

**120. Elements of Computer Programming**

Fall, Winter, Spring, Summer. 3(3-0)  
MTH 111 concurrently. Students may not receive credit in both 110 and 120.

FORTRAN programming; arithmetic and logical operations; functions and subroutines.

**300. Computer Programming**

Fall, Winter, Spring, Summer. 3(2-4)  
110 or 120.

Programming techniques, digital representation of data, computer structure and organization. Recent developments in computing.

**301. Digital Computers**

Fall, Winter, Spring. 4(4-0) 110 or 120 or approval of department.

Computer arithmetic including number systems, operations, logic organization; instructional codes.

**302. Machine and Assembly Languages**

Winter, Spring, Summer. 4(4-0) 301.

Characteristics of machine languages; details of computer instructions; contrasts with compiler languages; structure of assembly languages including fixed and relocatable addresses, mnemonic codes, pseudo instructions, program linkage and macro instructions.

**303. Compiler Languages and Monitors**

Fall, Spring, Summer. 4(4-0) 302.

Implementation of compilers; function and implementation of higher level systems; multi-programming.

**305. List Processing Languages**

Winter. 3(3-0) 110 or 120 or approval of department.

The mechanics of a typical list-processing language will be presented with illustrative problems; characteristics, advantages and disadvantages of the language will be considered.

**306. COBOL Programming**

Spring. 3(3-0) 110 or 120 or approval of department.

The mechanics of COBOL, a business data processing language, will be presented with illustrative problems; characteristics, advantages and disadvantages of the language will be considered.

**411. Information Theory**

Winter. 3(3-0) 303, STT 441.  
Information measure, coding, transmission and recognition associated with man-machine systems.

**421. Digital Computer Design**

Fall. 3(3-0) 303, PHY 288.  
Number systems; Boolean algebra; switching problems using combinational logic; minimization of combinational networks.

**422. Sequential Machines I**

Winter. 3(3-0) 421.  
Digital computer operations and the associated design of control elements using synchronous and combinational switching circuits.

**423. Sequential Machines II**

Spring. 3(3-0) 422.  
Design of arithmetic, memory, and input-output units including the use of asynchronous switching circuits.

**451. Mechanical Language I**

Fall. 3(3-0) 503; MTH 215.  
The basis of mechanical language, conventions, literals and variables; arithmetic and logical operations; structured operands.

**452. Mechanical Language II**

Winter. 3(3-0) 451.  
Search and scanning methods for ranking; key transformations; metaprograms.

**453. Mechanical Language III**

Spring. 3(3-0) 452.  
Computation graphs and minimization techniques relating to memory use; compiled instruction generation and special register allocation.

**490. Special Problems**

Fall, Winter, Spring, Summer. 1 to 5 credits. Approval of department.  
Investigation of a topic in the computer area, either hardware or software.

**801. Special Problems**

Fall, Winter, Spring, Summer. 1 to 4 credits. May re-enroll for a maximum of 8 credits. Approval of department.

**811. System Methodology and Simulation**

Fall. 3(2-3) MTH 215; STT 441 or concurrently. Interdepartmental with Systems Science and Social Science (College of) and administered by Systems Science.

First of three courses providing a working knowledge of the design and control of multi-process systems by simulation. Needs analysis, feasibility analysis, preliminary design using simulation models, microscopic simulations—Monte Carlo, analog, digital and hybrid simulation of macroscopic systems, simulation languages, applications to physical and socioeconomic systems.

**812. System Identification**

Winter. 3(2-3) SYS 811. Interdepartmental with Systems Science and Social Science (College of) and administered by Systems Science.

Identification of system structure from operating data; correlation function, frequency response, multi-point boundary value, econometric and other methods, applications to physical and socioeconomic systems.

**813. System Project**

Spring. 3(1-6) SYS 812. Interdepartmental with Systems Science and Social Science (College of) and administered by Systems Science.

Team application of simulation methods to the design and/or control of a multi-process system. Projects will be taken from case studies or new problem areas where appropriate.

**817. Parametric Pattern Recognition**

Winter. 3(3-0) STT 441, computer programming.  
The decision-theoretic approach to pattern recognition using decision rules, parameter estimation, sub-optimum strategies, optimum strategy without learning, learning, and sequential recognition.

**818. Nonparametric Pattern Recognition**

Spring. 3(3-0) 817.  
The non-statistical approach to pattern recognition. Discriminant functions, clustering, non-parametric learning, and algorithms for recognition.

**825. Theory of Combinational Circuits**

Fall. 3(3-0) 423 or approval of department.

Switching algebra and related group and lattice theory; decomposition; the synthesis of multiple-output switching functions using multi-level combinational circuits.

**826. Theory of Digital Machines**

Winter. 3(3-0) 825.  
Sequential machines; machine specification in terms of states and transitions; decomposition; state minimization and assignment.

**827. Switching Theory**

Spring. 3(3-0) 826.  
Asynchronous and speed independent circuits; static and dynamic hazards; use of race conditions.

**831. Operator Precedence Grammars**

Fall. 3(3-0) 453 or approval of department.

Grammar definition; techniques of recognition; matrix representation of precedence relations; sentence decomposition using precedence matrices.

**832. Bounded Context Translation**

Winter. 3(3-0) 831.  
Algorithms for analyzing bounded context grammars; introduction to transformational grammars.

**833. Formal Programming Systems**

Spring. 3(3-0) 832.  
Coconstruction of a formal programming language; processors for formal languages.

**835. Data Structures in Information Processing**

Fall. 3(3-0) 453.  
Memory hierarchy and allocation algorithms; information collection; management, processing, retrieval and display; implications for machine, language and problem organization.

**836. Simulation of Stochastic Systems**

Winter. 3(3-0) 835.  
Computational aspects of the development, verification, and utilizations of algorithms for simulating models of discrete, stochastic systems; processing using Random Walks and Markov Chains.

**837. Computer-Aided Design of Deterministic Systems**

Spring. 3(3-0) 835.  
Formal language specification of time-dependent, deterministic systems; automatic production, management, and solution of system-associated equations.

**911. General Automata Theory I**

(E E 981.) Fall. 3(3-0) SYS 827 or approval of department. Interdepartmental with the Electrical Engineering Department.  
Characterization of machines and programs as finite automata; structure and decomposition of finite automata.

**912. General Automata Theory II**

(E E 982.) Winter. 3(3-0) 911. Interdepartmental with the Electrical Engineering Department.  
Linear bounded automata; turing machines; recursive sets; degree of difficulty of computations.

**913. General Automata Theory III**

(E E 983.) Spring. 3(3-0) 912. Interdepartmental with the Electrical Engineering Department.  
Reliability and redundancy of finite automata; threshold logic nets; pattern recognition automata; command and control automata.

**CROP SCIENCE CSC**  
**College of Agriculture and Natural Resources**

**101. Crop Science**

Fall. 3(3-0)  
Principles of identification, adaptation, management, and utilization of field crops for food and fiber. Fundamentals of crop management, breeding, weed control, crop quality, and tropical crops in world agriculture.

**250. Plant and Animal Genetics**  
Spring. 4(4-0) N S 192 or B S 211.  
Fundamental genetic principles with particular reference to problems in plant and animal biology.

**251. Plant and Animal Genetics Laboratory**  
Spring. 1(0-2) 250 concurrently.

**301. Forage Crops**  
(201.) Fall. 3(2-2) Sophomores.  
Distribution, morphology, identification, physiology, management and utilization of forage crops for hay silage, and pasture for livestock and for soil improvement and conservation.

**402. Principles of Weed Control**  
Fall. 3(2-2) Juniors. Interdepartmental and administered jointly with the Horticulture Department.  
Comprehensive study of principles underlying weed control practices, and factors involved in both mechanical and chemical control.

**406. Crop Improvement and Seed Production**  
Winter. 4(3-2) N S 193.  
Practical methods of crop improvement, seed production, storing, cleaning, packing, and distribution, seed certification of small grains, legumes, corn, beans, potatoes, visits to seed agencies and seed farms.

**407. Special Crop Problems**  
Fall, Winter, Spring, Summer. 1 to 3 credits. May re-enroll for a maximum of 6 credits. Approval of department.  
Independent comprehensive study of some area of crop science.

**408. Principles of Plant Breeding**  
Spring. 4(3-2) 250. Interdepartmental and administered jointly with the Horticulture Department  
Application of genetics and other sciences to breeding and improvement of agronomic and horticultural crops.

**415. Turfgrass Management**  
Spring. 3(2-2)  
Adaptation characteristics and utilization of turf grasses, management principles and physiological bases for the establishment and maintenance of turf for lawns, athletic fields, golf courses, cemeteries, parks, highways and air-fields.

**420. Seminar**  
Winter. 1(1-0) May re-enroll for a maximum of 4 credits. Interdepartmental and administered jointly with the Soil Science Department.

**485. Seed Science**  
(912.) Spring. 3(3-2) Approval of department.  
Morphological and physiological changes during seed formation, development, maturation and germination. Practical and biological aspects of seed drying, storage, deterioration, dormancy and quality. Current problems and research in seed science.

**813. Field Plot Techniques**  
(913.) Fall of even-numbered years. 3(2-2) Approval of department.  
Design of field plot and greenhouse experiments including some phases of the analysis of data. A proportion of laboratory time is devoted to techniques of preparing for and planting greenhouse and field plots.

**814. Advanced Field Crop Studies**  
(914.) Fall, Winter, Spring, Summer. 1 to 3 credits. Approval of department.  
Opportunity for students to prepare graduate level reports on specific fields.

**830. Physiological Genetics**  
Winter. 3(3-0) Approval of department. Interdepartmental with and administered by the Forestry Department.  
Physiological bases for genetic variation in higher plants including adaptive physiology, quantitative genetics, growth correlations, biochemical genetics, hybrid physiology, and gene-cology.

**831. World Crop Adaptation**  
Spring. 3(3-0)  
Distribution, adaptation, and importance of crops in world agriculture and their production as influenced by climate, soil, people and markets.

**851. Quantitative Genetics in Plant Breeding**  
Fall. 4(3-1) One course in genetics or breeding, and one course in biometry, or approval of department.  
Genetic systems and quantitative inheritance in relation to the establishment of superior populations.

**899. Research**  
Fall, Winter, Spring, Summer. Variable credit.

**902. The Nature and Management of Reserve and Storage Materials in Crops**  
Winter. 3(2-2)  
Effect of agricultural practices on the consequent development of plants with particular reference to storage organs and materials.

**903. Advanced Grassland Management**  
Spring of odd-numbered years. 3(2-2) Basic undergraduate courses in Crop Science.  
Advanced studies concerned with the establishment, maintenance and utilization of grassland crops.

**904. Seminar**  
Fall, Winter, Spring. 1(1-0) Required of majors; others: approval of department.  
Studies and presentation of research in crop science.

**920. Design and Analysis of Agronomic Experiments**  
Spring. 3(3-0) STT 423 or approval of department.  
Constructing and analyzing designs for experimental investigations in the biological sciences.

**923. Preservation and Storage of Field Crops**  
Spring of even-numbered years. 3(2-2)  
Effects of equilibrium moisture contents, rapidity of establishment of equilibrium, relative humidity, chemical composition, rapidity of fermentation, molding or heating, pressure, temperature, etc. upon the quality of stored crops.

**951. Cytogenetics in Plant Breeding**  
Winter of odd-numbered years. 3(3-0) BOT 827, 919, or approval of department. Interdepartmental with the Horticulture Department.  
Application of cytogenetic principles to plant breeding. Significance of recombination, role of induced mutations, polyploid, chromosome substitution, and aneuploid analyses as they apply to the field of plant breeding.

**952. Plant Breeding Biometrics**  
Winter of even-numbered years. 4(3-2) Approval of department.  
Biometrical genetics as it applies to plant breeding. Includes studies of path coefficients, partitioning of variance, and the principles of selection in a changing environment.

**953. Cytogenetics in Plant Breeding Laboratory**  
Winter of odd-numbered years. 3(0-6) 951 or concurrently. Interdepartmental with and administered by the Horticulture Department.  
Laboratory course to accompany 951.

**999. Research**  
Fall, Winter, Spring, Summer. Variable credit.

**DAIRY DRY**  
**College of Agriculture and Natural Resources**

**214. Dairy Production**  
Fall, Spring. 4(3-2)  
Dairy cattle in modern agriculture. Normal cow behavior. Feeding, breeding and management of herd. Commercial milk production and marketing milk.

**323. Dairy Cattle Judging**  
Spring. 3(0-6)  
Desired type in dairy cattle. Judging and show ring procedures. Competitive judging. Teams selected to represent Michigan State University in national competition.

**413. Dairy Farm Management**  
Spring. 3(2-2)  
Analysis of dairy farm organization and operations. Dairy herd management practices. Dairy cattle housing with emphasis on economical and efficient usage. Use of dairy records in the farm operation.

**424. Dairy Cattle Breeding**  
Spring. 4(2-4) ANS 461.  
Applications of population genetics to improving dairy cattle. Use of selection, aids to selection, and systems of mating to formulate breeding plans. Inheritance of economic traits. Breed improvement programs.

**433. Dairy Cattle Nutrition**  
Winter. 4(3-2) ANS 325.  
Principles of ruminant nutrition and application to actual feeding practices in commercial dairy herds. Rumen fermentation as related to feed utilization, milk production and milk composition.

**444. Milk Secretion**  
Winter. 4(3-2) Interdepartmental and administered jointly with the Physiology Department.  
Anatomy of mammary gland. Hormonal and nervous control of mammary growth, initiation and maintenance of lactation. Biochemistry of milk secretion. Physiology of milking; physiological, pathological and management factors affecting lactation.

**445. Endocrinology and Reproduction of Farm Animals**  
Fall. 4(3-2) PSL 240. Interdepartmental and administered jointly with the Physiology Department.  
Endocrine and reproductive systems are presented with emphasis upon characteristics which can be altered for economic benefit and upon causes, prevention, and treatment of endocrine abnormalities.