UNIVERSITY OF KENTUCKY
APPLICATION FOR CHANGE IN EXISTING COURSE: MAJOR & MINOR

1. Submitted by College of Engineering Date 9/15/05

Department/Division offering course Chemical & Materials Engineering

2. Changes proposed:
   (a) Present prefix & number MSE 402G Proposed prefix & number Same
   (b) Present Title Electronic Materials and Processing
       New Title SAME
   (c) If course title is changed and exceeds 24 characters (including spaces), include a sensible title (not to exceed 24 characters) for use on transcripts:

   (d) Present credits: 4 Proposed credits: 3
   (e) Current lecture: laboratory ratio 3/3 Proposed: 3/0
   (f) Effective Date of Change: (Semester & Year) Fall 2006

3. To be Cross-listed as:

   Prefix and Number

   Signature: Department Chair

4. Proposed change in Bulletin description:
   (a) Present description (including prerequisite(s):
       This course will examine electron behavior in a variety of materials and the processing methods used for integrated device production. Additional topics will include thin film growth, diffusion, oxidation, electronic device principals, defect control, and a survey of current challenges to the semiconductor industry. Lecture: 3 hours laboratory: 3 hours per week. Prereq: MSE 102, MSE 301 or related engineering/science senior/graduate level courses with instructor permission

   (b) New description:
       This course will examine electron behavior in a variety of materials and the processing methods used for integrated device production. Additional topics will include thin film growth, diffusion, oxidation, electronic device principals, defect control, and a survey of current challenges to the semiconductor industry. Prereq: MSE 201, MSE 301 or related engineering/science senior/graduate level courses with instructor permission

   (c) Prerequisite(s) for course as changed: MSE 201, MSE 301 or related engineering/science senior/graduate level courses with instructor permission

5. What has prompted this proposal?
   Upon recommendation from our advisory board, and input from students and faculty, we are dropping the lab component of this course, along with that of four others, and are creating two 3-credit hour labs, to be offered in two consecutive semesters.

6. If there are to be significant changes in the content or teaching objectives of this course, indicate changes:

7. What other departments could be affected by the proposed change?

8. Is this course applicable to the requirements for at least one degree or certificate at the University of Kentucky? □ Yes □ No

9. Will changing this course change the degree requirements in one or more programs? * □ Yes □ No
   If yes, please attach an explanation of the change.*
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12. If the course is 400G or 500 level, include syllabi or course statement showing differentiation for undergraduate and graduate students in assignments, grading criteria, and grading scales. [X] Check here if 400G-500.

12. Is this a minor change? [ ] Yes [X] No
(NOTE: See the description on this form of what constitutes a minor change. Minor changes are sent directly from the Dean of the College to the Chair of the Senate Council. If the latter deems the change not to be minor, it will be sent to the appropriate Council for normal processing.)

13. Within the Department, who should be consulted for further information on the proposed course change?
Name: DR. LYNN PENN Phone Extension: 7-7897

Signatures of Approval:

[Signature] [Date]
Department Chair

[Signature] [Date]
Dean of the College

[Signature] [Date]
Undergraduate Council

[Signature] [Date]
Graduate Council

[Signature] [Date]
Academic Council for the Medical Center

[Signature] [Date]
Senate Council

[Signature] [Date]
Date of Notice to University Senate

**If applicable, as provided by the Rules of the University Senate.

ACTION OTHER THAN APPROVAL

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The Minor Change route for courses is provided as a mechanism to make changes in existing courses and is limited to one or more of the following:

a. change in number within the same hundred series;
b. editorial change in description which does not imply change in content or emphasis;
c. editorial change in title which does not imply change in content or emphasis;
d. change in prerequisite which does not imply change in content or emphasis;
e. cross-listing of courses under conditions set forth in item 3.0;
f. correction of typographical errors. [University Senate Rules, Section III - 3.1]

Rev 3/04
Catalog Description: Electrons in metals, alloys, semiconductors and insulators, semiconductor devices, methods to produce and process electronic materials; solidification of electronic materials, defect control, diffusion of dopants, oxidation and methods of structural, electronic and chemical characterization. Prereq: Engineering standing, MSE 301, PHY 361 or graduate level. 3 units.

Topics:

1. REVIEW OF THEORIES DESCRIBING THE BEHAVIOR OF ELECTRONS

Basic review of key Materials Principles -classic electronic properties- Drude/Matthiessen Model - wave and particle nature of electrons - wave equations Schrodinger equation - application of Schrodinger equation to free electrons, electron in a one-dimensional infinite potential energy well and finite potential barrier - electron tunneling.

2. ELECTRONS IN METALS AND ALLOYS

Extension of electron in a one-dimensional potential energy well to three dimensions - degeneracy - free electron theory of metals - Fermi energy - density of states function - Fermi function - photoemission and thermionic emission of electrons Free electron approach - effective mass of electrons valence electrons as charge carriers - drift velocity of electrons - drift mobility of electrons - relaxation time - effect of defects, impurities - Hall effect.

Test I

3. ELECTRONS IN SEMICONDUCTING AND INSULATING MATERIALS


4. ELECTRICAL CONDUCTIVITY IN SEMICONDUCTING AND INSULATING MATERIALS

Density of charge carriers in a semiconductor/insulator - conductivity equation - intrinsic semiconductors - extrinsic semiconductors - n-type and p-type semiconductors Fermi energy in intrinsic and extrinsic semiconductors compensation - work function - effect of temperature on charge carrier density effect of impurities on charge carrier mobility - dielectric materials -organic conductors.

Test II
5. BASIC SEMICONDUCTOR DEVICES

Metal-metal interface - metal-semiconductor interface ohmic contacts - rectifying contacts - p-n junction rectifier tunnel diode - p-n-p junction transistor - field effect transistor - Effects of defects.

6. ADVANCED ELECTRONIC DEVICES

Laser diodes, solar cells, quantum dots, thin-film transistors, organic conductors, displays

Test III Final (Thurs. 5/4 10:30am)

7. Current topic presentation

The field of electronic materials is constantly changing and as students you should be taught how to read current news and have it relate to engineering practice. For instance with news a product announcement of a blue laser you should be able to identify the engineering benefits (i.e. higher data density on DVDs) and the engineering challenges overcome and still present (crystal growth without thread dislocations and p-type doping). The purpose of the assignment is to a) have students communicate effectively b) have a recognition for life long learning and c) have a knowledge of contemporary issues. Grading will be on effective communication and depth of research into the topic (i.e. using various sources and relation to the course material).

Students will be randomly chosen to speak 1 week ahead of assignment. The topic will be chosen by the instructor to best fit with current lecture topic. However the student may suggest another topic for the instructor to deem appropriate for lecture content. The presentations will be 10 minutes long. The presentation must be on PowerPoint and provided to the professor electronically by 6pm the day before assigned presentation. This will be posted on the course web-site for other students to be able to print personal copies. Questions about these presentations will be on the exams and final.

Grades based on:

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<th>Test 1</th>
<th>Test 11</th>
<th>Test 111</th>
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<td></td>
<td>(20%)</td>
<td>(20%)</td>
<td>(25%) (Final)</td>
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Current topic presentation (5%)

Class participation (5%)

Homework (25%)

Grades will be distributed by relative curve (with consideration to performance of past years and the level of proficiency required).

Graduate level students will be graded on different grade distribution curve (relative to graduate students only). In addition graduate students must give another presentation to teach a related materials processing to the class. A list of possible topics will be provided by the instructor. The assignment consists of a 10 min. presentation lecture and a 5-10 page written report to be distributed to all class members.
The grade distribution for **graduate students** is as follows:

- Test 1: (20%)
- Test 11: (20%)
- Test 111: (25%) (Final)

Current topic presentation (5%)
Materials processing lecture (15%)
Class participation (5%)
Homework (15%)


The instructor considers this book to be excellent for instruction but is slightly elementary for upper level work. Thus there will be significant supplements in lecture from the following books (students with strong interests in the field may consider purchasing as reference)

- "Solid State Physics" N. W. Ashcroft and N. D. Mermin
- "Modern Semiconductor Device Physics" S.M. Sze
- "Complete guide to Semiconductor Devices" K. Ng
- "Semiconductor Device Fundamentals" Pierret

Homework problems will be assigned during the semester to illustrate the subject matter and indicate the types of questions that will be asked in the tests. The solutions will be reviewed in class.

Make-up tests are strongly discouraged and will only be given in the case of extreme illness as per student by-laws. To receive a make-up test, the instructor must be notified in writing prior to the scheduled time of the test.

**Goals:** This course is designed to introduce materials engineering students at the junior level to solid state physics, electronic device principles and methods for producing, processing and designing electronic materials. Graduate level students from outside departments will gain important fundamental knowledge of electronic device operation and fabrication techniques that could be applied to active research areas.

**Outcomes:** The students will be able to apply electronic materials science to semiconductor fabrication and semiconductor properties. The students will also be able to identify, analyze and solve a variety of problems that relate to electronic materials properties, fabrication and processing. They will also be able to locate additional information in the literature that pertains to electronic materials and processing and apply the principles from this course to a variety of materials design problems. The extent to which the students achieve these outcomes is evaluated by three in-class tests and homeworks that include material and device design problems.

**Course Relevance:** Electronic materials are increasingly being viewed as a distinct class of materials in addition to the traditional materials classifications such as metals, ceramics and polymers. It is important that students obtain exposure to this unique materials type and experience the methods that are used in developing the traditional materials science theme of relating properties to structure. In particular manufacturing techniques and material choices for devices are critical areas for Materials students. Nearly all stumbling blocks in the electronics industry will require a materials/chemical approach to solve the engineering problems.