2016 - 2017 FALL SEMESTER
MECE 407 INNOVATIVE ENGINEERING ANALYSIS AND DESIGN
PROJECT TOPICS

1- Design, construction and control of a cart-inverted pendulum control system:

- There will be a cart and an inverted pendulum mounted on the cart that rotates freely 360 degrees
- The cart will move over a rail (dimensions of the real will be at most 1.20 meter)
- The maximum pendulum length will be 40 cm.
- The weight of the cart will be 2 kg at most- The pendulum will be controlled on crane mode and inverted pendulum mode.
- Two sensors will be used to detect the cart position and pendulum angle for the control purpose.
- A motor will actuate the cart, the motor can be replaced in any place on the system depending on the design specifications.
- Monitoring the variables related with the system can be done using MATLAB or LABVIEW.
- Any microcontroller can be used.
- The intention in this project is manufacturing the system, modelling the system mathematically, and controlling it in inverted pendulum and crane mode.

2- Design, construction and control of a heat transfer system:

- The basic materials that will be used to manufacture this system are: a tube (it can be made of any material and the length will be at most 1 meter) with insulation, temperature sensors (can measure heats between -10 and 100 degrees),a fan (to flow air to the tube), heating coil (will be mounted just in the opening of the tube), a motor (to move the fan), extra circuitry to convert and use AC to DC and use it heat the heating coil, any microprocessor.
- Operation principle: The heating coil and the fan mounted just to the opening of the coil will be controlled due to the information gained from temperature sensors mounted inside the tube at different locations (some can be just close to the openings and some can be just anywhere inside the tube. The temperature information will be processed in a microprocessor and the microprocessor will produce two control signals (one for the fan and one for the circuitry that energize the heating coil).
- Task: Construction, Modelling and control of this control system

- Basic control applications: to keep the temperature constant at some point inside the tube depending on temperature measurements, to change the temperature to another set points, opening some holes over the tube as external disturbances and controlling.

3- Design, construction and control of a 2 tank water circulation system:

- The system is constructed but it is not modelled.
- This system has two motors: the first motor pumps the water inside the reservoir to the first tank and the second motor pumps the water from the first tank to the second tank.
- There are two pressure sensors at the bottom of the tanks that measures the water level.
- These water levels will be processed by a microcontroller with the help of extra circuitry and control signals will be given to the pumps for control and modelling operations.
- Modelling and control operations: by giving some control signals, the approximate linearized mathematical model of the system will be obtained. After modelling, some water level control tasks will be carried out such as set point tracking. There are also valves to let excessive water in the tanks to flow to the reservoir. These valves will be used as disturbances. The performance of the algorithm implemented on the microcontroller to control the water levels will be also tested in case of these disturbances.

4- Design, Manufacture And Implementation of A Mini Size Tension Test Equipment:

-max force 500 kg,
-hydraulic or trapezoidal thread actuated,
-on-line force measurement with stain gages or load cells,
-on-line displacement measurement,
-all data should be transfered on-line to a computer,
-on-line plot of the engineering stress. vs. strain variation,
-necessary programmes (embedded or the ones to be run at the computer side) should be prepared to calculate stress, strain, deflection, area change of the specimen
-all the necessary sensors and the actuators will be selected and mounted by the project members
- thread actuted power system equiped with gear box(es) could be used for the sake of simplicity and economy,
-tension tests should be performed using small size/diameter samples made of steel, copper, polimer and composites.

5- Assemble Of Small Mechanical Parts By An Industrial Robot Using An Image Processing Technique:

- the industrial robot available in the lab will be used (or the ones available -completed projects could also be used if we oblige to)
- the mechanical parts will be placed randomly (in a mixed order) in front of the robot
- a camera will be used to identify the mechanical parts (bolts, nuts, washers, pins, cores, etc)
- the suitable image processing strategy will be determined/selected by the group members after the literature survey,
- the mechanical parts will have a suitable size and geometry for easy gripping by the robot.
- mechanical parts will be mounted/assembled to a prepared steel block (the block will be machined in the workshop of the faculty),
- if the students will have a great progress at this project topic in a short while, the mechanical parts may be placed randomly on a slowly moving conveyor band.

6- Design, Implementation and Test of Autonomous Vehicles: Lane Following and Platooning:

The intention of the project is to design a small experimental vehicle platform that can perform different autonomous tasks: the vehicle can follow a road on its own (lane following); the vehicle can follow another vehicle with the same speed at a given safety distance (platooning). Such system contains various mechatronic system components:

- There will a vehicle platform,

- Actuation will be performed by DC motors

- The vehicles will communicate via a wireless technology

- The vehicles will be able to follow a line using infrared sensors,

- Each vehicle will be able to follow its predecessor vehicle at a given distance/speed using distance sensors and acceleration sensors

- Each vehicle will be able to perform pre-defined maneuvers (accelerate/decelerate) and additional maneuvers by remote control

- A microcontroller or single-board computer will be used for computations,

- At least two such vehicles should be realized for test purposes

- The project comprises mechanical design of the vehicle platform, selection of suitable sensors, design of the electrical circuitry, controller design and microcontroller programming.

7- Development of micro machining 3D laser printer:

In this project our aim is implementing a 3D laser printer for micro machining applications. This gadget will exhibit some attributes such as portability, compactness and re-configurability based on optical design. A programmable spatial Light Modulator (SLM) will be used to manipulate the collimated light. This structured light then will be directed onto a special mixture (Photo sensitive resin) by a relay optical system for molding operation. Technical specifications of the Project outcome: Transmitter and receiver units will include different types of LED's and/or laser diodes, lenses, mirrors and collimation units. SLM will be coupled to this designed optical system. Optical detectors such as CMOS or CCD will be used to collect information for real time molding operation. All operations (post processing, molding, drilling, etc.) will be controlled by a Labview Programming Language.

8 - Design, construction and control of a DC motor speed control system:

There will be A DC motor which is energized by a DC power supply. This DC power supply will be controlled by a controller. Due to the control process the DC motor will be able to run at different desired speeds and it will have the ability to track some reference speed signal. To get information from the DC motor speed and position sensors should be used. Last step for this process is to perform a system identification process and obtain an approximate linear model for the system.

-For this project the following materials will be necessary: DC power supply, controller, a suitable DC motor (the specifications will be determined later in the project) extra circuitry functioning as an interface between the power supply, the controller and the DC motor, sorts of position or angular velocity measuring sensors.

-For visual interface and data acquisition, LABWİEV or MATLAB or any other suitable program can be used.

9 - Design, construction and control of a DC motor position control system:

There will be A DC motor which is energized by a DC power supply. This DC power supply will be controlled by a controller. Due to the control process the DC motor will be

able to track different angular positions reference signals. To get information from the DC motor, speed and position sensors should be used. Last step for this process is to perform a system identification process and obtain an approximate linear model for the system.

-For this project the following materials will be necessary: DC power supply, controller, a suitable DC motor (the specifications will be determined later in the project) extra circuitry functioning as an interface between the power supply, the controller and the DC motor, sorts of position or angular velocity measuring sensors.

-For visual interface and data acquisition, LABWİEV or MATLAB or any other suitable program can be used.