

**Proposal for
Final Year Project 2007/2008
School of Electrical and Electronic Engineering
USM**

Lecturer: En. Muhammad Nasiruddin bin Mahyuddin
Domain of project: *Mechatronics*

Project	Project Title/Synopsys	Pre-requisite/ Special Requirement
1	<p>Title:</p> <p><i>Underwater system:</i> The development of mini-submersible autonomous underwater vehicle (mini AUV).</p> <p>Synopsys:</p> <p>This project involves the design of small sized autonomous underwater vehicle which will be equipped with control system to control the sinking and rising motion of the vehicle in the water. The principle of submarine will be applied here. The mini AUV will be made to sink at certain depth predetermined by the user and required to control the depth of the sinking over certain period of time. The transient response of the sinking AUV from one depth to another will be observed. Disturbance to the surrounding water condition will be introduced in a form of ripple wave to evaluate its robustness in depth control. As the outcome of the project out of 100%, the student will gain 15% in the mechanical design of the vehicle, 30% in the design of the embedded control system and 30% in the system components integration technique and 25% in control techniques.</p>	<p>Control system design, mechatronic system design, Basic physics: the study of principle of buoyancy.</p>

2	<p>Title:</p> <p><i>Underwater system: Yaw control of partially submerged (positive buoyant) mini water-vehicle (mini AUV).</i></p> <p>Synopsys:</p> <p>This project deals with the design of partially submerged small sized water vehicle that is able to navigate autonomously in an environment and at the same time avoids the surrounding obstacle. The mini AUV will remain at positive buoyancy thereby, floating just beneath the water surface. In this project, the sinking or depth control is not of concern. Instead, the student is required to design the system onboard that houses the embedded control system and the sensors required for obstacle avoidance mission. The mini AUV will simply avoids the adjacent/surrounding obstacle by means of reading from the sensors (laser, ultrasound, IR) and the information feedback to the microcontroller will determine the next move of the mini AUV in maintaining the navigation whilst successful avoids contact. The transient response performance of the mini AUV will be observed during the course of developing it. As the outcome of the project out of 100%, the student will gain 15% in the mechanical design of the vehicle, 30% in the design of the embedded control system and 30% in the system components integration technique and 25% in control techniques.</p>	<p>Control system design, mechatronic system design, Basic physics: the study of principle of buoyancy.</p>
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3	<p>Title:</p> <p><i>Underwater system:</i> The development of Magneto-rheological fluid (MR fluid) linear damper for future underwater robot manipulator application.</p> <p>Synopsys:</p> <p>This project focuses on the relatively new field of actuator development. The project involves the development of Magneto-rheological fluid (MR fluid) based linear damper that is potentially be used in future underwater robot manipulator application. The composition of MR fluid is a suspension of micro-meter magnetic particle in carrier fluid usually lubricant oil. Importantly, the yield stress of the fluid when in its ‘excited’ state can be controlled very accurately (using any control system scheme) by varying the magnetic field intensity. The fluid's ability to transmit force can be controlled with an electromagnet, which gives rise to its many potential control-based applications. The MR fluid can be regarded as smart fluid of which engineer can leverage its special characteristic in many fields. It is able contribute added value to pneumatic actuator used in robots by providing precise linear position control. As the outcome of the project out of 100%, the student will gain 35% in the mechanical design of the MR linear damper, 20% in the design of the embedded control system and 30% in the system components integration technique and 15% in control techniques.</p>	<p>Control system design, mechatronic system design, Theory of electromagnets and a study on the MR fluid is helpful.</p>
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4	<p>Title:</p> <p><i>Underwater system:</i> The development of MR fluid based rotary braking system for future underwater robot manipulator application.</p> <p>Synopsys:</p> <p>This project's scope is same as project no. 3. The only difference is that the student in this project will deal with rotary motion instead of linear. The rotary pneumatic actuator will be coupled with the developed MR rotary brake to enable for precise position and velocity control. As the outcome of the project out of 100%, the student will gain 35% in the mechanical design of the MR rotary damper, 20% in the design of the embedded control system and 30% in the system components integration technique and 15% in control techniques.</p>	<p>Control system design, mechatronic system design, Theory of electromagnets and a study on the MR fluid is helpful.</p>
5	<p>Title:</p> <p><i>Sensor development:</i> Precision Motion Control of a mobile robot with self-made incremental encoder (using Hamamatsu sensor module).</p> <p>Synopsys:</p> <p>This project will focus on the sensor development of the incremental encoder. The student will learn the principle of the incremental encoder as the rotary sensor in many mechatronics and robotic application. The student will utilize the use of Hamamatsu module to develop his/her own incremental encoder, thereby customizing our own sensor resolution for desired application. The student will need to use the ready-made mobile robot that is operated by PIC microcontroller as a test bed. The self-made encoder will be installed in the mobile robot and served as motion control feedback for navigation. As the outcome of the project out of 100%, the student will gain 45% in the mechanical design of mobile robot integrated with self-made incremental encoder and 30% in the motion control system integration technique and 25% in precision control techniques.</p>	<p>Control system design, mechatronic system design, sensor and instrumentation as well as knowledge on PIC Basic system is required.</p>

6	<p>Title:</p> <p><i>Mobile robot: BioInspired neural controller for a mobile robot navigation.</i></p> <p>Synopsys:</p> <p>This project involves the study of a bio-inspired neural controller used to govern a mobile robot. The network's architecture is based on the understanding that neurophysiologists have obtained on the nervous system of some simple animals, like arthropods or invertebrates. The neuronal model mimics the behavior of the natural cells present in the animal, and elaborates the continuous signals coming from the robot's sensors. The output generated by the controller, after scaling, commands the wheel rotation and therefore the robot's linear and angular velocity. The mobile robot, thanks to the controller, presents different behaviors, like reaching a sonorous source and avoiding obstacles. In order to test the control strategy and the neural architecture, Matlab simulation was implemented. As the outcome of the project out of 100%, the student will gain 60% in the neural network algorithm and 40% in Matlab simulation.</p>	Control system design, mechatronic system design, knowledge on Artificial Intelligence and Matlab usage is helpful.
7	<p>Title:</p> <p><i>Mobile robot: Genetic programming of obstacle avoidance wireless mobile robot using OOPIC microcontroller.</i></p> <p>Synopsys:</p> <p>This project focuses on the development of a mobile robot that will be controlled by OOPIC microcontroller. Genetic programming will be used as means of control techniques in obstacle avoidance. The genetic programming will be used to evolve the obstacle avoidance program in the microcontroller. The mobile robot is also required to be controlled remotely by means of Bluetooth. As the outcome of the project out of 100%, the student will gain 55% in the genetic programming algorithm for obstacle avoidance, 30% in the mobile robot fabrication and 15% in wireless hardware integration.</p>	Control system design, mechatronic system design, knowledge on artificial intelligence and robotics would do a help.

8	<p>Title:</p> <p><i>Mobile robot: The development of two-wheel balancing robot.</i></p> <p>Synopsys:</p> <p>The uniqueness of the inverted pendulum system has drawn interest from many researches due to the unstable nature of the system. The idea of a mobile inverted pendulum robot has surfaced in recent years and has attracted interest from control system researchers worldwide. A two-wheeled differential drive mobile robot based on the inverted pendulum model is to be built as a platform. As the robot is mechanically unstable, it becomes necessary to explore the possibilities of implementing a control system to keep the system in equilibrium. The student is required to build the two-wheel balancing robot and implements the given Kalman filter in a weight matrix and the given tuned PID controller to balance the robot in equilibrium. As the outcome of the project out of 100%, the student will gain 45% in the mechatronic development of two-wheel balancing robot, 10% in the kalman filter implementation and 45% in control techniques.</p>	<p>Control system design, mechatronic system design, knowledge on microcontroller and robotics design would help.</p>
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9	<p>Title:</p> <p><i>Embedded system on robot: FPGA hardware implementation of neural Networks algorithm for mobile robot autonomous navigation.</i></p> <p>Synopsys:</p> <p>This project focuses on the hardware implementation of a fully digital and fully interconnected feed forward backpropagation artificial neural network using FPGA. The neural networks algorithm is the algorithm which is used for mobile robot autonomous navigation, specifically in controlling the tracking behaviour of an autonomous mobile robot. The network consists of an input layer with five nodes, a single hidden layer with four nodes and output layer with two nodes. These nodes are fully interconnected to each other between adjacent layers. In actual application, the input data are provided by a set of ultrasonic sensor mounted at the front of vehicle. As the outcome of the project out of 100%, the student will gain 65% in the FPGA hardware implementation of neural network algorithm, 25% in algorithm testing.</p>	<p>Knowledge on embedded system, FPGA, neural networks are required.</p>
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10	<p>Title:</p> <p><i>Intelligent control:</i> Fuzzy Logic control on controlling the elevation of Magnetic ball suspension system. The underlying principle of mag-lev train.</p> <p>Synopsis:</p> <p>Magnetic levitation is becomingly widely applicable in magnetic bearings, high speed ground transportation, vibration isolation. Magnetic bearings support radial and thrust loads in rotating machinery. In addition, magnetic suspension generates levitation action in rectilinear motion devices such as high-speed ground transportation systems. Magnetic levitation is immensely beneficial in rotary and rectilinear devices as it yields a non-contact support, without lubrication, thus eliminating friction. In this project, a magnetic ball suspension system is to be constructed whereby it is used to levitate a steel ball in air by the electromagnetic force by an electromagnet. The ‘maglev’ system consists of an electromagnet, a ball rest, a ball position sensor and a steel ball. As the outcome of the project out of 100%, the student will gain 45% in the development of Maglev system, 35% in fuzzy logic algorithm and 20% in control techniques.</p>	<p>Knowledge on the principles of electromagnet, control system and fuzzy logic are to be learnt.</p>
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11	<p>Title:</p> <p><i>Intelligent control:</i> Fuzzy logic control of a fan&plate control apparatus using PIC microcontroller and Brushless DC motor.</p> <p>Synopsys:</p> <p>The apparatus will have rich dynamics, suitable to evaluate modern advanced digital controllers. The angle orientation of the hinged plate is controlled by blowing air stream on to it by dc motor fan. The angular position of the hinged plate is measured by low friction potentiometer. The fuzzy logic controller algorithm will be programmed inside the PIC microcontroller which will control the variable speed of the fan, thereby controlling the stream of air blowing against the plate. The actuator for the system will be a BLDC ((brushles DC motor).</p> <p>Once the project is finished, prior to the fuzzy logic controller implementation, the system will be characterized into various dynamical elements (fan time constant, air transport lag, disturbance from air turbulence and non-minimum phase). As the outcome of the project out of 100%, the student will gain 45% in the development of fan&plate apparatus, 25% in fuzzy logic algorithm and 30% in interfacing technique with PIC microcontroller.</p>	<p><i>Control system, Digital Control system, Control System Design would do a help.</i></p>
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12	<p>Title:</p> <p><i>Intelligent control:</i> Fuzzy logic control of a fan&plate control apparatus using computer controlled system and Brushless DC motor.</p> <p>Synopsys:</p> <p>The apparatus will have rich dynamics, suitable to evaluate modern advanced digital controllers. The angle orientation of the hinged plate is controlled by blowing air stream onto it by BLDC ((brushless DC motor). The angular position of the hinged plate is measured by low friction potentiometer. The fuzzy logic controller algorithm will be programmed via software in the PC and the variable speed of the fan is to be controlled. This will in turn control the stream of air blowing against the plate of which the angle position of the plate is controlled. Once the project is finished, prior to the fuzzy logic controller implementation, the system will be characterized into various dynamical elements(fan time constant, air transport lag, disturbance from air turbulence and non-minimum phase). As the outcome of the project out of 100%, the student will gain 45% in the development of fan&plate apparatus, 35% in fuzzy logic algorithm and 20% in control techniques. As the outcome of the project out of 100%, the student will gain 45% in the development of fan&plate apparatus, 25% in fuzzy logic algorithm and 30% in interfacing technique with computer controlled system.</p>	<p><i>Control system, Digital Control system, Control System Design would do a help.</i></p>
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13	<p>Title:</p> <p><i>Mechatronic:</i> The development of rotary inverted pendulum for control system application.</p> <p>Synopsys:</p> <p>This project involves the development of rotary inverted pendulum system that serves as a teaching tool for modern control system subject in undergraduate course or in postgraduate level. The new design introduced permits minimal usage of work space in the laboratory. Once finished, the system will be used by the students to study single loop or multiloop control PID (undergraduate students), state feedback or state observer, fuzzy logic and neural networks control (postgraduate students).</p> <ul style="list-style-type: none"> • The industrial application perspective: The completed system will be used to simulate the real-life crane dynamics(eventually controlling the swinging) at construction site or at the ship dock yard. • The inverted pendulum is the fundamental to the control problem of the two-wheel balancing robot. <p>As the outcome of the project out of 100%, the student will gain 75% in the development of rotary inverted pendulum system, 25% in fuzzy logic algorithm and 30% in interfacing technique with PIC microcontroller.</p>	<p><i>Control system, Digital Control system, Control System Design would do a help.</i></p>

<p>14</p>	<p>Title:</p> <p><i>Mechatronic:</i> The Development of basic computer controlled system to control 5 DOF robot manipulator (robot mentor in the lab is utilized).</p> <p>Synopsys:</p> <p>This project focuses on the development of a computer controlled system which will be interfaced with the existing MENTOR robot in mechatronic lab. The MENTOR robot is a 5 DOF manipulator robot that is actuated by a servo motor and the angular position for each joint is read by a potentiometer coupled to the servo motor. The student is required to design and develop an interface circuit between a PC and the MENTOR robot so that it can be controlled via software or HMI (human-machine interface) device. As the outcome of the project out of 100%, the student will gain 65% in the development of mechatronic system integration technique (signal conditioning, ADC and DAC board) and 25% in software.</p>	<p><i>Control system, Digital control system, Control System Design would do a help.</i></p>
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