University of Minnesota policy, instructional time per credit:
https://policy.umn.edu/education/instructionaltime

University of Minnesota policy, expected academic work per credit:
https://policy.umn.edu/education/studentwork

Course descriptions*

*derived from https://onestop2.umn.edu/pcas/viewCatalogProgram.do?programID=108&strm=1183&campus=UMNTC

EE 5621 - Physical Optics

Credits: 3.0 [max 3.0]

Typically offered: Every Spring

Physical optics principles, including Fourier analysis of optical systems/images, scalar diffraction theory, interferometry, and coherence theory. Diffractive optical elements, holography, astronomical imaging, optical information processing, microoptics.

prereq: [3015, CSE grad student] or dept consent

EE 5613 - RF/Microwave Circuit Design Laboratory

Credits: 2.0 [max 2.0]

Grading Basis: A-F only

Typically offered: Every Spring

Scattering parameters, planar lumped circuits, transmission lines, RF/microwave substrate materials, matching networks/tuning elements, resonators, filters, combiners/dividers, couplers. Integral lab.

prereq: [[5601 or concurrent registration is required (or allowed) in 5601], CSE grad student] or dept consent

EE 5601 - Introduction to RF/Microwave Engineering

Credits: 3.0 [max 3.0]

Typically offered: Periodic Fall & Spring

Fundamentals of EM theory and transmission lines concepts. Transmission lines and network analysis. CAD tool. Lumped circuit component designs. Passive circuit components. Connectivity to central communication theme.

prereq: [3601

EE 4951W - Senior Design Project (WI)

Credits: 4.0 [max 4.0]

Typically offered: Every Fall & Spring

Team participation in formulating/solving open-ended design problems. Oral/written presentations.

prereq: 3015, 3115, 3102, attendance first day of class

EE 4161W - Energy Conversion and Storage (WI)

Credits: 3.0 [max 3.0]

Typically offered: Every Spring

Fundamental physics/chemistry of selected energy conversion and energy storage devices. Connections with their electric power applications. Role of grid, application to electric vehicles. Lectures, lab, student presentations.

prereq: 3161 or instr consent

EE 5333 - Analog Integrated Circuit Design

Credits: 3.0 [max 3.0]

Typically offered: Every Fall

Fundamental circuits for analog signal processing. Design issues associated with MOS/BJT devices. Design/testing of circuits. Selected topics (e.g., modeling of basic IC components, design of operational amplifier or comparator or analog sampled-data circuit filter).

prereq: [3115, CSE grad student] or dept consent

EE 5323 - VLSI Design I

Credits: 3.0 [max 3.0]

Typically offered: Every Fall

Combinational static CMOS circuits. Transmission gate networks. Clocking strategies, sequential circuits. CMOS process flows, design rules, structured layout techniques. Dynamic circuits, including Domino CMOS and DCVS. Performance analysis, design optimization, device sizing.

prereq: [2301, 3115, CSE grad student] or dept consent

EE 4231 - Linear Control Systems: Designed by Input/Output Methods

Credits: 3.0 [max 3.0]

Course Equivalencies: 01355 - AEM 4321/EE 4231/ME 5281

Typically offered: Every Fall

Modeling, characteristics, performance of feedback control systems. Stability, root locus, frequency response methods. Digital implementation, hardware considerations.

prereq: [3015, [upper div CSE or grad student in CSE major]] or instr consent

EE 3161 - Semiconductor Devices

Credits: 3.0 [max 3.0]

Typically offered: Every Fall & Spring

Elementary semiconductor physics; physical description of pn junction diodes, bipolar junction transistors, field-effect transistors.

prereq: Upper div CSE, 2011, Phys 1302, Phys 2303 or Chem 1022

EE 4341 - Embedded System Design

Credits: 4.0 [max 4.0]

Typically offered: Every Spring

Microcontroller interfacing for embedded system design. Exception handling/interrupts. Memory Interfacing. Parallel/serial input/output methods. System Buses and protocols. Serial Buses and component interfaces. Microcontroller Networks. Real-Time Operating Systems. Integral lab.

prereq: 2301, 2361, upper div CSE

EE 4111 - Advanced Analog Electronics Design

Credits: 4.0 [max 4.0]

Typically offered: Every Spring

Basic integrated circuit building blocks of differential amplifiers, high bandwidth, instrumentation amplifiers. Current/voltage references. Feedback, stability, and noise in electronic circuits. Integral lab.

prereq: 3015, 3115

EE 3601 - Transmission Lines, Fields, and Waves

Credits: 3.0 [max 3.0]

Typically offered: Every Fall, Spring & Summer

Properties of transmission lines, electrostatics, magnetostatics, and electromagnetic waves in unbounded space. Guides, cavities, radiation theory, antennas.

prereq: [2011, [Math 2243 or Math 2373 or Math 2573], [Phys 1302 or Phys 1402], CSE] or dept consent

EE 3102 - Circuits and Electronics Laboratory II

Credits: 2.0 [max 2.0]

Typically offered: Every Fall, Spring & Summer

Experiments in circuits/electronics. Team design project.

prereq: [3101 or CSE or dept consent], attendance first day of class

EE 3025 - Statistical Methods in Electrical and Computer Engineering

Credits: 3.0 [max 3.0]

Typically offered: Every Fall, Spring & Summer

Notions of probability. Elementary statistical data analysis. Random variables, densities, expectation, correlation. Random processes, linear system response to random waveforms. Spectral analysis. Computer experiments for analysis and design in random environment.

prereq: [3015, CSE upper division] or instr approval

EE 4301 - Digital Design With Programmable Logic

Credits: 4.0 [max 4.0]

Typically offered: Every Fall & Summer

Introduction to system design/simulation. Design using Verilog code/synthesis. Emulation using Verilog code.

prereq: 2301, [1301 or CSCI 1113 or CSCI 1901]

EE 3115 - Analog Electronics

Credits: 3.0 [max 3.0]

Typically offered: Every Fall, Spring & Summer

Basic differential amplifiers using FETs and BJTs. Current sources for differential amplifiers. Op-amp-based differential amplifiers. IC op amps as multi-stage amplifiers. Ideal (dc) feedback. Stability and compensation of negative feedback amplifiers. Sinusoidal oscillators. Waveshaping circuits. Power amplifiers. Use of circuit simulators.

prereq: [3015 or concurrent registration is required (or allowed) in 3015, CSE upper division] or dept consent

EE 3101 - Circuits and Electronics Laboratory I

Credits: 2.0 [max 2.0]

Typically offered: Every Fall, Spring & Summer

Experiments in circuits/electronics.

prereq: [2002, [3115 or concurrent registration is required (or allowed) in 3115], CSE] or dept consent

EE 3015 - Signals and Systems

Credits: 3.0 [max 3.0]

Typically offered: Every Fall & Spring

Basic techniques for analysis/design of signal processing, communications, and control systems. Time/frequency models, Fourier-domain representations, modulation. Discrete-time/digital signal/system analysis. Z transform. State models, stability, feedback.

prereq: [2011, CSE Upper Division] or dept consent

CHEM 1066 - Chemical Principles II Laboratory (PHYS)

Credits: 1.0 [max 1.0]

Course Equivalencies: 01879 - Chem 1066/Chem 1076H

Grading Basis: A-F only

Typically offered: Every Fall, Spring & Summer

Basic laboratory skills while investigating physical and chemical phenomena closely linked to lecture material. Experimental design, data collection and treatment, discussion of errors, and proper treatment of hazardous wastes.

prereq: concurrent registration is required (or allowed) in 1062

CHEM 1062 - Chemical Principles II (PHYS)

Credits: 3.0 [max 3.0]

Course Equivalencies: 01885 - Chem 1062/Chem 1072H

Typically offered: Every Fall, Spring & Summer

Chemical kinetics. Radioactive decay. Chemical equilibrium. Solutions. Acids/bases. Solubility. Second law of thermodynamics. Electrochemistry/corrosion. Descriptive chemistry of elements. Coordination chemistry. Biochemistry.

prereq: Grade of at least C- in 1061 or equiv, concurrent registration is required (or allowed) in 1066; registration for 1066 must precede registration for 1062

EE 2361 - Introduction to Microcontrollers

Credits: 4.0 [max 4.0]

Typically offered: Every Fall, Spring & Summer

Basic computer organization, opcodes, assembly language programming, logical operations and bit manipulation in C, stack structure, timers, parallel/serial input/output, buffers, input pulse-width and period measurements, PWM output, interrupts and multi-tasking, using special-purpose features such as A/D converters. Integral lab.

Prereq: 2301, [1301 or CSCI 1113 or CSCI 1901]

EE 2011 - Linear Systems, Circuits, and Electronics

Credits: 3.0 [max 3.0]

Typically offered: Every Fall, Spring & Summer

Sinusoidal steady state analysis. AC power calculations. Laplace transforms. Laplace transforms in circuit analysis. Elementary filter circuits. Frequency response of elementary MOSFET amplifiers. BJT characteristics and biasing. BJT small signal models and elementary amplifiers. Frequency response of BJT amplifiers. Use of circuit simulators.

prereq: 2001

PHYS 1302W - Introductory Physics for Science and Engineering II (PHYS, WI)

Credits:	4.0 [max 4.0]
Course Equivalencies:	00079
Typically offered:	Every Fall & Spring

Use of fundamental principles to solve quantitative problems. Motion, forces, conservation principles, fields, structure of matter. Applications to electromagnetic phenomena.

prereq: 1301W, concurrent registration is required (or allowed) in Math 1272 or Math 1372 or Math 1572

EE 2301 - Introduction to Digital System Design

Credits:	4.0 [max 4.0]
Typically offered:	Every Fall & Spring

Boolean algebra, logic gates, combinational logic, logic simplification, sequential logic, design of synchronous sequential logic, VHDL modeling, design of logic circuits. Integral lab.

prereq: MATH 1272 or MATH 1372 or MATH 1572

EE 2002 - Introductory Circuits and Electronics Laboratory

Credits:	1.0 [max 1.0]
Typically offered:	Every Fall, Spring & Summer

Introductory lab in electronics to accompany 2001. Experiments with simple circuits. Familiarization with basic measurement tools and equipment.

prereq: 2001 or concurrent registration is required (or allowed) in 2001

EE 2001 - Introduction to Circuits and Electronics

Credits: 3.0 [max 3.0]

Typically offered: Every Fall, Spring & Summer

Physical principles underlying circuit element models. Kirchhoff's laws. Independent/dependent sources. Opamps. Linearity in circuits. Diodes and rectification. FET characteristics, biasing, small signal models, and simple amplifiers. Transients in first- and second-order circuits. CMOS-based logic gates. Circuit simulators.

prereq: concurrent registration is required (or allowed) in PHYS 1302, concurrent registration is required (or allowed) in (MATH 2243 or MATH 2373 or MATH 2573)

CHEM 1065 - Chemical Principles I Laboratory (PHYS)

Credits: 1.0 [max 1.0]

Course Equivalencies: 01878 - Chem 1065/Chem 1075H

Grading Basis: A-F only

Typically offered: Every Fall, Spring & Summer

Basic laboratory skills while investigating physical and chemical phenomena closely linked to lecture material. Experimental design, data collection and treatment, discussion of errors, and proper treatment of hazardous wastes.

prereq: concurrent registration is required (or allowed) in 1061

CHEM 1061 - Chemical Principles I (PHYS)

Credits: 3.0 [max 3.0]

Course Equivalencies: 01884 - Chem 1061/Chem 1071H

Typically offered: Every Fall, Spring & Summer

Atomic theory, periodic properties of elements. Thermochemistry, reaction stoichiometry. Behavior of gases, liquids, and solids. Molecular/ionic structure/bonding. Organic chemistry and polymers. energy sources, environmental issues related to energy use.
Prereq-Grade of at least C- in [1011 or 1015] or [passing placement exam, concurrent registration is

required (or allowed) in 1065]; intended for science or engineering majors; concurrent registration is required (or allowed) in 1065; registration for 1065 must precede registration for 1061

PHYS 1301W - Introductory Physics for Science and Engineering I (PHYS, WI)

Credits:	4.0 [max 4.0]
Course Equivalencies:	00078
Typically offered:	Every Fall, Spring & Summer

Use of fundamental principles to solve quantitative problems. Motion, forces, conservation principles, structure of matter. Applications to mechanical systems.

prereq: concurrent registration is required (or allowed) in Math 1271 or concurrent registration is required (or allowed) in Math 1371 or concurrent registration is required (or allowed) in Math 1571

MATH 2243 - Linear Algebra and Differential Equations

Credits:	4.0 [max 4.0]
Course Equivalencies:	Math 2243/2373/2573
Typically offered:	Every Fall, Spring & Summer

Linear algebra: basis, dimension, matrices, eigenvalues/eigenvectors. Differential equations: first-order linear, separable; second-order linear with constant coefficients; linear systems with constant coefficients.

prereq: [1272 or 1282 or 1372 or 1572] w/grade of at least C-

LA 1201 - Learning from the Landscape (AH, DSJ)

Credits:	3.0 [max 3.0]
Grading Basis:	A-F or Aud
Typically offered:	Every Fall

Physical elements shaping the world. Shapes, forms, and order of towns, cities, and countryside. How design, planning, and natural systems, taken together, shape physical surroundings. Lectures, discussions, field trips.

CSE 1001 - First Year Experience

Credits: 1.0 [max 1.0]

Grading Basis: A-F only

Typically offered: Every Fall

Resources and strategies for college success. Majors and career opportunities offered in the physical sciences, mathematics, and engineering. Personal responsibility, academic integrity, and level of academic rigor required for success. Personal action plan for achievement in CSE.

prereq: CSE, fr

CSCI 1113 - Introduction to C/C++ Programming for Scientists and Engineers

Credits: 4.0 [max 4.0]

Typically offered: Every Fall, Spring & Summer

Programming for scientists/engineers. C/C++ programming constructs, object-oriented programming, software development, fundamental numerical techniques. Exercises/examples from various scientific fields.

prereq: Math 1271 or Math 1371 or Math 1571H or instr consent

WRIT 1301 - University Writing

Credits: 4.0 [max 4.0]

Course Equivalencies: 00120 - Writ 1301/Writ 1401

Grading Basis: A-F only

Typically offered: Every Fall, Spring & Summer

Drafting, revising, editing. Academic genres. Critical reading, rhetorical analysis for principles of audience, purpose, and argumentative strategies. Emphasizes electronic/print library. Critical analysis, annotated bibliography, research paper.

prereq: Placement in Writ 1301

NSCI 1001 - Fundamental Neuroscience: Understanding Ourselves (TS)

Credits: 3.0 [max 3.0]

Grading Basis: A-F only

Typically offered: Every Fall & Spring

Assessing objectively the neuroscience information presented to public at-large across various media outlets. Explaining the potential importance of these discoveries.

MATH 2263 - Multivariable Calculus

Credits: 4.0 [max 4.0]

Course Equivalencies: Math 2263/2373/2573H/3251

Typically offered: Every Fall, Spring & Summer

Derivative as linear map. Differential/integral calculus of functions of several variables, including change of coordinates using Jacobians. Line/surface integrals. Gauss, Green, Stokes Theorems.

prereq: [1272 or 1372 or 1572] w/grade of at least C-

GEOG 1403 - Biogeography of the Global Garden (BIOL, ENV)

Credits: 4.0 [max 4.0]

Course Equivalencies: 02180

Typically offered: Every Fall & Spring

The geography of biodiversity and productivity, from conspicuous species to those that cause human disease and economic hardship. The roles played by evolution and extinction, fluxes of energy, water, biochemicals, and dispersal. Experiments demonstrating interactions of managed and unmanaged biotic with the hydrologic cycle, energy budgets, nutrient cycles, the carbon budget, and soil processes.

POL 1001 - American Democracy in a Changing World (SOCS)

Credits: 4.0 [max 4.0]

Course Equivalencies: (Select a set)

Typically offered: Every Fall, Spring & Summer

Introduction to politics/government in the United States. Constitutional origins/development, major institutions, parties, interest groups, elections, participation, public opinion. Ways of explaining politics, nature of political science. Emphasizes recent trends.

GER 1003 - Intermediate German

Credits: 5.0 [max 5.0]

Course Equivalencies: 01186 - Ger 1003/Ger 4003

Typically offered: Every Fall, Spring & Summer

Listening, reading, speaking, writing. Contextualized grammar/vocabulary. Authentic readings. Essay assignments.

prereq: 1002 or Entrance Proficiency Test

CSCL 1401W - Reading Literature: Theory and Practice (LITR, WI)

Credits: 3.0 [max 3.0]

Typically offered: Every Fall & Spring

How can we read/understand different ways that literature is meaningful? Emphasizes practice in reading a broad spectrum of world literature, literary theory.