120. **Elements of Computer Programming**  
Fall, Winter, Spring, Summer. 3(3-0)  
MTT 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 language including fixed and relocatable addresses, macro-macro codes, pseudo instructions, program linkage and macro instructions.

303. **Compiler Languages and Monitor**  
Fall, 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 theory, coding, transmission and recognition associated with man-machine systems.

421. **Digital Computer Design**  
Fall. 3(3-0) 303, PHY 259.  
Number systems; Boolean algebra; switching problems using combinational logic; minimization of combinational networks.

422. **Sequencial Machines I**  
Winter. 3(3-0) 421.  
Digital computer operations and the associated design of control elements using synchronous and combinatorial switching circuits.

423. **Sequencial 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) 300; MTT 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 memory/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.

501. **Special Problems**  
Fall, Winter, Spring. 1 to 4 credits. May be re-enrolled for a maximum of 8 credits. Approval of department.

511. **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.

512. **System Identification**  
Winter. 3(2-3) SY 811. Interdepartmental with Systems Science and Social Science (College of) and administered by Systems Science.

513. **System Project**  
Spring. 3(1-8) SY 812. Interdepartmental with Systems Science and Social Science (College of) and administered by Systems Science.

517. **Parametric Pattern Recognition**  
Winter. 3(3-0) STT 441, computer programming.

519. **Nonparametric Pattern Recognition**  
Spring. 3(3-0) 517.  
The non-parametric approach to pattern recognition using decision rules, parameter estimation, sub-optimal strategies, optimum strategy without learning, learning, and sequential recognition.

523. **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.

526. **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 relation; 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.  
Construction 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 oriented systems.

838. **Simulation of Stochastic Systems**  
Winter. 3(3-0) 835.  
Computational aspects of the development, verification, and utilization 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) 836.  
Formal language specification of time-dependent, deterministic system: automatic production, management, and relation of system-associated equations.

911. **General Automata Theory I**  
(E.E. 851.) Fall. 3(3-0) SYS 827 or approval of department. Interdepartmental with the Electrical Engineering Department.

912. **General Automata Theory II**  
(W.E. 852.) Winter. 3(3-0) 911. Interdepartmental with the Electrical Engineering Department.

913. **General Automata Theory III**  
(E.E. 853.) Spring. 3(3-0) 912. Interdepartmental with the Electrical Engineering Department.

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(3-0) N S 150 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  
(901) Fall, 2(3-0) Sappanieres.  
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(2-9) 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 192.  
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 9 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(3-2)  
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 airfields.

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 properties 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 Forage Department.  
Physiological bases for genetic variation in higher plants including adaptive physiology, quantitative genetics, growth correlations, biochemical genetics, hybrid physiology, and geneology.

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, polyplody, chromosome substitution, and Amphiblast 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(3-0)  
or concurrently, 2(3-0).  
Laboratory course to accompany 951.

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

DAIRY  
College of Agriculture and Natural Resources

214. Dairy Production  
Fall, Spring. 4(3-2)  

323. Dairy Cattle Judging  
Spring. 3(0-6)  
Desired type in dairy cattle. Judging and showing 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 cow housing with emphasis on economical and efficient usage. Use of dairy records in farm operation.

424. Dairy Cattle Breeding  
Spring. 4(3-4) 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.  

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.