ME808 **Robotics for Solar Energy** **3-0-1 4**

Course Objective:

The course is intended to teach the basic concepts of solar energy tracking systems. Concepts covered include the types of solar energy collections systems, types, need and applications of tracking systems, robotic methods of implementation, and the kinematics, and inverse kinematics necessary to solve more complex tracking system problems. The lab exercises will help the students understand how to apply robotic control system elements and how to solve forward and inverse kinematics problems for solar energy tracking systems.

Course Outcomes:

CO1 : Understand the various types of concentrating and non-concentrating solar energy systems

CO2 : Understand the need for tracking systems in solar energy systems and their correct application

CO3 : Ability to apply robotic control systems to solar energy tracking systems

CO4 : Ability to apply inverse kinematics to heliostats, including a dual-linear actuator pitch-roll heliostat

Modules:

Introduction: Solar Energy Basics and History

Solar Energy: Types of solar energy collection systems, photovoltaic, thermal, non-concentrating vs. concentrating, 2D and 3D concentration

Tracking Systems: Need for solar tracking systems, types of tracking systems, heliostat types, and evaluation of impact of tracking systems

Controls: Actuators and sensors used in solar energy tracking systems: rotary and linear actuators and position sensors, solar sensors, optical and camera based systems, Solar Position Algorithms (SPA), hybrid tracking approaches, control systems and controllers

Lab: Working with various kinds of actuators: stepper, DC servo and AC motors, linear actuators, sensors: encoders, tachometers, proximity and distance measuring sensors and vision

Robotics and Kinematics: Introduction, general mathematical preliminaries on vectors & matrices, direct kinematics problem, geometry based direct kinematics problem, robotic manipulator joint coordinate system, Euler angle & Euler transformations, roll pitch-yaw (RPY) transformation, Denavit–Hartenberg (DH) representation & displacement matrices for standard configurations

Lab: Software simulation of manipulators and hardware experimentation

Textbooks/References:

1. John J. Craig, “Introduction to Robotics: Mechanics and Control”, Pearson Education, 2008

2. W.B. Stine, R.W. Harrigan, “Solar Energy Systems Design", John Wiley and Sons, Inc., 1986

3. "Power from the Sun", https://www.powerfromthesun.net, William Stine and Michael Geyer, 2021

4. Perlin, John, “Let It Shine: The 6,000 Year Story of Solar Energy”, New World Library, 2013

Prerequisites:

Linear algebra / vector algebra, basic calculus, Matlab programming or similar

Pedagogy:

Learn relevant concepts from the reference books for solving the inverse kinematics of a dual linear actuator pitch/roll heliostat. Apply concepts and solutions in Matlab simulation. Write research paper illustrating solution and analysis, showing validation and hardware prototype built.

Evaluation Pattern:

100% - Scopus indexed paper publication

Activities/Content with direct bearing on Employability/Entrepreneurship/Skill development:

Practical application of robotics and kinematics to solve a real world hardware/controls problem in the field of solar energy.