KAMARAJ
COLLEGE OF ENGINEERING & TECHNOLOGY
(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)
S.P.G.Chidambara Nadar - C.Nagammal Campus
S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

B.E. MECHANICAL ENGINEERING

REGULATIONS – 2021

AUTONOMOUS SYLLABUS

CHOICE BASED CREDIT SYSTEM

VII & VIII SEMESTER CURRICULUM AND SYLLABUS

VISION:

To make the Department of Mechanical Engineering the unique of its kind in the field of Research and Development activities in the prominent field of Mechanical Engineering in this part of the world.

MISSION:

To impart highly Innovative and Technical Knowledge in the field of Mechanical Engineering to the urban and unreachable rural student folks through Total Quality Education.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: Graduates of the Programme will excel in Technical Knowledge and Apply Innovative skills in the field of Mechanical Engineering.

PEO 2: Graduates will contribute to the Technological Development and Research Activities through “Total Quality Education”.

PEO 3: Graduates of the Programme will accomplish Leadership Qualities and Social Responsibilities through “Life Long Learning”.

PROGRAM OUTCOMES:

After going through the four years of study, the Mechanical Engineering graduates will have the ability to

POs	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/evelopment of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO:1 Graduates will be able to Create and Analyze the Research and Development activites related to Design and Manufacturing.

PSO:2 Graduates will be able to Design and Develop need based products in Mechanical Engineering and allied Industries.

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REGULATIONS - 2021

CHOICE BASED CREDIT SYSTEM

B.E. MECHANICAL ENGINEERING

VII TO VIII SEMESTER CURRICULUM

SEMESTER VII

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	ME2401	Computer Integrated Manufacturing	PC	3	3	0	0	3
2	ME2402	Mechatronics and IoT	PC	3	3	0	0	3
3	GE2401	Universal Human Values and Ethics	HS	2	2	0	0	2
4		Management Elective	HS	3	3	0	0	3
5		Open Elective – II*	OE	3	3	0	0	3
6		Open Elective – III*	OE	3	3	0	0	3
7		Open Elective – IV*	OE	3	3	0	0	3
PRACTICALS								
8	ME2403	Computer Integrated Manufacturing Laboratory	PC	3	0	0	3	1
9	ME2404	Mechatronics and IoT Laboratory	PC	3	0	0	3	1
			TOTAL	**26**	**20**	**0**	**6**	**22**

***Open Elective Courses shall be chosen from the list of open electives offered by other programmes**

SEMESTER VIII

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	ME2451	Project Work	EM	20	0	0	20	10
			TOTAL	**20**	**0**	**0**	**20**	**10**

MANAGEMENT ELECTIVE

(Common to all Branches)

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	GE2491	Principles of Management	HS	3	3	0	0	3
2	GE2492	Total Quality Management	HS	3	3	0	0	3

OPEN ELECTIVE – II

(Offered to CSE, ECE, IT and ADS)

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	OME701	3D Printing and Design	OE	3	3	0	0	3
2	OME702	Creative Thinking	OE	3	3	0	0	3

OPEN ELECTIVE – III

(Offered to CSE, ECE, BT, CIVIL, IT, EEE, ADS)

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	OME703	Cost Management of Engineering Projects	OE	3	3	0	0	3
2	OME704	Electric and Hybrid vehicles	OE	3	3	0	0	3

OPEN ELECTIVE – IV

(Offered to CSE, ECE,BT,CIVIL,IT,EEE,ADS)

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	OME705	Fundamentals of Reverse Engineering	OE	3	3	0	0	3

Course Code	Course Name	L	T	P	C
ME2401	COMPUTER INTEGRATED MANUFACTURING	3	0	0	3

Category: Professional Core

a. Preamble

This course introduces to basics of data transaction, information integration and control of CIM. It provides the overview of evolution of automation, CIM and its principles. It comprehensively details an in-depth understanding of various Automation tools, including various material handling system. It enables the students to apply the knowledge of information technology in the field of automation for better enhancement.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Discuss the basics of CAD/CAM and principles of CIM.	K2
CO2	Describe Production planning, MRP, ERP and computer process control techniques.	K2
CO3	Discuss the concepts of group technology and FMS.	K2
CO4	Develop suitable manufacturing plan for a given manufacturing scenario.	K3
CO5	Select appropriate automation tools and material handling systems for a given scenario.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Introduction to CAD, CAM, CAD/CAM and CIM - Evolution of CIM - CIM wheel - Production concepts and mathematical models - Simple problems in production models - CIM hardware and software - Major elements of CIM system - Implementation of CIM - Computers in CIM - Computer networks for manufacturing - The future automated factory - Management of CIM - safety aspects of CIM - advances in CIM.

PRODUCTION PLANNING AND PROCESS CONTROL SYSTEMS 9

Production planning and Control System - Aggregate Production Planning and Master Production Schedule - Material Requirement Planning (MRP I) - Capacity Planning - Shop Floor Control - Inventory Control - types - Introduction to Manufacturing Resource Planning (MRP II) & Enterprise Resource Planning (ERP). Linear feedback control systems - Optimal control - Adaptive control - Sequence control and PLC & SCADA. Computer process control - Computer process interface - Interface hardware - Computer process monitoring - Direct digital control and Supervisory computer control.

GROUP TECHNOLOGY AND FMS 9

Part families - Visual - Parts classification and coding - Production flow analysis - Grouping of parts and Machines by rank order clustering method - Benefits of GT. FMS - Components - workstations - FMS layout configurations - Computer control systems - FMS planning and implementation issues - Machine cell design - Composite part concept, Holier method, Key machine concept - Simple problems - Quantitative analysis of FMS - Bottleneck model - Extended Bottleneck model - sizing the FMS - FMS applications, Benefits.

PROCESS PLANNING AND DATA ANALYSIS 9

Process planning - Activities in process planning, Informations required. Design to process planning - Selection of primary manufacturing processes - Sequencing of operations according to Anteriorities - forming of Matrix of Anteriorities - case study. Process sheet - case studies in Manual process planning. Computer Aided Process Planning - Variant process planning - Two stages in VPP - Generative process planning - Flow chart showing various activities in generative PP - Semi generative process planning - Comparison of CAPP and Manual PP. Overview of Automatic identification methods – Bar code technology - Automatic data capture technologies - Automated inspection.

AUTOMATED MATERIAL HANDLING SYSTEMS 9

Automated production line - system configurations, work part transfer mechanisms - Fundamentals of Automated assembly system - System configuration, Part delivery at workstations - Design for automated assembly - Overview of material handling equipments - Consideration in material handling system design - Ten principles of Material handling. Conveyor systems - Types of conveyors - Operations and features. Automated Guided Vehicle system - Types & applications - Vehicle guidance technology - Vehicle management and safety. Storage system performance - storage location strategies - Conventional storage methods and

equipments - Automated storage/Retrieval system and Carousel storage system. Deadlocks in Automated manufacturing systems - Petrinet models - Applications in Dead lock avoidance - smart manufacturing - Industry 4.0 - Digital manufacturing - Virtual manufacturing - IOT in manufacturing.

d. Activities

Students shall be expected to create posters for plant layout and process planning for industrial Automation.

e. Learning Resources

Text Books

1. Mikell .P. Groover., *Automation, Production Systems and Computer Integrated Manufacturing*, Pearson, 2018.
2. Kant Vajpayee S., *Principles of Computer Integrated Manufacturing*, Prentice Hall India, 2003.

Reference Books

1. Radhakrishnan ., Subramanyan S. and Raju V., *CAD/CAM/CIM*, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.
2. Yusuf Altintas., *Manufacturing Autmation,* Cambridge University Press, USA.2012.
3. Rao. P. N, Tewari. N. and Kundra. T.K., *Computer Aided Manufacturing*, Tata McGraw Hill Publishing Company, 2000.
4. James A. Regh and Henry W. Kreabber., *Computer Integrated Manufacturing*, 3rd Edition, Pearson Education, 2004.
5. Gupta A. K, Arora S. K., *Industrial Automation and robotics*, Third Edition, University Science Press, New Delhi, 2013.

Course Code	Course Name	L	T	P	C
ME2402	MECHATRONICS AND IoT	3	0	0	3

Category: Professional Core

a. Preamble

In a world of constant innovation, Mechatronics and IoT are combined to bridge the gap between the physical and digital worlds. Together, they empower smarter, interconnected systems that enhance automation, efficiency, and precision. This synergy unlocks endless possibilities while challenging us to address ethical and security considerations.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Select the sensors and transducers for different applications.	K3
CO2	Comprehend the architecture of microprocessor and microcontroller.	K2
CO3	Interpret the processing, programming and features of PLC.	K2
CO4	Explain the Fundamentals of IoT framework.	K2
CO5	Build simple IoT system using Raspberry Pi and Arduino.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Introduction to Mechatronics Systems - Examples of mechatronic system - Washing Machine - Automatic Camera - Engine management system - Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers - LVDT - Capacitance sensors - Strain gauges - Eddy current sensor - Hall effect sensor - Temperature sensors - Light sensors - Stepper and Servo actuators.

MICROPROCESSOR AND MICROCONTROLLER **9**

Introduction - Architecture of 8085 - Pin Configuration - Concepts of 8051 microcontroller - Block diagram - Temperature Control - Stepper Motor Control.

PROGRAMMABLE LOGIC CONTROLLER **9**

Introduction - Basic structure - Input and output processing - Programming - Mnemonics - Timers, counters and internal relays - Data handling - Selection of PLC.

INTRODUCTION TO IoT **9**

New design paradigm - Internet of Things - IoT Framework- understanding the full potential of IoT - challenges of implementing effective IoT Systems - effective Implementation of IoT - detailed procedure - case studies of successful IoT Applications - Home automation, Agriculture , power management system , smart street light system.

ARDUINO AND RASPBERRY PI BASED IOT SYSTEMS **9**

Arduino Boards - Arduino Peripherals - Arduino integrated development environment - Arduino IDE - Raspberry Pi Boards - Raspberry Pi Peripherals - Raspberry interfaces - Raspberry Pi with python programming.

d. Activities

Students will be exposed to the elements and techniques involved in mechatronics systems.

Students will be practiced to build simple IoT systems using Arduino and Raspberry Pi.

e. Learning Resources

Text Books

1. W.Bolton., *Mechatronics*, 4th Approach, Prentice Hall, 2008.
2. Ramesh S Gaonkar., *Microprocessor Architecture, Programming, and Applications with the 8085*, 5th Edition, Prentice Hall, 2008.
3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry., *IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things*, 1st Edition, Cisco Press, 2017.
4. Sami S.H and Kisheen Rao G., *The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers*, 1st Edition, CRC Press, 2022.

Reference Books

1. Bradley D.A, Dawson D, Buru N.C and Loader A.J., *Mechatronics*, Chapman and Hall, 1993.
2. Clarence W, de Silva., *Mechatronics*, First Indian Re-print, CRC Press, 2013.
3. Devadas Shetty and Richard A. Kolk., *Mechatronics Systems Design*, PWS publishing company, 2007.
4. Krishna Kant ., *Microprocessors & Microcontrollers*, Prentice Hall of India, 2007.

Course Code	Course Name	L	T	P	C
GE2401	UNIVERSAL HUMAN VALUES AND ETHICS	2	0	0	2

Category: Science and Humanities

a. Preamble

This course is intended to provide a much-needed orientational input in value education to the young enquiring minds.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Define the essential complementarily between 'VALUES' and 'SKILLS' for ensuring happiness and prosperity.	K2
CO2	Explore Human being as the Co-existence of the Self and the Body.	K3
CO3	Develop holistic perspective towards value-based living in a natural way.	K3
CO4	Explain the interconnectedness of the four orders of Nature and existence.	K2
CO5	Comprehend the ethics of human values, Humanistic education and constitution, strategies of value-based life and profession.	K2

c. Course Syllabus **Total : 30 Periods**

INTRODUCTION TO VALUE EDUCATION **6**

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity - the Basic Human Aspirations, Happiness and Prosperity - Current Scenario, Method to Fulfil the Basic Human Aspirations.

HARMONY IN THE HUMAN BEING **6**

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self,

Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.

HARMONY IN THE FAMILY AND SOCIETY **6**

Harmony in the Family - the Basic Unit of Human Interaction, 'Trust' - the Foundational Value in Relationship, 'Respect' - as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order.

HARMONY IN THE NATURE/EXISTENCE **6**

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence.

IMPLICATIONS OF THE HOLISTIC UNDERSTANDING - A LOOK AT PROFESSIONAL ETHICS **6**

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Holistic Technologies, Production Systems and Management Models - Typical Case Studies, Strategies for Transition towards Value-based Life and Profession.

d. Activities

Practice Sessions - Introduction to Value Education

1 Sharing about Oneself

2 Exploring Human Consciousness

3 Exploring Natural Acceptance

Practice Sessions – Harmony in the Human Being

4 Exploring the difference of Needs of Self and Body

5 Exploring Sources of Imagination in the Self

6 Exploring Harmony of Self with the Body

Practice Sessions – Harmony in the Family and Society

7 Exploring the Feeling of Trust

8 Exploring the Feeling of Respect

9 Exploring Systems to fulfil Human Goal

Practice Sessions – Harmony in the Nature (Existence)

10 Exploring the Four Orders of Nature

11 Exploring Co-existence in Existence

Practice Sessions – Implications of the Holistic Understanding – a Look at Professional Ethics

12 Exploring Ethical Human Conduct

13 Exploring Humanistic Models in Education

14 Exploring Steps of Transition towards Universal Human Order

e. Learning Resources

https://fdp-si.aicte-india.org/UHV-II_Lectures_PPTs.php

https://fdp-si.aicte-india.org/UHV-II%20Practice%20Sessions.php

Text Books

1. R R Gaur, R Asthana, G P Bagaria., *The Textbook A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019.
2. R R Gaur, R Asthana, G P Bagaria., *The Teacher's Manual A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi,2019.

Reference Books

1. EkParichaya, A Nagaraj., *JeevanVidya*, JeevanVidyaPrakashan, Amarkantak, 1999.
2. A.N. Tripathi ., *Human Values*, New Age Intl. Publishers, New Delhi, 2004.
3. Mohandas Karamchand Gandhi ., *The Story of My Experiments with Truth*. 2009.
4. J C Kumarappa., *Economy of Permanence*.2017.
5. Maulana Abdul Kalam Azad., *India Wins Freedom*.1988.

Course Code	Course Name	L	T	P	C
ME2403	COMPUTER INTEGRATED MANUFACTURING LABORATORY	0	0	3	1

Category: Professional Core

a. Preamble

This laboratory converges into a dynamic space with cutting-edge technology and hands-on learning experiences to provide students with a comprehensive and immersive experience in the world of modern manufacturing, automation, and quality control. The Laboratory is committed to equipping students with the knowledge and skills needed to thrive in the world of advanced manufacturing.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Set up and operate CNC machines using part programming safely and effectively.	K3
CO2	Interpret engineering drawings and convert them into CAM programs for CNC machining.	K3
CO3	Develop robot programs using programming languages and navigate VLAB's user interface effectively for robot modeling and simulation.	K3
CO4	Utilize measurement and inspection tools with Machine Vision System and Analyze the measurement data.	K4
CO5	Design and simulate virtual models of manufacturing systems including machines, material handling equipment and production lines.	K3

c. Course Syllabus **Total: 45 Periods**

I. Manual CNC Part Programming

1. Study of CNC Machines and NC Programming.
2. Facing, Step Turning, Taper Turning, Circular Interpolation in turning using CNC Trainer Lathe.

3. Linear, Circular Interpolation, Pocketing operation using CNC Trainer Mill using CNC Trainer Mill.
4. Peck Drilling in Pitch Circle Diameter with Canned Cycle using CNC Trainer Mill.

II. CAM Simulation and Part Program Generation

1. NC code generation for Step Turning, Facing Operations, Circular Interpolation, Peck Drilling, Grooving and Threading operations using MASTERCAM software.
2. NC code generation for Contour Milling, Pocket Milling, Drilling and Tapping operations using MASTERCAM software.
3. Simuation and NC code generation for sheet metal component using MASTERCAM software.

III. Robot Programming.

1. Study of Robot Programming.
2. Robot Simulation Using VAL (Versatile Assembly Language) Programming through VLabs, IIT Kharagpur.

IV. Computer Aided Inspection

1. Inspection with Computer Aided Machine Vision System and Measure the length and area via open-source software support.
2. Measure Particle Analysis in any sample SEM images via open-source software support.

V. Virtual Simulations

1. Modelling and Simulation of Simple Plant Simulation Model using any open-source software support.
2. Modelling and Simulation of Material Handling Systems using any open-source software support.
3. Simulation and evaluation of product feasibility for optimization of manufacturing process in virtual environment using any open source software.

d. Activities

Students are encouraged to design and evaluate group projects that involve designing and building a complete manufacturing or automation system from scratch, integrating various

technologies to practical situations and gain valuable skills in manufacturing, automation, and control systems.

e. Learning Resources

Text Books

1. Mike Mattson., *CNC Programming: Principles and Applications*, Delmar, 2020.
2. Lentin Joseph., *Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy*, Apress, 2018.
3 Averill M. Law and W. David Kelton., *Simulation Modeling and Analysis.*

References

1. https://cttc.mfgelearning.com/
2. https://blogs.sw.siemens.com/tecnomatix/getting-started-with-plant-simulation-software/
3 https://youtu.be/JQAZ--c9YfI

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Qty
HARDWARE		
1.	CNC Lathe Trainer with FANUC controller	1
2.	CNC Mill Trainer with FANUC controller	1
3.	Laser Printer	1
4.	Image Processing Setup for Computer Aided Inspection	1
5.	Computer Nodes (Windows based OS with 8GB Ram)	30
SOFTWARE		
6.	Any CAM Software for tool path generation for planer machining, contour machining, drilling, turning etc. & post processing modulus for different CNC controllers.	15 Licences
7.	Any open-source software which supports computer aided inspection technique for measuring length, area and particle size analysis.	15
8.	Any open-source software which supports simulation of virtual models of manufacturing systems including machines, material handling equipment and production lines.	15

Course Code	Course Name	L	T	P	C
ME2404	MECHATRONICS & IoT LABORATORY	0	0	3	1

Category: Professional Core

a. Preamble

Mechatronics & IoT Lab is a cutting-edge facility designed to foster innovation, collaboration, and hands-on learning at the intersection of Mechatronics and the Internet of Things.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Construct the basic arithmetic operation programs using microprocessor.	K3
CO2	Apply the simple interfacing programs using 8085.	K3
CO3	Demonstrate process control applications with various sensors and actuators and controllers.	K3
CO4	Construct IoT applications using Arduino and Node MCU.	K3
CO5	Build IoT applications using Raspberry Pi.	K3

c. Course Syllabus **Total : 45 Periods**

List of Experiments

1. Assembly language programming of 8085.
2. Stepper motor interface.
3. Traffic light interface.
4. Sequencing of two pneumatic cylinders using PLC.
5. Design of pneumatic circuit for robotic gripper applications.
6. Temperature control in a process loop.
7. Pressure control in a process loop.
8. Flow control in a process loop.
9. Temp and Humidity measurement using Arduino.
10. Fire alarm indication using Buzzer using Arduino.
11. IR Temperature sensor using Arduino.

12. Gas leakage detection using Arduino.
13. Study the ESP8266 WIFI module - light control application.
14. Blink program using Raspberry Pi.
15. Stepper Motor control using Raspberry Pi.
16. Study of Health Monitoring system.

d. Activities

Students are given design project as teams with the maximum of three members. Student should submit project report with project completion certificate/ satisfactory certificate from the industry / Research Organization / committee framed by Head of the Department.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 500 GB, 4 GB RAM).	30
2.	Basic Microprocessor Kit.	5
3.	Basic Pneumatic Trainer Kit.	1
4.	Electro Pneumatic Trainer Kit.	1
5.	Multi process station (Temperature , pressure , flow)	1
6.	PLC Pneumatic Trainer Kit.	1
7.	Arduino Boards.	10
8.	Node MCU.	10
9.	Raspberry PI 4.	10
10.	Software: Arduino IDE, Third Party Cloud API like (Azure / Think speak), Python 3 interpreter.	30 license

Course Code	Course Name	L	T	P	C
GE2491	PRINCIPLES OF MANAGEMENT	3	0	0	3

Category: Science and Humanities

a. Preamble

This course introduces fundamental principles of management, emphasizing their universal applicability in diverse organizations. It covers core managerial functions, explores organizational structures, and provides insights into effective global leadership qualities and skills.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the trends and challenges of management in global scenario, the different types of organization and its effectiveness.	K2
CO2	Utilize the strategies and policies which are involved in planning, Steps involved in the process of planning and use it for decision.	K2
CO3	Explain the structure, purpose, selection and recruitment process in organizations.	K2
CO4	Explain the various motivational theories and processes of management including its functions.	K2
CO5	Compare and contrast the various control techniques.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS **9**

Definition of Management - Nature, Scope and Functions of Management - Evolution of Management - Contributions of FW Taylor (14 principles of Management), Henri Fayol, Elton Mayo, Roethilisberger, H.A.Simon and P.F Drucker - Management theories - Science or Art - Manager Vs Entrepreneur- types of managers managerial roles and skills - Evolution of Management - Scientific, human relations, system and contingency approaches - Current trends and issues in Management.

PLANNING **9**

Nature and purpose of planning - Planning process - Types of planning - Objectives - Setting objectives - Policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.

ORGANISING **9**

Nature and purpose - Formal and informal organization - Organization chart - Organization structure - Types - Line and staff authority - Departmentalization - delegation of authority - Centralization and decentralization - Job Design - Human Resource Management - HR Planning, Recruitment, selection, Training and Development, Performance Management , Career planning and management.

DIRECTING **9**

Directing meaning - importance - principles of directing - Motivation - Motivation theories - Motivational techniques - Job satisfaction - Job enrichment - Leadership - 14 types and theories of leadership - Communication - Process of communication, types of communication and its uses - Barrier in communication - Effective Communication - Communication and IT.

CONTROLLING **9**

System and process of controlling - Budgetary and non - Budgetary control techniques - Use of computers and IT in Management control - Productivity problems and management - Inventory Management - PERT, CPM - Application - Control and performance - Direct and preventive control.

d. Activities

Students shall be given exposure to various concepts of delegation of authority, centralization, and decentralization within the college premises.

e. Learning Resources

Text Books

1. Harold Koontz and Heinz Weihrich, *Essentials of Management*, Tata McGraw Hill, 2020.
2. Stephen P. Robbins and Mary Coulter, *Management*, Pearson, 2019.

Reference Books

1. Robert Kreitner and Mamata Mohapatra, *Management*, Biztantra, 2008.
2. Stephen A. Robbins and David A. Decenzo and Mary Coulter, *Fundamentals of Management*, Pearson Education, 9th Edition,2016.

3. Tripathy PC and Reddy PN, *Principles of Management*, Tata McGraw Hill, 2021.

Course Code	Course Name	L	T	P	C
GE2492	TOTAL QUALITY MANAGEMENT	3	0	0	3

Category: Management Elective

a. Preamble

Quality is the mantra for success or even for the survival of any organization in this competitive global market. Total Quality Management (TQM) is an enhancement to the traditional way of doing business. It is a proven technique to guarantee survival in world class competition. It integrates fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach. At the end of the course the students are expected to recognize the quality issues in an organization and analyze the ways to solve those using TQM techniques, and demonstrate skills in using modern TQM tools.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe TQM concepts of selected enterprise.	K2
CO2	Comprehend the TQM principles and how it is implemented in a selected enterprises.	K2
CO3	Discuss the various traditional and new TQM tools.	K2
CO4	Explain the fundamentals of QFD and TPM.	K2
CO5	Apply QMS and EMS in business organization.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Concept of Quality and Quality Management - Determinants of quality of a product & Service - Reliability - Definition of TQM - Basic concepts of TQM - TQM Framework - Barriers to TQM - Benefits of TQM - Gurus of TQM (Brief Introduction) - Quality statements - vision, mission, and policy.

TQM PRINCIPLES **9**

Continuous Improvement Process - Deming Philosophy - Juran Trilogy - PDSA cycle - Kaizen - Concepts of Quality circle - Japanese 5S principles and 8D methodology.

TQM TOOLS & TECHNIQUES I **9**

The seven traditional tools of quality - New management tools - Six-sigma Process Capability - Bench marking: Reasons for benchmarking , Benchmarking process, Understanding Current Performance, Planning, Pitfalls and Criticisms of Benchmarking - FMEA: Intent, Documentation, Stages: Design FMEA and Process FMEA.

TQM TOOLS & TECHNIQUES II **9**

Quality circles - Quality Function Deployment: QFD Team - Benefits of QFD - Voice of the customers - Organization of Information - House of Quality - QFD Process - Taguchi quality loss function - TPM: Concepts, improvement needs - Performance measures - Cost of Quality.

QUALITY AND ENVIRONMENTAL MANAGEMENT SYSTEM **9**

Introduction - Benefits of ISO Registration - ISO 9000 Series of Standards - Sector Specific Standards: AS 9100, TS16949 and TL 9000 - ISO 9001 Requirements - Implementation - Documentation - Internal Audits - Registration - ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction - ISO 14000 Series Standards - Concepts of ISO 14001 - Requirements of ISO 14001 - Benefits of EMS.

d. Activities

Students shall be exposed to learn the knowledge and skills necessary to drive organizational excellence through the implementation of effective quality management strategies.

e. Learning Resources

Text Books

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe., *Total Quality Management*, Revised 3rd Edition, Pearson Education Asia, 2013.
2. Suganthi L & Anand Samuel., *Total Quality Management*, Prentice Hall Publications, 2004.

Reference Books

1. Kiran.D.R., *Total Quality Management: Key concepts and case studies*, Butterworth - Heinemann Limited, 2016.
2. Shridhara Bhat K., *Total Quality Management: Text and Cases*, Himalaya Publishing House India, 2nd Edition, 2016.

Course Code	Course Name	L	T	P	C
ME2451	PROJECT WORK	0	0	20	10

Category: Professional Core

a. Preamble

Project-based learning plays a pivotal role in fostering critical thinking, problem-solving, and research skills among students. This abstract provides an overview of a structured project assessment and evaluation process that encompasses project reports, reviews, and viva voce examinations for groups of 3 to 4 students working on approved topics.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Identifying a potential problem based on literature survey/impending industrial/real time needs.	K2
CO2	Categorizing various solution methodologies to solve problem taken for study.	K3
CO3	Carry out design/experimental procedure relevant to the problem.	K3
CO4	Analyse design/experimental results.	K4
CO5	Draw conclusion based on analysis and recommend solution to potential engineering problems.	K6

c. Course Syllabus **Total: 300 Periods**

Project reports and to face reviews and viva voce examination. The students in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a project supervisor 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 shall be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on project evaluation process as recommended in the respective regulations.

The student can also be permitted to work on the project in an Industry/ Research organization with the due permission from Head of the Department. The Engineer / Scientist from Industry/ research organization can jointly act as supervisor in addition to the project supervisor. The student should undergo project evaluation process as recommened in the respective regulations.

Course Code	Course Name	L	T	P	C
OME701	3D PRINTING AND DESIGN	3	0	0	3

Category: Open Elective

a. Preamble

This course explores the core concepts of 3D printing, and insights of CAD (Computer-Aided Design). This course empowers the learners to become proficient in harnessing the power of 3D printing and design to shape the future, from custom prosthetics to architectural marvels, and from personalized fashion to aerospace components.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the selection of a 3D printing process.	K2
CO2	Explain the principle and process of Polymer-based Additive Manufacturing techniques.	K2
CO3	Discuss the principle and process of Metal-based Additive Manufacturing techniques.	K2
CO4	Describe the various materials used in Additive Manufacturing techniques.	K2
CO5	Recognize the elements of Design for Additive Manufacturing.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Introduction, Process, Classification, Advantages - Additive V/s Conventional Manufacturing processes - CAD Data formats, Data translation, Data loss, STL format - Additive Manufacturing Application Domains: Aerospace, Electronics,n Health Care, Defense, Automotive, Construction, Food Processing, Machine Tools.

AM MATERIALS **9**

Polymers, Metals, Non-Metals, Ceramics - Various forms of raw material - Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their Properties - Support Materials- FGM – Composite Materials in AM - Properties of Materials for Metal AM.

POLYMER ADDITIVE MANUFACTURING **9**

Stereo- Lithography, LOM, FDM, SLS, Binder Jet technology- Process, Process parameter, Process Selection for various applications - Defects and their causes - Inspection and Testing of polymer-based AM.

METAL ADDITIVE MANUFATURING **9**

Selective Laser Melting (SLM), Laser Beam Melting (LBM), Laser Metal Fusion (LMF), Direct Metal Laser Sintering (DMLS), Electron Beam melting (EBM), Laser Cladding, Directed Energy Deposition and Laser Metal Deposition Process, Laser Engineered Net Shaping (LENS), Wire Arc AM, Friction Stir AM - Inspection and Testing metal AM.

DESIGN FOR ADDITIVE MANUFACTURING **9**

AM technology selection - Build strategies - Minimum feature size - Surface finish - Elimination of support structures - Guidelines for internal geometry like flow paths, cooling channels, cavities and others - Guidelines for making lightweight objects - Guidelines for making functionally gradient objects - DFAM: Process specific strategies, Rules and Recommendations

d. Activities

Students shall be exposed to learn additive manufacturing techniques through laboratory practical demo.

e. Learning Resources

Text Books

1. Ian Gibson, David W. Rosen and Brent Stucker., *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing*, Springer 2010.
2. Soloman S., *3D Printing and Design*, Khanna Publishing House, Delhi, 2020.

Reference Books

1. Andreas Gebhardt., *Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing*, Hanser Publisher, 2011.
2. CK Chua, Kah Fai Leong., *3D Printing and Rapid Prototyping Principles and Applications*, World Scientific, 2018.
3. J.D. Majumdar and I. Manna., *Laser-Assisted Fabrication of Materials*, Springer Series in Material Science, 2013.

Course Code	Course Name	L	T	P	C
OME702	CREATIVE THINKING	3	0	0	3

Category: Open Elective

a. Preamble

In today's complex and rapidly changing world, the ability to think critically is a valuable asset. This course is designed to help you cultivate and sharpen your critical thinking skills, equipping you with the tools to approach problems, issues, and decisions with clarity, rationality, and effectiveness.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the various models and methods of creativity.	K2
CO2	Describe the various models of innovation and methods of identifying real world problems.	K2
CO3	Explain the various stages of creative thinking and brainstorming.	K2
CO4	Apply the creative thinking techniques to solve a critical real world problem.	K3
CO5	Analyze the various contemporary issues and the factors influencing the critical thinking.	K4

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO CREATIVITY **9**

Evoluation - Creativity Methods - Negative Attitudes That Block Creativity - Conceptions of Creativity - Creativity Myths - Three levels of emotional design: Visceral, Behavioral and Reflective - Process design, reengineering, and creativity - Characteristics of the Creative Person.

INNOVATION & IDENTIFING PROBLEM **9**

Creative Thinking Versus Critical Thinking - Models of Innovation - Seven Idea Team Models - Idea Teams and Workforce Team - Deconstrution of Problems - Fishbone Diagram - Concept and Mind Mapping - Clear Problem Statement - Defining the problem.

CREATIVE THINKING **9**

Convergent Versus Divergent Thinking - Inspiration - Idea Conceptualization Phase - Brainstorming - Rules & Limitations - Lateral Thinking - Brainwriting - Mental Blocks to Creative Thinking and Problem Solving - Selection Criteria - Screening Tools for Selecting the Best Idea.

TECHNIQUES FOR CREATIVE THINKING **9**

Random Input - Problem Reversal - Six Thinking Hats - The Discontinuity Principle- SCAMPER - Synectics - TRIZ - Forced Relationships/Analogy - Attribute Listing - Morphological Analysis - NLP Techniques.

CONTEMPORARY ISSUES AND WORLDVIEWS - CASE STUDIES **9**

Contemporary Issues and Practices in Creativity and Problem Solving - Ethical Considerations - Social, Economic, and Political factors affecting innovation with examples - Case studies.

d. Activities

Students are assigned tasks to apply the SCAMPER technique to modify or improve existing products, processes, or systems. Also, students are assigned with design challenges related to everyday products or engineering projects by encouraging them to sketch out their ideas and present them to the class.

e. Learning Resources

Text Books

1. La Verne Abe Harris., *Idea Engineering Creative Thinking and Innovation,* Momentum Press, 2014.

   Robert P. Crawford., *Techniques of Creative Thinking,* Fraser Pub. Co, 2012.

Reference Books

1. Semyon D. Savransky., *Engineering of creativity: introduction to TRIZ methodology of inventive problem solving,* CRC Press, 2016.
2. W. Eder, S. Hosnedl., *Design Engineering A Manual for Enhanced Creativity,* Crc Press, 2008.

Course Code	Course Name	L	T	P	C
OME703	COST MANAGEMENT OF ENGINEERING PROJECTS	3	0	0	3

Category: Open Elective

a. Preamble

This subject "Cost Management of Engineering Projects" explore the students with a comprehensive understanding of the principles, techniques, and strategies essential for orchestrating the financial aspects of complex engineering undertakings in all engineering endeavors, whether in construction , Manufacturing on infrastructure development.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Describe the costing concepts and their role in decision making.	K2
CO2	Explain the project management concepts and their various aspects in selection.	K2
CO3	Interpret costing concepts with project execution.	K2
CO4	Comprehend the costing techniques in service sector and various budgetary control techniques.	K2
CO5	Determine the quantitative techniques in cost management.	K2

c. Course Syllabus **Total: 45 Periods**

INTRODUCTION TO COSTING CONCEPTS **9**

Objectives of a Costing System - Cost concepts in decision-making - Relevant cost - Differential cost - Incremental cost and Opportunity cost - Creation of a Database for operational control.

INTRODUCTION TO PROJECT MANAGEMENT **9**

Project: meaning - Different types - cost overruns centres - various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities - Detailed Engineering activities - Pre project execution main clearances

and documents - Project team: Role of each member - Importance Project site: Data required with significance - Project contracts

PROJECT EXECUTION AND COSTING CONCEPTS **9**

Project execution Project cost control - Bar charts and Network diagram - Project commissioning: mechanical and process - Cost Behaviour and Profit Planning Marginal Costing - Distinction between Marginal Costing and Absorption Costing - Break-even Analysis - Cost - Volume - Profit Analysis - Various decision making problems - Pricing strategies: Pareto Analysis - Target costing - Life Cycle Costing.

COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL **9**

Just-in-time approach - Material Requirement Planning - Enterprise Resource Planning - Activity Based Cost Management - Bench Marking - Balanced Score Card and Value-Chain Analysis - Budgetary Control: Flexible Budgets - Performance budgets - Zero-based budgets.

QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT **9**

Linear Programming - PERT/CPM - Transportation problems - Assignment problems - Learning Curve Theory.

d. Activities

Students will engage in a practical workshop aimed at equipping them with the knowledge and skills necessary to effectively manage and optimize costs in engineering projects.

e. Learning Resources

Text Books

1. John M. Nicholas, Herman Steyn., *Project Management for Engineering, Business and Technology*, Taylor & Francis, 2020.
2. Albert Lester., *Project Management, Planning and Control*, Elsevier/Butterworth - Heinemann, 2007.

Reference Books

1. Ashish K. Bhattacharya., *Principles & Practices of Cost Accounting* A. H. Wheeler publisher, 1991.
2. Vohra N.D., *Quantitative Techniques in Management*, Tata McGraw Hill Book Co. Ltd, 2007.

Course Code	Course Name	L	T	P	C
OME704	ELECTRIC AND HYBRID VEHICLES	3	0	0	3

Category: Open Elective

f. Preamble

This comprehensive syllabus on Electric and Hybrid Vehicles addresses the pressing importance of electric vehicles (EVs) and delves into key aspects such as power sources, motor types, dynamics, architecture, converters, power management, and energy strategies. It provides an in-depth exploration of the advantages and limitations associated with hybrid and electric vehicles while elucidating the fundamental components, operational principles, and their respective functionality.

g. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the electric vehicles (EVs) and their significance in the contemporary automotive industry.	K2
CO2	Discuss various energy source options available for modern vehicles.	K2
CO3	Exploring the various types of motors used in the electric and hybrid vehicles.	K2
CO4	Converse about the hybrid and electric vehicles, focusing on their controllers and converters.	K2
CO5	Explore the concepts of hybrid and electric vehicles, their components, operational modes, and their economic aspects.	K2

h. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Need for Electric vehicle - Comparative study of diesel, petrol, hybrid - Series and parallel hybrid vehicles, and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency - Electric vehicle chassis and Body layout, Electric Vehicle Recharging Systems.

ENERGY SOURCES **9**

Battery Parameters - Different types of batteries - Lead Acid- Nickel Metal Hydride - Lithium ion- Sodium based - Metal Air. Battery Modelling, flexible fuel vehicles (FFV), solar powered vehicles. Fuel Cell - Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Battery Pack Design and Sizing - Cell arrangement and configurations, Performance and range - Battery size, Battery Pack Design, and Integration.

MOTORS AND DRIVES **9**

Types of Motors- DC motors - AC motors, PMSM motors, BLDC motors, switched reluctance motors working principle, construction, and characteristics. Power Electronics- Inverters, Motor Control Algorithms - Field-Oriented Control (FOC) Direct Torque Control (DTC).

POWER CONVERTERS AND CONTROLLERS **9**

Dynamics and architecture of hybrid and electrical vehicles, DC-DC converters, DC- AC converters. Solid state Switching elements and characteristics - BJT, MOSFET, IGBT, SCR and TRIAC - Power Converters - rectifiers, inverters, and converters - Energy management strategy (EMS) - General architecture - Deterministic Rule - Optimization.

HYBRID AND ELECTRIC VEHICLES **9**

Main components working principles of a hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies - Economy of hybrid and electric Vehicles - Case study.

i. Activities

Students shall be exposed to understand the differences between traditional gasoline-powered vehicles, electric vehicles (EVs), and hybrid vehicles

Assign a task to the students to design an electric vehicle considering design requirements such as range, maximum velocity, acceleration, and power requirement.

j. Learning Resources

Text Books

1. James Larminie and John Lowry., *Electric Vehicle Technology Explained,* John Wiley &Sons, 2003.
2. Iqbal Husain., *Electric and Hybrid Vehicles-Design Fundamentals* , CRC Press, 2003.

Reference Books

1. Mehrdad Ehsani., *Modern Electric, Hybrid Electric and Fuel Cell Vehicles*, CRCPress, 2005.
2. Lino Guzzella., *Vehicle Propulsion System,* Springer Publications, 2005.
3. Ron HodKinson., *Light Weight Electric/ Hybrid Vehicle Design*, Butterworth Heinemann Publication, 2005.

Course Code	Course Name	L	T	P	C
OME705	**FUNDAMENTALS OF REVERSE ENGINEERING**	**3**	**0**	**0**	**3**

Category: Open Elective

a. Preamble

This course details the various aspects of how reverse engineering works in product design and development. It also describes the working of 3D scanning hardware & software operations and procedure to generate 3D model.

b. Course Outcome

After successful completion of the course, the students will be able to

CO. No.	Course Outcome	Knowledge Level
CO1	Discuss the fundamental concepts and principles of reverse engineering in product design and development.	K2
CO2	Apply the concept and principles of data processing, part performance and system compatibility in reverse engineering.	K3
CO3	Apply the concepts of 3D scanning hardware & software operations and procedure to generate 3D model in Reverse Engineering.	K3
CO4	Explain the various design rules for developing product through 3D printing.	K2
CO5	Apply the concept of reverse engineering in Automotive Industry, Aerospace Industry, Medical Industry, Software Industry.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO REVERSE ENGINEERING **9**

Need of Reverse Engineering - Methodologies - Phases of Reverse Engineering, Conceptual System Reasons for Reverse Engineering - Difficulties - Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction - Dimensional Measurement - Prototyping.

DATA PROCESSING FOR REVERSE ENGINEERING **9**

Statistical Analysis - Data Analysis - Reliability and Theory of Interference - Weibull Analysis - Data Conformity and Acceptance - Data Report - Performance Criteria - Methodology of Performance Evaluation - System Compatibility.

REVERSE ENGINEERING FOR 3D PRINTING **9**

Introduction, working principle of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types - Applications- Preparation techniques for Scanning objects.- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling - 3D inspection- Case studies.

3D PRINTING FROM REVERSE ENGINEERING **9**

General design considerations for 3D printing, 3D printed features - Design Rules for Material extrusion, Binder jetting, Material jetting, SLA, SLS.

APPLICATION OF REVERSE ENGINEERING **9**

Reverse Engineering in the Automotive, Aerospace, Medical and Software Industries. Case studies and Solving Industrial projects in Reverse Engineering. Legality: Patent - Copyrights - Trade Secret - Third-Party Materials.

d. Activities

Students were given exposure scan the 3D physical models and convert it into CAD files. Students are exposed to various softwares related to reverse engineering, and also information related to calibration of 3D scanner.

e. Learning Resources

Text Books

1. Robert W. Messler., *Reverse Engineering: Mechanisms, Structures, Systems & Materials*, 1st Edition, McGraw-Hill Education, 2014.
2. Wego Wang., *Reverse Engineering Technology of Reinvention*, CRC Press, 2011.

Reference Books

1. Scott J. Lawrence., *Principles of Reverse Engineering* , Kindle Edition, 2022.
2. Kevin Otto and Kristin Wood., *Product Design: Techniques in Reverse Engineering and New Product Development*, Prentice Hall, 2001.
3. Kathryn, A. Ingle., *Reverse Engineering*, McGraw-Hill, 1994.
4. Linda Wills., *Reverse Engineering* , Kluver Academic Publishers, 1996.

5. Vinesh Raj and Kiran Fernandes, *Reverse Engineering: An Industrial Perspective*, Springer- Verlag London Limited, 2008.