(2004-) 2017 Computer Engineering Program

Electrical Engineering & Computer Science Department
Undergraduate Advising Office
3415 EECS (734.763.2305)/ 2808 BBB (734.763.6563)

This brochure applies to students who entered the College of Engineering during or after Fall 2004*

Thank you for your interest in the Computer Engineering (CE) program. Computer engineering focuses on the theory and practice of analysis and design of complex digital systems, including general-purpose computers and special-purpose embedded systems. CE straddles the line between hardware and software, and partially overlaps computer science and electrical engineering programs. CE students learn how to design hardware-software systems from transistors to systems software. Microprocessors are a central topic, and our curriculum includes both designing microprocessors and building hardware-software systems that contain microprocessors. While many of our graduates go on to work at traditional computer companies (e.g., AMD, Apple, ARM, IBM, Intel, Microsoft, RedHat, and Samsung), many also go to work for the much more numerous companies that embed computers within other products such as cars, consumer electronics, appliances, medical devices, tractors, and airplanes.

Undergraduate Advising Office Information:

If you are considering or declared as a CE major, we highly recommend that you see a CE faculty advisor every term, even if you know what courses you want to take. There may be options or constraints that you are unaware of as you plan your schedule. Frequent meetings with a faculty advisor will help ensure that you get the most out of your education here and that you have no surprises when you apply for your diploma. To see a faculty advisor, please set up an appointment online at **https://www.eecs.umich.edu/eecs/undergraduate/index.html.**

For routine questions not covered by this handout, such as whether a course will satisfy a particular requirement, you have several options:

- Check the EECS Advising Web page: **http://www.eecs.umich.edu/eecs/undergraduate/index.html**. This site includes information about scheduling appointments with advisors, registration procedures, course offerings, book lists, time schedules, advising hours, and career planning advice.
- Talk to the EECS Undergraduate Advising Office staff. Feel free to drop in at the EECS Undergraduate Advising Offices (3415 EECS or 2808 BBB) or email **eceadvising@umich.edu**.
- Email us at **ceadvisor@umich.edu**.

EECS Grading & Repeat Policies

A grade of C- or below in any of the College Core, Program Core, or Technical Electives is considered a failing grade and the course must be repeated or substituted with another. [Note: Grades of C- through D- are acceptable for Intellectual Breadth requirements or for Free Electives.] Students are limited to attempting each of the three 200-level courses (EECS 203, EECS 280, EECS 281) at most twice. An attempt includes, but is not limited to, a notation of any letter grade ("A-F"), withdraw ("W"), Pass/Fail ("P"/"F"), Transfer ("T"), or Incomplete ("I") posted on your U-M transcript. At most one attempt from Summer 2014 and earlier will count against this limit. Exceptions to this rule can be granted by the Chief Program Advisor *only in extraordinary circumstances.*

This handout covers rules and advice for the CE program as of the 2016–2017 academic year. By default, your program is determined by the rules that are in effect when you enter the College of Engineering. See the advising web page or contact us if you have any questions.

(2004-) 2017 Computer Engineering
Core, Upper Level, and EECS Elective Requirements

Core Electives

8 credits (2 courses) from the following list (prerequisites in parentheses):

281: Algorithms & Data Structures (EECS 203 & 280)
312: Digital Circuits (EECS 216)
351: Intro. Digital Signal Process. (EECS 216)
373: Microproc. Based Systems (EECS 270 & 370)

Upper Level CE Electives

10 credits (typically 3 courses) from the following list, one of which should be a Major Design Experience course offering, see next section for more details (prerequisites in parentheses):

427: VSLI Design I (EECS 270, 312, & 320)
442: Computer Vision (EECS 281)
452: Digital Signal Processing Design Lab (EECS 280, 216, & [351 or 455])
461: Embedded Control Systems (EECS 216 or 373)
467: Autonomous Robotics (EECS 281)
470: Computer Architecture (EECS 270 & 370)
473: Adv. Embedded Sys. (EECS 373 & [215 or 281])
478: Logic Circuit Synthesis & Opt. (EECS 203 & 270)
482: Intro to Operating Systems (EECS 281 & 370)
483: Compiler Construction (EECS 281 & 370)
489: Computer Networks (EECS 482)
527: Layout Synthesis and Optimization (EECS 281 or 478) and (EECS 427 or EECS 470)
570: Parallel Computer Architecture (EECS 470)
573: Microarchitecture (EECS 470)
578: Computer-Aided Design Verification of Digital Systems (EECS 478)
582: Advanced Operating Systems (EECS 482)
583: Advanced Compilers (EECS 281 & 370)
589: Advanced Computer Networks (EECS 489)
627: VLSI Design II (EECS 427)

Major Design Experience (MDE)

The MDE in Computer Engineering has three parts which must be elected concurrently:

1. EECS 496, a 2-credit course covering non-technical aspects of design, such as large multidisciplinary project design principles, team strategies, ethics, entrepreneurial skills, and social and environmental awareness
2. TCHNCLCM 496, a 2-credit technical communication course
3. An approved 400-level course that devotes the majority of the class to a large design and implementation project or a series of closely related projects

Approved MDE courses for Computer Engineering:
EECS 427 VLSI Design I (EECS 270 and EECS 312 and EECS 320)
EECS 452 Digital Signal Processing Design Laboratory (EECS 280 and (EECS 216) and (EECS 351))
EECS 467 Autonomous Robotics (EECS 281)
EECS 470 Computer Architecture (EECS 270 and 370)
EECS 473 Advanced Embedded Systems (EECS 373 & [215 or 281])

No longer MDE courses from Fall 2012, onward:
EECS 483 Compiler Construction and EECS 583 Advanced Compilers

Additions and deletions may be made to this list at any time; check with the advising office before committing to a particular course. You may request special permission to use an MDE project course from another program (including the Multidisciplinary Design Program), but this class will generally not count as an upper-level elective (normally it is a flex tech). If you plan on taking advantage of this option you must discuss this with the CE Chief Program Advisor.

EECS Elective

3 credits (typically 1 course) from the following EECS courses: 281, 311, 312, 320, 330, 334, 351, 373, 376, 381, 388, 411, 413, 414, 417, 419, 420, 421, 423, 424, 427, 429, 430, 434, 435, 438, 441, 442, 445, 452, 453, 455, 458, 460, 461, 467, 470, 473, 475, 477, 478, 480, 481, 482, 483, 484, 485, 586, 487, 489, 492, 493, 494, 497, and MECHENG 552 (for dual CE-ME majors only). Other EECS courses may be approved on a case-by-case basis.

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Flexible Technical Elective Requirements

Listed below are courses that meet the Flexible Technical Elective requirement for CS-Eng, CS-LSA, and CE. Other courses (including Special Topics courses like EECS 398 and 498) may be approved on a term-by-term basis. Please see the Undergraduate Advising Office with questions. **All tutoring and seminar courses are excluded.**

Directed/Independent Study Rule: Up to 4 credits of directed study (ENGR 355, ENGR 455, EECS 499 only; EECS 399 counts toward General Electives) count toward Flexible Technical Elective requirements. This applies to all independent/directed study courses including those from other departments and multidisciplinary design. Additional credits count toward General Electives. The credits must be taken for a letter grade to meet FTE requirements.

Aerospace Engineering

AEROSP 215	Intro to Solid Mechanics & Aerospace Structures	300-level & above (except 494 & 495), for AERO 390 & 490: see Directed Study Rule
AEROSP 225	Intro to Gas Dynamics	

Atmospheric, Oceanic and Space Sciences

Any AOSS course at the 300-level of higher (499: see Directed Study Rule above)

Biology

BIO 305	Genetics	Any 400-level and above course (see Directed Study Rule above)

Biomedical Engineering

BIOMEDE 221	Biophysical Chemistry	300-level & above (490, see Directed Study Rule)
BIOMEDE 231	Intro to Biomechanics	

Chemical Engineering

CHE 230	Material & Energy Balances	300-level & above, CHE 490 subject to Directed Study Rule above

Chemistry

CHEM 210	Structure and Reactivity I	CHEM 241	Introduction to Chemical Analysis (2 cr.)
CHEM 211	Investigations in Chemistry (1 cr.)	CHEM 242	Intro. to Chemical Analysis Lab. (2 cr.)
CHEM 215	Structure and Reactivity II (3 cr.)	CHEM 260	Chemical Principles (3 cr.)
CHEM 216	Synth. & Characterization of Org. Compounds (2 cr.)	300-level or higher (see Directed Study Rule above)	
CHEM 230	Physical Chemical Principles and Applications (3 cr.)		

Civil and Environmental Engineering

CEE 211	Statics and Dynamics	CEE 230	Energy and Environment
CEE 212	Solid and Structural Mechanics	CEE 265	Sustainable Engineering Principles
		300-level & above (except 303, see Directed Study Rule above)	

Complex Systems

CMPLXSYS 270	Agent Based Modeling

Economics

ECON 401	Intermediate Microeconomic Theory (last term as a Flex Tech- Fall'13)	ECON 409	Game Theory
ECON 402	Intermediate Macroeconomic Theory (last term as a Flex Tech- Fall'13)	ECON 452	Intro. to Statistics and Econometrics II

Electrical Engineering and Computer Science

EECS 230	Electromagnetics I	EECS 285	A Programming Language or Computer System (2 cr)
		300-level & above (except EECS 314, 399, 406, 410; 499 subject to Directed Study Rule)	

Engineering

ENGR 350	International Lab Experience for Engineers
ENGR 355	Intermed. Multidisciplinary Engin. Project (see Directed Study Rule above)
ENGR 403	Scientific Visualization

ENGR 450	Multidisciplinary Design (see Directed Study Rule above)
ENGR 455	Advanced Multidisciplinary Design (see Directed Study Rule above)

Industrial and Operations Engineering

~~IOE 201~~	~~Economic Decision Making (2 cr.) [not open to students with senior standing] (last term as a Flex Tech- FA12)~~

IOE 202	Operations Modeling (2 cr.) [not open to students with senior standing]
300-level & above, except 373 & 422 (490 subject to Directed study rule)	

Materials Science and Engineering

MATSCIE 220	Intro to Materials & Manufacturing
MATSCIE 242	Physics of Materials

MATSCIE 250	Principles of Engineering Materials
300-level & above (MATSCIE 490, see Directed study rule above)	

Mathematics

MATH 214	Linear Algebra and Differential Equations*
MATH 216	Introduction to Differential Equations

MATH 217	Linear Algebra*
Any MATH course at the 300-level of higher (except 310, 327, 333, 385, 389, 399, 422, 429, 431, 485, 486, 489, 497)	

Mechanical Engineering

MECHENG 211	Introduction to Solid Mechanics
MECHENG 235	Thermodynamics I (3 cr.)

MECHENG 240	Introduction to Dynamics and Vibrations
MECHENG 250	Design and Manufacturing I
300-level & above (MECHENG 490 & 491, see Directed study rule above)	

Naval Architecture and Marine Engineering

NAVARCH 260	Introduction to Nuclear Engineering
NAVARCH 270	Marine Design

300-level & above (NAVARCH 490, see Directed study rule above)

Nuclear Engineering and Radiological Sciences Engineering

~~NERS 211~~	~~Introduction to Nuclear Engineering (last term as a Flex Tech- FA12)~~

NERS 250	Fundamentals of Nuclear Engineering
300-level & above, 499 subject to Directed study rule	

Performing Arts Technology (PAT dual majors ONLY)

PAT 452	Interactive Media Design II (3 cr.)

PAT 462	Digital Sound Synthesis (3 cr.)

Physics

Any 300-level course or above (except 333, 334, 365, 420, 481) Tutoring classes are excluded

School of Information

SI 301	Models of Social Info. Processing
SI 364	Building Interactive Applications

SI 422	Evaluation of Systems and Services

Statistics

STATS 401	Applied Statistical Methods II
STATS 403	Intro to Quantitative Research Methods
STATS 406	Introduction to Statistical Computing
STATS 415	Data Mining and Statistical Learning

STATS 426	Introduction to Theoretical Statistics (3 cr.)
STATS 430	Applied Probability
STATS 470	Introduction to the Design of Experiments
STATS 531	Analysis of Time Series

Technology & Operations

TO 414	Advanced Analytics (3 cr.)

*Credit will only be given for ONE of the following courses: MATH 214, 217, 417, 419, and 513.

(2004-) 2017 Computer Engineering
Advisory Track Options

The CE program does not require that students choose a specific track. However, each track represents a coherent course of study on a particular topic that a student may later pursue as a career. CE tracks have some overlap, so that (a) students do not have to commit to a single track from their junior year, (b) most students will be able to change their track half-way through without delaying their graduation, and (c) most students taking "reasonable courses" should be able to complete a track by selecting two appropriate courses in their final semester. Underlined courses meet the MDE requirement (however, the list of MDE-approved courses undergoes small changes in most semesters – please check the latest list). Those *in italics* are *not* CE electives. Undergraduate students may take 500-level courses, but only one such course counts toward a track.

Computer Architecture: 281, 470, and two of (373, 427, 570, 573). This track teaches students how to design modern microprocessors and microprocessor-based systems starting from components such as logic gates. Students interested in designing the next generation of microprocessors should select this track.

Computer-Aided Design: 281, 478 and two of ((470 or 427), 477, 480, 527, 578, 579, 586). This track prepares students to improve and use sophisticated automated integrated circuit and computer system design algorithms and software tools. Functional validation and test of digital systems are part of this track. Students who want a deep understanding of logic design fundamentals and using computers to aid in the design the next-generation digital integrated circuits should select this track.

Computer-Based Control Systems*: 373, 460, 461, and one of (281, 560, 561). This track prepares students to design and build computer systems that monitor and control mechanical and other physical processes in real time. Students interested in developing and implementing the algorithms that unify sensors, computers, and actuators into machines that are heavily integrated into the physical world should select this track. Also see *Robotics and Vision* track.

Digital Signals and Systems: *301*, 351, 452 and one of (442, 455, 501, 556). This track prepares students to design digital hardware-software systems that encode, decode, transform, and analyze digital signals. Students interested in developing a theoretical understanding and thorough practical skills for manipulating and communicating video, audio, and other digital signals should select this track.

Embedded Systems: 281, 373, and two of (452, 458, 461, 473, 489, 571, 598-Embedded). This track prepares students for the analysis and design of application-specific computers that run smartphones, medical devices, wireless sensor networks, and vehicles. Topics such as low-power design, real-time systems, and hardware security are covered. Students interested in designing portable and application-specific computer systems should select this track.

Robotics and Vision: 281, 442, 467 and one of (461, 492, 556, 568). This track prepares students to design computer systems that move through their physical environments, recognize objects and activities, and draw conclusions about their surroundings. Relative to the "Computer-Based Control Systems" track, the Robotics and Vision track is (1) more focused on specific applications, (2) involves multi-dimensional geometry, linear algebra, as well as motion and mechanical modeling, to a greater extent, and (3) focuses more on high-level algorithms and systems. Students interested in designing the digital controllers for robots should select this track.

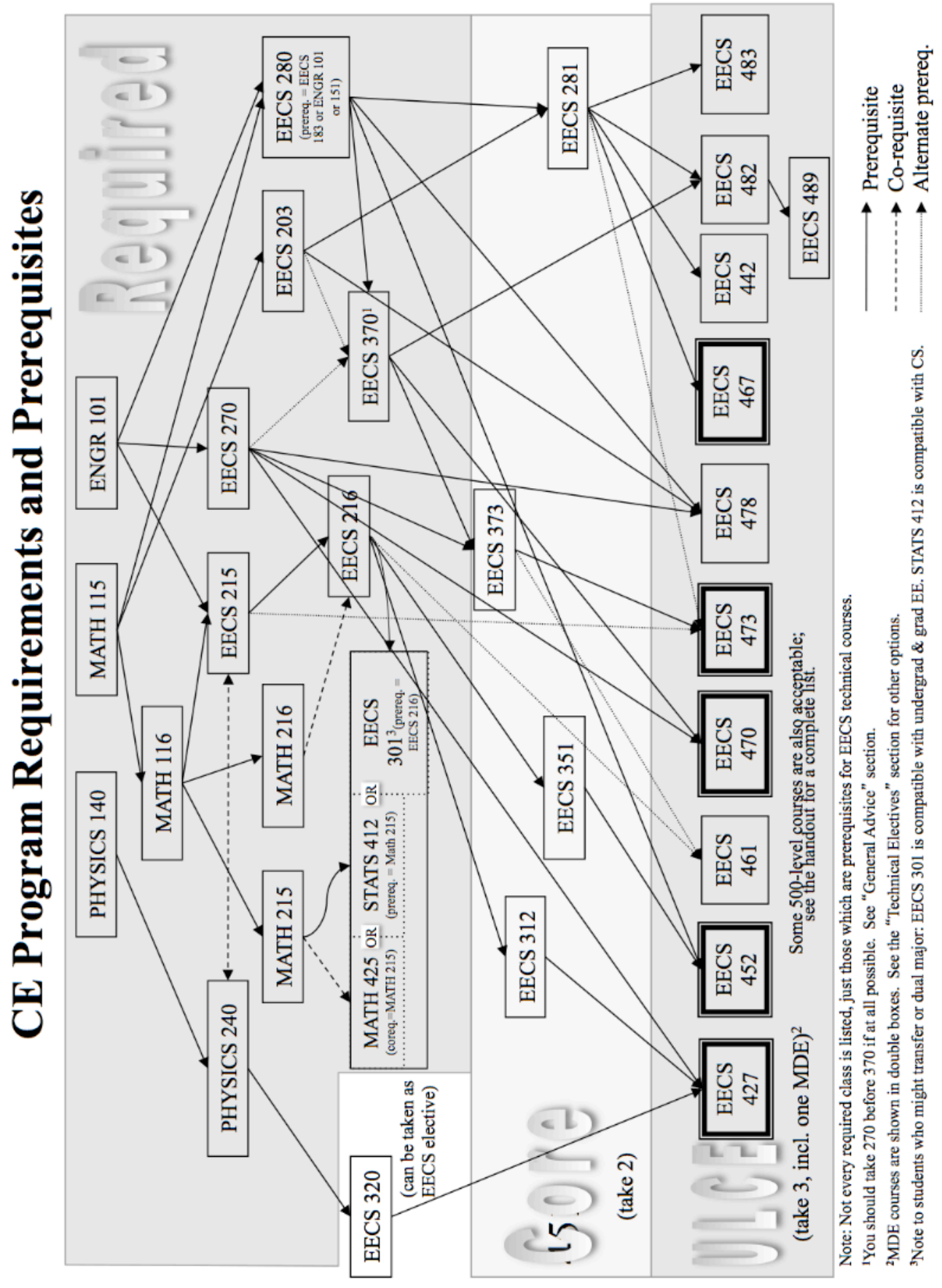
System Software*: 281, 373, 482 and one of (483, 489, 571, 582, 583). In this track, students develop an expertise in designing software that interacts heavily with the hardware and/or environment of the system on which it runs. Students interested in understanding the application- and hardware-dependent implications of software design decisions, such as processing speed, security, usage of memory and power, should select this track.

VLSI systems (Chip Design): 312, 320, 427 and one of (311, 470, 478, 527, 627). This track prepares students for the analysis and design of high-performance, low-power, and reliable integrated circuits. If you want to design the complex, high-performance, and energy-efficient digital circuits that are fundamental to modern and future computers, then this is the track for you.

Custom Track: Intended for students with high GPA and a strong motivation to pursue specific educational goals. A faculty sponsor is recommended, especially for students actively involved in research. If you want to be a jack of all trades or have a plan of study that does not fit into any of the above tracks, discuss the plan with your advisor and create a custom track.

* This track does not currently include an MDE. Students will still need to meet the MDE requirement.

(2004-) 2017 Computer Engineering
Prerequisite Dependency Graph



(2004-) 2017 Computer Engineering Program
Sample Schedule (2016): B.S.E. Computer Engineering

		Terms							
	Credit Hours	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Subjects required by all programs (55 hrs.)									
Mathematics 115, 116, and 216	12	4	4	-	4	-	-	-	-
Mathematics 215	4	-	-	-	-	4	-	-	-
[1]ENGR 100	4	-	4	-	-		-	-	-
ENGR 101	4	4	-	-	-	-	-	-	-
[2]Chemistry 125/130 or Chemistry 210/211	5	-	5	-	-	-	-	-	-
Physics 140 with Lab 141; 240 with Lab 241	10	5		5	-	-	-	-	-
Intellectual Breadth	16	4	4	-	4	-	4	-	-
Program Subjects (32 hrs.)									
[3]EECS 203, Discrete Mathematics	4	-	-	4	-	-	-	-	-
[4]EECS 215, Introduction to Circuits	4	-	-	-	4	-	-	-	-
EECS 216, Signals and Systems	4	-	-	-	-	4	-	-	-
EECS 270, Intro to Logic Design	4	-	-	4	-	-	-	-	-
EECS 280, Programming and Elem. Data Structures	4	-	-	-	4	-	-	-	-
EECS 370, Intro to Computer Organization	4	-	-	-	-	4	-	-	-
EECS 301, Math 425 or Stat 412	3	-	-	-	-	-	3	-	-
TCHNCLCM 300	1	-	-	-	-	1	-	-	-
[5]TCHNCLCM 496/EECS 496	4	-	-	-	-	-	-	-	4
Technical Electives (28 hrs.)									
[6]Flexible Technical Electives	7	-	-	-	-	-	-	5	2
[6]EECS Electives	3	-	-	-	-	-	-	3	-
Core Electives	8	-	-	-	-	-	8	-	-
[6]Upper Level CE Electives	10	-	-	-	-	-	-	4	6
Free Electives (13 hrs.)	13	-	-	3	-	3	-	4	3
Total	**128**	**17**	**17**	**16**	**16**	**16**	**15**	**16**	**15**

This is only an example. Don't be concerned if your schedule differs.

[1] Although any ENGR 100 section is acceptable, students interested in CE are encouraged to consider the "Microprocessors and Toys" section when offered. Note that this section requires ENGR 101 or prior programming experience as a prerequisite.

[2] Students who qualify are encouraged to take CHEM 210 (4 hrs.) & CHEM 211 (1 hr.) as a replacement for CHEM 130 (3 hrs.) & 125/126 (2 hrs.).

[3] MATH 465 may be used in place of EECS 203.

[4] EECS 215 must be preceded or accompanied by Physics 240.

[5] TCHNCLCM 496 and EECS 496 are to be taken concurrently with each other and with a technical Major Design Experience (MDE) course.

[6] Extra credits may flow from Upper Level Electives to EECS Electives to Flexible Technical Electives. As such most students will fulfill these requirements by taking three 4-credit Upper Level Electives, one 4-credit EECS Elective and one 4-credit Flexible Technical Elective.

(2004-) 2017 Computer Engineering
General Advice and Information

- Most technical electives can be counted in multiple elective categories, and while they cannot be counted more than once, they can be split between two eligible categories. For example, EECS 489 counts as an upper-level elective, an EECS elective, and a flexible technical elective. You may count all 4 credits toward your upper-level elective, or two credits toward your upper-level electives and two credits toward your EECS elective, or three credits toward your EECS elective and one credit toward your flexible technical electives.

- **Most students are able to satisfy their upper-level (10 credits), EECS (3 credits), and flexible technical elective requirements (7 credits) with five 4-credit courses**: three classes from the upper-level list, one additional EECS elective course, and one from the flexible technical elective list. All of the upper-level elective courses can count as EECS electives, and anything that can count as an EECS elective also counts as a flexible technical elective.

- **Intellectual Breadth – WARNING: This is easy to mess up!** The rules about Intellectual Breadth requirements are complex and not always intuitive. See the CoE Bulletin for details: (**http://www.engin.umich.edu/college/academics/bulletin/ug-ed/reqs - intellectualbreadth**). **If you have questions, please contact the EECS Undergraduate Advising Office.** Note that **Test Credit for Foreign Languages** (AP credits and credits by exam) at the 100-level count only as general electives. For more information about credit for languages, contact the appropriate department, e.g., the Asian Languages Dept. maintains information in the Chinese exam, etc.

- The advising office maintains workload surveys by polling current undergrads to gather their opinions of the workload in various EECS courses. These are helpful when planning courses for future semesters and can be viewed here: http://www.eecs.umich.edu/eecs/undergraduate/survey/

- Try to balance the number and types of classes you take in a term. Most students had best avoid taking more than three EECS classes at once; depending on the specific classes, two EECS classes and a free elective can be plenty! Among the classes you take, it is typically easier to take a lab class and a programming class as opposed to two lab classes or two programming classes. 270, 215, 216, 373, and 452 are all lab classes. 280, 281, 482, 483, and 489 are all programming classes. 203 and MATH 425 are both math classes. 373, 427, and 470 all include very time-consuming labs/projects; you should not take more than one of these in a given term.

- **The Michigan Embedded Systems Hub** (http://www.eecs.umich.edu/hub/) is a great place to learn about the basics of embedded systems (embedded programming, soldering, and board design) and to get help with projects. It offers a number of introductory lessons and there are office hours for getting help with personal projects.

Unofficial CoE Student Advising Form - Computer Engineering

For advising only; NOT official audit. Students -- consult with your advisor to confirm course selections satisfy degree requirements.

Last Name: _____ First Name: _____ Emplid: _____ Unique ID: _____ GPA: ____ CTP:__ Elected Hrs:__
Req Term: ____Minor(s): _____Honor(s): _____Dual: _ Subplan: _____ As of: _____

Common Requirements (CoE)

Units Required: 36-39 Units (In Progress and Earned): _

- ☐ Math115
- ☐ Math116
- ☐ Math215
- ☐ Math216
- ☐ Engr100
- ☐ Engr101
- ☐ Chem 130 or 210
- ☐ Chem 125/126 or 211
- ☐ Physics140
- ☐ Physics141
- ☐ Physics240
- ☐ Physics241

☐ 50 units minimum residency taken at UM-AA campus

Category	Subject	Nbr	Sctn	Units	Term	Grade	Note

Intellectual Breadth

☐ Units Required: 16 Units Earned:
☐ 3 units of Humanities ☐ Upper Div (3 units min)

Category	Subject	Nbr	Sctn	Units	Term	Grade	Note

General Electives (General)

Units Required: 13 Units Earned: _ ☐ 128 Credits Toward Prog Req

Category	Subject	Nbr	Sctn	Units	Term	Grade	Note

Courses not eligible or not used for credit (NFC)

Category	Subject	Nbr	Sctn	Units	Term	Grade	Note

Program Subjects (Prog)

Units Required: 32 Units Earned: _ Major GPA: _

- ☐ EECS203
- ☐ EECS215
- ☐ EECS216
- ☐ EECS270
- ☐ EECS280
- ☐ EECS370
- ☐ EECS496
- ☐ TCom300
- ☐ TCom496
- ☐ EECS301/MATH425/STATS412

☐ 30 units 300 or higher tech courses taken at UM-AA while enrolled in CoE

Category	Subject	Nbr	Sctn	Units	Term	Grade	Note

Program Core Electives (Core)

☐ Core: EECS 281,312,351,373 Units Reqd: 8 Units Earned:_

Category	Subject	Nbr	Sctn	Units	Term	Grade	Note

Upper Level Technical Elec(ULTE) + Major Design (MDE)

☐ Units Required: 10 Units Earned: _ ☐ MDE

Category	Subject	Nbr	Sctn	Units	Term	Grade	Note

EECS Electives (EECS)

☐ Units Required: 3 Units Earned: _

Category	Subject	Nbr	Sctn	Units	Term	Grade	Note

Flex Technical Electives (FlexTech)

☐ Units Required: 7 Units Earned: _

Category	Subject	Nbr	Sctn	Units	Term	Grade	Note

Advisor:_____ Date:_____