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.

951. **Cytogenetics in Plant Breeding**

Winter of odd-numbered years. 3(3-0) BOT 427, BOT 828, or approval of 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.

999. **Doctoral Dissertation Research**

Fall, Winter, Spring, Summer. Variable credit.

DAIRY SCIENCE

See Animal Science.

EARTH SCIENCE

See Geology.

ECONOMICS   EC

College of Business

Courses are classified as follows:
Applied Welfare Economics—410.
Labor Economics and Industrial Relations—305, 306, 455, 457.
Money and Banking—318, 330, 470.
International Economics—428.
Public Finance—406, 407, 408.
Price and Value Theory—324, 325, 426.
Income and Employment Theory—326, 451, 470.
History of Economic Thought—421, 422.
Industrial Organization and Control—444, 445.
Economic Development, Regional Studies, and Comparative Economics Systems—430, 431, 434.

200. **Introduction to Macroeconomics**

Fall, Winter, Spring, Summer. 4(4-0) Open to Freshmen. Students may begin sequence with either EC 200 or EC 201. Not open to students with credit in IDC 204.

Determinants of Gross National Product, unemployment, inflation and economic growth. National income accounting, fiscal policy; aggregate demand and supply management.

201. **Introduction to Microeconomics**

Fall, Winter, Spring, Summer. 4(4-0) Open to Freshmen. Students may begin sequence with either EC 200 or EC 201. Not open to students with credit in IDC 205.

Economic institutions, reasoning and analysis. Consumption, production, determination of price and quantity in different markets, income distribution, market structure and normative analysis.

210. **Fundamentals of Economics**

Fall, Winter. 4(4-0) MTH 215 or MTH 228; or concurrently. Students may not earn credit in EC 210 if they have credit in either EC 200 or EC 201.

Economic principles, institutions and reasoning using mathematics, when useful, as a tool of analysis. Consumption, production, the market system, income distribution and elements of employment and inflation theory.

251H. **Households, Firms and Markets**

Fall. 5(5-0) Honors College students.

Microeconomic theory and its applications to analysis and policy. Substitutes for EC 201, EC 324, and EC 325.

252H. **Macroeconomics and Public Policy**

Winter. 5(5-0) Honors College students.

Theory of national income, unemployment, inflation and economic growth and its application to economic analysis and policy. Substitutes for EC 200, EC 326 and EC 327 combined.

305. **Industrial Relations and Trade Unionism**

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

Development, aims, structure, and functions of labor and employer organizations. Their relation to economic, political, and legal institutions and their impact on society. Primary issues in collective bargaining.

306. **Government Programs for Workers**

(456.) Winter. 4(4-0) EC 201. Interdepartmental with Public Affairs Management.

Economics of selected government institutions and programs for workers. Social security, worker's compensation, Unemployment Insurance, OSHA, employment and training programs, wages and hours legislation, anti-discrimination programs.

318. **Money, Credit and Banking**

Fall, Winter, Spring, Summer. 4(4-0) EC 200 or EC 210.

Commercial banking and the money supply. The Federal Reserve System, the Treasury, and other financial institutions. Sources and uses of funds in the financial market.

324. **Microeconomics I**

Fall, Winter, Spring, Summer. 3(3-0) EC 200 and EC 201, or EC 210.

Theory of production and cost. Theory of the firm under varying market structures.

325. **Microeconomics II**

Fall, Winter, Spring, Summer. 3(3-0) EC 200 and EC 201, or EC 210, and EC 324.

Consumer choice and theory of demand. Theory of distribution and factor rewards. Welfare economics and general equilibrium theory.

326. **Macroeconomics I**

(320.) Fall, Winter, Spring, Summer. 3(3-0) EC 200 and EC 201 or EC 210.

Review of national income accounting. Determination of aggregate output, employment, the price level, and the inflation rate. Policy applications.

327. **Macroeconomics II**

(321.) Fall, Winter, Spring, Summer. 3(3-0) EC 326.

Consumption theories, investment theories, role of expectations, theories of economic growth and cycles, stabilization policies, and other advanced topics.

330. **Investments and Security Markets**

Fall, Spring. 3(3-0) EC 200 or EC 210, Juniors.

The stock market; principles of investment; analysis of selected industries and corporaions; regulation by the Securities and Exchange Commission.

337. **American Social and Economic History: Foundations**

Winter. 4(4-0) Interdepartmental with and administered by the Department of History.

Multiple sources of economic growth in economic, social and political change, education, science and technology, political action, and other factors, mid-19th century.

338. **American Social and Economic History: Modern Trends**

Spring. 4(4-0) Interdepartmental with and administered by the Department of History.

Urbanization, origins and implications of largescale organizations in business and other sectors of society, and sources of economic growth since mid-19th century.

361. **Economic Development of Asia**

Fall. 3(3-0) EC 200 and EC 201 or EC 210.

Population and resources; comparison of three economic systems: Communism in China, free enterprise in Japan and socialism in India; the role of Japan in regional trade and development.

362. **Economic Development of Latin America**

Winter. 3(3-0) EC 200 and EC 201 or EC 210.

Concentration of political and economic power as related to income distribution, tax structures, agrarian reform; inflation, trade, exchange rates, integration; population and employment policy.

363. **Economic Development of Tropical Africa**

Spring, 3(3-0) EC 200 and EC 201 or EC 210. Interdepartmental with Public Affairs Management.

African economic development in historical perspective. Analysis of contemporary economic development problems faced by tropical African countries. Alternative strategies for African economic development.

371A. **European Economic History to 1800**

Fall. 4(4-0) Interdepartmental with and administered by the Department of History.

Economic history of medieval and early modern Europe stressing the nature of agrarian societies, the growth of cities, the divergence of the European economies, and the Industrial Revolution in England.

371B.   European Economic History after 1800

Winter. 4(4-0) Interdepartmental with and administered by the Department of History.

The industrialization of Europe stressing urbanization, national rivalry, problems of the maturation of capitalist institutions, and the social and ecological impact of economic growth in the twentieth century.

400.   Independent Study

Fall, Winter, Spring, Summer. 1 to 4 credits. Seniors or approval of department:

Research and reading course for students interested in doing independent work in economics.

401.   Interpreting Economic News and Research

Winter. 3(3-0) EC 200 and EC 201 or EC 210 or EC 251H and EC 252H.

Reporting and interpreting economic news and research. Sources of data and research information. Critical examination of written and broadcast reports through application of economic principles. Case studies.

406.   Public Expenditure: Theory and Policy

Fall, Spring. 4(4-0) EC 201 or EC 210. Interdepartmental with Public Affairs Management.

Expenditure theory; objectives and rationale of government activity in the market system; efficiency criteria in government decision-making; planning-programming-budgeting systems and cost-benefit analysis.

407.   Public Revenues

Winter. 4(4-0) EC 201 or EC 210.

Principles and theory of the distribution of tax burdens and the incidence of taxation. Income, sales, property, and other major revenue sources.

408.   State and Local Finance

Spring. 4(4-0) EC 201 or EC 210 or EC 251H.

Fiscal problems at the state and local levels of government, including revenues, expenditures, borrowing, and intergovernmental fiscal relations.

410.   Medical Economics

Spring. 3(3-0) EC 200, EC 201, or approval of department.

Demand, supply and economic efficiency in the markets for health services. Demand for medical care, organization forms, methods of payment, utilization and cost, and public policy for health care.

412.   The Economics of Poverty

Winter. 3(3-0) EC 200, EC 201.

Theory of the distribution of income and wealth. Concepts and measurement of welfare. Definitions of poverty. Effects of public and private programs on the poor.

413.   Urban Economics

Fall. 4(4-0) EC 200, EC 201.

Location theory and urban development. Economics of city size and urban-suburban conflict. Economic aspects of certain community problems like housing, transportation, welfare and poverty. Strategies for urban development.

417.   Land Economics

Fall, Spring. 4(4-0) Interdepartmental with Public Affairs Management, and Food Systems Economics and Management and the Department of Resource Development. Administered by the Department of Resource Development.

Factors affecting man's economic use of land and space resources. Input-output relationships; development, investment, and enterprise location decisions. Land markets; property rights, area planning; zoning and land use controls.

421.   Economic Thought I

Fall, Summer. 4(4-0) EC 200 and EC 201, or EC 210.

Forerunners of classical economics. Development of classical economic thought from Adam Smith to J. S. Mill. The socialist reaction.

422.   Economic Thought II

Winter, Spring. 4(4-0) EC 200 and EC 201, or EC 210.

The decline of classical economics and the rise of marginalist value and distribution theory. Marxism and institutionalism.

426.   Introductory Mathematical Economics

Spring. 3(3-0) EC 324, EC 326, MTH 214.

Mathematical analysis of production, cost, and consumer choice. Mathematical models of aggregative and general-equilibrium economic systems.

428.   International Trade

(427.) Fall, Winter, Spring, Summer. 3(3-0) EC 200 and EC 201, or EC 210. EC 428 and EC 429 are a two-term sequence. Student should take the courses in succeeding terms, though they may begin with either course.

Pure theory of trade and comparative advantage. Free trade versus protection. Customs unions. U.S. commercial policy. Trade problems of less-developed nations.

429.   International Finance

Fall, Winter, Spring, Summer. 3(3-0) EC 200 and EC 201, or EC 210. EC 428 and EC 429 are a two-term sequence. Students should take the courses in succeeding terms, though they may begin with either course.

Balance-of-payments accounting. Foreign exchange markets. Balance-of-payments mechanisms. The international monetary system.

430.   Stagnation and Development in Emerging Societies

Winter, Summer. 4(4-0) EC 200 and EC 201, or EC 210.

Obstacles to economic growth, theories of economic development, reorganizing agriculture and industry; problems in mobilizing the economy to accommodate new productive techniques; population problems.

431.   Principal Issues in Promoting Economic Development

Spring. 4(4-0) EC 430.

Structural change and growth, capital formation and investment criteria; financing development; foreign trade and finance in development; government and planning.

434.   Comparative Economic Systems

Fall, Winter, Summer. 4(4-0) EC 200 and EC 201, or EC 210.

Characteristics and functions of an economic system. Analysis of alternative patterns of economic control, planning and market structure. Experiences under capitalism, socialism and mixed economies. Consideration of their theories and philosophies.

440.   Radical Political Economy

Spring. 3(3-0) EC 200 and EC 201, or EC 210, or EC 251H and EC 252H.

Development and contemporary characteristics of capitalism from Marxian-radical perspective. Historical materialism and class analysis. Radical critique of modern economics. Relationship of inequality, racism, alienation and other problems to the structure of capitalism.

444.   Private Enterprise and Public Policy

Fall, Winter, Spring, Summer. 3(3-0) EC 201 or EC 210.

Competition and monopoly in the American economy. Problems of antitrust.

445.   Economics of Regulated Industries

Winter. 4(4-0) EC 444.

Government policy and role of competition in the public utility and transportation industries.

451.   Introduction to Econometric Methods

Fall, Spring. 4(4-0) EC 324, EC 326; STT 422 or STT 442 or STT 316.

Specification, estimation and interpretation of econometric models. Understanding and evaluation of current quantitative work in economics.

453.   Women and Work: Issues and Policy Analysis

Winter. 3(3-0) PAM 201 or EC 200 or EC 201 or approval of department. Interdepartmental with and administered by Public Affairs Management.

Quantity and quality of labor force participation by women, current status and past trends. Issues analyzed include differential earnings and occupations of men and women, employment discrimination and labor legislation.

455.   Labor and the Law

Spring. 4(4-0) EC 305.

Development and current status of labor law as it applies to unions, employers, employees and collective bargaining. Economic and social issues regulated by, and posed by, labor law.

457.   Analysis of Labor Markets

Spring. 4(4-0) EC 200 and EC 201, or EC 210.

Theories of labor market behavior, empirical evidence and policy implications. Topics include labor supply, labor demand, wage differentials (due to education, discrimination, and union membership), competition and mobility.

460.   Regional Economics

Winter. 4(4-0) R D 417 or EC 324. Interdepartmental with Food Systems Economics and Management, Public Affairs Management, and the Department of Resource Development. Administered by the Department of Resource Development.

Forces affecting location decisions of firms, households and governments. Applications to agricultural, industrial, and regional developments.

461.   Regional Economics Laboratory

Spring. 1(0-2) R D 460 and approval of department. Interdepartmental with Public Affairs Management, and Food Systems Management and the Department of Resource Development. Administered by the Department of Resource Development.

Evaluation and use of analytical models designed to solve regional economic problems.

463. Economics of Urban Education
(UMS 463.) Spring. 3(3-0) EC 201 or EC 210.

Political economy of urban schools. Education as a commodity: efficient production and distribution, supply and demand for education, financing education, planning education to meet job needs and social mobility.

470. Monetary Theory
Fall. 3(3-0) EC 327.

Relationship between money and interest rates, prices and output.

480. Mathematics for Economists
Fall. 5(5-0) MTH 113, graduate status in either economics, agricultural economics or College of Business, or approval of department. Interdepartmental with and administered by the Department of Mathematics.

Matrix algebra, determinants, quadratic forms, characteristic values. Partial derivatives, chain rule, Jacobian matrix, Taylor series, constrained optimization, linear differential equations. Mathematics introduced and developed using student's background in economics.

800. Economic Analysis I
Fall, Winter. 4(4-0) EC 324.

Consumption, exchange and production.

801. Economic Analysis II
Winter, Spring. 4(4-0) EC 800.

The Firm. Market behavior and price formation (competition, monopoly and mixed cases). Distribution.

802. Economic Analysis III
Spring, Summer. 4(4-0)

Comparative statics analysis of macroeconomic problems.

806A. Public Expenditures
Fall. 3(3-0) Approval of department.

Public sector allocation and redistribution. Public goods, externalities, market imperfections, property rights. Cost-benefit analysis and PPBS. Alternative theories of the state. Political theories of public expenditures.

806B. Public Revenues
Winter. 3(3-0) Approval of department.

Theory of taxation. Incidence and economic effects, especially on income and wealth redistribution. Institutional and policy analysis of the U.S. federal tax system.

806C. State and Local Public Finance
Spring. 3(3-0) Approval of department.

State and local expenditure systems in theory and practice; tax and nontax revenues; intergovernmental fiscal relationships; the fiscal problems of metropolitan governments.

810. Economics of Public Choice
Winter. 3(3-0) Approval of department. Interdepartmental with the departments of Agricultural Economics, and Resource Development. Administered by the Department of Agricultural Economics.

Economics of alternative institutions for collective action. Emphasis on property rights and natural resources. Public goods, externalities non-marginal change, commonwealth, income and power distribution, grants, welfare criteria and market failure.

811. Public Program Analysis
Spring. Summer of odd-numbered years. 3(3-0) EC 324 or approval of department. Interdepartmental with the departments of Resource Development, and Agricultural Economics. Administered by the Department of Agricultural Economics.

Application of benefit-cost analysis to public programs of resources development. Issues and case studies in budgeting, investment criteria, pricing, externalities, and coordination.

812A. Microeconomics I
Winter. 3(3-0) EC 324, EC 325; EC 480 or MTH 215 or concurrently.

Theories of consumption and production; duality, cost and expenditure functions; imput demand; revealed preference.

812B. Microeconomics II
Spring. 3(3-0) EC 812A.

Functional forms in production and consumption; competitive equilibrium; theories of non-competitive markets; imperfect information and behavior under uncertainty; multiproduct firms.

812C. Microeconomics III
Fall. 3(3-0) EC 812B.

General equlibrium and welfare; optimality of competition; market failures; economics of linear and nonlinear programming and input-output analysis.

813A. Macroeconomics I
Fall. 3(3-0) EC 326, EC 327; EC 480 or MTH 215 or concurrently.

Income accounting and price indices; comparative statics of macroeconomics models; consumption and investment functions; the money supply.

813B. Macroeconomics II
Winter. 3(3-0) EC 813A.

Demand for money; portfolio theory; theories of inflation and unemployment.

813C. Macroeconomics III
Spring. 3(3-0) EC 813B.

Models of macroeconomic disequlibrium; macro dynamics and the effects of search; theories of neoclassical and optimal economics growth.

815. Labor Force Behavior
Spring. 4(4-0) LIR 809, EC 457 or approval of department. Interdepartmental with and administered by the School of Labor and Industrial Relations.

Theoretical and empirical analysis of factors affecting labor force participation rates, unemployment levels, employment distribution, hours of work, and labor mobility. Concepts and measurement methods.

818A. Monetary Theory
Fall. 3(3-0) EC 812C, EC 813C, and EC 835 and approval of department.

Monetary and interest theories.

818B. The Theory of Monetary Policy
Winter. 3(3-0) EC 818A or approval of department.

Theories of the transmission of monetary policy to output, employment and prices.

818C. Problems in Monetary Policy
Spring. 3(3-0) EC 818B.

Goals and techniques of monetary policy.

821A. Competition and Monopoly in American Industry
Fall. 3(3-0) Approval of department.

Examination of structure, behavior, and performance in industries.

821B. Government Policy Toward Private Enterprise
Winter. 3(3-0) Approval of department.

Evolution of government policy with respect to such problems as conspiracy, monopoly, mergers, unfair practices, and discrimination. Economic and legal appraisal of policy alternatives.

821C. Problems Related to Regulated Industries
Spring. 3(3-0) Approval of department.

Departures from market competition as a policy norm, as in public utilities and transportation.

826A. Theory of International Trade
Fall. 3(3-0) EC 428 or approval of department.

Classical and modern theories of international trade. Application of modern techniques of economic analysis to international trade theory.

826B. Theory of International Trade Policy
Winter. 3(3-0) EC 826A.

Various means by which a government may influence the volume, character, and direction of its foreign commerce. In this connection an analysis is made of the theory of the tariff, the subsidy, exchange control, and quotas. Emphasis on the economic impact of trade controls upon a nation and the world.

826C. International Exchanges and Capital Flows
Spring. 3(3-0) EC 826B.

Theory of exchange rates and international money markets especially with reference to other than current account items in balances of payments. Analysis of sources, causes, effects of capital flows with developing economies considered as a special case.

831. Mathematical Economics I
Fall of even-numbered years. 3(3-0) EC 812; MTH 214, MTH 334.

Economic behavior of firms, households, commodity markets. Relation of traditional theories to programming models, theory of games and other decision theories. Dynamic models of behavior. Equilibrium of multiple markets.

832. Mathematical Economics II
Winter of odd-numbered years. 3(3-0) EC 813; MTH 215, MTH 334.

Mathematical models of growth and fluctuations dealing with macroeconomics, monetary theory, fiscal policy. The cobweb, static and dynamic multipliers, multiplier-accelerator models, trade cycle models. Relations among stocks, flows and time lags.

833. Mathematical Programming
Spring. 3(3-0) EC 800; or EC 812A; MTH 334. Interdepartmental with the departments of Agricultural Economics, and Statistics and Probability. Administered by the Department of Agricultural Economics.

Linear programming. Theory of linear economic models. Topics in nonlinear programming.

835.   Introduction to Econometrics

Fall, Spring, Summer. 3(3-0) EC 325; STT 422. Interdepartmental with the Department of Agricultural Economics.

Specification, estimation and interpretation of economic models. Applications to empirical problems.

IDC.   Subsaharan Africa Seminar

For course description, see Interdisciplinary Courses.

841A.   History of Economic Thought: Classical

Fall. 3(3-0)

Early thought, mercantilism, physiocracy, and classical economics.

841B.   History of Economic Thought: Heterodox

Winter. 3(3-0)

Historicism, socialism, and institutionalism.

841C.   History of Economic Thought: Modern

Spring. 3(3-0)

Development of marginalism, general equilibrium theory, employment theory, and mathematical economics.

850.   The Development of Economic Institutions

Fall. 3(3-0) EC 430 or approval of department.

Cross-cultural analysis of factors influencing the organization of economies. Motivation, values, and technological change. Growth of markets, entrepreneurship, industrial labor force and the diffusion of knowledge.

851.   The Economics of Secular Change

Winter. 3(3-0) EC 324, EC 326 or approval of department.

Empirical studies of long-run economic trends and a consideration of alternative hypotheses explaining these trends including classical Marxian, Harrod-Domar, and other general theories of economic development. Population growth, technological change, capital formation, occupational distribution, urbanization, and international trade.

852.   Economic Problems of Underdeveloped Areas

Spring. 3(3-0) EC 324, EC 326 or approval of department.

Overcoming problems relating to early stages of economic development; investment priorities, mobilizing savings, balance of payment considerations; and policies and programs of various types.

855.   The Industrial Revolution in Europe

Winter of even-numbered years. 3(3-0) EC 318, EC 324. Interdepartmental with the Department of History.

The preconditions that led to the momentous changes in agriculture and industry in Europe from 1700-1914.

857.   Wage Theory

Fall. 3(3-0) EC 324, EC 326 or approval of department. Interdepartmental with the School of Labor and Industrial Relations.

Advanced analysis of: theories of wage determination; labor market research, economic effects of collective bargaining upon the national wage structure, output, employment, distribution of national income, the price level; nature and effects of government wage policies.

858.   Collective Bargaining

Fall, Winter, Spring. 3(3-0) EC 305 or approval of department. Open to graduate students in economics and related fields such as labor and industrial relations, psychology, sociology, anthropology, political science, business, and history. Interdepartmental with and administered by the School of Labor and Industrial Relations.

Problems and issues in the administration and negotiation of collective bargaining agreements; includes both economic and noneconomic aspects of industrial relations policies and practices.

860.   Economics of the Firm

Fall, Winter, Summer. 4(4-0) Graduate students in Business Administration. Not open to Economics majors.

Analysis of the firm. Problems facing management; economizing in use of resources, optimal combinations of products, pricing, competitive forces in markets affecting the firm.

861.   American Economy

Fall, Winter, Spring, Summer. 4(4-0) Thirty credits in MBA core program. Not open to Economics and Agricultural Economics majors.

Determinants of the national income, employment, and capital formation. National income accounts. Business fluctuations. Fiscal and monetary policy.

862.   Business and Public Policy

Winter. 4(4-0) EC 860 or approval of department. Not open to majors.

Problem of government regulation of business. Economic models which relate to regulation. Regulatory legislation, regulatory bodies, and alternatives available.

876.   Statistical Inference in Economics I

Fall. 3(3-0) EC 812A or EC 801; STT 443 or STT 863; or approval of department. Interdepartmental with the departments of Agricultural Economics, and Statistics and Probability.

Review and extension of single-equation regression models. Properties of least-squares estimators under alternative specifications. Problems of analyzing nonexperimental data. Errors in variables, autoregressive and heteroscedastic models.

877.   Statistical Inference in Economics II

Winter. 3(3-0) EC 876 or approval of department. Interdepartmental with the departments of Agricultural Economics, and Statistics and Probability.

Specification interpretation and estimation of simultaneous equation models. Nonlinear models. Bayesian approach to estimation problems. Recent developments in econometrics.

878.   Statistical Inference in Economics III

Spring. 3(3-0) EC 877 or approval of department. Interdepartmental with the departments of Agricultural Economics, and Statistics and Probability.

Validation and application of dynamic econometric models. Bayesian approach to estimation problems. Recent developments in econometric methods and in applied econometric research.

880.   Organization and Control in the Political Economy: Institutions and Theory

Winter of even-numbered years. 4(4-0) Interdepartmental with the Department of Management.

Organization and technique in choice and implementation of economic (especially planning, programming) functions of political authority.

881.   Organization and Control in the Political Economy: Selected Problems

Winter of odd-numbered years. 4(4-0) Approval of instructor. Interdepartmental with the Department of Management.

Analysis of role and tasks, appropriate techniques and organizational structures of political agencies in planning and management of complex programs.

891.   Topics in Applied Econometrics

Spring. 3(3-0) EC 835 or EC 877.

Topics in applied econometrics with particular attention to problems of testing hypotheses in the context of economic models.

895.   Graduate Reading in Economics

Fall, Winter, Spring, Summer. Variable credit.

900.   Selected Problems in Advanced Microeconomic Theory

Fall, Winter, Spring, Summer. 3(3-0) May reenroll for a maximum of 12 credits. EC 812A, EC 812B, EC 812C; EC 813C.

Advanced applications of economic methodology to the analysis of household and firm behavior; risk; uncertainty, and transactions costs.

972.   Methodological Approaches to Research

Fall of even-numbered years, Summer of odd-numbered years. 3(3-0) Two terms of graduate study in social science or approval of department. Interdepartmental with and administered by the Department of Agricultural Economics.

Selection, planning and conduct of research. Alternative research approaches. Role of theory, beliefs and valuations. Critical appraisal of research studies.

990B.   Industrial Organization and Public Policy Workshop

Fall, Winter, Spring. 3 to 16 credits. Approval of department.

Critical evalution of research reports by staff and other students. Students writing doctoral dissertations in the appropriate areas are encouraged to participate in workshop and may do so while registered for EC 999.

990C.   Mathematical Economics and Econometrics Workshop

Fall, Winter, Spring. 3 to 16 credits. EC 812A, EC 832; or approval of department. Interdepartmental with the Department of Agricultural Economics.

Critical evaluation of research reports by staff and other students. Students writing doctoral dissertations in the appropriate areas are encouraged to participate in workshop and may do so while registered for EC 999.

990D. *Economic Development*
Workshop

Fall, Winter, Spring, Summer. 3 to 16 credits. EC 850, EC 851, EC 852 or approval of department.

Critical evaluation of research reports by staff and students. Students writing doctoral dissertations in Development are encouraged to participate in the workshop and may do so while registered for EC 999.

999. *Doctoral Dissertation Research*

Fall, Winter, Spring, Summer. Variable credit. Approval of department.

EDUCATION

See Administration and Curriculum; Counseling, Educational Psychology and Special Education; and Teacher Education.

ELECTRICAL ENGINEERING AND SYSTEMS SCIENCE

College of Engineering

Electrical Engineering   E E

230. *Digital Logic Fundamentals*

Fall, Winter, Spring, Summer. 4(4-0) CPS 120 or CPS 251.

Boolean algebra; combinational logic and minimization; sequential system fundamentals and components; arithmetic operations and devices; memory devices and ensembles; data conversion principles; digital integrated circuits; practical engineering design problems.

231. *Computer Organization and Usage*

Fall, Winter, Spring. 4(4-0) E E 230.

Computer structure and machine language; macros; addressing techniques; computer bus; program segmentation and linkage; microcomputer case study; survey of applications in science and engineering.

275. *Consumer Electronics*

Fall, Winter, Spring. 3(3-0)

Electronic circuit components and devices; their operation in transmitters, receivers, stereoamplifiers, etc. Electronic measurements, magnetic recording, speaker systems, and other topics will be considered.

300. *Electric Circuits I*

Fall, Winter. 4(4-0) MTH 113.

Current voltage and power. DC and transient circuit analysis. Forced response. Sinusoids and the phasor concept. Bridges.

301. *Electric Circuits II*

Winter, Spring. 4(4-0) E E 300, MTH 214.

Sinusoidal steady-state response. Average power and rms concepts. Complex frequency response. Magnetically coupled circuits. Two-port networks. Transfer functions.

302. *Basic Electronic Circuits*

Spring, Summer. 4(4-0) E E 301, MTH 215.

Volt-ampere characteristics of diodes and transistors. Voltage, current and power amplification. Stability, transient and high-frequency effects. Feedback, oscillators and operational amplifiers.

303. *Electronics Laboratory I*

Winter, Spring. 1(0-3) E E 300; E E 301 concurrently.

Electronic test equipment and measurement fundamentals. Experimental verification of topics covered in E E 300 and E E 301. Computer-aided circuit analysis and design.

304. *Electronics Laboratory II*

Fall. 1(0-3) E E 302.

Experimental verification of topics covered in E E 302. Single-stage and multi-stage transistor amplifier design and analysis. Applications of linear integrated circuits. Computer-aided circuit design.

305. *Electromagnetic Fields and Waves I*

Fall, Winter. 3(3-0) MTH 310, PHY 288.

Vector analysis, Electrostatic fields; EM sources, scalar potential, Poisson's and Laplace's equations, dieletric media, capacitance, and energy storage. Boundary value problems for electronstatic fields.

306. *Electromagnetic Fields and Waves II*

Winter, Spring. 4(4-0) E E 305.

Magnetostatic fields; EM sources, vector potential, magnetic media, inductance, and energy storage, time-varying fields and Maxwell's equations; potential theory and boundary-value problems. Energy conservation and conversion.

307. *Electromagnetic Fields and Waves III*

Spring, Summer. 3(3-0) E E 306; E E 308 concurrently.

Application of Maxwell's equations; radiation, propagation, reflection, and power flow of plane EM waves; EM boundary value problems. Transmission line theory: transient and steady state waves, standing and traveling waves, reflections and standing-wave-ratio.

308. *Fields and Waves Laboratory*

Spring, Summer. 1(0-3) E E 306; E E 307 concurrently.

Experimental investigation of: charged particle motion in EM fields, dieletric and magnetic properties and materials, probing of currents and charges, and propagation of transient and steady-state waves. Digital computer solutions for EM field and wave problems.

345. *Introduction to Electronic Instrumentation Systems*

Fall, Winter, Spring. 4(3-3) PHY 288.

Basic electronic concepts; passive and active components; operational amplifiers; switching devices, equivalent circuits; transducers; signal conditioning; recording; data management; basic elements of control.

355. *Deterministic Communication Systems*

(455.) Fall, Spring. 3(3-0) E E 301, MTH 214. Interdepartmental with Systems Science.

Communication systems. Representation of signals in time and frequency domain. Processing of signals by linear, simple nonlinear and time-variant systems. Linear and nonlinear, analog and digital modulation and demodulation; for example, AM, FM, PCM.

413. *Analysis of Control Systems*

(313.) Fall. 4(4-0) E E 301, E E 355 or SYS 312. Interdepartmental with and administered by Systems Science.

Control system characteristics, performance criteria, transient and steady-state responses, error analysis, stability, root locus and frequency response techniques. Controller design using root locus and frequency response methods.

414. *Control Systems Laboratory*

(464.) Winter. 1(0-3) E E 231, E E 304, E E 413. Interdepartmental with Systems Science.

Experimental investigations of feedback systems. Study of solid state controllers. Properties and applications of phase lock loops. Introduction to digital control.

415. *Digital Control Systems*

Winter. 3(3-0) E E 231, SYS 311, SYS 413. Interdepartmental with Systems Science.

Organization of digital control systems, classical and modern techniques for the design of digital control systems. Hardware and software considerations with emphasis on microprocessor implementation.

418. *Introduction to Computer-Aided Circuit Design*

Spring. 3(3-0) CPS 120, E E 302.

Introduces the techniques used for automatic formulation, analysis and optimization of linear and nonlinear electronic circuits. Students will write a modest but useful analysis program package.

419. *Physical Phenomena and Electronic Instrumentation I*

Winter. 4(3-3) PHY 289, PHY 298 or approval of department, MTH 215. Interdepartmental with and administered by Physics.

Concepts of electronics relative to uses in investigations of physical phenomena and their subsequent applications to provide reliable instrumentation. Nuclear radiation detectors, photometers and magnetometers are examples of specific topics covered.

420. *Electromechanical Energy Conversion*

Spring. 3(3-0) E E 301, E E 306.

Review of electromagnetics; design, specification, and use of d.c. machines in industrial and servo-control application, synchronous generators and transformers for power systems; three phase power, per unit notation.

421. *Power System Analysis*

Fall. 3(3-0) E E 307, E E 420.

Model of power system components; analysis and planning techniques including load flow, short circuit, transient stability; voltage and frequency control; economic operation of power systems.

430. *Digital Electronics I*

Fall, Spring. 3(2-3) E E 230, E E 302.

Diodes and transistors as switching elements; logic families, data conversion circuits; memory circuits; digital subsystem design.

431. *Digital Electronics II*

Fall, Winter, Summer. 3(2-3) E E 231; E E 430.

Case study of a small computer system; I/O controller design; bus interface requirements, interrupt structure, and data transfer. Digital system design.