Minnesota State University, Mankato

Curriculum Proposal

Please type or select the requested information. Print completed forms, add appropriate paper attachments, and route through MSU’s curricular process for recommendations and decisions.

<table>
<thead>
<tr>
<th>College:</th>
<th>Science, Engineering and Technology</th>
<th>(Check all that apply):</th>
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<tbody>
<tr>
<td>Department:</td>
<td>Electrical and Computer Engineering</td>
<td>Undergraduate</td>
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<tr>
<td>Program:</td>
<td>Computer Engineering</td>
<td>Graduate</td>
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<tr>
<td>Type of Change:</td>
<td>PROGRAM PROPOSALS</td>
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<tr>
<td>Proposed:</td>
<td>Redesign - Change in Degree Award</td>
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<td>Title Current:</td>
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<tr>
<td>Title Proposed:</td>
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<tr>
<td>24-Char. Abbrev:</td>
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Proposal #: 357
Effective Date of Change: [ ] Graduate
Academic Year: [ ] 06-07
(For Office Use Only)

Course Designator and Number: 
Number of Credits: 
(if applicable)

Include a course or program description for the Bulletin (30-40 words maximum for courses, 100 for programs):
Program description should remain as currently found in the bulletin.

Rationale or Justification for change:
We believe that the changes proposed are required for our Computer Engineering program to remain current and to move forward toward accreditation.

***For General Education or Cultural Diversity Courses Only***

<table>
<thead>
<tr>
<th>GE Category #</th>
<th>GE Category Name (Maximum of 3 Categories)</th>
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</table>

* For Writing Intensive Courses, attach a description of the kind and quantity of writing.
* For Upper Division Courses, include a description of the respects in which it is broad and general rather than narrow and specific, and so suitable as GE.

Attach paper copies of the following:
- a. Syllabus or course outline.
- b. Course’s student learning outcomes associated with each GE competency or CD designation.
- c. List of strategies to be used to assess students’ achievement of each GE competency or CD designation.

***For New Courses***

<table>
<thead>
<tr>
<th>Instructional Type:</th>
<th>Lecture</th>
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<tbody>
<tr>
<td>Course is an elective.</td>
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<tr>
<td>Course is required for program</td>
<td></td>
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<tr>
<td>Pre- or Co-requisites:</td>
<td></td>
</tr>
<tr>
<td>Other courses are being changed or eliminated. (Explain.)</td>
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</tr>
</tbody>
</table>

Course will be offered:
- [ ] Fall Semester
- [ ] Spring Semester
- [ ] Summer Session
- [ ] Other Semester

■ Course content or title is similar to courses in other departments. (Attach copy of letter of agreement with other program(s) contacted. Indicate the nature of the discussions and/or resolution of differences or potential conflicts.)

Attach paper copies of the following:
- a. Syllabus or course outline.
- b. Course’s student learning outcomes.
- c. A list of resources required to offer and support this course.
- d. A description of how teaching this course will affect department staffing.
- e. If 400/500 level course, an explanation of added expectations of graduate students.

Revised September 2002
### Signature Page ###

**Department**
- Recommended
- Not Recommended

Comments: 

**College Curriculum Committee**
- Recommended
- Not Recommended

Comments: 

**College Dean**
- Recommended
- Not Recommended

Comments: 

**General Education Subcommittee**
- Recommended
- Not Recommended

Comments: 

**Undergraduate Curriculum and Academic Policy Committee**
- Recommended
- Not Recommended

Comments: 

**Faculty Association Graduate Committee**
- Recommended
- Not Recommended

Comments: 

**Graduate Dean**
- Recommended
- Not Recommended

Comments: 

**Academic Affairs Council**
- Recommended
- Not Recommended

Comments: 

**Senior Vice President and Vice President for Academic Affairs**
- Approved
- Not Approved

Comments: 

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Revised September 2002
Memorandum

To: Course and Curriculum Committees
CC: [Click here and type name]
From: William B Hudson, Chair ECET
Date: February 15, 2007 (Information previously provided – revised here for clarity)
Re: Computer Engineering Curriculum Changes

Attached please find the revised curriculum for the Computer Engineering degree program. Please be aware that many of the courses required for the Computer Engineering degree are also required for the Electrical Engineering degree so that changes in both Electrical and Computer Engineering degree programs need to be reviewed and considered jointly.

Specific points to note:

- Because of required sequencing of courses to meet prerequisites changes in the program are first shown on a modified student advising form to establish that course prerequisites are met and also that students would be able to complete the program in four years

- Changes in this program do not change current engineering general education requirements

- Course additions proposed as part of this proposal include, EE 106 and EE 107 to help in addressing student retention issues through integrated freshmen year departmental hands on courses

- The addition of a of CS 220 course requirement to be offered by the new CS department to better meet the needs of transfer students with the inclusion of a support lab EE 235 for computer engineering students needing additional hardware experience beyond that required for a Computer Science student

- Two additional math courses are being required to better assist students in preparing for graduate school and to meet the discrete math requirement of our accrediting agency

- Additional courses added for the degree include EE 341, EE 358 and EE 350 to provide students better preparation in topics relevant to Computer Engineering as recommended by our Industrial Advisory Board

- Addition of an additional semester of design through the creation of a new design course in the junior year EE336
• Addition of two new courses EE 381 and EE 382 to address the current weaknesses in students' exposure to digital design

• Changes in credit hours for EE 332, EE 341, EE 333, EE 353, EE 350, EE 467, EE 250, and EE 477 to allow more consistent class scheduling to aid in student learning and faculty scheduling.

• To address the recommendations of our Industrial Advisory Board to create a much more hardware focused Computer Engineering program many of the previous COMS courses have been eliminated as shown on supporting documentation.

• Shown on the draft advising sheet are three courses EE 385, EE 387 and EE 389 that are felt to be important to the growth of the program that are not being proposed at this time because of resource constraints.

• The total credit hours required for the Computer Engineering degree would not change with the proposed curriculum changes.

Provided in support of this proposal and identified as attachment 2 are the required program student learning outcomes as defined by our accreditation agency ABET. These outcomes listed as topics are supported by course outcomes which have been created for all courses and mapped to the provided learning outcomes.

Minutes of department meetings supporting these changes are provided and marked as attachment 3.

Our program accreditation requires both assessment and improvement. Accreditation Criteria 2 requires that we evaluate and determine that the Computer Engineering program prepares students to meet career and professional requirements normally one to five years after graduation. It is required that we have in place a process by which we determine this and use the results to improve our Computer Engineering program. Further Criteria 3 of our accreditation requires that we assess program outcomes (competencies at graduation) and use these results to improve the Computer Engineering program. An overview of the assessment plan for the Computer Engineering program is provided as attachment 4.

As can be seen the change in the Computer Engineering program has implications for new course requirements in Computer Science, Math and Mechanical Engineering. Correspondence related to these changes can be found marked as attachment 5.

Resources

Resources required to support the changes will occur through departmental reallocation of existing resources and will change only as student numbers increase as would occur with the existing curriculum.

Staffing

Departmental staffing is adequate to address the program changes. Staffing needs will change only as student numbers change which would occur with the current program.

Library Needs
No changes would occur relative to necessary library holdings.

**Bulletin Copy**

Changes in bulletin copy should only reflect changed course offering and program requirements as provided in the supporting materials.
<table>
<thead>
<tr>
<th>Change in Credit Hours</th>
<th>Freshman (Fall)</th>
<th>Credit Hours</th>
<th>Freshman (Spring)</th>
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<td>EE 254 Digital &amp; Circuits Lab (1)</td>
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<td>EE 240 Evaluation of Circuits (1)</td>
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Notes:

Note 1: SPEE 233 can be replaced by SPEE 102, or ENG 271

*H/SS:
   Humanities 6-7 credits
   Social Sciences 6-7 credits
   13 total credits one class following at the 300 or 400 level

Economics
ECON 201 or 202 3 credits

** EE Electives
   Previous computer engineering requirements had no electives
   Now need to require 6 credits of electrical engineering electives to reach 128 total

*** Business Area Electives:
   Total of 3 credits
   EE 450 – 3 credits

Total Credits = 128
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<th>Computer Engineering</th>
<th>Proposed Program Changes</th>
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<td>128</td>
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* Selected from 400 level EE courses
Attachment 2 - The Computer Engineering Student Learning Outcomes

Students completing the Computer Engineering degree program will be able to:
(a) to apply knowledge of mathematics, science, and engineering
(b) to design and conduct experiments, as well as to analyze and interpret data
(c) to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) to function on multi-disciplinary teams
(e) to identify, formulate, and solve engineering problems
(f) understand professional and ethical responsibility
(g) to communicate effectively
(h) have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) understand the need for, and an ability to engage in life-long learning
(j) understand contemporary issues
(k) use the techniques, skills, and modern engineering tools necessary for engineering practice.
Minutes of the Meeting of part of the faculty of Department of Electrical and Computer Engineering and Technology
31 October 2006

Present: Han-way Huang, William Hudson, Julio Mandojana, Thomas Hendrickson, John Caven, Muhammad Khaliq, Vincent Winstead, Paul Lindfors

1. The minutes of the meeting of 3 October 2006 were approved.

2. Department Good News

   2.1 IEEE speakers
   2.2 IEEE tour of Winland Electronics on Monday, 30 October
   2.3 Grants?
   2.4 Grant applications

3. The personnel committee will be forthcoming in the near future regarding the request by Dr. Kapadia to be promoted to rank of Full Professor.

4. Faculty interested in teaching summer courses need to apply to Dr. Hudson soon. Those who have expressed interest thus far are: Khaliq, Kapadia, Mandojana and Winstead. The courses that will probably be offered are EE-230 and EE-231.

5. Some graduate courses have experienced a problem with insufficient enrollment. The department needs to develop a system of written commitment by graduate students so the department can plan the courses and teaching loads more effectively. Ideas were forwarded, but no action was taken.

6. Thanks to Mandojana and Allen for preparation of course and program materials and Mandojana and Hudson for steering the course and curriculum changes through the Course and Curriculum Committee of the college. The process was tedious but necessary. The faculty had reviewed and approved the Course and Curriculum materials previously but to provide a clear paper trail Hudson and Winstead will circulate a form that will preserve a written record of faculty approval of the course and curriculum changes by way of email.

7. Mandojana will tour Winstead and Zhang through Goodrich so possible courses for Spring Semester 2007 can be identified. Planning for this tour will be done by the 3 participants.

8. Hudson was surprised by the announcement regarding IEEE publications and a complete shift to electronic forms that arrived from the library. Several faculty noted the absence of journals they thought had once were present. The rushed schedule and extent of the changes will be investigated by Hudson.

9. Jeff Pribyl of Chemistry and Geology has been discussing with the engineering program heads the development of a new, 3-credit chemistry course for engineering students. This course would have no laboratory. Such a course would allow electrical, mechanical and computer engineering students greater program flexibility but the laboratory component may be needed by civil engineering students. It was agreed that students could still take Chemistry-201 in place of the new course when it is offered.

10. Other issues were tabled.
The ECET department has invested many meetings during the last two years to the refinement of all of the department programs. The department faculty have had many votes as we have worked to refine the curriculum to best serve our students and our constituent groups. The final affirmation of these changes has be accomplished by an email vote sent to faculty after changes recommended by the College Course and Curriculum were implemented - Email attached as well as program summaries.

The results of email vote are as follows:

- Electronic Engineering Technology: Approve 8, Disapprove 1
- Computer Engineering Technology: Approve 9, Disapprove 0
- Electrical Engineering: Approve 9, Disapprove 0
- Computer Engineering: Approve 9, Disapprove 0
Minutes of the Meeting of part of the faculty of Department of Electrical and Computer Engineering and Technology
07 November 2006

Present: Gale Allen, Han-way Huang, William Hudson, Paul Lindfors, Julio Mandojana, R. A. Nair, Mahbubur Syed, Vincent Winstead, Vincent Zhang

1. Presentation by Diane Richards, Collection Development Librarian: Questions regarding change to electronic form of journals and possibility of "missing" journals were answered. Receiving the journals in electronic form will duplicate the printed journals now received plus add others. The apparently "missing" journals are still present in printed form.

2. The minutes of the meeting of 31 October 2006 were approved.

3. Curriculum issues dominated the meeting. Hudson reported that all program changes that were approved previously were not going to be approved by the Dean because of staffing issues. Working with David Haglin of CIS many changes were preserved while some changes were not included or a compromise with CIS was worked out. A list of the present and revised programs that are expected to be approved for EE, CompE, EET, and CompET are attached. No easy summary of the situation can be made. Motion made and seconded all present voted to move forward with the programs as defined in the attached forms.

4. Summer teaching remained as reported previously: 1) courses that would be offered would be EE-230 and 231 and 2) interested faculty are Kapadia, Khaliq, Mandojana, and Winstead.

5. Khaliq went home sick this afternoon so the procedure and timetable for review of materials and decision regarding the submission for promotion from Kapadia will be announced later.

6. Allen distributed a list of general education courses for engineering technology majors that cover multiple categories. This list should aid students to complete their degree programs in the minimum 128 credits and the list should be used during pre-registration reviews on Thursday and Friday. A copy is attached.

7. Upon suggestion by the Dean the department agreed to drop the courses listed below because they will not be included in the revised programs:

   EE-101, 380, 462
   EET_101, 225, 230, 400, 480, 488, 489
Electrical and Computer Engineering and Technology Department
Program and Course Assessment

**Educational Objective Assessment (1-5 years after graduation)**
Efforts are made to contact graduates of all department programs for at least five years following graduation. Surveys are used based on the major that ask graduates for their impressions on how their program of study prepared them for their career. Information from these surveys is fed back into the program to make improvements. Both students and faculty are involved in this effort.

**Constituent Input**
Input from Internship employers is gathered through internship reports to assist in program assessment and improvement. Further input is obtained by faculty through the use of company survey forms to determine specific company skill set needs. Information from these surveys and reports is used to refine curriculum to better meet the needs of employers as they use ever evolving technologies.

**Course Assessment**
Outcomes are established for each course that map to the required ABET a-k outcomes for each of the degree offerings. Each instructor in the ECET department is responsible for assessing student competency in each course outcome area. This information is gathered each semester and is reviewed by the department assessment committee which then makes recommendations to the ECET faculty regarding possible improvement areas. All department faculty scan examples of student work to create assessment portfolios to support our accreditation and assessment efforts.

**Student Input for Assessment**
Input from students in all department programs is solicited by a student advisory board meeting and through the use of online surveys supported through MSU assessment office. The surveys are offered students each semester and solicit and analyze responses by program of study and by year in the program. As with all of the other assessment tools this information is fed back into the assessment loop to support program improvement efforts.
From: Hudson, William B  
Sent: Tuesday, October 17, 2006 1:36 PM  
To: Haglin, David  
Subject: EE 106

David,

I understand you have proposed changes to your CS major whereby your students will be required to take our EE 106. We welcome this opportunity for our EE and CE students to interact with your CS students in this course. We have designed our pre-requisite structure for EE 106 to ensure that the CS majors will be prepared to enroll in this course without taking additional EE courses.

We look forward to working with the CS department to support all of our students.

Sincerely,

Bill Hudson

---

William B Hudson, Chair ECET Department  
Minnesota State University, Mankato, MN 56001
Bill Hudson,

I understand you have proposed changes to your CE major whereby your students will be required to take our CS 320 and CS 360 courses. We welcome this opportunity for our CS students to interact with your CE students in these courses. We have designed our pre-requisite structure on CS 320 and CS 360 to ensure that the CE majors will be prepared to enroll in those courses without taking additional CS courses.

Sincerely,

David Haglin

Dr. David J. Haglin, Chair
Computer and Information Sciences Department
Minnesota State University, Mankato, MN 56001
http://theory.cs.mnsu.edu/haglin
Hudson, William B

From: Pearson, Larry M
Sent: Tuesday, November 07, 2006 10:56 AM
To: Hudson, William B
Subject: RE: Curricular Changes

Bill,

Our department is supportive of your department requiring the additional courses Math 180 and Math 223 for Computer Engineers. At some point in the future it would be helpful to have an estimate of the number of additional students in these courses for scheduling purposes.

Sincerely,
Larry Pearson, Chair
Mathematics and Statistics

From: Hudson, William B
Sent: Monday, November 06, 2006 8:50 PM
To: Pearson, Larry M
Subject: Curricular Changes

Larry,

We would like to revise the curriculum for Computer Engineers to include Math 180 and Math 223. In order for this move forward I need an email of support from you. If you have any questions please feel free to contact me.

Thanks!

Bill
Hudson, William B

From: Johnson, Charles
Sent: Monday, February 26, 2007 11:53 AM
To: Hudson, William B
Subject: RE: ME 299 for Computer Engineers

Bill,

I do not see any problem with adding ME299 for the Computer Engineering degree.

Charlie

Charles W. Johnson, Ph.D., P.E.
Professor and Chair
Mechanical and Civil Engineering
Minnesota State University, Mankato

From: Hudson, William B
Sent: Thu 2/15/2007 3:04 PM
To: Johnson, Charles
Subject: ME 299 for Computer Engineers

Charlie,

As part of the Computer Engineering refinement we would like to add ME 299 to the required courses for our Computer Engineering degree. If you agree with this change I would appreciate an email in support of this change.

Thanks for your time and consideration!

Bill
PROGRAM REDESIGN APPLICATION

RELATED POLICY or STATUTE: MS 1996, Ch. 368, Sec. 33; MS 1995, Ch. 248, Article 11, Sec. 10; and MS 1996, Ch. 398, Sec. 38; Board Policy 3.14, 3.17, 3.19

[This form is designed for electronic use. You should have some familiarity with the Word table-making function. Enter your information in the correct box on the Tables below.] Please submit an individual form for each program you are redesigning. Multiple changes to the same program may be made on the same form. You may delete all the tables that do not apply to your redesign request.]

<table>
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<tr>
<th>S-Digit CIP #</th>
<th>Program Name Computer Engineering</th>
<th>Award Bachelor of Science</th>
<th>Cr Length 128</th>
<th>Location's MSU, Mankato</th>
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<td>Name of affiliated educational institution that offers one or more credits in this program: None</td>
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<td>Is this award jointly offered: Yes No - No</td>
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SECTION II: PROPOSED CHANGES TO PROGRAM

Effective start date/s: Fall 2007

Rationale for Proposed Change/s: Revise curricula to support accreditation

Section IIA: NAME CHANGE

Current: | Proposed:

Section IIB: CIP CHANGE*

Current: | Proposed:

Current Program Outcomes: | Proposed Program Outcomes:

*Contact staff to determine whether change is permitted as a redesign, or whether a new program proposal is required.

Section IIC: CHANGE CREDIT LENGTH WITHIN POLICY

Previous: | Proposed:

Section IID: CHANGE CREDIT LENGTH TO EXCEED POLICY

Credit length beyond the policy limits will be approved only if one or more of the following conditions exist: a) the length is required by a state or national licensing body or other regulatory agency, accrediting association, or board; b) the program is employer-sponsored where the employer specifies the required credits as a condition for conferring the award; or c) a formal task analysis has been conducted within the last three years and the results endorsed by an advisory committee. Request for a program length in excess of policy from a professional association or advisory committee is not sufficient for approval.

Previous Length: | Proposed Length:
State Rationale for Exceeding Policy Limits (Attach evidence as appropriate in an appendix):

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<th>Section II E: ADD CURRICULUM ALTERNATIVE/S*</th>
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<td>CIP Code:</td>
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<td>Total Credits:</td>
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<td>Option or Emphasis or certificate that is a subcredential of existing award (choose one):</td>
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<td>Courses unique to this alternative:</td>
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<td>COURSE TITLE/NUMBER</td>
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<td>Number of Credits</td>
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<tr>
<td>EXISTING COURSE/S</td>
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<td>Yes</td>
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*Change in Curriculum Alternative(s):* If you are adding multiple alternatives to a single program, please identify each separately and list courses separately by copying and pasting this section as many times as necessary.

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<td>Name of Alternative:</td>
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*Delete Curriculum Alternative(s):* If you are deleting multiple alternatives, identify each separately. Add additional lines as necessary.

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<tr>
<th>Section II G: AWARD CHANGE</th>
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<tbody>
<tr>
<td>Current Award:</td>
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<td>Proposed Award:</td>
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List courses for both current award and proposed award
### Section IIH: CREATE NEW AWARD IN RELATED ACADEMIC AREA

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<th>Name:</th>
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Please list all courses for the new award below:

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<tr>
<th>COURSE TITLE/NUMBER</th>
<th>Number of Credits</th>
<th>EXISTING COURSE/S</th>
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*Creating new awards in related academic areas: Before completing this section, contact Academic Program staff to verify that you can make these proposed changes as redesigns. If you are adding awards in multiple related areas, identify each...*
SECTION III: REDESIGNED PROGRAM SUMMARY

Program Requirements:

Complete this section if the number of credits in the award has increased from the previous design, or if it is a new award.

Use the following headings to provide information on each of the components in the program. List all credit totals required for the students to graduate, including prerequisites. If this application is for multiple awards (AAS and/or diplomas and/or certificates) duplicate this table and list requirements for each award separately.

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<tr>
<th>Program Component</th>
<th>Previous Credits</th>
<th>Proposed Credits</th>
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<tr>
<td>General Education/Liberal Studies Eng, H/SS, Gen Studies, Econ, Bus</td>
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<td>26</td>
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<tr>
<td>Prerequisites Math, Chem, Physics,</td>
<td>27</td>
<td>35</td>
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<td>Major-Core COMS, EE</td>
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<td>60</td>
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<tr>
<td>Major-Alternative (see above)</td>
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<tr>
<td>Major-Restricted Electives</td>
<td>3</td>
<td>7</td>
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<tr>
<td>Required Minor (or est. 20 credits)</td>
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<tr>
<td>Free Electives</td>
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<tr>
<td>TOTAL PROGRAM CREDITS</td>
<td>128</td>
<td>128</td>
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</table>

SECTION IV: APPROVAL VERIFICATION

Application Author: William B Hudson

Title: Professor and Chair Electrical and Computer Engineering and Technology

Campus: Minnesota State University, Mankato

Phone and E-Mail: 507-389-5639 william.hudson@mnsu.edu

Approval Chief Academic Officer: [Signature]

Approval of President: [Signature]
College of Science, Engineering and Technology
Curriculum Committee Meeting Minutes
TR E210, Thursday, March 8, 2007

Present: Harry Petersen (AMET), Gregg Marg (Biology for Beth Lavoie), Jim Rife (Chemistry/Geology), Gregg Asher (CIS), Julio Mandojana (ECET), Dan Singer (Math/Statistics), Karen Chou (ME/CivE), Youwen Xu (Physics/Astronomy), Mahbubur Syed (UCAP Representative for CSET).

1. The meeting was called to order at 5:05 PM.
2. The minutes of 10-31-2006 meeting were approved as written.
3. Karen Chou reported that the proposals which were approved by the Committee and have all required documents have been moved forward to UCAP. However, although proposals 734 and 717 were approved by the Committee, when they reached UCAP the signature pages were missing. Karen will sign the proposals and return them back to UCAP.
4. Karen Chou summarized the proposals that will be reviewed in this meeting.
5. The Committee reviewed and approved 28 proposals.
6. Proposals 711, 712, 748, 749 have been resubmitted and renumbered to 7269, 7270, 7271 and 7272, and the Committee approved the later ones.

Meeting adjourned at 5:55 PM.

Respectfully submitted,

Youwen Xu, Secretary
Computer Engineering

College of Science, Engineering & Technology
Department of Electrical and Computer Engineering and Technology
137 Traffon Science Center S • 507-389-5747
Web site: www.cset.mnms.edu/cecet

Chair: Bill Hudson, Ph.D.
Program Coordinator: Julio Mandojana, Ph.D.

Gale Allen, Ph.D.; Mark Dvorak, Ph.D.; Tom Hendrickson, Ph.D.; Han-Way Huang, Ph.D.; Bill Hudson, Ph.D.; Rajiv Kapadia, Ph.D.; Muhammad Khaliq, Ph.D.; Paul Lindfors, Ph.D.; Julio Mandojana, Ph.D.; Ramakrishna Nair, Ph.D.; Vincent Winstead, P.E., Ph.D.; Qun Zhang, Ph.D.

Computer Engineering (CE) encompasses the research, development, design and operation of computers and computerized systems and their components. This program leads to a Bachelor of Science in Computer Engineering. The primary objective of the Computer Engineering program is to educate engineering professionals who possess sound design and analytical background coupled with a strong laboratory experience supporting Computer Engineering concepts. This means that the department prepares its graduates for:
1. Entry into the engineering work environment with well developed design and laboratory skills.
2. Further study toward advanced degrees in engineering and other related disciplines.
3. Advancement into managerial ranks and/or entrepreneurial endeavors.

The educational objectives for our Bachelor of Science in Computer Engineering degree are to prepare our graduates to:

1. Function as responsible members of society with an awareness of the social, ethical, and economic ramifications of their work.
2. Become successful practitioners in engineering and other diverse careers.
3. Succeed in full time graduate and professional studies.
4. Pursue continuing and life-long learning opportunities.
5. Pursue professional registration.
6. Provide foundational education that allows for personal growth and flexibility through their career.

Our metrics for determining success in meeting these objectives will include:
1. Assessment of societal, economic awareness, and ethical performance of our graduates by the graduate and employer.
2. Monitoring of the success of our graduates in the work force.
3. Monitoring of the success of our graduates in graduate and professional programs.
4. Assessment of continuing and life-long learning by the graduate (and their employer as applicable.).
5. Reviewing the number and success of our students completing professional registration to advance their careers.

In support of these objectives, the program provides a curriculum including the following components that will prepare students for excellent careers in Computer Engineering:
1. A strong background in the physical sciences; mathematics, including discrete math; and engineering sciences, including extensive hands-on laboratory instruction.
2. An integrated design component including instruction in basic practices and procedures, creativity, control, economics, and synthesis. The process begins with basic instruction during the freshman year and concludes with a capstone design project.
3. A choice of sub-disciplines in the senior level electives.
4. Opportunities for students to develop sensitivity to the social and humanistic implications of technology and motivate them to make worthwhile contributions to the profession and society, while upholding the highest standards of professional ethics.
5. A course in engineering economics to promote awareness of the economic aspects of engineering.
6. Preparation for continuing study and professional development.

During the senior year, as allowed by the state, students will be required to take the Fundamentals of Engineering (FE) examination or its equivalent.

The curriculum offers students the opportunity to emphasize a number of specialized areas including advanced digital systems, communications, digital signal processing, networking and system design.

The recommended high school preparation is two years of algebra, one year of geometry, one-half year of trigonometry, one-half year of college algebra, and a year each of physics and chemistry plus a programming language. Without this background it may take students longer than four years to earn a degree. During the first two years students take science and mathematics courses common to all branches of engineering (pre-engineering), as well as supporting work in English, humanities, and social sciences. Second-year computer engineering students complete physics, mathematics and 200-level engineering and computer science courses.

**Admission to Major.** Admission to the college is necessary before enrolling in non-engineering 300- and 400-level courses. Minimum college requirements are:
During spring semester of the sophomore year, students should submit an application form for admission to the Computer Engineering program. Admission to the program is selective and, following applications to the department, subject to approval from the faculty. The department makes a special effort to accommodate transfer students. Only students admitted to the program are permitted to enroll in upper-division engineering courses. No transfer credits are allowed for upper-division engineering courses except by faculty review followed by written permission.

Before being accepted into the program and admitted to 300-level engineering courses (typically in the fall semester), a student must complete a minimum of 56 semester credits including the following:
- General Physics (calculus-based) (10 credits)
- Calculus, Differential Equations, Probability & Statistics (20 credits)
- Electrical Engineering Circuit Analysis I and II (including laboratory) (7 credits)
- Chemistry (5 credits)
- English Composition (4 credits)
- Computer Sciences (Java and C++) (4 credits)
- Introduction to Electrical and Computer Engineering (6 credits)

A cumulative GPA of 2.5 for all science and math courses must have been achieved for program admittance. Grades must be "C" or better for courses to be accepted.

GPA Policy. Students graduating with a degree in Computer Engineering must have:
1. completed a minimum of 20 semester credit hours of upper division EE and CS courses at Minnesota State Mankato.
2. have a cumulative GPA of 2.25 on all upper division EE and CS courses, and
3. have completed their senior design sequence at Minnesota State Mankato.
4. have taken the Fundamentals of Engineering (FE) exam or its equivalent and achieved the desired competency level.

Petition to evaluate transfer credits must occur no later than the first semester the student is enrolled in or declared a major housed in the Department of Electrical and Computer Engineering Technology.

Accreditation
Computer Engineering is not an accredited program by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

P/N Grading Policy. A student who majors in CE must elect the grade option for all required courses including courses offered by another department.

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**COMPUTER ENGINEERING BSEC**

**Required for Major (Prerequisites, 65 credits):**

- **CHEM 201** General Chemistry I (5)
- **COMS 110** Foundations of Computer Science (4)
- **COMS 211** Fundamentals of Computer Science I (4)
- **COMS 212** Fundamentals of Computer Science II (4)
- **COMS 171** Introduction to C++ Programming (3)
- **CS 220** Machine Structures and Programming (3)
- **EE 106** Intro to EE and CE I (3)
- **EE 107** Intro to EE and CE II (3)
- **EE 230** Circuit Analysis I (3)
- **EE 231** Circuit Analysis II (3)
- **EE 235** Microprocessor Engineering Lab I (1)
- **EE 240** Evaluation of Circuits (1)
- **EE 244** Intro to Digital Systems (3)
- **EE 254** Digital and Circuits Lab (1)
- **EE 295** Computer Hardware and Organization (3)
- **ENG 101** Composition I (4)
- **ENG 271** Technical Communication (4) OR
- **SPEE 233** Public Speaking for Technical Professionals (3) OR
- **SPEE 102** Public Speaking (3)
- **MATH 121** Calculus I (4)
- **MATH 122** Calculus II (4)
- **MATH 180** Mathematics for Computer Science (4)
MATH 223 Calculus III (4)
MATH 321 Ordinary Differential Equations (4)

MATH 354 Concepts of Probability and Statistics (3) OR
ME 291 Engineering Analysis (3)

PHYS 221 General Physics I (5)
PHYS 222 General Physics II (5)

Required for Major (additional General Studies) Additional Supporting Studies (13 credits)
Choose a minimum of 13 credits from the following Humanities and Social Sciences courses:

**Humanities (6-7 credits)**
Courses acceptable by department or program include:

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FOREIGN LANGUAGE 200 level or above; HIST all except 490 and higher;

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* Note: EET 125 may be substituted for HUM 250W

**Social Sciences (6-7 credits)**
Courses accepted by department or program include:

| ANTH all courses except 480 and above: |
| GEOR 100 | GEOR 101 | GEOR 103 | GEOR 340 | GEOR 341 | GEOR 425 | GEOR 430 |
| GEOR 435 | GEOR 437 | GEOR 445 | GEOR 446 | GEOR 450 | GEOR 454 | GEOR 456 |

| POL all except: |
| POL 420 | POL 421 | POL 422 | PCL 490 and above; |
| PSYC all except: |
| PSYC 201 | PSYC 202 | PSYC 291 | PSYC 303 | PSYC 390 | PSYC 391 | PSYC 473 and above; |
| SOC all except: |
| SOC 201 | SOC 202 | SOC 466 | SOC 469 | SOC 470 | SOC 485 and above; |
| URBS all except: |
| URBS 301 | URBS 302 | URBS 481 and above; |
| WOST all except: |
| WOST 260 | WOST 277 | WOST 290 | WOST 320 | WOST 430 | WOST 460 and above; |

In general, graduation credits toward the humanities requirement is not allowed for any course in subject areas such as speech communication, writing, art, music or theater that involve performance or practice of basic skills.

At least 3 credits of the courses selected to complete the above requirements must be 300-level or above. At least one 300-level course must follow a lower level course in the same subject area.

For a complete listing of approved Humanities and Social Science courses please consult the department web site.

In addition, you must select one course from the following:

| ECON 201 | Principles of Macroeconomics (3) |
| ECON 202 | Principles of Microeconomics (3) |

**Required for Major (Engineering Plus Computer Science, 40 credits):**

| COMS 310 | Data Structures and Algorithms (4) |
| COMS 320 | Machine Structures and Programming (4) |
COMS 380 — Systems Analysis and Design (4)
COMS 480 — Operating Systems (4)
COMS 462 — Communication Protocols (4) (COMS 362 is pre-req.)
CS 320 — Computer Architecture (3)
CS 380 — Systems Programming (3)
EE 250 — Engineering-Economics (2)
EE 332 — Electronics I (3)
EE 333 — Electronics II (3)
EE 334 — Microprocessor Engineering (3)
EE 336 — Principles of Engineering Design I (1)
EE 337 — Principles of Engineering Design II (1)
EE 341 — Signals and Systems (3)
EE 342 — Electronics Laboratory (1)
EE 344 — Design and Evaluation of Microprocessors (1)
EE 350 — Engineering Electromagnetics (3)
EE 358 — Control Systems (3)
EE 368 — Control Systems Lab (1)
EE 383 — Communication Systems Engineering (2)
EE 383 — Communication Systems Laboratory (1)
EE 380 — Logic Synthesis and Simulation using HDL’s (2)
EE 462 — Computer Architecture (2)
EE 381 — Digital System Design with Testability (3)
EE 382 — Digital System Design with Testability Lab (1)
EE 450 — Engineering Economics (3)
EE 467 — Principles of Engineering Design III (1)
EE 477 — Principles of Engineering Design IV (1)
EE 483 — Advanced Communications Systems Engineering (3) — OR
EE 484 — VHDL Design (3)
ME 299 — Thermal Analysis (2)

Required Electives
Choose a minimum of 7 credits from the following courses:
EE 453, EE 471, EE 472, EE 475, EE 476, EE 479, EE 480, EE 481, EE 484, EE 487

Required Minor: None.

GPA: A cumulative grade-point average of 2.5 for all science, math and engineering courses must have been maintained. Grades must be "C" or better for course to be accepted. Minnesota State Mankato students should complete the pre-engineering courses listed under the major.

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**COURSE DESCRIPTIONS**

**Computer Science**

CS 220

(Add course description)

CS 320

(Add course description)

CS 380

(Add course description)

**COMS 110—(4) Foundation of Computer Science**

This course provides a comprehensive introduction to the foundations of computer science. The topics covered include algorithms, pseudocode, computer theory, computer hardware, computer software, and the related social issues. Lab work develops familiarity with both hardware and software.
The course is intended to provide knowledge and skills applicable to all disciplines while providing a broad introduction to the field of computer science.
Pre: MATH 112 (College Algebra)
Fall, Spring
GE-13
COMS-174 (4) Introduction to C++ Programming
This course provides an introduction to programming using C++. Emphasis on structured programming concepts with a brief discussion of object-oriented programming. Control structures, expressions, input-output, arrays, and functions.
Fall, Spring

COMS-211 (4) Fundamentals of Computer Science I
This is the first course in a two-course sequence for students who are planning to major or minor in computer science. The course emphasizes concepts needed for continuing study in computer science, the use of abstraction in program design, and advanced problem-solving skills. Programming in a high-level language is a focal point of the course.
Prereq: A grade of A or B in COMS-110. Coreq: MATH-121 (Calculus I)
Fall, Spring

COMS-212 (4) Fundamentals of Computer Science II
This course is a continuation of COMS-211. The course introduces students to object-oriented concepts and programming techniques. It also covers essential data structures such as linked lists, stacks, and queues, and trees. The student will be expected to produce larger applications, utilizing multiple compilation units.
Prereq: COMS-211
Fall, Spring

COMS-310 (4) Data Structures & Algorithms
Study of trees, hashing, and graph algorithms. Analysis of algorithms, memory management, and proof techniques.
Prereq: COMS-212, MATH-180 or MATH-121
Fall, Spring

COMS-330 (4) Machine Structures and Programming
Introduction to computer hardware and its design including Boolean logic, basic digital circuits, number representations, and digital arithmetic. Instruction set design, digital storage, performance metrics, processor datapath, and control, pipelining, memory hierarchy, buses, and I/O interfacing, parallel processing.
Prereq: COMS-212, MATH-180 or MATH-121
Fall, Spring

COMS-380 (4) Systems Analysis & Design
This course explores both structured as well as object-oriented systems analysis and design. Use of upper-end-tower CASE tools are employed in the analysis, design, and implementation of a team-oriented term project.
Prereq: COMS-212, Fall, Spring
Prereq: COMS-260 or COMS-320, Spring

COMS-462 (4) Communication Protocols
Advanced coverage of data communication and networking protocols with an emphasis on protocol design and implementation. Topics addressed will include data transmission methods, error detection and recovery, flow control, routing, data throughput, and performance analysis of existing and emerging Internet protocols.
Prereq: COMS-362
Variable

Electrical Engineering

EE-101 (4) Introduction to Engineering I
Discussion of historical, educational, and professional aspects of engineering. Problem solving, study approaches and techniques, and the motivation behind modern engineering education and practices. Lab sessions cover the basics of word processing, spreadsheets, databases, drawing, and graphing programs as well as preparation of plan to graduation and study techniques.
Fall

EE 106 (3) Introduction to EE and CE I
(Add course description)

EE 107 (3) Introduction to EE and CE II
(Add course description)

EE 230 (3) Circuit Analysis I
This course is meant to develop Electrical Engineering Circuit Analysis skills in DC and AC circuits. It includes circuit laws and theorems, mesh and node analysis. Natural and step response of RL, RC, and RLC circuits.
Prereq: PHYS 222 or concurrent, MATH 321 or concurrent
EE 231 (3) Circuit Analysis II
Continuation of Circuit Analysis I to include special topics in circuit analysis.
Pre: EE 230 and EE 240, MATH 321, PHYS 222
Spring

EE 235 (1) Microprocessor Engineering Lab I

(Add course description.)

EE 240 (1) Evaluation of Circuits
Prerequisites: Must be taken concurrently with EE 230.
Fall

EE 244 (2) Introduction to Digital Systems
Simple coding schemes, Boolean algebra fundamentals, elements of digital building blocks such as gates, flip-flops, shift registers, memories, etc.; basic engineering aspects of computer architecture.

EE-250 (3) Engineering Economics
Overview of accounting and finance and their interactions with engineering, manufacturing, marketing, R&D and sales. Lectures include the development and analysis of financial statements, time value of money, decision-making tools, ratio analysis, cost of capital, depreciation, taxes, cash flow, rate of return and forecasting.
Fall

EE 253 (1) Logic Circuits Lab
Laboratory support to complement EE 244. Use of laboratory instrumentation to measure characteristics of various logic circuits and digital subsystems. Experimental evaluation of digital logic devices and circuits including logic gates, flip-flops, and sequential machines.
Prerequisite: EE 230 and concurrent with EE 244.
Spring

EE 254 (1) Digital and Circuits Lab
Laboratory support for EE 231 and EE 244. Experimental evaluation of AC and transient circuits, digital logic devices including logic gates, flip flops, and sequential machines.
Pre: EE 230, EE 240 and concurrently with EE 231 and EE 244
Spring

EE 295 (3) Computer Hardware and Organization

(Add course description.)

EE 298 (1-4) Topics
Varied topics in Electrical and Computer Engineering. May be repeated as topics change.
Prerequisite: to be determined by course topic

EE 303 (3) Introduction to Solid State Devices
Introduction to crystal structure, energy band theory, conduction and optical phenomenon in semiconductors, metals and insulators. Study of equilibrium and non-equilibrium charge distribution, generation, injection, and recombination. Analysis and design of PN-junctions, (bipolar transistor, junction) and MOS field-effect transistors. Introduction to transferred electron devices and semiconductor diode laser.
Pre: PHYS 222, and MATH 321
Fall

EE 304 (1) Lab: Introduction to Solid State Devices
Laboratory support for EE 303. Experiments include resistivity and sheet resistance measurements of semiconductor material, probing material, probing of IC chips, PN-junction IV and CV measurements, BJT testing to extract its parameters, MOSFET testing and evaluating its parameters, CV-measurements of MOS structure, and familiarization with surface analysis tools.
Fall

EE 332 (3) Electronics I
Semiconductor device characteristics including diodes, BJTs, JFET's and MosFET's. Also discuss DC bias circuits, along with small signal, large signal, and SPICE device modeling and analysis. Small-signal amplifiers (single and Multi-stage), power amplifiers, differential amplifiers, and feedback
amplifier, concepts and design will be discussed.

EE 333 (3) Electronics II
This is the second course of the electronics sequence. Design and analysis skills will be developed by examining the 741 and related devices. Additional course topics include filters, tuned circuits, signal generators, and wave-shaping. Digital circuits including the basics of various forms of MOS and bipolar digital logic and memory will be studied.
Pre: EE 332
Spring

EE 334 (3) Microprocessor Engineering
Use of microprocessors and microcontrollers in engineering applications. Topics include assembly language programming, smart and programmable controllers, memory design including dynamic memory and direct memory access, bus standards and protocol, serial and parallel I/ O, interfacing with other programmable systems, maskable and non-maskable interrupts.
Pre: EE 244
Fall

EE 336 (1) Principles of Engineering Design I
(Add course description.)

EE 337 (1) Principles of Engineering Design II
Application of the design techniques in the engineering profession. Electrical engineering project and program management and evaluation including computer assisted tools for planning and reporting, design-to-specification techniques and economic constraints.
Pre: Admission to EE program
Spring

EE 341 (3) Signals & Systems
Analysis of linear systems and signals in the time and frequency domain. Laplace and Fourier transforms. Z-transform and discrete Fourier transforms.
Pre: MATH 321
Spring

EE 342 (1) Electronics Laboratory
This lab is designed to accompany EE 332. The lab covers the experimental measurement and evaluation of diode, BJT, and MOS characteristics; various feedback topologies; oscillator and op-amp circuits; and rectifiers and filter circuitry.
Pre: EE 231 and EE 332 taken concurrently.
Fall

EE 344 (1) Design & Evaluation of Microprocessors
Laboratory support for EE 334. Study of various single board computers through assembly language programming. Basic input/output, ports, memory, addressing, timers, A/D converters, seria and parallel communication protocol, and interrupt processing.
Pre: Concurrent with EE 334
Fall

EE 350 (3) Engineering Electromagnetics
Pre: MATH 223 and PHYS 222
Spring

EE 353 (3) Communication Systems Engineering
Pre: EE 332
Spring

EE 358 (3) Control Systems
Pre: EE 341
Spring

EE 363 (1) Communication Systems Laboratory
Bit error measurement.
Pre: Concurrent with EE 353
Spring

EE 368 (1) Control Systems Laboratory
Laboratory support for EE 358. Experimental evaluation of basic control system concepts including transient response and steady state performance. Analog and digital computers.
Pre: EE 341 and concurrent with EE 358
Spring

EE 380 (2) Logic Synthesis and Simulation using HDLs
Design of combinational and sequential systems and peripheral interfaces. Emphasis is placed on hardware description languages, computer-aided tools, simulations, and implementation.

EE 381 (3) Digital System Design with Testability
(Add course description.)

EE 382 (1) Digital System Design with Testability Lab
(Add course description.)

EE 439 (3) Electronics for Non-Electrical Engineering Majors
Topics covered include power supplies, operational amplifiers and feedback circuits, linear and nonlinear circuits and applications, analog switches, digital logic gates and devices, A/D and D/A converters, microprocessors, and basic control systems.
Pre: PHYS 221 and PHIL 222
Variable

EE 450 (3) Engineering Economics
(Add course description.)

EE 453 (3) Advanced Communications Systems Engineering
Behavior of analog systems and digital systems in the presence of noise, principles of digital data transmission, baseband digital modulation, baseband demodulation/detection, bandpass modulation and demodulation of digital signals. Channel coding, modulation and coding trade-offs, spread spectrum techniques, probability and information theory.
Pre: EE 353 and EE 363
Fall

EE 462 (3) Computer Architecture
A study of various computer architectures, including concepts of instruction, execution, instruction pipe-lining, superscalar design, multiprocessor systems, memory system design, and I/O system design.

EE 463 (3) Advanced Digital System Design
Design of combinational and sequential systems and peripheral interfaces. Design techniques using MSI and LSI components in an algorithmic state machine; implementation will be stressed. Rigorous timing analysis, transmission-line effects and metastability of digital systems will be studied.
Prerequisite: EE 244

EE 467 (1) Principles of Engineering Design I I I
The design and organization of engineering projects. Project proposals, reporting, feasibility studies, and interpretation. Specification preparation, interpretation, and control. Issues involving creativity, project planning and control, and intellectual property rights. Students enrolled in this course must initiate and complete a design project in a small team format.
Pre: EE 337 and senior standing
Fall

EE 471 (3) Advanced Control Systems
This course is a continuation of EE 358. Techniques for the analysis of continuous and discrete systems are developed. These techniques include pole placement, state estimation, and optimal control.
Pre: EE 358 and EE 368
Fall

EE 472 (3) Digital Signal Processing
Develop design and analysis techniques for discrete signals and systems via Z-transforms, Discrete Fourier Transforms, implementation of FIR and IIR filters. The various concepts will be introduced by the use of general and special purpose hardware and software for digital signal processing.
EE 475 (3) Integrated Circuit Engineering
Introduction to theory and techniques of integrated circuit fabrication processes, oxidation, photolithography, etching, diffusion of impurities, ion implantation, epitaxy, metallization, material characterization techniques, and VLSI process integration, their design and simulation by SUPREM.
Pre: EE 303 and EE 392
Fall

EE 476 (3) Antennas, Propagation, & Microwave Engineering
Principles of electromagnetic radiation, antenna parameters, dipoles, antenna arrays, long wire antennas, Microwave antennas, Mechanisms of radiowave propagation, scattering by rain, sea water propagation, guided wave propagation, periodic structures, transmission lines, microwave/millimeter wave amplifiers and oscillators, MIC & MMIC technology.
Pre: EE 350
Variable

EE 477 (1) Principles of Engineering Design IV
Completion of design projects and reports. Lectures on ethics, issues in contracting and liability, concurrent engineering, ergonomics and environmental issues, economics and manufacturability, reliability and product lifetimes. Lectures by faculty and practicing engineers.
Pre: EE 467
Spring

EE 479 (3) Superconductive Devices
Pre: EE 303
Variable

EE 480 (1) Integrated Circuit Fabrication Lab
Introduction to integrated circuit fabrication processes, device layout, mask design, and experiments related to wafer cleaning, etching, thermal oxidation, thermal diffusion, photolithography, and metallization. Fabrication of basic integrated circuit elements pn junction, resistors, MOS capacitors, BJT and MOSFET in integrated form. Use of analytic tools for in process characterization and simulation of the fabrication process by SUPREM.
Pre: Concurrent with EE 475
Fall

EE 481 (1) VLSI Design Laboratory
This laboratory accompanies EE 484. The laboratory covers the basics of layout rules, chip floor planning, the structure of standard cells and hierarchical design, parasitic elements, routing, and loading. Students will learn to design and layout standard cells as well as how to use these cells to produce complex circuits. The laboratory culminates with the individual design and layout of a circuit.
Pre: Concurrent with EE 484
Spring

EE 482 (3) Electromechanics
Electrical power and magnetic circuit concepts, switch-mode converters, mechanical electromechanical energy conversion, DC motor drives, feedback controllers, AC machines and space vectors, permanent magnet AC machines and drives, induction motors and speed control of induction motors, stepper motors.
Pre: EE 230
Fall

EE 484 (3) VLSI Design
Pre: EE 333
Spring

EE 487 (3) RF Systems Engineering
Pre: EE 353 and EE 363
Variable

EE 488 (2) Thermal Systems Engineering
Environmental property sensors.
Pre: PHYS 222 and EE 333

EE 491 (1-4) In-Service

EE 497 (1-6) Internship

EE 498 (1-4) Topics
Varied topics in Electrical and Computer Engineering. May be repeated as topics change. Prerequisite: to be determined by course topic

EE 499 (1-6) Individual Study