

**ENGR 4412 Senior Engineering Design I // Fall 2004
Senior Design Projects**

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PROJECT #WC1 – Thermal Properties of Biomaterials

PROJECT #WC2 – Monte Carlo Simulation of Laser-Tissue Interaction

PROJECT #WC3 – Laser Applications in Medicine

PROJECT #WC4 – Laser Cancer Treatment

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PROJECT #BJ1 – Construction of a Mode Converter for a He-Ne Laser

The project involves construction of a mode converter for transforming Hermite-Gaussian modes, from an open cavity He-Ne laser containing an etalon, into Laguerre-Gaussian modes. To analyze the orbital angular momentum associated with these modes, the mode converter will be incorporated into a Mach-Zehander interferometer.

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PROJECT #EL1 – Computer Simulation of Flow in Porous Media

This project involves modifying an existing code written at Oklahoma University that models flow in porous media as flow through a randomly generated pipe network. Need to have an interest (and preferably a course) in fluid mechanics and experience with C/C++ programming.

PROJECT #EL2 – Experimental Apparatus to Measure Pipe Friction, Minor Losses, and Flow through Piping Networks

This project will involve designing, constructing, and testing an apparatus that will measure flow rates through pipes of various sizes and construction material, through common piping elements (i.e. valves, elbows, reductions, etc.), and through a network of pipes. The focus of the apparatus will be computer data acquisition of pressures and flow rates at low cost.

PROJECT #EL3 – Experimental Apparatus to Measure Temperature Distributions in Various Solid Geometries with Arbitrary Boundary Conditions

This project involves design, construction, and testing of an apparatus that allows students to expose rectangular, cylindrical, and spherical geometries to any combination of boundary conditions including constant temperature, constant heat flux, and insulated. The basic idea of this project is to embed bare thermocouples into a liquid that hardens. The mold, once frozen, may be exposed to the boundary conditions listed above as temperatures are monitored and recorded using computer data acquisition.

PROJECT #EL4 – Experimental Apparatus to Measure and Observe Flow in Flow Reduction Meters

This project involves modifying an existing flow system to measure the pressure

drop through nozzles, orifice plates, or other flow reducers and to employ LabView hardware/software to obtain pressure drops and measured flow rates for the system.

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PROJECT #DM1 – Flow Visualization of Rotating Fluids

We are interested in getting useful flow visualization information for a vertically spinning fluid. Initial investigations should probably focus on the long time or solid body rotation times. Students would investigate what materials we have on hand that would work best in this case and perhaps go from there. We could certainly try immiscible fluids doped with iodine for color. We have a number of dyes, including some that may luminesce. We also have lycodium powder.

Students in senior design probably have all of the mathematical preparation they need. Some capability with chemicals and mixing solutions is warranted, but this is probably not an over-demanding requirement. If the flow-visualization works out OK we would probably want to model some of the flow lines.

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PROJECT #MS1 – Three-Dimensional Finite Element Modeling of a Proximal Femoral arthroplasty Using Solid Works®

The objective of this project is to generate a three dimensional model representing cortical bone for proximal femurs while undergoing a cement-based total hip arthroplasty.

Total hip arthroplasty is one of the most successful and frequently performed surgical procedures. Developed in the 1960s and early 1970s by Sir John Charnley, Austin Moore, and others, hundreds of thousands of patients have obtained relief from crippling arthritis and have avoided the significant morbidity and mortality associated with hip fractures.

PROJECT #MS2 – Investigation and Design of a Micro Turbines for industrial design using Solid Works®

Microturbines are a relatively new sort of distributed generation technology being used for stationary energy generation applications. They are a type of combustion turbine that produces both heat and electricity on a relatively small scale. Microturbines offer several potential advantages compared to other technologies for small-scale power generation, including: a small number of moving parts, compact size, lightweight, greater efficiency, lower emissions, lower electricity costs, and opportunities to utilize waste fuels. Waste heat recovery can also be used with these systems to achieve efficiencies greater than 80%.

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PROJECT #WW1 – Photonic Crystal Device Simulation

Photonic crystals are periodic dielectric structures that have a band gap that forbids propagation of a certain frequency range of light. This property enables one to control light with amazing facility and produce effects that are impossible with conventional optics. Photonic crystals are the optical analogue of electron conduction in crystals, can be described exactly using Maxwell's Equations, and solved by computer simulation. (See <http://ab-initio.mit.edu/photons/> and the references therein) The purpose of this project is simulate photonic crystal devices that are the optical analogue of semiconductor devices. This work will involve analytical work and computational work. A good working ability with vector calculus, electromagnetic theory, and computer programming skill is required.

PROJECT #WW2 – Lienard-Wiechert Potentials

In Maxwell's theory, the electromagnetic field of an accelerated charge particle is given in terms of the Lienard-Wiechert potential. Furthermore, the energy flux radiated is found as proportional to the acceleration of the charge. The purpose of the project is to give a geometrical explanation of the phenomena. By the use of the geometrical tools, it is also intended to find the Lienard-Wiechert potentials in higher dimensions. This work will involve mostly analytical work and a good working ability with vector calculus and classical electromagnetic theory.

PROJECT #WW3 – Ritz Emission Theory of Electrodynamics

In the Ritz emission theory of electrodynamics, the electromagnetic field of an accelerated charge particle can be given in terms of a Lienard-Wiechert-like potential. Using these potentials, the energy flux radiated from an accelerated charge can then be calculated in the Ritz theory. The purpose of this project is to perform this calculation and compare to the standard theory. This work will involve mostly analytical work and a good working ability with vector calculus and classical electromagnetic theory.

PROJECT #WW4 – Origin of Inertia

Mach's principle asserts that the physical origin of all inertial reaction forces is an interaction of the object with chiefly the most distant matter in the universe. (Inertial reaction forces are those things that push back on you when you push on stuff.) Radiation reaction forces are experienced by charged objects as they "launch" energy in the form of radiation when they are accelerated by external forces. (These are recoil forces, like those experienced when "launching" bullets out of a gun in your hand.) When examined, the origin of inertia and radiation reaction turn out to have some very strange consequences, notwithstanding that no "new physics" is involved. (See <http://chaos.fullerton.edu/~jimw/general/> and links therein) These ideas are explored in this project using linearized gravitation theory. This work will involve mostly analytical work and a good working ability with vector calculus and an interest in gravitational theory.

PROJECT #WW5 – Conversion of 8" Dobsonian Mount Telescope to Automatic Tracking and GOTO Scope

The Department of Physics and Engineering has two 8" Newtonian reflector telescopes with Dobsonian mount. The purpose of this project is to convert one

or both of these to computer-controlled GOTO scopes. (See <http://www.bbastrodesigns.com/cot/cot.html> and the links there.) This project will require work with robotic control of stepper motors and the associated electronics and computer interfacing.

PROJECT #WW6 – Construction of a CCD Camera for Astronomical Imaging with Department's Telescopes

The Department of Physics and Engineering has several 8" telescopes with computer control. The purpose of this project is to build a CCD camera for use with these telescopes using the Texas Instrument CCD chip TC245 or equivalent. (See <http://www.wvi.com/~rberry/cookbook/cookbook.htm> and the links there.) This project will require electronics work with CCD chip and the associated electronics and computer interfacing.

PROJECT #WW7 – Build and Use a Radio Telescope

The purpose of this project is to build a small radio telescope and use it to perform one or more of the following astronomical observations:

1. Monitor Solar Activity Periodicity
2. Radio Map the Plane of the Milky Way
3. Perform Radio Drift Scans of Astronomical Point Sources

(See <http://www.radiosky.com/> and the references there.) This project will require electronics work and the associated computer interfacing.