PROPOSAL 33-04

BS PROGRAM IN ELECTRICAL ENGINEERING, CONCENTRATION IN PHOTONICS

Introduction
This proposal is to create a Concentration under the existing Bachelor of Science in Electrical Engineering to be called "Photonics". Photonics differs from electronics in that photons replace electrons as the conveyor of information. There is clearly demand for optics and photonics education by the population of undergraduate electrical engineering students. However, there is no formalized optics and photonics education program in our geographical region. We propose to fill this void, and simultaneously make a richer offering to our students through implementing a concentration in Photonics Engineering. This program will serve two important goals: (1) it will educate students in an attractive area where there are outstanding career opportunities; and (2) we will create yet another way to distinguish Michigan Tech from other competing universities, helping us meet our goal of becoming a "national university of choice".

Related Programs
There are at least 50 universities in the United States that offer courses in optics and photonics to undergraduate electrical engineering students. Of these, at least 12 offer a BS in Electrical Engineering with "concentration", "emphasis", "option", or "concentration" in optics and/or photonics (Boise State, California Polytechnic, Colorado State, North Dakota State, Oregon State, Princeton, University of Alabama-Huntsville, University of Massachusetts-Lowell, University of Missouri-Rolla, University of New Mexico, University of Pittsburgh, and University of Utah). Additionally, at least eight other universities offer BS degrees in Optical Science, Optical Engineering, Photonics, or Photonics Engineering. In some cases these programs are run from a free-standing Optics or Photonics department, while in other cases they are run from inside another department, most typically a physics department (Rose-Hulman Institute of Technology, Saginaw Valley, St. Cloud State, University of Arizona, University of California-Davis, University of Northern California, University of Rochester, Rochester Institute of Technology). Also, Vanderbilt University has a "curricular focus" on Biomedical Optics run out of its Biomedical Engineering department.

If the on-line data provided by these universities is accurate, the number of undergraduates seeking education in optics and photonics in the United States is on the order of a few tens of thousands nationwide. There are also extremely active optics and photonics education programs in Canada, Australia, England, France, and New Zealand, and in some cases, these international programs benefit from aggressive government efforts to enhance optics and photonics education in these countries. Clearly, there is significant activity both in the United States and internationally in the area of optics and photonics education. These students feed a research and industrial base that will grow due to, for example, demand for higher bandwidth in the "last mile" of computer networks, and ever higher speed optical switching for the physical backbone of the Internet; demand for innovative medical imaging techniques, demand for remote sensing products for environmental and earth resource monitoring; and surveillance needs for homeland security.

Rationale
"Underpinning the explosive growth of optics are investments in *education and research*.

Research continues to lead to extraordinary discoveries. Although the field is growing rapidly and its impact is both pervasive and far-reaching, it remains a "multidiscipline" with components in many university departments and government programs. *The presence of optics in these diverse programs reflects its pervasiveness, but also reveals its Achilles' heel.* Trends and developments in optics can easily be missed in such a disaggregated enterprise. Educational and research organizations will need to pay close attention to ensure that the field develops in a healthy way that ensures continuing benefits to society." (from Harnessing Light, National Research Council Report, National Academy Press, 1998, p4)

"There are only a few formal postgraduate educational programs in optics. In most universities, optics is taught in a wide range of departments; biology, physics, materials science, electrical engineering, computer science, and others; as befits the span of the field's applications. Academic research in optics is no less diverse, and in their diversity, universities have made indispensable contributions to furthering optical technologies. In information technology, for example, academic programs are particularly strong in the basic sciences and the development of device technologies, but weak in the corresponding systems, packaging, and applications areas. Accordingly, universities are relatively ineffective in transferring technologies to U.S. industry and in keeping pace with the needs of newly developing systems." (from Harnessing Light, National Research Council Report, National Academy Press, 1998, p18)

Recent advances in electronic technology have been simply astounding. Performance at a fixed price has doubled every 18 months for almost 50 years. While this trend shows no sign of decline, a maturing light wave, or photonics technology, is causing the widespread proliferation of systems in which photons are replacing electrons. This technology is most striking in the area of wired digital communication, which is increasingly implemented with optical fibers. Other applications of photonics technology which impact the world include medical imaging technology, biometrics, environmental systems which monitor for pollution and warn against chemical and biological attacks, and military, consumer, and commercial imaging and surveillance systems.

Curriculum Design
The curriculum for this program exists already. The undergraduate courses already offered in photonics by the Department of Electrical and Computer Engineering include:

Course 1: Introduction to Photonics (EE2190)

Course 2: Optical Sensing & Imaging (EE3190)

Course 3: Lightwave Devices (EE3291)**Course 4: Optical Communications and Imaging Systems** (Senior level course which will be taught in 2004-2005.)

Course 5: Lasers and Non-Linear Optics (EE4441)

Course 6: Digital Image Processing (EE4254)

Teaching Lab (Junior level course which will be taught in 2004-2005.)

New Course Description
None

Additional Resources Required
None

Planned Implementation Date
Fall 2004

Accreditation Requirements
None

Adopted by Senate: 7 April 2004
Approved by President: 22 April 2004