W-3/9/17

LSC Use Only Proposal No: LSC Action-Date: AP-2/6/14	UWUCC Use Only Proposal No: 13-106 UWUCC Action-Date: AP-3/4/14	Senate Action Date:

Curriculum Proposal Cover Sheet - University-Wide Undergraduate Curriculum Committee

Contact Person(s) **Stan Sobolewski**	Email Address **sobolews@iup.edu**
Proposing Department/Unit **Physics**	Phone **7-4590 or 7-2370**

Check all appropriate lines and complete all information. Use a separate cover sheet for each course proposal and/or program proposal.

1. Course Proposals (check all that apply)

____ New Course ____ Course Prefix Change ____ Course Deletion

X Course Revision ____ Course Number and/or Title Change ____ Catalog Description Change

Current course prefix, number and full title: ***EOPT 150 Fundamentals of Photonics and Laser Safety***

Proposed course prefix, number and full title, if changing:

2. Liberal Studies Course Designations, as appropriate

X This course is also proposed as a Liberal Studies Course (please mark the appropriate categories below)

____ Learning Skills X Knowledge Area ____ Global and Multicultural Awareness ____ Writing Intensive (include W cover sheet)

____ Liberal Studies Elective (please mark the designation(s) that applies – must meet at least one)

____ Global Citizenship ____ Information Literacy ____ Oral Communication

____ Quantitative Reasoning ____ Scientific Literacy ____ Technological Literacy

3. Other Designations, as appropriate

____ Honors College Course ____ Other: (e.g. Women's Studies, Pan African)

4. Program Proposals

____ Catalog Description Change ____ Program Revision ____ Program Title Change ____ New Track

____ New Degree Program ____ New Minor Program ____ Liberal Studies Requirement Changes ____ Other

Current program name:

Proposed program name, if changing:

5. Approvals	Signature	Date
Department Curriculum Committee Chair(s)	[signature]	10/18/2013
Department Chairperson(s)	[signature]	10/18/2013
College Curriculum Committee Chair	[signature]	10/18/2013
College Dean	[signature]	10/21/13
Director of Liberal Studies (as needed)	[signature]	2/7/14
Director of Honors College (as needed)		
Provost (as needed)		
Additional signature (with title) as appropriate		
UWUCC Co-Chairs	Gail Sechrist	3/5/14

1 Curriculum Proposal Cover Sheet (see above)

2. Course Syllabus (New Department Record of syllabus)

I. CATALOG DESCRIPTION

EOPT 150 Fundamentals of Photonics and Laser Safety

3 class hours
0 lab hours
3 credits
(3c-0l-3cr)

Introduces the field of photonics. Acquaints the student with the various concepts associated with the nature of light and lasers. Explores the nature of light and lasers using problem solving techniques and practical current applications. Topics include: nature and property of light, basic geometrical optics, basic physical optics and principles of lasers.

II. COURSE OBJECTIVES

By the end of the semester the student will be able to:
1) demonstrate the nature and properties of light.

EUSLO 1 *Informed Learners* and EUSLO 2 *Empowered Learners*

Rationale: The homework and class assignments will ask students to examine specific phenomena and use the concepts of physics to explain that phenomena. An example is the electromagnetic spectrum. When a student is asked to describe the emission spectrum from a light source, terms such as wavelength and frequency must be used by the student to provide a complete description.

2) construct and position optical systems.

EUSLO 1 *Informed Learners* and EUSLO 2 *Empowered Learners*

Rationale: The course will provide opportunities for the student to classify human eye, camera, microscope, telescope, laser and other optical systems.

3) explain various light sources and safety issues related to these light sources.

EUSLO 1 *Informed Learners* and EUSLO 2 *Empowered Learners and EUSLO 3 Responsible Learners*

Rationale: In this class, students will be presented with different types of light sources, such as nonlaser and laser light sources. The human eye will be examined by the students to avoid various hazards. This will empower the students to apply safety precautions to other types of lasers they may run across during their life. Part of becoming a responsible learner is identifying hazards and dangers in the environment; that is a part of personal responsibility. The ability to relate the dangers of lasers is a characteristic of a responsible learner.

4) describe the basic optics principles of reflection, refraction, interference, diffraction and polarization.

EUSLO 1 *Informed Learners* and EUSLO 2 *Empowered Learners*

Rationale: Modeling optical phenomena mathematically will allow the students to make predictions and estimates. The ability to create graphical mathematical models from which predictions can be made is a characteristic of empowered learners.

5) describe the working principles of lasers.

EUSLO 1 *Informed Learners* and EUSLO 2 *Empowered Learners*

Rationale: Various technological developments in lasers will be discussed, as well as the underlying physics principles. For example, a variety of lasers such as gas, solid state, semiconductor lasers will be discussed. Students will learn their output characteristics including the wavelengths, power capabilities and beam properties. Students will demonstrate knowledge of these lasers through homework and tests.

III. COURSE OUTLINE (42 academic hours)

1. Nature of Light (7 hours)

a. Review of math needed in performing mathematical operations required by this course.
b. Define the following properties of light: speed, frequency, wavelength and energy and describe the dual nature of light.
c. Describe Huygens' principle and the superposition principle.
d. Define the terms *reflection*, *refraction*, and *index of refraction* and explain how they are related.
e. Explain diffraction and interference in terms of Huygens' principle.
f. List the three types of emission and identify the material properties that control the emission type.
g. Describe in a short paragraph the electromagnetic spectrum and sketch a diagram of the key optical regions and uses.
h. Give a basic explanation of atoms and molecules and their ability to absorb, store, and emit quanta of energy.
i. Define the primary equations describing the relationships between temperature of, wavelength of, and energy emitted by a blackbody and a gray body.
j. Describe Blackbody radiation.

2. Light Sources and Laser Safety (7 hours)

a. Define the following properties of laser light such as monochromaticity, directionality and coherence.

a. Define the following properties of laser light such as monochromaticity, directionality and coherence.
b. Distinguish between the different types of nonlaser light sources and identify their characteristics.
c. Recognize and avoid various nonbeam hazards, such as electrical and chemical hazards.
d. Label a diagram of the human eye. Given the basic information required, calculate retinal spot size and retinal irradiance.
e. Describe three general types of laser hazard controls, and list five laser safety precautions applicable to all types of lasers.
f. Laser safety standard and safety classifications

3. Basic Geometrical Optics (10 hours)

a. State the *law of reflection* and show with appropriate drawings how it applies to light rays at plane and spherical surfaces.
b. State *Snell's law of refraction* and show with appropriate drawings how it applies to light rays at plane and spherical surfaces.
c. Define *index of refraction* and give typical values for glass, water, and air. Calculate the *critical angle* of incidence for the interface between two optical media and describe the process of *total internal reflection.*
d. Describe *dispersion* of light and show how a prism disperses white light. Calculate the *minimum angle of deviation* for a prism and show how this angle can be used to determine the refractive index of a prism material.
e. Use *ray-tracing techniques* to locate the images formed by plane and spherical mirrors. Use the *mirror equations* to determine location, size, orientation, and nature of images formed with spherical mirrors.
f. Use *ray-tracing techniques* to locate images formed by *thin lenses.*
g. Use the *lensmaker's equation* to determine the focal length of a thin lens. Use the *thin-lens equations* to determine location, size, orientation, and nature of the images formed by simple lenses.
h. Describe optical instrument such as camera, microscope and telescope.

4. Basic Wave Optics (9 hours)

a. Describe the relationship between *light rays* and *wave fronts*, and define *phase angle* and its relationship to a *wave front.*
b. State the *conditions required* for producing *interference patterns* and define *constructive* and *destructive* interference.
c. *Calculate the* thickness of *thin films* designed to *enhance* or *suppress* reflected light.
d. Describe *single-slit diffraction* and *calculate positions of the minima* in the diffraction pattern.
e. Distinguish between *Fraunhofer* and *Fresnel* diffraction.
f. Sketch typical Fraunhofer *diffraction patterns* for a *single slit, circular aperture,* and *rectangular aperture*, and use equations to calculate *beam spread* and *fringe locations.*
g. *Describe* a transmission grating *and calculate positions of different orders of diffraction.*

h. Describe what is meant by *diffraction-limited optics* and describe the difference between a *focal point in geometrical optics* and a *focal-point diffraction pattern in wave optics*.
i. Describe how *polarizers/analyzers* are used with polarized light.
j. State the *Law of Malus* and explain how it is used to calculate intensity of polarized light passing through a polarizer with a tilted transmission axis.
k. Calculate *Brewster's angle of incidence* for a given interface between two optical media.
l. Describe scattering of light.

5. Principles of Lasers (9 hours)

a. Understand how laser operates, how gain or amplification is produced.
b. Know how various beam characteristics occur.
c. Know about longitudinal and transverse modes.
d. Design laser cavities or resonators
e. Be familiar with Q-switching, mode locking.
f. Be familiar with how a variety of laser types work and be familiar with their wavelengths, power capabilities, and beam properties.
g. A brief survey of different types of lasers and their typical applications.

Final Exam (to be held during the finals week) (2 hours)

IV. EVALUATION METHODS

The final grade will be determined as follows:

Final Exams	(25%)
Quizzes	(25%)
Midterms	(25%)
Homework	(25%)

V. GRADING SCALE

Grading Scale: A: ≥90% B: 80-89% C: 70-79% D: 60-69% F: <60%

VI. ATTENDANCE POLICY

Formal attendance and participation in class discussions are required. Attendance policy will follow the one prescribed in the Undergraduate Catalog

VII. REQUIRED TEXTBOOKS, SUPPLEMENTAL BOOKS AND READINGS

Text Books

Bahaa, Saleh and Teich, Malvin , Fundamentals of Photonics (Wiley Series in Pure and Applied Optics) by, 2nd edition (2007), ISBN: 978-0-471-35832-9

Barat Ken Laser Safety: Tools and Training, CRC Press, (2008) ISBN-13: 978-1420068542

CORD Communications, Fundamentals of Light and Lasers, (2013) ISBN 1-57837-699-8

Supplemental Reading

Taylor, Nick, Laser: The Inventor, the Nobel Laureate, and the Thirty-Year Patent War Backinprint.com (2007) ISBN 0595465285

VIII. SPECIAL RESOURCE REQUIREMENTS

None.

IX. BIBLIOGRAPHY

Barat, Ken, Laser Safety in the Lab, SPIE Press Monograph PM212 (December 2011) ISBN-10: 0819488194

Csele, Mark, Fundamentals of Light Sources and Lasers, 2008, John Wiley & Sons, ISBN 0-471-47660-9

Henderson R., Guide to Laser Safety, Chapman & Hall, 1st edition (January 15, 1997) ISBN: 0412729407

Henderson R., Schulmeister, K., Laser Safety, IOP Publishing 1st edition (Dec 2003); ISBN: 0750308591

Marshall, Wesley and Sliney, David, H., LIA Laser Safety Guide, Laser Institute of America; 10th edition (August 2000), ISBN: 0912035064

SUMMARY OF CHANGES

The primary objectives, topics and course activities are not being significantly changed. The purpose of this course revision is to map the course objectives to the new Liberal Studies Expected Undergraduate Student Learning Objectives (EUSLO). The prerequisites are also being removed as well as the lab experiments, since that is not necessary for a Liberal Studies Science Class

We are seeking to make EOPT 150 a 3-credit non-lab Natural Science Course. There are a few reasons why we would like EOPT 150 to be a Liberal Studies Knowledge area course.

One issue some of us in Physics have with the more traditional liberal studies science knowledge courses is that they are too broad. The students receive a smattering of each topic, but there is no depth. Part of the reasons there is little depth, at least in some Physics Liberal Studies courses, is the mathematics background necessary for the course. (PHYS 131 and 132 are an exception to this.) Algebra is not a requirement for EOPT 150, so the entering skills for EOPT 150 are not much different from SCI 105. EOPT 150 explores one area of physics - lasers - in much detail hopefully allowing a non-science student to appreciate the depth of the scientific process.

A second issue has to do with our entering majors who do poorly the math placement test, do not place into MATH 125. They cannot take PHYS 131. We are thinking of having these students start off in the A.S. E.O.L.E.T. (Electro-Optics and Laser Engineering Technology) program, and they would take EOPT 150 to start. EOPT 150 would be their LS Science course. Note that the B.S. Physics program does the same in that PHYS 131 is their LS science knowledge course.

We remove the lab requirement to make this course less constrained by the lab equipment, lab space and lab supervision. However, for these students in the E.O.L.E.T. Program, they will not be badly affected because each core EOPT course has a built in lab component to fully develop their hands-on skills.

Sample assignment

Homework - Who discovered the Laser?

We have seen how Lasers operate and where they fit in today's technical world. The history of modern physics roughly parallels the development of the laser. However, one aspect we have not yet encountered in this class is the controversy around the patent for the laser. Several principles and inventions had to be developed before the modern day laser was invented.

Based upon your reading of Laser: The Inventor, the Nobel Laureate, and the Thirty-Year Patent War briefly explain on paper (to turn in), the role of each of these individuals in the invention of the laser. In your discussion, be sure to list one prominent idea or device that was critical in the development of the laser. Lastly decide if there is only one inventor of the laser. If there is, who was it and why.

1. Nikolai Basov
2. Albert Einstein
3. Gordon Gould
4. Theodore Maiman
5. Isidor I. Rabi
6. Charles Townes

Bring this list with you to the next class. During the class you will be working in groups of three to four and you group must come to a consensus as to the rank order of importance of the discoveries of these individuals. Submit your own ranking as well as the ranking of your group. In the group ranking and discussion, be sure to explain the rationale of your ranking, and how it came to an agreement. Lastly as a group, decide if there is only one inventor of the laser. If there is, who was it and why.

Grading Guide

Each individual student will receive a score which is a sum of the individual score and the group score.

	8 - Target	**6 - High**	**4-Average**	**2 -Low**
Individual effort	All 6 individuals correctly identified with appropriate prominent idea listed	All 6 individuals correctly identified with 4 out of 6 prominent ideas listed	All 6 individuals correctly identified with 4 out of 6 prominent ideas listed	Less than 6 individuals identified, or less than 3 prominent ideas listed
Group Effort	All members agree to rank order, if there was disagreement, all agree at the end, with an explanation of the resolution	All members do not agree, reason for disagreement is clearly stated.	All members agree, however no discussion or explanation of agreement.	Members in the group disagree, no discussion on reason for disagreement

Part II

Liberal Studies Course Approval Checklist
Instruction Sheet

Use this checklist for all Liberal Studies categories other than writing-intensive sections; a different checklist is available for this If you have questions, contact the Liberal Studies Office, 103 Stabley, telephone 357-5715

This checklist is intended to assist you in developing your course to meet IUP's Criteria for Liberal Studies and to arrange your proposal in a standard order for consideration by the Liberal Studies Committee (LSC) and the University-Wide Undergraduate Curriculum Committee (UWUCC) When you have finished, your proposal will have these parts:

_X_ Standard UWUCC Course Proposal Cover Sheet, with signatures and Liberal Studies course designation checked

_X_ Course syllabus in UWUCC format

NA_ UWUCC course analysis questionnaire Needed only if this is a new course not previously approved by the University Senate These are not considered by the LSC but will be forwarded to the UWUCC along with the rest of the proposal after the LSC completes its review

This is not a new course; it has been approved by the University Senate

_X__ Assignment instructions for one of the major course assignments and a grading rubric or grading criteria for that assignment

_X__ Answers to the four questions listed in the Liberal Studies Course Approval General Information (one page)

Old Course Syllabus

I. **Course Description**

EOPT 150 Fundamentals of Photonics and Laser Safety (2c-1l-3cr)

Prerequisites: PHYS 100 or Placement Test

This course is an introduction to the field of photonics. Course content is designed to acquaint the student with the various concepts associated with the nature of light and lasers. Students will explore the nature of light and lasers using hands-on explorations, problem solving techniques, and practical current applications. Topics covered include: nature and property of light, optical handling and positioning, basic geometrical optics, basic physical optics and principles of lasers.

II. **Course Outcomes**

After successfully completing the course, the student will be able to:

1. Demonstrate the nature and properties of light
2. Handle and position optical systems
3. Demonstrate an understanding of various light sources and safety issues related to these light sources.
4. Describe the basic optics principles of reflection, refraction, interference, diffraction and polarization.
5. Describe the working principles of lasers.

III. **Detailed Course Outline (28 academic hours plus 3 lab hours/week for 14 weeks)**

1. Nature of Light (4 academic hours + 2 labs)

   a. Define the following properties of light: speed, frequency, wavelength and energy and describe the dual nature of light.
   b. Describe Huygens' principle and the superposition principle.
   c. Define the terms *reflection*, *refraction*, and *index of refraction* and explain how they are related.
   d. Explain diffraction and interference in terms of Huygens' principle.
   e. List the three types of emission and identify the material properties that control the emission type.
   f. Describe in a short paragraph the electromagnetic spectrum and sketch a diagram of the key optical regions and uses.
   g. Give a basic explanation of atoms and molecules and their ability to absorb, store, and emit quanta of energy.
   h. Define the primary equations describing the relationships between temperature of, wavelength of, and energy emitted by a blackbody and a gray body.

2. Optics Handling and Positioning (4 academic hours + 2 labs)

   a. Bulk optical materials and their properties.
   b. Optical coatings
   c. Surface quality of optical components and inspection methods
   d. Care and cleaning of optics
   e. Lab mountings and positioning equipment

3. Light Sources and Laser Safety (4 academic hours + 2 labs)

   a. Define the following properties of laser light such as monochromaticity, directionality and coherence
   b. Distinguish between the different types of nonlaser light sources and identify their characteristics.
   c. Recognize and avoid various nonbeam hazards, such as electrical and chemical hazards.
   d. Label a diagram of the human eye. Given the basic information required, calculate retinal spot size and retinal irradiance.
   e. Describe three general types of laser hazard controls, and list five laser safety precautions applicable to all types of lasers.

4. Basic Geometrical Optics (6 academic hours + 3 labs)

   a. State the *law of reflection* and show with appropriate drawings how it applies to light rays at plane and spherical surfaces.
   b. State *Snell's law of refraction* and show with appropriate drawings how it applies to light rays at plane and spherical surfaces.
   c. Define *index of refraction* and give typical values for glass, water, and air. Calculate the *critical angle* of incidence for the interface between two optical media and describe the process of *total internal reflection.*
   d. Describe *dispersion* of light and show how a prism disperses white light. Calculate the *minimum angle of deviation* for a prism and show how this angle can be used to determine the refractive index of a prism material.
   e. Use *ray-tracing techniques* to locate the images formed by plane and spherical mirrors. Use the *mirror equations* to determine location, size, orientation, and nature of images formed with spherical mirrors.
   f. Use *ray-tracing techniques* to locate images formed by *thin lenses.*
   g. Use the *lensmaker's equation* to determine the focal length of a thin lens. Use the *thin-lens equations* to determine location, size, orientation, and nature of the images formed by simple lenses.

5. Basic Wave Optics (6 academic hours + 3 labs)

   a. Describe the relationship between *light rays* and *wave fronts*, and define *phase angle* and its relationship to a *wave front.*

b. State the *conditions required* for producing *interference patterns* and define *constructive* and *destructive* interference.
c. *Calculate the* thickness of *thin films* designed to *enhance* or *suppress* reflected light.
d. Describe *single-slit diffraction* and *calculate positions of the minima* in the diffraction pattern.
e. Distinguish between *Fraunhofer* and *Fresnel* diffraction.
f. Sketch typical Fraunhofer *diffraction patterns* for a *single slit, circular aperture,* and *rectangular aperture*, and use equations to calculate *beam spread* and *fringe locations*.
g. *Describe* a transmission grating *and calculate positions of different orders of diffraction.*
h. Describe what is meant by *diffraction-limited optics* and describe the difference between a *focal point in geometrical optics* and a *focal-point diffraction pattern in wave optics*.
i. Describe how *polarizers/analyzers* are used with polarized light.
j. State the *Law of Malus* and explain how it is used to calculate intensity of polarized light passing through a polarizer with a tilted transmission axis.
k. Calculate *Brewster's angle of incidence* for a given interface between two optical media.

6. Principles of Lasers (4 academic hours + 2 labs)

a. Understand how laser operates, how gain or amplification is produced
b. Know how various beam characteristics occur
c. Know about longitudinal and transverse modes
d. Design laser cavities or resonators understand unstable resonators
e. Be familiar with Q-switching, mode locking
f. Be familiar with how a variety of laser types work and be familiar with their wavelengths, power capabilities, and beam properties

Final Exam (to be held during the finals week)

List of lab experiments

Lab 1 Measurement of wavelength, frequency and speed
Lab 2 Black body emission
Lab 3 Optical lapping and polish
Lab 4 Optical component handling, cleaning and positioning
Lab 5 Coherent length measurement and monochormaticity
Lab 6 Laser hazard controls and safety precautions
Lab 7 Law of reflection
Lab 8 Law of refraction
Lab 9 Dispersion measurement
Lab 10 Interference measurement
Lab 11 Diffraction measurement

Lab 12 Polarization measurement
Lab 13 Laser longitudinal and transverse mode characterization
Lab 14 Laser output characterization

IV. **Evaluation Methods**

The final grade will be determined as follows:

Exams (25%): 25% for both midterm exam and final exam. Each exam will consist of multiple-choice questions, circuit sketches and calculations, and a circuit design and construction problem. The final exam will be cumulative and require the student to integrate knowledge acquired throughout the course.

Quizzes (25%): Two quizzes will be administered during the semester.

Lab Reports (25%): Students will turn in lab reports weekly (due one week after the laboratory exercise). Grading will be based on quality of laboratory participation, quality and completeness of report, and neatness.

Homework (25%) Students will be assigned approximately 10 homework problem sets, entailing basic design and calculations, internet searches and reports, and questions based on chapter reading material.

V. **Example Grading Scale**

Grading Scale: A: $\geq$90% B: 80-89% C: 70-79% D: 60-69% F: <60%

VI. **Undergraduate Course Attendance Policy.**

Formal attendance and participation in class discussions are required. Attendance policy will follow those as proscribed in the Undergraduate Catalog

VII. **Required Textbook(s), Supplemental Books and Readings.**

1. *Fundamentals of Light and Lasers,* CORD Communications, ISBN PHO337-8
2. *Fundamentals of Photonics* by B. E. A. Saleh and M. C. Teich (2nd Edition), Wiley-Interscience, ISBN: 978-0-471-35832-9 (2007)
3. *Laser Safety: Tools and Training*, by Ken Barat, CRC Press, ISBN-13: 978-1420068542 (2008)

VIII. **Special Resource Requirements.** None

IX. **Bibliography.**

- Fundamentals of Photonics (Wiley Series in Pure and Applied Optics) by Bahaa E. A. Saleh and Malvin Carl Teich, 2nd edition (2007), ISBN: 978-0-471-35832-9

- Fundamentals of Light Sources and Lasers by Mark Csele, 2004, John Wiley & Sons, ISBN 0-471-47660-9
- A Guide to Laser Safety, by R Henderson; Chapman & Hall; 1st edition (January 15, 1997) , ISBN: 0412729407
- LIA Laser Safety Guide, by Wesley Marshall and David H. Sliney, Laser Institute of America; 10th edition (August 2000), ISBN: 0912035064
- Laser Safety, by R Henderson, K Schulmeister; IOP Publishing 1st edition (Dec 2003); ISBN: 0750308591

VIII Special resource requirements: None

Submit the original of the completed proposal to the Liberal Studies Office (103 Stabley) In addition to the signed hard copy, email the proposal as a Word or RTF file attachment to Liberal-Studies@iup.edu

Please Number All Pages

Liberal Studies Course Approval General Information
On a separate sheet of paper, please answer these questions
(Do not include this sheet or copies of the questions in your proposal; submit only the answers)

1) The lecture and lab portion of the course will be taught by the same instructor. A laboratory manual has been incorporated into the course and is being used now to assume uniformity.

2) This class investigates mathematical descriptions of the physical world. While this topic is not an emphasis of the course, ethnic and racial minorities as well as women are discussed when appropriate. For example, Dr. Anthony Johnson is a Charter Fellow of the National Society of Black Physicists. He has served as President of the Optical Society of American (OSA). Johnson has focused his attention on the use of lasers for environmental and health purposes. His current research is in developing new laser innovations which will allow for the detection of small amounts of trace gases in medical and environmental systems.

3) One non-text book reading is required. An example presented in this proposal is: Laser: The Inventor, the Nobel Laureate, and the Thirty-Year Patent War. Students in the class will have a homework assignment based upon what they read in this book. Specifically is it clear that there is a single "inventor" for the laser or was the development of the laser a group effort?

4) This course is an entry-level course where no prior knowledge of science is required; the introductory course for majors has a math requirement. While this course is required for Electro-Optics majors, the emphasis is on the use and applications of lasers in everyday life. Lasers, once in the realm of science fiction, are now ubiquitous. This course is intended to give students knowledge of laser technology enabling them to appreciate application of technology to life. Ultimately, the Students will appreciate physics by studying one area in detail.

Part III letters of support
Not necessary - We are only mapping the course objectives to the new Liberal Studies objectives; the course objectives themselves are not changing. It is common knowledge these changes are in effect University wide.