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MichiganTech

Department of
Electrical and Computer Engineering

# Computer Engineering

## Technical Electives

## 1 Definition of Technical Electives

In the Computer Engineering Program, technical electives are 3,000-level or higher courses approved by the ECE Department Undergraduate Program Committee (UPC). On rare occasions, the UPC may list a 2,000-level course if and only if, in the UPC's opinion, it has *exceptional* technical content, focus, and rigor for a 2,000-level course.

## 2 Breadth and Depth Requirements

Technical Electives are grouped into "tracks", based on their content. Students must satisfy both *Breadth* and *Depth* requirements in their technical elective courses. Specifically:

- **Depth**: each student must complete at least 6 credits of coursework within any one track of the student's choosing.

- **Breadth**: each student must complete at least 3 credits in any track other than his/her chosen depth track (i.e., the student's technical electives must span at least two tracks).

## 3 Technical Elective Tracks

There are currently four technical elective tracks to choose from in the Computer Engineering program.

1. The **Embedded Systems** track focuses on embedded real-time systems. Courses in this track cover topics related to real-time control and/or digital signal processing applications. Students with depth in this track will be particularly attractive to embedded system design and manufacturing firms.

2. The **General Purpose Systems** track focuses on general purpose and high performance applications. Course topics in this track include computer architecture, operating systems, networking and communication, compilers, and software engineering. Students with depth in this track will be particularly attractive to general purpose computer firms.

3. The **Theory** track focuses on fundamental topics of a more theoretical or abstract nature. While a firm theoretical background is beneficial to any student, it may be particularly useful to students planning to pursue post-graduate education.

4. The **Enterprise** track contains courses listed as elective modules for the university's Enterprise program, and judged by the ECE Department Undergraduate Program Committee to have sufficient technical content, focus, and rigor.

# 4 Technical Elective Course List

The current list of Technical Elective Courses and their track assignments are listed in Appendix A. This list will be modified by the ECE Dept Undergrad Program Committee (UPC) on an as-needed basis to accommodate new courses, dropped courses, and/or significant content changes in existing courses. In addition, *the following conditions and restrictions apply*:

1. Some Technical Elective courses may be listed in more than one track. When a student takes such a course, the student may decide which of the listed tracks it shall be applied to.

2. In Appendix A, some table entries list a *range* of courses instead of a single course (e.g. All Math 4000-level courses are listed in single entry). This is done *only* to save space in the table. A student may take more than one course from the range of courses listed in any such entry (subject to all restrictions below).

3. One semester's employment in the Cooperative Education (*Co-op*) Program is equivalent to 2 credits of technical electives. All Co-op credits are assigned to the *Enterprise* track. *No more than 4 credits* of Co-op experience may be counted toward the degree requirements.

4. For *new* courses, the instructor initiating the course shall recommend track assignment(s) to the UPC.

5. "Special Topics" classes and other one-time classes with a fixed syllabus may be used as technical electives only with permission of the UPC. All such classes will be evaluated for technical content, focus, and rigor on a case-by-case basis.

6. Thesis, Research, Special Project and other "Individual Study" or "Team Project" style courses present assessment, grading, and quality control problems not found in other courses. Therefore, courses of this type may be used as technical electives only under the conditions specified in Appendix B. All such instances require departmental approval.

# Appendix A - CpE Approved Technical Electives Courses

9 credits minimum required:
at least 6cr. from one track
and 3 cr. from alternate

| Course Number and Title | | Embed | Gen Pur | Theory | Enterp |
|---|---|---|---|---|---|
| MA3150 | Multivariable Calculus | | | X | |
| MA3160 | Multivariable Calc with Tech | | | X | |
| MA3202 | Intro to Coding Theory | | X | X | |
| MA3203 | Intro to Cryptography | | X | X | |
| MA3210 | Intro to Combinatorics | | | X | |
| MA3310 | Intro to Abstract Algebra | | | X | |
| MA3450 | Intro to Real Analysis | | | X | |
| *MA4xxx* | *Math 4000-level crses* | | | X | |
| *MA5xxx* | *Math 5000-level crses* | | | X | |
| | | | | | |
| | | | | | |
| *CSxxxx* | Safety Critical Programming | X | | | |
| CS 3141 | Team Software Project | X | X | | |
| CS 3311 | Formal Models of Comp. | | | X | |
| CS 3411 | Systems Programming | | X | | |
| CS 3451 | Computer Administration | | X | | |
| CS 3621 | Computer Graphics | | X | | |
| CS 4121 | Programming Languages | | | X | |
| CS 4131 | Compiler Construction | | X | | |
| CS 4311 | Intro to Computation Theory | | | X | |
| CS 4321 | Intro to Algorithms | | | X | |
| CS 4331 | Intro to Parallel Programming | | X | | |
| CS 4421 | Database Systems | | | X | |
| CS 4451 | Network Administration | | X | | |
| CS 4461 | Computer Networks | | X | | |
| CS 4471 | Comp & Net Security | X | X | | |
| CS 4481 | Comp & Net Perf Analysis | X | X | | |
| CS 4611 | Intro to Computer Graphics | | | X | |
| CS 4711 | Software Processes & Management | X | X | | |
| CS 4712 | Software QA | X | X | | |
| CS4760 | Human-Computer Interactions | | X | | |
| CS 4811 | Artificial Intelligence | | | X | |
| CS 5131 | Compiler Optimization | | X | | |
| CS 5311 | Computation Theory | | | X | |
| CS 5321 | Adv. Algorithms | | | X | |
| CS 5331 | Parallel Algorithms | | | X | |
| CS 5411 | Advanced Operating Systems | | X | | |
| CS 5431 | Adv. Computer Architecture | | X | | |
| CS 5441 | Distributed Systems | | X | | |
| CS-5461 | Mobile Networks | X | X | | |
| *CS 56xx* | *Adv Graphics {CS 5600-5699}* | | | X | |
| CS 5711 | Adv. Software Engineering | X | X | | |
| CS 5811 | Adv. Artificial Intelligence | | | X | |
| | | | | | |

| Course Number and Title | | Embed | Gen Pur | Theory | Enterp |
|---|---|---|---|---|---|
| EE3140 | Electromagnetics | | | X | |
| EE3180 | Probability & Random Signal Anal. | X | | X | |
| EE3221 | Motor Drives | X | | | |
| EE4231 | Physical Electronics | | | X | |
| EE4232 | Electronic Applications | X | X | | |
| EE4250 | Communication Science | | | X | |
| EE4252 | Digital Signal Processing | X | | X | |
| EE4253 | Real Time Signal Processing | X | | | |
| EE4255 | Wireless Communications | | X | X | |
| EE4257 | Digital Image processing | X | | | |
| EE4261 | Classical Control Systems | X | | | |
| EE4262 | Digital and Non-linear Control | X | | | |
| EE4271 | Verilog HDL Design | | X | | |
| EE4272 | Computer Networks | | X | | |
| EE4723 | Comp. & Network Security | X | X | | |
| EE4732 | Real-Time System Design | X | | | |
| EE4735 | Embedded System Programming | X | | | |
| EE4751/575 | Verilog HDL Design | | X | X | |
| EE5220 | Transient Analysis Methods | | | X | |
| EE5340 | Statistical Optics | X | | X | |
| EE5410 | Engineering Electromagnetics | | | X | |
| EE5430 | Electronic Materials | | | X | |
| EE5500 | Statistical Signal Processing | X | | | |
| EE5520 | Fourier Optics | X | | X | |
| EE5522 | Digital Image processing | X | | | |
| EE5725 | Multi-Robot Systems demand | X | | | |
| *EE573x* | *Real-Time {EE 5730 - 5739}* | X | | | |
| EE5752 | Digital Storage Technologies | | X | | |
| EE5755 | Fault-Tolerant Systems demand | X | X | | |
| *EE577x* | *Adv Arch {EE 5770 - 5779}* | | X | | |
| MEEM4705 | Intro Robotics and Mechatronics | X | | | |
| | | | | | |
| *NNxxxx* | *Individual/team crses (see App B)* | | | | |
| ENT395- | Enterprise Market Principles | | | | X |
| ENT395( | Industrial Health and Safety | | | | X |
| ENT395( | Ethics in Eng'g Dsgn & Implem. | | | | X |
| ENT3961 | Enterprise Strategic Leadership | | | | X |
| ENT396- | Technology Commercialization | | | | X |
| ENT396- | Project Management | | | | X |
| ENT396( | Design for Manufacturing | | | | X |
| ENT397- | Practical Circuit Design | | | | X |
| ENT4951 | Bus. Plans & Budgeting in Ent. | | | | X |
| ENT495- | Global Competition | | | | X |
| *CO-OP* | *MTU Cooperative Ed Pgm* | | | | X |

*Look up semester offerings and pre-reqs*

# Appendix B – Rules and Procedures

## for Accepting Individual or Team Courses as CpE Technical Electives

The following rules and procedures are established to ensure that the academic rigor of Thesis, Research, Special Project and other “Individual Study" or “Team Project” courses accepted as CpE Technical Electives are consistent with that of established elective courses. These requirements are in addition to any prerequisites or other requirements imposed for the particular course in question.

# 1 General Requirements

1. **Proposal**: The student(s) wishing to take the course shall, in collaboration with the course instructor, submit a formal proposal for each course section for which CpE technical elective credit is requested.

2. **Approval**: Each proposal requires approval of the ECE Chair (or his/her designated representative).

3. **Timeline**: Proposals *must* be submitted to the ECE Undergraduate Advisor no later than the end of the first week of the term in question. Proposals *should* be submitted before the start of the term so that the approval process can be completed before the end of the free add/drop period.

4. **Outcomes**: Results produced must be documented in a final report, oral presentation, and/or poster.

5. **Eligibility**:

    a. **Student**: Each student must, at the time of submission, have a cumulative GPA ≥ 3.0.

    b. **Topic**: The course topic must be one that the instructor believes will yield publishable results, which he/she plans to incorporate into a submission external to MTU (e.g. a conference, workshop, or journal submission), with the student(s) listed as co-author(s).

    c. **Course Number**: The course number must be ≥ 3,000.

    d. **Grading**: Letter grades must be given; pass-fail options are *not* permitted.

6. **Multi Term Projects:** if the proposed section is part of a multi-term project, then:

    a. Only *one* report, oral presentation, or poster is required at the end of the *entire* project.

    b. Grades of *Incomplete* shall be given in intervening terms (similar to graduate theses) and converted to a letter grade upon completion of the entire project.

    c. A new proposal must be submitted for each term of the project.

7. **Elective Track**: The course instructor shall recommend which track the section applies to.

8. **Credits**: The course instructor shall determine the number of credits per section.

9. **Credit Limit**: No more than *6 credits total* may be counted toward the fulfillment of CpE technical electives by an individual student. They may be distributed over as many terms as desired.

# 2 Course Proposal

## 2.1 Style and Formatting

The main text of the proposal shall be printed in 12 point *times-new-roman* font (or equivalent)[1], and shall be single spaced, with one inch margins on all four sides. Professional, publication-quality writing style, grammar, spelling, and punctuation are expected.

## 2.2 Organization and Content

Each proposal must contain the following information, in the format specified below:

### 2.2.1 Title Page (one page per proposal),

- Project title
- Course number and term
- Name(s) of student(s) involved
- Name of instructor
- A 100 to 150 word Abstract for the *entire* project.

### 2.2.2 Statement of Work Page (one page per proposal)

A Statement of Work shall be presented, defining at least the goals, methods, and deliverables defined for the *entire* project. It must be sufficiently detailed to allow the ECE Chair to assess the academic rigor and eligibility of the course and to give the instructor a sufficient basis to assign grades for the course.

### 2.2.3 Certification Pages (one page per *student*),

The instructor shall review the first two pages of the proposal, and:

1. *For each individual student,* complete *Part 1* of a certification page as shown on page B.3,
2. Append all certification pages to the back of the proposal,
3. Forward the entire proposal package to the ECE undergraduate advisor.

The ECE Undergraduate Advisor shall ensure that each student meets the eligibility requirements, complete *Part 2* of each Certification Page, and forward the entire package to the ECE Chair.

The ECE Chair (or designated representative) shall review the package and complete *Part 3* of each Certification Page. This allows approval of the proposal as a whole with disapproval of any student who is ineligible. The course may then proceed without the participation of the ineligible student(s).

[1] Titles, section headers, etc may be larger than 12 points.

# Certification Page

***Part 1: Instructor's Certification***

Name of Student (one student per page) _____

Course Number _____ Term – Year _____ Credits for this term[2] _____

Elective Track to which this course shall be applied _____

This course section comprises term number _____ of an anticipated _____ term project.

Is the content of this course/project substantially different from the content of all *required* courses in the CpE bachelor's degree curriculum? Yes / No

Will a final written report, oral presentation, and/or poster be produced by the student(s) by the end of the *entire* project? Yes / No

Is it your intent to incorporate the final results of the project into a publication or presentation submission external to MTU, with the student(s) listed as co-author(s)? Yes / No

Is the "Statement of Work" sufficiently detailed to permit you to assign grades fairly and accurately at the completion of the entire project? Yes / No

Instructor's Signature _____ Date: _____

***Part 2: Undergraduate Advisor's Certification:***

As of this date, does this student have a cumulative GPA of at least 3.0? Yes / No

Advisor's Signature _____ Date: _____

***Part 3: ECE Department Approval:***

Does the ECE Department approve of both the content of this proposal as a technical elective for the CpE degree, and of this student's participation therein? Yes / No

Department Chair's Signature _____ Date: _____

[2] The suggested formula for determining credits is: (expected_hours_per_term / 42), rounded to the nearest integer.