

Introduction to MSC ADAMS

Course Code	ME28006
Course Title	Introduction to MSC ADAMS
Number of Credits	0-0-2-1
Course Type	Vocational Elective

Course Objectives:

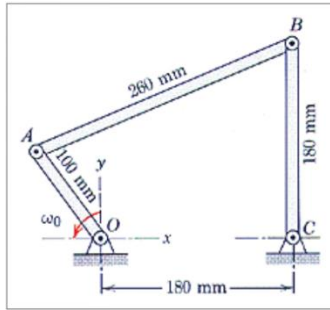
ADAMS is multi-body dynamic simulation software which helps to generate 3D models and understand the transient behaviour a physical system. With the help of this software one can incorporate springs, gears, belt drives, flexible bodies, contact between two surfaces to build real mechanical system and evaluate velocity, acceleration and distribution of forces throughout the mechanical system. It helps to investigate and study the kinetic and dynamic behaviour of the mechanical and mechatronics systems. Co-simulation is also possible between two interfaces such as ADAMS and MATLAB (simulink) to control and study the real time behaviour of the system. It also allows users to integrate different mechanical components with hydraulic, electronics and controls to test virtual prototypes accurately.

Course Outcome:

1. **Understand** the distribution of forces in different mechanical components of the systems.
2. **Implement** control systems in to the mechanical models.
3. **Develop** the real world prototypes by incorporating different mechanical components such as springs, gears, belt drives, bearing, cam modules and electric motors.
4. **Estimate** forces, acceleration, velocity and displacement at each component.
5. **Discuss** about different frequencies integrating flexibility properties.

Course contents:

1. Basics of model buildings, tools and techniques about ADAMS.
2. Preparation of ADAMS model from CAD solid model geometry.
3. **Modeling and Analysis of One-degree-of-freedom Pendulum.**
Find the initial force supported by the pin for a bar that swings in a vertical plane, given the initial angular displacement and initial angular velocity. Also, find the pendulum frequency.
4. Modeling and Analysis of **Spring mass Damper system.**
Find the force in spring damper at static equilibrium and natural frequency.
5. **Falling stone:** Find the displacement, velocity, and acceleration of a stone after one second, when the stone with zero initial velocity, falls under the influence of gravity.
6. Modeling and analyzing/animation of **Four Bar mechanism.**



Measurement of angular velocity.

7. Modeling and simulation of **simple gears**.

8. Functional Analysis of Suspension System

9. **Use Controls Toolkit in the analysis of lift mechanism**

- Create an input-signal block
- Create a summing-junction block
- Create a gain block
- Modify torque function

10. **Valvetrain Mechanism**

Use Adams/View to manipulate, inspect, simulate, and animate the valvetrain mechanism.

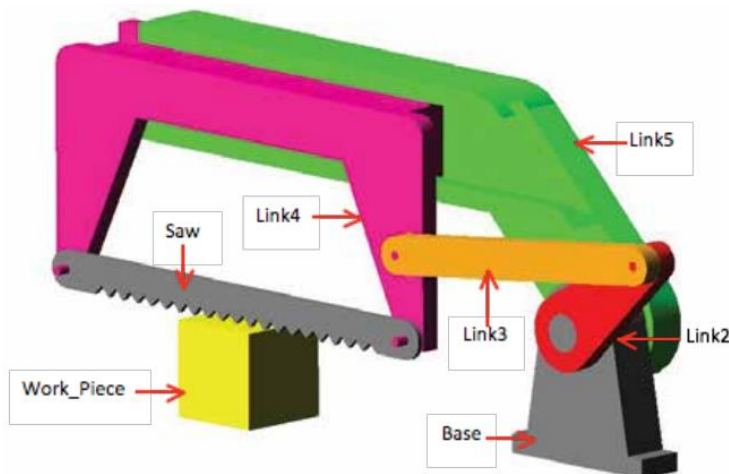
11. **Robot arm**

Construct a robot arm in Adams

- Manipulate the working grid for use with multi-planar part layouts
- Create a gear constraint between revolute joints
- Use a SFORCE to apply gripping torque to a robot manipulator
- Define 3D object contact and friction
- Synchronize joint motions and motor toques to perform a complex task

12. **Power Hacksaw Mechanism**

- Simulate the power hacksaw mechanism
- Create translational joint and revolution joints
- Apply motion to a revolution joint
- Define a contact between a solid and a solid



13. Adams/MATLAB Co-simulation on DC Motor

- Build a simple DC motor connected to an output shaft in both MATLAB/Simulink and Adams/View
- Compare the results of two different simulation methods

Text/ Referred books

1. **McConville, J. B. (2015). *Introduction to mechanical system simulation using Adams*. SDC publications.**
2. MSC ADAMS (2005). Release Guide. *Published by MSC*.

Introduction to LABVIEW

Course Code	ME28008
Course Title	Introduction to LabVIEW
Number of Credits	0-0-2-1
Course Type	Vocational Elective

Course Objectives:

The prime focus of this course is to provide the students with a basic understanding of the LABVIEW environment and to create the virtual instrument along with solving real world engineering problems by getting the physical values using sensors which are relevant to the academic and industrial applications.

Course Outcomes:

- ✓ **CO1:** Demonstrate proficiency in using LabVIEW to acquire and analyze data for mechanical engineering experiments.
- ✓ **CO2:** Develop skills in designing and implementing virtual instruments to control and monitor mechanical systems using LabVIEW.
- ✓ **CO3:** Apply programming concepts in LabVIEW to solve engineering problems related to data acquisition and control systems.
- ✓ **CO4:** Gain hands-on experience in interfacing sensors and actuators with LabVIEW for real-time data acquisition in engineering applications.
- ✓ **CO5:** Understand the principles of graphical programming and apply them to create efficient and user-friendly LabVIEW interfaces for experimental setups.
- ✓ **CO6:** Implement comprehensive LabVIEW-based solutions for complex engineering and industry standard problems.

Course Contents:

Experiment-1: Getting Started with LABVIEW

Objective: Introduce students to the LABVIEW environment and its basic components.

Exercises:

1. Introduction:

Brief overview of LABVIEW and its applications, importance of LABVIEW in engineering, explore the LABVIEW user interface, including the Front Panel and Block Diagram, create a simple VI with basic controls (e.g., numeric input, buttons) and indicators.

2. Running a Basic VI:

Execute the VI created in the previous step, discuss the concept of a VI (Virtual Instrument) and how it functions.

Experiment-2: Control Basics & Data Acquisition

Objective: Familiarize students with basic digital controls and data acquisition.

Exercises:

1. Digital Controls:

Implement digital controls using buttons and switches, create a simple program that responds to user input.

2. Simple Automation:

Integrate LABVIEW with a basic mechanical system (simulated or physical). Control the system using LABVIEW, emphasizing basic automation concepts.

3. Analog Data Acquisition:

Introduce analog input signals. Introduction of NI hardware and sensor integration. Configure LABVIEW to read and display analog data from a sensor.

Experiment-3: Signal Processing

Objective: Provide an introduction to basic signal processing concepts using LABVIEW.

Exercises:

1. Analog Signal Processing:

Apply basic signal processing techniques (e.g., filtering, amplification) to analog signals. Visualize the impact on the signals.

Experiment-4: Introduction to User Interface Design

Objective: Teach students how to create user-friendly interfaces for their LABVIEW applications.

Exercises: Front Panel Design:

Enhance the user interface by incorporating charts and graphs for data visualization. Implement interactive elements for user input.

Experiment-5: Final Project

Objective: Apply all learned concepts to a small-scale project.

Exercises:

- Exercise-1.** Create a VI to draw all arithmetic operation using only two entered numbers.
- Exercise-2.** Convert the given temperature (in Celsius) to Fahrenheit and vice versa.
- Exercise-3.** Perform the conversion from Degrees to Radians and vice versa.
- Exercise-4.** For two Boolean inputs perform all the logical operations and show the result in different indicators.
- Exercise-5.** Create a VI to find out whether the entered number is even or odd. Use two different Boolean indicators for displaying the result.
- Exercise-6.** Create a VI to concatenate multiple strings to get a single string using string palette and show the string length for the entered string.
- Exercise-7.** Using the SEARCH AND REPLACE node create a VI to search for the string and replace it with the desired.
- Exercise-8.** Create a VI where the entered number is checked if it is greater or less than 100 and informs this using a string and Boolean indicator.
- Exercise-9.** Create a SUB-VI which performs all the arithmetic operations of the two entered numbers.
- Exercise-10.** Using CASE structure create a VI for finding the square root of a number only if the number is positive and displays "SQUARE ROOT NOT POSSIBLE" if the given number is negative.
- Exercise-11.** Create a VI to control the light of three different rooms using case structure. Only the light of the selected room no. glows at a time.
- Exercise-12.** Create a VI to create a sine wave using formula node. Perform the $(x1+2)*\log(x1)$ using configure formula node.
- Exercise-13.** Create a VI to find the maximum and minimum variable from an array.
- Exercise-14.** Create a VI to bundle and unbundle a cluster of data.
- Exercise-15.** Create a VI to acquire, analyze and present an EEG using Virtual instrumentation.
- Exercise-16.** Create a VI which determines the temperature of a room/body using thermistors.
- Exercise-17.** Create a VI to find the range (in distance) using IR and Ultrasonic sensors.
- Exercise-18.** Create a VI to use photocells in light sensing encoders.
- Exercise-19.** Create a VI to find the relative humidity using humidity sensor.
- Exercise-20.** Create a VI to measure the flow rate of the flowing fluid using flow-meter.
- Exercise-21.** Create a VI to find the acceleration of a body using accelerometer.
- Exercise-22.** Create a VI to program servo or geared motors using H-bridge driver.

Assessment Scheme:

Activity	Marks
Daily performance	50
Lab Record	30
Examination	20
Total	100

Text Books:

1. Dr. Robert H. Bishop, LabVIEW Student Edition Textbook, 2009.
2. National Instruments, Getting Started with LabVIEW, 2013

Industrial IOT

Course Code	ME28010
Course Title	Industrial IOT
Number of Credits	0-0-2-1
Course Type	Vocational Elective

Course Objectives:

The primary objective of this laboratory is to introduce Industrial Internet of Things (IIoT) concepts and practical applications to the students. The prime focus of this course is to provide a basic understanding of Industrial IOT utilizing the Arduino IDE environment, integrating sensors with the ESP32 board, connecting to ThingSpeak cloud, performing data analysis, and optionally, sending data to Google Spreadsheets or integrating with Blynk. and to solve engineering problems relevant to the academic and industrial applications.

Course Outcomes:

- ✓ **CO1:** Demonstrate the foundational concepts in Industrial IoT, encompassing sensors, microcontrollers, and data transmission.
- ✓ **CO2:** Develop skill in utilizing the Arduino IDE and programming ESP32 and other microcontrollers for IoT applications.
- ✓ **CO3:** Apply practical skills to incorporate diverse sensors with ESP32 boards for data acquisition in industrial contexts.
- ✓ **CO4:** Analyze and interpret sensor data on the ThingSpeak platform, showcasing proficiency in data visualization and interpretation.
- ✓ **CO5:** Implement data logging and integration with external platforms like Google Spreadsheets, showcasing the ability to extend IoT applications.
- ✓ **CO6:** Showcase competence in integrating ESP32 with Blynk Cloud applications for real-time monitoring, providing additional capabilities for IoT applications.

Course Contents:

Lab-1:

Introduction to the course, software description, understand the basics of IoT and its applications in industrial settings. Install and configure Arduino IDE, set up the ESP32 board, and ensure a successful LED blinking program.

Lab-2:

Connect a temperature sensor (e.g., DHT11/LM35) to the ESP32, read sensor data, and display it on the Serial Monitor.

Lab-3:

Set up a 5v relay on the Arduino to control high voltage (AC or 24V DC supply) with microcontroller (ESP32 or Arduino boards).

Lab-4:

Configure the ESP32 to send temperature data to ThingSpeak, create a ThingSpeak channel, and visualize data on the ThingSpeak platform.

Lab-5:

Perform basic data analysis using ThingSpeak MATLAB Analysis and Visualizations tools to interpret temperature trends over time.

Lab-6:

Extend data logging capabilities by configuring the ESP32 to send sensor data to a Google Spreadsheet.

Lab-7:

Create a Blynk account, set up a basic Blynk project, and interface with the ESP32 for real-time monitoring.

Lab-8:

Configure the ESP32 to send temperature data to a Blynk app, enabling real-time visualization and control.

Lab-9:

Integrate multiple sensors (e.g., temperature and light sensors) with the ESP32 and send data to ThingSpeak for simultaneous monitoring.

Lab-10:

Explore advanced features of ThingSpeak, such as adding multiple fields, setting up data alerts, and customizing visualizations.

Lab-11:

Implement basic security measures for IoT data transmission, such as using HTTPS with ThingSpeak or securing Blynk communication.

Lab-12:

Design and present own IoT projects, integrating multiple sensors, platforms, and advanced features.

Text Books:

1. Raj Kamal, Internet Of Things, McGraw Hill, 2017.
2. Arsheep Bahga, Vijay Madisetti, INTERNET OF THINGS - A HANDS-ON APPROACH, Orient Blackswan Private Limited, 2015.
3. Cuno Pfister, Getting Started with the Internet of Things, O'Reilly – 2011, 1st Edition.

Additive Manufacturing

Course Code	ME28011
Course Title	Additive Manufacturing
Number of Credits	0-0-2-1
Course Type	Vocational Elective

Course Objective:

Additive Manufacturing (AM) is a modern manufacturing technology also known as 3D printing process, will provide a clear understanding about the process, acceptability and usability in various field. AM technologies classified on the basis material types will be focused with its real life applications with advantages and disadvantages. Different types of errors associated with AM and CAD technology will be discussed with suitable error minimization processes. Various reverse engineering process will be discussed and practically implemented with its real life applications.

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

- CO1: To understand the concept of additive manufacturing, its benefits and applications in various field.
- CO2: To know the various liquid, powder and solid material based technologies in Rapid Prototyping and Rapid Tooling process.
- CO3: To know the application of AM process in the field of Biomedical.
- CO4: To design solid models and converting it to 3D printing readable file format required for part fabrication.
- CO5: To focus on the various types errors in the RP parts and errors during CAD file conversion.
- CO6: To apply reverse engineering process to generate data for fabrication RP part.

Course Contents:

1. Introduction to Additive Manufacturing Technologies:

Need & Development of AM systems, AM process chain, Impact of AM and Tooling on Product Development, Benefits, Applications, Digital prototyping, Virtual prototyping.

Model Preparation using Solid Modelling Software.

2. Classification of Additive Manufacturing Technologies:

Classification of AM technologies on the basis of Materials types. Discussion on various AM processes based solid, liquid and semi solid type of materials along with its application, advantages and disadvantages.

Hands on practice for model creation and saving on particular file format.

3. Data Processing for AM Technologies:

Process planning for AM, CAD model preparation, data requirements & geometric modelling techniques: Wire frame, surface and solid modelling data formats.

Hands on practice for the fabrication of Single components and Assembly components.

4. Rapid Tooling:

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect, Fabrication processes, Applications, Rapid tooling techniques such as laminated metallic tooling, direct metal laser sintering, vacuum casting.

Hands on practice for the fabrication of pattern and mould preparation.

5. Reverse Engineering Processes:

Introduction to reverse engineering, Integration of reverse engineering with AM technology.

Hands on practice to generate model data in reverse engineering process integrated with AM process

Reference Books:

1. Rapid Prototyping: Principle and Applications, Rafiq I Noorani, Wiley & Sons, 2006.
2. Rapid prototyping: Principles and applications, Chua C.K., Leong K.F., and Lim C.S., Yes Dee Publishing Pvt. Ltd, Third edition, 2010.
3. Rapid Prototyping and Engineering Applications, Frank W. Liou, CRC Press, Special Indian Edition, 2007.
4. Additive manufacturing, R.B. Choudhary, Khanna Publication, 2022

Simulation using ANSYS

Course Code	ME28012
Course Title	Simulation using ANSYS
Number of Credits	0-0-2-1
Course Type	Vocational Elective

Course Objectives:

ANSYS commercial software is employed to carry out simulations in order to obtain solutions to several engineering problems. This software is also used for academic purposes to solve fundamental problems in various fields. With the help of this software one can simulate real-world problems based on structural analysis using advanced solver options, including linear dynamics, nonlinearities, thermal analysis, multiphase flow, materials, composites, hydrodynamic, etc. The tool is efficient in predicting the behavior of the components in the manufacturing industry and real-world environments. This software also provides facility to the investigators to employ user-defined functions (UDFs) as per definition of their research problem to its capabilities significantly. Using the skill of this software, one can substantially improve the technical knowledge in various fields.

Course Outcome:

- CO1. Understand** the importance of simulations over the experiment and analytical analysis.
- CO2. Implement** simulated solutions in various practical applications in engineering operations.
- CO3. Develop** real-world prototypes or models which would be useful in several fluid flow, heat transfer, design processes.
- CO4. Estimate** temperature and velocity distribution in heat transfer and fluid flow phenomena.
- CO5. Discuss** the innovative findings observed in the simulated results of engineering problems.
- CO6. Evaluate the** Free vibration of truss using ANSYS.

Course Contents:

1. Fundamental understanding of introduction to advantages of simulation over the experiment and analytical analysis. Basic steps to operate the ANSYS commercial software. Downloading and Installing ANSYS Student
2. Modelling of laminar flow through pipe. Analysis can be carried out for different Reynolds numbers.
3. Modelling of fluid flow and heat transfer analysis through a heated pipe with constant wall temperature.
4. Study of heat transfer and fluid flow around a cylinder within the rectangular cavity. Lumped heat capacitance model.
5. Flow and heat transfer from heat sink using Ansys.
6. Stress and deformation analysis of truss using Ansys.
7. Stress and deformation analysis of cantilever beam using Ansys.
8. Static stress analysis of one dimensional (1D) simply supported beams using Ansys.
9. Free vibration analysis of truss using Ansys.
10. Exercise problems based on the learning of this elective.

Text/ Referred books:

Stolarski, T., Nakasone, Y. and Yoshimoto, S., 2018. Engineering analysis with ANSYS software. Butterworth-Heinemann.

Development of Autonomous Wheeled Robots

Course Code	ME28017
Course Title	Development of Autonomous Wheeled Robots
Number of Credits	0-0-2-1
Course Type	Vocational Elective

Course Objective:

Nowadays, robotics is playing a vital role in industry 4.0, and autonomous wheeled robots are being applied to minimize human efforts and to improve the production rate. This course gives fundamental knowledge about wheeled robotics and its different hardware and software components. Moreover, the subject discusses kinematics equations, which will be implemented to control the motion of wheeled robots through the actuators. Further, the present course also describes the integration of various sensors and their programming, which will be used to make an autonomous control system for a robot.

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

- CO1:** Understand the fundamentals of wheeled robotics and its different components.
- CO2:** Apply locomotion constraint features to travel the wheeled robots in different surface conditions.
- CO3:** Apply various sensors integration on wheeled robots for autonomous navigation.
- CO4:** Analyze the kinematics of wheeled robots.
- CO5:** Create a robot programming to make an autonomous sensor-actuator control system.
- CO6:** Design of automation solutions using wheeled robots.

Course Contents:

1. About Locomotion for Wheeled Robot:

Key issues for locomotion, wheeled mobile robot's locomotion, Legged wheeled robots.

2. Wheeled Robots Kinematics:

Kinematic models and constraints, Representing robot position, Forward kinematic models, Wheel kinematic constraints, Degree of freedom.

3. Sensors for Autonomous Wheeled Robots:

Various sensors for wheeled robots, Sensor classification, Ultrasonic sensor, Infrared sensor, Vision sensor, Inertial measurement unit (IMU).

4. Actuators for Autonomous Wheeled Robots:

Various actuators for wheeled robots, DC motor, Servo motor, Stepper motor, Motor controller.

5. Wheeled Robots Programming:

Robot programming language features, Computer control and robot software (monitor mode, run mode and editor mode), Arduino microcontroller programming, Raspberry Pi programming, Complete design of an autonomous wheeled robot.

Reference Books:

1. R. Siegwart, I.R. Nourbakhsh, D. Scaramuzza, Introduction to Autonomous Mobile Robots, MIT Press, 2011.
2. S.G. Tzafestas, Introduction to Mobile Robot Control, Elsevier Science, 2013.
3. G. Dudek, M. Jenkin, Computational Principles of Mobile Robotics, Cambridge University Press, 2010.
4. T. Bräunl, Embedded Robotics Mobile Robot Design and Applications with Embedded Systems, Springer Berlin Heidelberg, 2013.
5. U. Nehmzow, Mobile Robotics A Practical Introduction, Springer London, 2012.

3D CAD Design using Solid Works

Course code	: ME28019
Course Title	: 3D-CAD Design using Solid Works
Number of Credits	: 0-0-2-1
Course Type	: Vocational Elective

Course Objective:

To provide basic knowledge in the area of 3D modelling using CAD tools. The program covers essential aspects of creating 3D models, assemblies, and drawings using SolidWorks.

Course Outcome:

After going through the course, the students will be able to

- CO1:** Navigate the SolidWorks interface adeptly, efficiently utilizing tools and commands for 3D modelling, assembly, and drawing generation.
- CO2:** Demonstrate proficiency in transforming 2D sketches into accurate and detailed 3D models, applying dimensions, constraints, and geometric relationships effectively.
- CO3:** Showcase competence in assembling components, applying constraints, and simulating assemblies to ensure functionality and structural integrity within SolidWorks.
- CO4:** Generate precise and comprehensive 2D drawings from their 3D models, incorporating industry-standard annotations, dimensions, and detailing practices effectively.
- CO5:** Showcase advanced assembly skills, including top-down assembly approaches, subassembly creation, aesthetic enhancements, and rendering for realistic visualizations.
- CO6:** Apply their acquired SolidWorks knowledge and skills to practical projects, conceptualizing, designing, and presenting fully realized models that demonstrate proficiency in real-world design scenarios.

Course Descriptions:

Module-1

Basic Features of Solidworks

- About Solidworks
- Brief description of Solidworks User Interface
- Mouse Functions

Module -2

Basic Features of Part Modelling

- Invoking & Setting the Sketcher Workbench
- Understanding Sketcher Terms
- Drawing Sketches Using Sketcher Tools
- Drawing Display Tools
- Concept of Constraints & Applying Geometrical Constraints
- Other Sketching Tools
- Editing & Modifying Sketches
- Mirror Operation in Sketch
- Creation of different types of Patterns
- Scale up or Scale down of a sketch

- Projection of 3D body on a 2D sketch plane

Module -3

Sketches Based Features

- Extrude Features
- Cut Features
- Draft Features
- Reference Elements: Reference Plane, Reference Point, Reference Line
- Projection of 3D Elements on a Plane
- Dynamically Rotating the View of the Model using Rotate Tool, Compass
- Modifying the View Orientation & Display Modes of the Model
- Assigning a Material to the Model & Measuring Weight
- Revolving Features: Shaft, Groove

Module -4

Dress-Up and Editing Features

- Advanced Modelling Tools: Hole, Fillet, Chamfer, Draft, Shell Feature
- Editing the Sketch of a Sketch Based Feature, Redefining the Sketch Plane
- Managing Features & Sketches Using Cut, Copy, Paste & Delete
- Understanding the Parent Child Relationships
- Evaluate: Mass properties , Measuring between Elements

Module -5

Advanced Part Modelling

- Creating Equation based model.
- Mirroring Features & Bodies
- Patterns: Rectangular Patterns, Circular Patterns
- Inserting a new body & Inserting Features in the new body
- Advanced Modeling Tools: Rib, wrap and Intersect.

Module -6

Basic Features of Assembly Modelling

- Types of Assembly Design Approach
- Bottom-Up Assembly: Inserting Components
- Moving & Applying Constraints, Editing Assembly Constraints
- Deleting Components, Replacing Components
- Editing Components Inside an Assembly
- Sectioning & Exploding an Assembly

Module -7

Advance Assembly Modelling

- Creating Base Part in the Top-Down Assembly
- Creating Subsequent Component in the Top-Down Assembly
- Creating Subassemblies in the Top-Down Assembly
- Provide natural look to a model

- Final Rendering of a Model

Module -8

Motion Study

- Introduction to Motion Study & Motion Study Properties
- Introduction to Motors
- Use of Rotary Motors
- Use of Linear Motors (Linear Actuators)

Module -9

SolidWorks Drawing

- Introduction to Interactive Drafting
- Type of Views, Generating Drawing Views, Generating the Exploded View

Reference Book:

1. Amit Bhatt, SolidWorks 2023 - Step-By-Step Guide: Part, Assembly, Drawings, Sheet Metal, & Surfacing, CADFolks publisher, 6th Edition
2. Dassault Systemes SolidWorks Corporation (2020-2021), Fundamentals of 3D Design and Simulation.

System Thinking

Course Code	ME28021
Course Title	System Thinking
Number of Credits	0-0-2 1
Course Type	Vocational Elective

Course Objectives

Problems in real life originate because of interactions of multiple entities in multiple ways. In order to conceptualize such problems, it is necessary to identify the entities, build up the most plausible links between them, and think systemically to locate the root cause of the problems. System mapping, system modelling, and system simulation help to strengthen the thinking process and to suggest solutions to the problems.

The objective of this laboratory-based vocational course is to let the students use the vast opportunity that the human mind offers to logically map the mental images into simple diagrams to conceptualize real-life problems and offer plausible solutions. The course will also allow the students to consider diverse socio-economic, environmental, engineering, and management problems, build representative dynamic models, and simulate them using dynamic simulation software platforms.

Course Outcomes

After going through the course, the students will be able to

CO1: Conceptualize real-life problems in terms of the related entities and their interrelationships.

CO2: Develop diagrammatic tools to represent systemic relationships and build models.

CO3: Make qualitative simulation and prognosticate likely behaviour under varying circumstances.

CO4: Build dynamic models using concepts of stocks, physical and information flows, delays, and table functions.

CO5: Use systems thinking software packages to simulate the built models and evaluate the effects of structural and policy interventions.

CO6: Design structural and policy interventions to ameliorate the effects of the problems.

Course Contents:

Module 1—Problem conceptualization: Key Variables, Reference Mode, Causal-Loop Diagrams, System Archetypes, Qualitative Simulation.

Module 2—Model Building: Stock-Flow Diagrams, Physical and Information Delays, Nonlinearities, and Parameter Estimation.

Module 3—Model Simulation and Evaluation: VENSIM and STELLA software packages, Continuous Simulation, Sensitivity Analysis, and Validation Tests.

Module 4—Structural and Policy Tests, Policy Evaluation, and Recommended Intervention.

Module 5—Interfacing Built Models with External Data, Controls, and Games.

Textbook

Richmond, B. (2004), An Introduction to Systems Thinking with STELLA, ISEE Systems, Inc. ISBN-13 : 978-0970492111