newton methods.

UNIT II CONSTRAINED NONLINEAR OPTIMIZATION 9

Direct methods – the complex method, cutting plane method – indirect methods – interior and exterior penalty function methods, Khun-Tucker conditions, Lagrangian method.

UNIT III INTEGER AND DYNAMIC PROGRAMMING 9

Introduction to integer programming – solution techniques - graphical method, the branch, and bound technique, Gomary's cutting plane method, examples of the application in manufacturing/design systems – introduction to dynamic programming - bellman's principle of optimality, examples of the application on routing problem, inventory problem.

UNIT IV NETWORK OPTIMIZATION MODELS 9

Terminology of networks – the shortest route problem – the minimum spanning tree problem – the maximum flow problem – the minimum cost flow problem – the network simplex method.

UNIT V NON-TRADITIONAL OPTIMIZATION MODELS 9

Introduction to non-traditional optimization, computational complexity – NP-hard, NP-complete, no free lunch theorem – working principles of simulated annealing, Tabu search, and neural networks, simple applications. Introduction to Genetic Algorithms, Ants Colony Algorithm, Particle Swarm Algorithm, Hybrid Algorithms, and Simple Applications.

TOTAL: 45 HOURS

TEXTBOOKS:

1. Singiresu S Rao, "Engineering Optimization: Theory and Practice", Wiley-Interscience, Third Edition, 1996.
2. Kalyanmoy Deb, "Optimization for engineering design", Prentice Hall India Pvt. Ltd., New Delhi, 2000.
3. David E Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Addison Wesley Pub Co., 1989.
4. Marco Dorigo and Thomas Stutzle, "Ant Colony Optimization", Prentice Hall of India, 2005.

REFERENCE BOOKS:

1. Maurice Clerc, "Particle Swarm Optimization", ISTE, 2007
2. Dimitri P Bertsekas, "Dynamic Programming: Deterministic and Stochastic Models", Prentice Hall, 1987.
3. Stephen G Nash and Ariela Sofer, "Linear and Nonlinear Programming", McGraw Hill College Div., 1995.
4. Fred Glover, Manuel Laguna and Fred Laguna, "Tabu Search", Kluwer Academic Publishers,1997.

WEBSITES:

1. https://www.shsu.edu/~eco_dgf/web_chapter_a.pdf
2. https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/3/PG_M.Sc._Mathematics_31132%20OPTIMIZATION%20TECHNIQUES.pdf
3. https://archive.nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L2slides.pdf

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C1E01.1	3	3	2	3	2	2	-	-	3	3	3	3	2	-
C1E01.2	3	3	2	3	2	2	-	-	3	3	3	2	2	-
C1E01.3	3	3	2	3	2	2	-	-	3	3	3	2	2	-
C1E01.4	3	3	2	3	2	2	-	-	3	3	3	2	2	-
C1E01.5	3	3	2	3	2	2	-	-	3	3	3	2	2	-
C1E01	**3.0**	**3.0**	**2.0**	**3.0**	**2.0**	**2.0**	**-**	**-**	**3.0**	**3.0**	**3.0**	**2.1**	**2.0**	**-**

24MECCR1E02 ADDITIVE MANUFACTURING AND TOOLING 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**
End Semester Exam: 3 Hours

COURSEOBJECTIVES

The goal of this course is for students;

- Develop an understanding of the principles, development, and applications of Additive Manufacturing (AM).
- Apply reverse engineering and CAD modelling techniques to prepare data for rapid prototyping.
- Analyze the specifics of various AM processes like SLA, SGC, FDM, LOM, SLS, and LENS, including materials and limitations.

COURSE OUTCOMES

Upon completion of this course, the students will be able to;

- Explain the core concepts and significance of Additive Manufacturing in modern product development.
- Apply reverse engineering techniques and CAD modelling principles for efficient data preparation.
- Analyze various AM processes, assessing their strengths, weaknesses, and practical applications.
- Evaluate the quality and suitability of parts created by different AM methods in real-world scenarios.
- Interpret the additive manufacturing concepts to design tooling solutions for industries, considering industrial requirements and limitations.

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 Applications.

UNIT– II REVERSE ENGINEERING AND CAD MODELING 9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and 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 RAPID PROTOTYPE 9

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses 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 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– Case Studies.

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

TOTAL HOURS:45

TEXT BOOKS

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.

REFERENCES

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

WEBSITES

1. https://www.additivemanufacturing.media/articles/big-ideas-in-am-10-examples-of-3d-printed-tooling
2. https://amchronicle.com/insights/applications-and-benefits-of-am-in-tooling/

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C1E02.1	2	1	-	-	3	2	-	-	-	1	1	1	3	-
C1E02.2	3	2	1	-	3	2	-	-	1	1	1	1	3	-
C1E02.3	3	2	1	-	3	2	-	-	-	1	1	1	3	-
C1E02.4	3	2	1	-	3	2	-	-	-	1	1	1	3	-
C1E02.5	3	2	1	-	3	2	-	-	1	1	1	1	3	-
C1E02	**2.8**	**1.8**	**1.0**	**-**	**3.0**	**2.0**	**-**	**-**	**1.0**	**1.0**	**1.0**	**1.0**	**3.0**	**-**

24MECCR1E03 COMPUTER APPLICATION IN DESIGN 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal**:40** External**:60** Total**:100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to;

- Apply computer graphics fundamentals for better visualization in CAD simulations.
- Use curve and surface modelling techniques to represent complex shapes in CAD.
- Develop interactive programs using programming languages for solving design challenges in CAD.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to;

- Compare and contrast the properties of different curve and surface representations.
- Develop interactive programs for design problem-solving in CAD.
- Identify solid modelling for complex geometry creation in CAD.
- Apply visual realism in CAD simulations using shading and colouring techniques.
- Construct Assembly of parts using CAD software.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9

Output primitives (points, lines, curves, etc.,), 2-D and 3-D transformation (Translation, scaling, rotators) windowing - view ports - clipping transformation.

Representation of curves – Bezier curves - cubic spline curve - B – Spline curves - Rational curves –Surface Modeling techniques - surface patch – Coon’s patch- bi-cubic patch – Bezier and B-spline surfaces – Volume modelling – Boundary models – CSG- other modelling techniques.

UNIT II INTRODUCTION TO CAD SOFTWARE 9

Writing interactive programs to solve design problems and production of drawings - using any languages like Python and Java programming etc.- the creation of surfaces - solids, etc. using solid modelling packages (prismatic and revolved parts).

UNIT III SOLID MODELING 9

Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations - constructive solid Geometry - comparison of representations - user interface for solid modelling.

Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc.– Communication standards.

UNIT IV VISUAL REALISM 9

Hidden – Line – Surface – solid removal algorithms shading – colouring. Introduction to parametric and variational geometry-based software and their principles of creation of prismatic and lofted parts using these packages.

UNIT V ASSEMBLY OF PARTS 9

Assembly modelling - interferences of positions and orientation - tolerances analysis - mass property calculations - mechanism simulation.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Radhakrishnan P and Subramanyan S, CAD/CAM/CIM, 2nd edition, New Age International Pvt. Ltd, 2008
2. Ibrahim Zeid, CAD/CAM Theory and Practice,2nd edition, McGraw Hill Inc., New York, 2009

REFERENCE BOOKS:

1. Vera B Anand, Computer Graphics and Geometric Modeling for Engineers,1st edition, John Wiley & Sons, New York, 2000
2. Barry Hawhes, The CAD/CAM Process,1st edition, Pitman Publishing, London, 2007(digital)
3. William M Newman and Robert Sproul, Principles of Interactive Computer Graphics,1st edition, McGraw Hill Inc., New York, 2001.

WEBSITES:

1. https://www.vssut.ac.in/lecture_notes/lecture1530947994.pdf
2. https://community.wvu.edu/~bpbettig/MAE455/Lecture_1_CAD_intro.pdf
3. https://transport.itu.edu.tr/docs/librariesprovider99/dersnotlari/dersnotlarires112e/not/cadd-1.pdf?sfvrsn=4

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C1E03.1	3	2	1	-	2	-	-	-	-	1	-	2	-	2
C1E03.2	3	2	1	-	2	-	-	-	-	1	-	2	-	2
C1E03.3	3	2	1	-	2	-	-	-	-	1	-	2	-	2
C1E03.4	3	2	1	-	2	-	-	-	-	1	-	2	-	2
C1E03.5	3	2	1	-	2	-	-	-	-	1	-	2	-	2
C1E03.5	**3.0**	**2.0**	**1.0**	**-**	**2.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**-**	**2.0**

24MECCR1E04 COMPUTER INTEGRATED MANUFACTURING 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to;

- To develop an ability to apply knowledge of mathematics, science, and engineering aspects.
- To increase the ability to know the application of principles of group technology in computer-aided process planning.
- To develop the ability to apply knowledge on working of the shop floor control and data collection system in FMS.

COURSE OUTCOMES:

Upon completion of this course, the student can able to;

- Make use of computer-integrated manufacturing concepts in industries.
- Apply the principles of group technology in computer-aided process planning.
- Identify the working process of the shop floor control
- Utilize the automated data collection system in FMS.
- Develop CIM architecture for practical application.

UNIT I INTRODUCTION 9

The meaning and origin of CIM– the changing manufacturing and management scene – External communication – islands of automation and software–dedicated and open systems–manufacturing automation protocol – product-related activities of a company– marketing engineering – production planning – plant operations – physical distribution– business and financial management.

UNIT II GROUP TECHNOLOGY 9

Group technology– – part families – Classification and coding – Approaches to computer aided process planning – variant approach and generative approaches

UNIT III SHOP FLOOR CONTROL AND INTRODUCTION OF FMS 9

Shop floor control–phases –factory data collection system –automatic identification methods– Bar code technology–automated data collection system. FMS–components of FMS – types –FMS workstation –material handling and storage systems– FMS layout –computer control systems–application and benefits.

UNIT IV CIM IMPLEMENTATION AND DATA COMMUNICATION 9

CIM and company strategy – system modeling tools –IDEF models – activity cycle diagram – CIM open system architecture (CIMOSA)– manufacturing enterprise wheel–CIM architecture – Product data management–CIM implementation software. Communication fundamentals– local area networks –topology – LAN implementations – network management and installations –MRP, ERP concepts

UNIT V OPEN SYSTEM AND DATA BASE FOR CIM 9

Open systems–open system inter connection – manufacturing automations protocol and technical office protocol (MAP /TOP). Development of databases –database terminology– architecture of database systems–data modeling and data associations –relational data bases – database operators – advantages of data base and relational database.

TOTAL: 45 HOURS

TEXT BOOK

1. Mikell.P.Groover, Automation, Production Systems and computer integrated manufacturing, Pearson Education, Delhi, 2011.
2. Yoremkoren, Computer Integrated Manufacturing system, McGraw-Hill, New York, 2005.

REFERENCE BOOK

1. Kant Vajpayee S, Principles of computer integrated manufacturing, Prentice Hall India, New Delhi, 2003.
2. Radhakrishnan P and Subramanyan S, CAD/CAM/CIM, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000

WEB REFERENCES

1. http://en.wikipedia.org/wiki/Computer-integrated_manufacturing
2. http://www.technologystudent.com/rmprp07/intman1.html
3. http://www.computerintegratedmanufacturing.com/

CO-PO MAPPING

CO - PO Mapping: (Low - 1; Medium - 2; High - 3)														
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
C1E04.1	3	2	1	-	1	-	-	-	-	1	-	1	-	2
C1E04.2	3	2	1	-	1	-	-	-	-	1	-	1	-	2
C1E04.3	3	2	1	-	1	-	-	-	-	1	-	1	-	2
C1E04.4	3	2	1	-	1	-	-	-	-	1	-	1	-	2
C1E04.5	3	2	1	-	1	-	-	-	-	1	-	1	-	2
C1E04	**3.0**	**2.0**	**1.0**	-	**1.0**	-	-	-	-	**1.0**	-	**1.0**	**-**	**2.0**

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PROFESSIONAL ELECTIVE II

24MECCR2E01 MODELING SIMULATION AND ANALYSIS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is for students

- Gain a comprehensive understanding of simulation's historical context, nature, limitations, and diverse applications.
- Apply various modelling approaches to represent real-world scenarios, including manual simulation for queuing and inventory problems.
- Assess the quality of random number generation using different techniques and statistical tests.

COURSE OUTCOMES

Learners should be able to

- Explain about simulation's historical context, nature, limitations, and diverse applications.
- Apply various modelling approaches to represent real-world scenarios, including manual simulation for queuing and inventory problems.
- Assess the quality of random number generation using different techniques and statistical tests.
- Analyze the process of generating random variates for diverse distributions using techniques like the inverse transform and empirical methods.
- Develop skills to enhance system performance through input modelling, verification, validation, variance reduction, and output analysis.

UNIT I INTRODUCTION TO SIMULATION 9

Definition – history - nature of computer modelling and simulation, limitations of simulation, areas of application. System and environment**:** Components of a system – types of simulation - discrete and continuous systems. Modelling approaches – simulation examples - manual simulation using event scheduling, single-channel queue, two server queue, simulation of an inventory problem.

UNIT II RANDOM NUMBER GENERATION AND TESTING 9

Techniques for generating random numbers - midsquare method - midproduct method - constant multiplier technique - additive congruential method - linear congruential method – combined linear congruential generators – feedback shift register generators - tests for random numbers – frequency test - the Kolmogorov-Smirnov test, the chi-square test. Independence test – runs up and runs down, runs above and below the mean, autocorrelation.

UNIT III RANDOM VARIATE GENERATION 9

Inverse transform technique - exponential distribution, uniform distribution, Weibull distribution, Triangular distribution. Empirical continuous distribution - generating approximate normal variates - Erlang distribution. empirical discrete distribution - discrete uniform distribution - poisson distribution - geometric distribution - acceptance - rejection technique for poisson distribution - gamma distribution.

UNIT IV STAGES IN MODEL BUILDING 9

Input modeling – data collection, identifying the distribution with data, parameter estimation, goodness of fit tests, selecting input models without data, models of arrival processes. verification and validation of simulation models – variance reduction techniques, antithetic variables, calibration and validation of models. output analysis –stochastic nature of output data, measures of performance and their estimation, output analysis for terminating simulation.

UNIT V MANUFACTURING SYSTEMS MODELLING 9

Objectives and performance measures – modelling system randomness – sources of randomness, machine downtime.

TOTAL HOURS: 45

TEXTBOOKS

1. Jerry Banks, John S, Carson II, Barry L Nelson and David M Nicol, “Discrete Event System Simulation”, Prentice Hall Inc., 2006.
2. Law A M, “Simulation Modeling and Analysis”, Tata McGraw Hill Companies Inc, 2008.
3. Gordon G, “Systems Simulation”, Prentice Hall Ltd., 2006.

REFERENCES

1. Narsingh Deo, “System Simulation with Digital Computer”, Prentice Hall of India, 2007.
2. Francis Neelamkovil, “Computer Simulation and Modeling”, John Wiley and Sons, 1987.
3. Ruth M Davis and Robert M O'Keefe, “Simulation Modeling with Pascal”, Prentice Hall Inc., 1989.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C2E01.1	3	2	1	2	2	-	-	-	-	-	1	-	3	-
C2E01.2	3	2	1	2	2	-	-	-	-	-	1	-	3	-
C2E01.3	3	2	1	2	2	-	-	-	-	-	1	-	3	-
C2E01.4	3	2	1	2	2	-	-	-	-	-	1	-	3	-
C2E01.5	3	2	1	2	2	-	-	-	-	-	1	-	3	-
Average	**3.0**	**2.0**	**1.0**	**2.0**	**2.0**	-	-	-	-	-	**1.0**	-	**3.0**	-

24MECCR2E02 ADVANCED MANUFACTURING PROCESSES 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is to

- Understand surface cleaning, coating methods, and their economic implications.
- Introduce advanced machining techniques and their applications.
- Explore advanced machining methods like laser, plasma, and electron beam machining.

COURSE OUTCOMES

Upon completion of this course, the students can able

- Explain the methods of surface coating and their economic implications.
- Summarize the principles and characteristics of mechanical and electrical energy-based machining processes.
- Compare the working principles of thermal chemical energy-based machining processes.
- Illustrate the steps involved in the processing of particulate ceramics and composite materials.
- Outline the stages involved in the fabrication of microelectronic devices.

UNIT– I SURFACE TREATMENT 9

Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

UNIT– II NON-TRADITIONAL MACHINING 9

Introduction, need, AJM, Parametric Analysis, Process capabilities, USM –Mechanics of cutting, models, Parametric Analysis, WJM –principle, equipment, process characteristics, performance, EDM – principles, equipment, generators, analysis of R-C circuits, MRR, Surface finish, WEDM.

UNIT–III LASER BEAM MACHINING 9

Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electron Beam Machining - Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electro Chemical Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.

UNIT– IV PROCESSING OF CERAMICS 9

Applications, characteristics, classification. Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics. Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

UNIT– V FABRICATION OF MICROELECTRONIC DEVICES 9

Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in microelectronics, surface mount technology, Integrated circuit economics. E-Manufacturing, nanotechnology, and micromachining, High speed Machining.

TOTAL: 45 Periods

TEXT BOOKS

1. Dearnley, P. A. Introduction to surface engineering. Cambridge University Press, 2017.
2. Benedict, Gary F. Nontraditional manufacturing processes. Vol. 19. CRC press, 1987.
3. Chawla, Krishan K. Composite materials: science and engineering. Springer Science & Business Media, 2012.
4. Franssila, Sami. Introduction to microfabrication. John Wiley & Sons, 2010.

REFERENCE BOOKS

1. Grzesik, Wit. Advanced machining processes of metallic materials: theory, modelling and applications. 2nd Ed, Elsevier, 2017.
2. James SR. Introduction to the principles of ceramic processing. John Willey and Sons Inc, New York. 1988.

WEBSITES

1. https://home.iitk.ac.in/~nsinha/Non-traditional-machining
2. https://www.mems-exchange.org/MEMS/fabrication.html

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C2E02.1	2	-	-	-	-	-	-	-	-	1	-	2	2	-
C2E02.2	2	-	-	-	-	-	-	-	-	1	-	2	2	-
C2E02.3	2	-	-	-	-	-	-	-	-	1	-	2	2	-
C2E02.4	2	1	-	-	-	-	-	-	-	1	-	2	2	-
C2E02.5	2	1	-	-	-	-	-	-	-	1	-	2	2	-
Average	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**2.0**	**-**

24MECCR2E03 **CONTROL SYSTEMS IN ROBOTICS** **3 H - 3 C**

Instruction Hours/week: **L: 3 T: 0 P: 0** **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSEOBJECTIVE

The goal of this course is for students

- Comprehend basic control system components like mechanical and electrical systems using math models.
- Study how control systems respond over time and frequency, using various inputs to assess performance.
- Apply methods for stability assessment to design stable control systems.

COURSE OUTCOMES

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

- Grasp control system basics and depict them with math models.
- Analyze control systems' behavior in time and frequency domains, assessing performance against standards.
- Apply stability analysis to design stable control systems.
- Solve equations for different systems, considering controllability.
- Evaluate control system parts and comprehend their uses and how to choose them.

UNIT I SYSTEMS AND THEIR REPRESENTATION 9

Basic elements in Control Systems - Mathematical Models - Mechanical translational - Mechanical rotational - Electrical systems - Transfer functions - Block diagrams. Reduction techniques - signal flow graph-Thermal-Hydraulic-Pneumatic Systems.

UNIT II TIME AND FREQUENCY RESPONSE 9

Time domain specifications-types of test inputs-I and II order systems-response generalized error series-steady state error-frequency domain specifications-polar plot, bode plot

UNIT III STABILITY OF CONTROL SYSTEMS 9

Characteristic equation-location of roots in S plane for stability - Routh Hurwitz criterion-root locus technique construction-Gain and phase margin-Nyquist stability criterion.

UNIT IV STATE VARIABLE ANALYSIS AND DESIGN 9

Concepts of state variables and state model -state models for linear continuous time systems

Solution of state equations - Concepts of controllability and observability - State variables and Linear Discrete-time systems - problems.

UNIT V CONTROL SYSTEM COMPONENTS 9

Servomotor-stepper motor- synchro -resolver- amplidyne - planar motor: types, principle, Application and Selection-Passive Compliances

TEXT BOOKS

1. A. Nagoor Kani, "Control Systems," RBA publications (P) Ltd., 2007
2. M. Gopal, "Control Systems principles and Design," Tata McGraw-Hill Publishing Company Limited," 2003.

REFERENCES

1. K. Ogata, "Modern Controls Engineering," Prentice Hall of India Pvt. Ltd, 2005.
2. B.C. Kuo, "Automatic Control Systems Control System Engineering," Prentice Hall of India Pvt. Ltd., 2004.
3. I.J. Nagrath and Gopal, "Control System Engineering," New age international (P) Ltd., 2006.

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C2E03.1	3	2	1	-	2	-	-	-	-	1	-	2	2	-
C2E03.2	3	2	1	1	2	-	-	-	-	1	-	2	2	-
C2E03.3	3	2	1	1	2	-	-	-	-	1	-	2	2	-
C2E03.4	3	2	1	1	2	-	-	-	-	1	-	2	2	-
C2E03.5	3	2	1	1	2	-	-	-	-	1	-	2	2	-
Average	**3.0**	**2.0**	**1.0**	**0.8**	**2.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**2.0**	**-**

24MECCR2E04 VIBRATION ANALYSIS AND DIAGNOSIS 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Apply forced vibration analysis techniques to single-degree freedom systems.
- Utilize Fourier analysis to examine system response to non-harmonic excitations.
- Employ methods like Duhamel's Integral for analyzing responses to arbitrary loading.

COURSE OUTCOMES:

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

- Analyze forced vibrations in single-degree freedom systems subjected to non-harmonic and transient excitation.
- Interpret system response using Fourier analysis and predict behavior under arbitrary loading.
- Utilize Duhamel's Integral to calculate the system's response to various loading conditions.
- Apply modal analysis to analyze forced vibrations in multi-degree freedom systems.
- Evaluate the applicability of vibration analysis techniques for diagnosing industrial systems and implementing vibration monitoring.

UNIT I FORCED VIBRATION SYSTEM 9

Forced vibration with non-harmonic and transient excitation of single-degree freedom systems, Fourier analysis, Response to arbitrary loading (Duhamel's Integral), Impulse response, Mechanical shock, Parametric Excitation.

UNIT II MULTI-DEGREE FREEDOM SYSTEMS 9

Two-degree Freedom System, Multi-degree Freedom systems, modal analysis, Matrix iteration Method, Transfer matrix Method, Myklestadt-Prohl Method, Rayleigh's minimum principle, Stodola's Method, Hoizer's Method.

UNIT III VIBRATIONS OF CONTINUOUS SYSTEMS 9

Vibrations of Continuous systems governed by wave equation and Euler Bernoulli equation, strings, membranes, rods, beams.

UNIT IV VIBRATION ANALYSIS AND VIBRATION MONITORING 9

Experimental Methods in Vibration Analysis, industrial applications – rotors and other systems, vibration standards, vibration monitoring.

UNIT V CONDITION MONITORING THROUGH VIBRATION ANALYSIS 9

Frequency analysis, Filters, Vibration signature of active systems, vibration limits and standards. Contaminant analysis, SOAP and other contaminant monitoring techniques.

TOTAL: 45 HOURS

TEXTBOOKS:

1. P. Srinivasan, “Mechanical Vibration analysis” – 2nd Ed., TMH.1995
2. J.G. Rao & K. Gupta, “Introductory course on Theory and Practice of Mechanical Vibrations”, – New Age Publication, 1995.

REFERENCE BOOKS:

1. L. Meirovitch, “Elements of Vibration Analysis”, Tata McGraw Hill, Second edition, 2007.
2. W. T. Thomson, “Theory of Vibration with Applications”, CBS Publ., 1990.

WEBSITES:

1. https://www.emerson.com/documents/automation/brochure-vibration-analysis-for-machinery-health-diagnosis-ams-en-6652272.pdf
2. https://www.tinex-diagnostika.si/slike/PRUFTECHNIK_Vibration_Handbook.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C2E04.1	3	2	1	-	-	-	-	-	-	2	-	2	2	-
C2E04.2	3	2	1	-	-	-	-	-	-	2	-	2	2	-
C2E04.3	3	2	1	-	-	-	-	-	-	2	-	2	2	-
C2E04.4	3	2	1	-	-	-	-	-	-	2	-	2	2	-
C2E04.5	3	2	1	-	-	-	-	-	-	2	-	2	2	-
Average	**3.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**2.0**	**-**	**2.0**	**2.0**	**-**

PROFESSIONAL ELECTIVE III

24MECCR3E01 **MODERN MATERIAL HANDLING SYSTEMS** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Apply principles of material handling to select appropriate equipment for various applications.
- Analyze the components and theory of hoisting equipment for efficient material handling.
- Utilize different load handling equipment and attachments for specific material handling needs.

COURSE OUTCOMES:

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

- Select suitable material handling equipment based on application requirements.
- Evaluate the components and operational theory of hoisting equipment for safe and effective usage.
- Apply diverse load-handling equipment and attachments to enhance material handling processes.
- Recommend appropriate surface and overhead transportation equipment for optimized material movement.
- Assess the design and functionality of elevating and conveying equipment for seamless material transfer.

UNIT I FLEXIBLE HOISTING APPLIANCES 9

Types, Selection and applications of material handling equipment, choice of material handling equipment - hoisting equipment components and theory of hoisting equipment-chain and ropes - selection of ropes, pulleys, pulley systems, sprockets and drums.

UNIT II LOAD HANDLING EQUIPMENT AND BRAKES 9

Forged standard hooks- forged Ramshorn hooks- solid triangular eye hooks- crane grabs, electric lifting magnetic - grabbing attachments for loose materials. arresting gear - brakes: shoe, band and cone elements of shoe brakes -thermal calculation in shoe brakes.

UNIT III SURFACE AND OVERHEAD TRANSPORTATION EQUIPMENT 9

Hand-operated trucks- powered trucks -tractors - electronically controlled tractors - hand truck on rails - industrial railroad equipment: locomotives – winches – capstans – turntables – monorail conveyors -pipe rail systems - flat bar monorails. Rail travelling mechanism, cantilever and monorail cranes, cogwheel drive, mono cable tramways - reversible tramways.

UNIT IV ELEVATING EQUIPMENT 9

Continuous - motion vertical conveyors – reciprocating - motion vertical conveyors - stackers – work levellers and tailgates - industrial lifts - passenger lifts - freight elevators - mast type elevators - vertical skip hoist elevators, bucket elevators: design, loading and bucket arrangements.

UNIT V CONVEYING EQUIPMENT 9

Belt conveyors - chain conveyors - apron conveyors – escalators - flight conveyors - roller conveyors - oscillating conveyors. design of belt conveyors, screw conveyors and pneumatic conveyors.

(Use of approved design data book is permitted)

TOTAL: 45 HOURS

TEXTBOOKS:

1. Chowdary. R. B and Tagore. G. R.N, "Materials Handling Equipment," Khanna Publishers, 1996.
2. Rudenko. N, "Materials Handling Equipment," MIR Publishers, 1969.
3. Spivakovsky. A. O and Dyachkov. V. K., "Conveying Machines," MIR Publishers, 1985.

REFERENCE BOOKS:

1. Alexandrov, M, "Industrial Robotics," MIR Publishers, 1981.
2. Boltzharol, A, "Materials Handling Handbook," Tata McGraw Hill, 1958.
3. Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book," Suma Publishers, 1983.

WEBSITES:

1. https://users.encs.concordia.ca/~andrea/indu421/Presentation%207%20(MH).pdf
2. https://me.gecgudlavalleru.ac.in/images/admin/pdf/1594616688_III-I-Material-Handling-(OE).pdf
3. https://www2.isye.gatech.edu/~mgoetsch/cali/logistics_systems_design/material_handling_systems/material_handling_systems.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E01.1	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E01.2	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E01.3	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E01.4	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E01.5	3	2	1	-	-	-	-	-	-	1	-	1	2	-
Average	**3.0**	**2.0**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**2.0**	**-**

24MECCR3E02 CAD FOR SMART MANUFACTURING 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is to

- Understand the fundamental concepts of smart manufacturing.
- Explore various types of manufacturing systems
- Analyze the key performance indicators of manufacturing system performance.

COURSE OUTCOMES

Upon completion of this course, the students can able

- Explain the core concepts of smart manufacturing.
- Outline the characteristics and functions of various manufacturing systems.
- Illustrate the key performance indicators used to measure manufacturing system performance.
- Discuss the concept of group technology and cellular manufacturing.
- Utilize the concept of digital and smart manufacturing systems.

UNIT I OVERVIEW OF COMPONENTS OF MANUFACTURING SYSTEM 9

Overview, Scope of smart manufacturing, components of manufacturing systems, Design, operation, and control of manufacturing systems.

UNIT II TYPES OF MANUFACTURING SYSTEMS 9

Single station cells, manual assembly lines, automated production lines, transfer lines, analysis automated assembly systems.

UNIT III PERFORMANCE OF MANUFACTURING SYSTEM 9

Productivity, quality, reliability, agility, responsiveness, sustainability, utilization & availability, flexibility, reconfigurability, resiliency, efficiency and effectiveness of manufacturing system, metrics and key performance indicators.

UNIT IV GROUP TECHNOLOGY AND CELLULAR MANUFACTURING 9

Flexible manufacturing systems, changeable manufacturing systems, Just-In-Time and lean production, automation. Agile/demand driven manufacturing, Quick response manufacturing, world class manufacturing and holonic manufacturing systems.

UNIT V COMPUTER INTEGRATED MANUFACTURING 9

Enterprise Integration (ISA-95 and other standards), Digital Manufacturing and smart manufacturing systems.

TOTAL: 45 HOURS

TEXT BOOKS

1. M. P. Groover, "Automation, Production systems and Computer Integrated Manufacturing". 3rd edition, Pearson Education, 2015. ISBN: 978-9332549814.
2. N. Singh, "Systems Approach to Computer Integrated Design and Manufacturing", 1st edition, Wiley India, 2011. ISBN: 978-8126530410.
3. E. Turban, L. Volonino, "Information Technology for Management: Transforming Organizations in the Digital Economy", 7th edition, Wiley India Private Limited, 2010. ISBN: 978-8126526390.

REFERENCE BOOKS

1. G. Chryssolouris, "Manufacturing Systems: Theory and Practice". 2nd edition, Springer, 2006. ISBN: 978-1441920676.
2. W. J. Hopp, M. L. Spearman, "Factory Physics", 3rd edition, Waveland Press, 2011.
3. R. Askin and C. Standridge, "Modeling and Analysis of Manufacturing Systems", 1st edition, John Wiley, 1992. ISBN: 978-0-471-51418-3.

WEBSITES

1. https://www.leanproduction.com/
2. https://www.isa.org/standards-and-publications/isa-standards

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E02.1	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C3E02.2	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C3E02.3	2	1	-	-	-	-	-	-	-	1	-	1	2	-
C3E02.4	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E02.5	2	1	-	-	-	-	-	-	-	1	-	1	2	-
Average	**2.2**	**1.2**	**1.0**	**-**	**-**	**-**	**-**	**-**	**-**	**1.0**	**-**	**1.0**	**2.0**	**-**

24MECCR3E03 COMPUTER AIDED TOOLING FOR MANUFACTURING 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is to

- Understand the integration of CAD, NC, and CAM systems to optimize manufacturing processes.
- Explore the different approaches to Computer-Aided Process Planning (CAPP) and their role.
- Gain insight into geometric tolerances, tolerance analysis, and modern quality control methods.

COURSE OUTCOMES

Upon completion of this course, the students can able

- Explain the concept of CAD/CAM integration and its significance in optimizing production processes.
- Summarize the role of process planning in CAD/CAM integration and its benefits.
- Outline the importance of geometric tolerances and their application in ensuring product quality.
- Relate the purpose and significance of reverse engineering in modern product development.
- Illustrate the strategies for managing data in reverse engineering projects.

UNIT– I COMPUTER AIDED MANUFACTURING 9

Manufacturing Processes – Removing, Forming, Deforming and joining – Integration equipment. Integrating CAD, NC and CAM – Machine tools – Point to point and continuous path machining, NC, CNC and DNC – NC Programming – Basics, Languages, G Code, M Code, APT – Tool path generation and verification – CAD/CAM NC Programming – Production Control – Cellular Manufacturing

UNIT– II COMPUTER AIDED PROCESS PLANNING 9

Role of process planning in CAD/CAM Integration – Computer Aided Process Planning – Development, Benefits, Model and Architecture – CAPP Approaches – Variant, Generative and Hybrid – Process and Planning systems – CAM-I, D-CLASS and CMPP – Criteria in selecting a CAPP System.

UNIT–III COMPUTER AIDED INSPECTION 9

Engineering Tolerances – Need for Tolerances – Conventional Tolerances – FITS and LIMITS – Tolerance Accumulation and Surface quality – Geometric Tolerances – Tolerances Practices in design, Drafting and manufacturing – Tolerance Analysis – Tolerance synthesis – Computer Aided Quality control – Contact Inspection Methods – Non-Contact Inspection Methods - Non optical.

UNIT– IV REVERSE ENGINEERING 9

Scope and tasks of Reverse Engineering – Domain Analysis – Process Duplicating – Tools for RE – Developing Technical data – Digitizing techniques – Construction of surface model – Solid part model – Characteristic evaluation – Software's and its application – CMM and its feature capturing – surface and solid modeling.

UNIT– V DATA MANAGEMENT 9

Strategies for Reverse Engineering Data management – Software application – Finding renewable software components – Recycling real time embedded software – Design experiments to evaluate a RE tools – Rule based detection for RE user interface – RE of assembly programs

TOTAL: 45 HOURS

TEXT BOOKS

1. Ibrahim Zeid and R. Sivasubramanian, “CAD/CAM Theory and Practice”, Revised First special Indian Edition, Tata Mc Graw Hill Publication, 2007
2. David D. Bedworth, Mark R. Henderson, Philp M. Wolfe, “Computer Integrated Design and manufacturing”, Mc Graw Hill International series, 1991
3. Catherine A. Ingle, “Reverse Engineering”, Tata Mc Graw Hill Publication, 1994

REFERENCE BOOKS

1. Donald R. Honra, “Co-ordinate measurement and reverse Engineering, American Gear Manufacturers Association.
2. Ibrahim Zeid, “Mastering CAD/CAM”, special Indian Edition, Tata Mc Graw Hill Publication, 2007
3. Linda Wills, “Reverse Engineering” Kluwer Academic Press, 1996.

WEBSITES

1. https://www.cirp.net/
2. https://www.gdandtbasics.com/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E03.1	2	1	-	-	-	-	-	-	-	1	-	2	1	-
C3E03.2	2	1	-	1	1	-	-	-	-	1	-	2	1	-
C3E03.3	2	1	-	1	1	-	-	-	-	1	-	2	1	-
C3E03.4	2	1	-	1	1	-	-	-	-	1	-	2	1	-
C3E03.5	2	1	-	1	1	-	-	-	-	1	-	2	1	-
Average	**2.0**	**1.0**	**-**	**1.0**	**1.0**	**-**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**1.0**	**-**

24MECCR3E04 **COMPUTATIONAL FLUID DYNAMICS** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**
End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Explain the Governing Equations of viscous fluid flows.
- Understand numerical modelling and its role in the field of fluid flow and heat transfer.
- Estimate the students to know the various discretization methods, solution procedures and turbulence modelling.

COURSE OUTCOMES:

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

- Solve engineering problems by computational fluid dynamics.
- List the importance of governing equations involved in CFD
- Solve problems in the field of fluid flow and heat transfer.
- Simplify the heat conduction problems using the finite difference method.
- Analyze the solutions for convection and diffusion problems.

UNIT I GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETIZATION 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 MODELLING 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 & $k - \varepsilon$, $k - \omega$ models – Standard and High and Low Reynolds number models.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Ghoshdastidar, P.S., "Computer Simulation of Flow and Heat Transfer", Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.
2. John D. Anderson. J R. "Computational Fluid Dynamics-The Basics with Applications" McGraw- Hill International Editions, 1995.
3. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2003.

REFERENCE BOOKS:

1. Subas and V. Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation,1980.
2. Versteeg and Malalasekera, N, "An Introduction to computational Fluid Dynamics The Finite Volume Method," Pearson Education, Ltd., Second Edition, 2014.

WEBSITES:

1. https://nptel.ac.in/courses/112105045
2. https://www.coursera.org/learn/applied-computational-fluid-dynamics

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E04.1	3	2	1	-	-	2	-	-	-	1	-	2	2	-
C3E04.2	3	2	1	-	1	2	-	-	-	1	-	2	2	-
C3E04.3	3	2	1	-	1	2	-	-	-	1	-	2	2	-
C3E04.4	3	2	1	-	-	2	-	-	-	1	-	2	2	-
C3E04.5	3	2	1	-	1	2	-	-	-	1	-	2	2	-
Average	**3.0**	**2.0**	**1.0**	**-**	**1.0**	**2.0**	**-**	**-**	**-**	**1.0**	**-**	**2.0**	**2.0**	**-**

PROFESSIONAL ELECTIVE IV

24MECCR3E05 MICRO ELECTRO MECHANICAL SYSTEMS (MEMS) 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
- To Educate on the rudiments of Microfabrication techniques.
- To introduce various sensors and actuators

COURSE OUTCOMES:

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

- Identify the knowledge to fabricate MEMS devices.
- Summarize the rudiments of micro-fabrication techniques
- Explain about sensors and actuators.
- Relate the feasibility of piezo and resistive sensors
- Identify the various materials used to state MEMS

UNIT I INTRODUCTION 9

Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Microfabrication - Silicon-based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis– Flexural beam bending- Torsional deflection.

UNIT II SENSORS AND ACTUATORS – I 9

Ethics with respect to science and research – Intellectual honesty and research integrity – scientific misconduct: Falsification – Fabrication and plagiarism (FFP) – Redundant Publications: duplicate and overlapping publications – salami slicing – Selective reporting and misrepresentation of date.

UNIT III SENSORS AND ACTUATORS – II 9

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors - Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph - Applications – Magnetic Actuators - Micromagnetic components – Case studies of MEMS in magnetic actuators- Actuation using Shape Memory Alloys

UNIT IV MICROMACHINING 9

Silicon Anisotropic Etching – Anisotrophic Wet Etching – Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE) – Isotropic Wet Etching – Gas Phase Etchants – Case studies - Basic surface micro machining processes – Structural and Sacrificial Materials – Acceleration of sacrificial Etch – Striction and Antistriction methods – LIGA Process - Assembly of 3D MEMS – Foundry process.

UNIT V POLYMER AND OPTICAL MEMS 9

Polymers in MEMS– Polimide - SU-8 - Liquid Crystal Polymer (LCP) – PDMS – PMMA – Parylene – Fluorocarbon - Application to Acceleration, Pressure, Flow and Tactile sensors- Optical MEMS – Lenses and Mirrors – Actuators for Active Optical MEMS.

TOTAL: 45 HOURS

TEXT BOOKS:

1. Stephen D Senturia, "Microsystem Design", Springer Publication, 2016.
2. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture” Tata McGraw Hill, New Delhi, 2012.

REFERENCE BOOKS:

1. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2016.
2. "Microelectromechanical Systems" by Dilip Kumar Bhattacharya and Brajesh Kumar Kaushik, 2018

WEBSITES:

1. https://www.studocu.com/in/course/
2. https://www.universitywafer.com/mems.html

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2
C3E05.1	3	2	1	-	-	-	-	-	2	1	-	2	2	2
C3E05.2	2	1	-	-	-	-	-	-	2	1	-	2	2	2
C3E05.3	2	1	-	-	-	-	-	-	2	1	-	2	2	2
C3E05.4	2	1	-	-	-	-	-	-	2	1	-	2	2	2
C3E05.5	3	2	1	-	-	-	-	-	2	1	-	2	2	2
Average	**2.4**	**1.4**	**1.0**	**-**	**-**	**-**	**-**	**-**	**2.0**	**1.0**	**-**	**2.0**	**2.0**	**2.0**

24MECCR3E06 **TRIBOLOGY IN DESIGN** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Explore friction, wear, and lubrication concepts in fluid dynamics.
- Use measurement methods to analyze engineering surface properties.
- Study friction theories and behaviours in fluid dynamics.

COURSE OUTCOMES:

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

- Apply friction, wear, and lubrication knowledge to fluid dynamics.
- Summarize the measurement techniques for engineering surface analysis.
- Select friction theories in fluid dynamics contexts.
- Interpret wear mechanisms impacting fluid dynamics.
- Identify lubricant properties and usage in fluid dynamics.

UNIT I INTRODUCTION 9

Introduction to Friction, Wear, and Lubrication. Types of friction, wear, and lubrication.

UNIT II ENGINEERING SURFACES 9

Properties and Measurement, Typical surface layers, Measurement Methods (Surface Profilometry, Optical Microscopy, Electron Microscopy), Surface Contact.

UNIT III FRICTION 9

Measurement Methods, Adhesion, Deformation, Friction Theories, Stick-slip, Rolling Friction of Metals, Friction of Non-Metallic friction theory and friction behaviors of metals Materials.

UNIT IV WEAR 9

Types of Wear and its Mechanisms (Adhesive, Abrasive Wear, Erosive Wear, processes, wear theory, wear behaviors of Corrosive/Oxidative Wear, Fatigue Wear), Wear of metals and non-metals, Wear of Ceramics, Wear of Polymers, Wear instruments for measuring friction and wear. Test (Pin on Disc Tribometer, Reciprocating Tribometer), Wear reduction methods.

UNIT V LUBRICANTS AND LUBRICATION 9

Lubricants and their types, Purpose of Lubrication, General Properties of Liquid Lubricants, Animal and Vegetable Oils, Mineral oils, Synthetic oils, Blended Oils, Lubricant Additives, Semi Solid Lubricant or Greases, Solid Lubricants, Testing of Lubricants (Viscometer, Four Ball Tester).

TOTAL: 45 HOURS

TEXTBOOKS:

1. Engineering Tribology, Gwidon W. Stachowiak and Andrew W. Batchelor, 4th Edition,2014.
2. Tribology: Friction and Wear of Engineering Materials, Ian Hutchings and Philip Shipway, 2nd Edition, 2017.

REFERENCE BOOKS:

1. Introduction to Tribology, Bharat Bhushan, Wiley, 2nd Edition, 2002.
2. Engineering Tribology by. Prasanth Sahoo, Prentice Hall India Learning Private Limited, 2005.
3. Fundamentals of Tribology, Ramsay Gohar and Homer Rahnejat, Imperial College Press, 2nd Edition, 2012.

WEBSITES:

1. https://nitsri.ac.in/Department/Mechanical%20Engineering/Tribology_in_Machine_Design.pdf
2. https://easyengineering.net/tribology-in-machine-design/
3. https://www.nationalbronze.com/Tribology%20Handbook%20(2nd%20Edition).pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E06.1	3	2	1	-	-	-	-	-	-	1	-	2	3	-
C3E06.2	2	1	-	-	-	-	-	-	-	1	-	2	3	-
C3E06.3	3	2	1	-	-	-	-	-	-	1	-	2	3	-
C3E06.4	2	1	-	-	-	-	-	-	-	1	-	2	3	-
C3E06.5	3	2	1	-	-	-	1	-	-	1	-	2	3	-
Average	**2.6**	**1.6**	**1.0**	**-**	**-**	**-**	**1.0**	**-**	**-**	**1.0**	**-**	**2.0**	**3.0**	**-**

24MECCR3E07 **DESIGN FOR SUSTAINABILITY** **3 H - 3 C**

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES

The goal of this course is for the students to:

- Understand the fundamental principles of computer graphics and its applications.
- Learn about 2D and 3D transformations and their role in rendering graphics.
- Explore windowing, viewports, and clipping techniques in computer graphics.

COURSE OUTCOMES

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

- Apply General Design Principles and GD&T for Manufacturability.
- Identify different casting processes and welding for new designs.
- Utilize best practices in milled, planned, shaped, and slotted parts to enhance precision and efficiency.
- Choose DFMA principles in designing with specific fasteners and connectors.
- Analyze techniques to reduce environmental impact through case studies.

UNIT- I INTRODUCTION **9**

Introduction - Economics of process selection - General design principles for manufacturability; Geometric Dimensioning & Tolerance (GD&T) – Form tolerancing: straightness, flatness, circularity, cylindricity – Profile tolerancing: profile of a line, and surface – Orientation tolerancing: angularity, perpendicularity, parallelism – Location tolerancing: position, concentricity, symmetry – run out tolerancing: circular and total–Supplementary symbols.

UNIT- II CAST & WELDED COMPONENTS DESIGN **9**

Design considerations for: Sand cast – Die cast – Permanent mould parts. Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment. Resistance welding–Design considerations for: Spot–Seam–Projection–Flash & Upset weldment.

UNIT- III FORMED & MACHINED COMPONENTS DESIGN **9**

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts – Forged parts. Design considerations for: Turned parts– Drilled parts – Milled, planned, shaped and slotted parts– Ground parts.

UNIT- IV DESIGN FOR ASSEMBLY **9**

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly– Computer Application for DFMA.

UNIT- V DESIGN FOR ENVIRONMENT **9**

Introduction– Environmental objectives–Global issues–Regional and local issues–Basic DFE methods–Design guide lines–Example 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

TOTAL: 45 HOURS

TEXT BOOKS:

1. Boothroyd, G, 2nd Edition 2002, Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Bralla, Design for Manufacture handbook, McGrawhill,1999.

REFERENCE BOOK:

3. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, MarcelDekker,1994.

WEBSITES:

1. http://www.sdmsite.org/
2. https://www.sustainabledesignresource.com/

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	PO11	PO12	PSO1	PSO2
C3E07.1	3	2	1	1	-	-	-	-	-	1	-	1	2	-
C3E07.2	3	2	1	1	1	-	-	-	-	1	-	1	2	-
C3E07.3	3	2	1	1	-	-	-	-	-	1	-	1	2	-
C3E07.4	3	2	1	1	1	-	-	-	-	1	-	1	2	-
C3E07.5	3	2	1	1	-	-	-	2	-	1	-	1	2	-
Average	**3.0**	**2.0**	**1.0**	**1.0**	**1.0**	**-**	**-**	**2.0**	**-**	**1**	**-**	**1.0**	**2.0**	**-**

24MECCR3E08 DESIGN FOR MANUFACTURING, ASSEMBLY AND ENVIRONMENT 3 H - 3 C

Instruction Hours/week: L: 3 T: 0 P: 0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

COURSE OBJECTIVES:

The goal of this course is for the students to:

- Apply design principles to enhance manufacturability and mechanical factors.
- Evaluate factors influencing form design considering working principle, material, and manufacturing processes.
- Design components with machining considerations for improved machinability and economy.

COURSE OUTCOMES:

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

- Design components with manufacturability and assembly in mind.
- Create forms that account for working principles, materials, and manufacturing methods.
- Develop optimized components for machining, economy, and assembly.
- Construct castings to minimize core requirements and machining complexities.
- Inspect environmental concerns into design decisions, promoting sustainability and adherence to regulations.

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 castings.

UNIT III COMPONENT DESIGN - MACHINING CONSIDERATION 9

Design features to facilitate machining - drills - milling cutters - keyways – Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for 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 THE ENVIRONMENT 9

Introduction – Environmental objectives – Global issues – Regional and local issues –Basic DFE methods – Design guide lines – Example application – Lifecycle assessment –Basic method – AT and T's environmentally responsible product assessment – Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly –Design for recyclability – Design for remanufacture – Design for energy efficiency –Design to regulations and standards.

Total: 45 Hours

TEXTBOOKS:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
3. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
4. Fixel, J. Design for the Environment, McGraw Hill., 1996.

REFERENCE BOOKS:

1. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
2. Harry Peck, Designing for manufacture, Pitman– 1973.

WEBSITES:

1. http://brharnetc.edu.in/br/wp-content/uploads/2018/11/29.pdf
2. https://www.energy.gov/sites/default/files/2021-07/Module_3D.pdf
3. https://www.dfma.com/forum/2019pdf/dewhurstpres.pdf

CO-PO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C3E08.1	3	2	1	-	-	2	-	-	2	1	-	1	2	-
C3E08.2	3	2	1	-	-	-	-	-	-	1	-	1	2	-
C3E08.3	3	2	1	2	3	-	-	-	-	1	-	1	2	-
C3E08.4	3	2	1	2	3	-	-	-	-	1	-	1	2	-
C3E08.5	3	2	1	-	-	3	3	2	-	1	-	1	2	-
Average	**3.0**	**2.0**	**1.0**	**2.0**	**3.0**	**3.0**	**3.0**	**2.0**	**2.0**	**1.0**	**-**	**1.0**	**2.0**	**-**