### Quantitative Methods in Educational Research

**B. Advanced Quantitative Methods in Educational Research.**
- Fall, Winter, Spring, Summer. 4(3-2)

- Principles and techniques in the application of inferential statistics to educational data with emphasis on the analysis of variance. Overview of correlation methods, non-parametric procedures and multi-variate techniques.

**C. Experimental Design in Education.**
- Winter, Spring, Summer. 4(3-2) 969B.

- Theory and practice in the design, analysis, and interpretation of experimental and quasi-experimental research.

### Seminars in Education

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

- Seminars in the various fields of emphasis.

### Readings and Independent Study in Education

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

- Study on an individual or group basis in the various fields of emphasis.

### Laboratory and Field Experience in Education

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

- Supervised advanced graduate practitioners, observation, internships, and externships in the various areas of emphasis.

### Research

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

### ELECTRICAL ENGINEERING AND SYSTEMS SCIENCE

#### College of Engineering

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credit Hours</th>
<th>Semester Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>305</td>
<td>Introduction to Electromagnetic Theory</td>
<td>4(4-0)</td>
<td>MTH 215, PHY 288</td>
</tr>
<tr>
<td>288</td>
<td>Vector analysis; electrostatic fields and sources; scalar potential; Poisson's and Laplace's equations; dielectric media; capacitance; energy storage; boundary value problems in electromagnetic fields.</td>
<td>3(3-0)</td>
<td>435, 425, 426</td>
</tr>
<tr>
<td>306</td>
<td>Electromagnetic Fields and Waves</td>
<td>4(4-0)</td>
<td>MTH 215, PHY 288</td>
</tr>
<tr>
<td>288</td>
<td>Magnetostatics and fields, vector potential; magnetic media; inductance; energy storage; time-varying fields; Maxwell's equations; energy conservation; potential theory; radiation concepts, plane waves, skin-effect, surface impedances.</td>
<td>3(3-0)</td>
<td>435, 425, 426</td>
</tr>
<tr>
<td>311</td>
<td>Fundamentals of System Modeling</td>
<td>4(4-0)</td>
<td>MTH 313, PHY 334</td>
</tr>
<tr>
<td>288</td>
<td>System measurements; signal representations; mathematical models for systems of lumped physical components, Kirchhoff's laws; linearity; impulse response; phasors, sinusoidal steady-state analysis; impedance, transfer functions.</td>
<td>3(3-0)</td>
<td>435, 425, 426</td>
</tr>
</tbody>
</table>

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*Effective March 1, 1969.*
460. Introduction to Electromagnetics
Spring. 3(3-0) PHY 288.
Electric and magnetic fields; boundary condi-
tions; Maxwell's equations. Electromagnetic
waves. Wave guides and cavities. Charged par-
ticles in an electromagnetic field.

801. Special Problems
Fall, Winter, Spring, Summer. 1 to
4 credits. Approval of department.
Investigation of a topic in electrical engineering
compatible with the student's prerequisites, in-
terest, and ability.

811. Noise and Fluctuation
Phenomena
Spring of even-numbered years; Sum-
er of odd-numbered years. 3(3-0) Approval of
department.
Nyquist formulation of thermal noise; noise
phenomena associated with electron tubes, tran-
sistors, beam and parametric devices, amplifiers,
mixers, and detectors; techniques and equip-
ment for noise measurements.

816. Quantum Electronics
(988.) Fall. 3(3-0) Approval of
department.
Quantum wave motion; Hamiltonian function
and operator; hydrogen atom and energy states;
transition probabilities; spontaneous and in-
duced transitions; statistical physics; transport
phenomena; band theory applied to conductors,
semiconductors and insulators.

818. Electrical Properties of
Materials I
Winter of odd-numbered years. 3(3-0)
Study of atomic and molecular properties affect-
ing the conductivity, permittivity, permeability,
absorbivity and radioactivity of materials; clas-
sical and quantum considerations.

819. Electrical Properties of
Materials II
Spring of odd-numbered years. 3(3-0)
Temperature and frequency effects on conduc-
tion, dielectric constant, and dielectric loss;
temperature, frequency and bias effects on the
behavior of ferrite materials; stimulated emis-
sion and absorption in materials.

831. Foundations of Network
Synthesis
Fall. 3(3-0) Approval of depart-
ment.
One-port networks; RL, RC and LC net-
works; driving point impedances; positive real
properties; realization procedures.

832. Filter Synthesis I
Winter. 3(3-0) 831.
Two-port LC networks; transmission character-
istics; filter design techniques based on image
parameters; Cauer filters.

833. Filter Synthesis II
Spring. 3(3-0) 833.
Scattering parameters; Butterworth, Chebyhev
and elliptic filters, phase equalizers synthesis
based on insertion functions.

835. Electromagnetic Theory I
(904.) Fall. 3(3-0) Approval of depart-
ment.
Physical concepts and mathematical solution of
Maxwell equations; boundary conditions; force
and energy equations; potential equations; Green's
d function; wave equations; radiation and
propagation of electromagnetic waves.

836. Electromagnetic Theory II
Winter. 3(3-0) 835.
Formulation of electric-circuit theory from view-
point of electromagnetic theory; calculation of
impedance; propagation of electromagnetic
wave in isotropic and anisotropic media; skin
effects; boundary value problems.

837. Guided Transmission
Systems
(812.) Spring. 3(3-0) 835.
Electromagnetic fields in open-wire lines, co-
axial lines and wave guides; power and energy
relationships; orthogonality properties; normal
modes; resonant cavities; modes of propagation
in stratified media; microwave circuits.

845. Mathematical Models for
Random Phenomena
Fall, Summer. 3(3-0) Approval of
department.
Generation of mathematical models that employ
probabilistic notions to describe control, com-
munication, and related systems, with emphasis
on distributions of random variables, condition-
ing, and properties of random sequences.

846. Analysis of Random Time
Functions
Fall, Winter. 3(3-0) 845.
Mathematical models for time-dependent ran-
dom phenomena; properties of correlation func-
tions and spectral densities; stationarity and
ergodicity; response of linear systems to random
inputs; introduction to applied harmonic analy-
sis.

847. Communication Systems
Winter, Spring. 3(3-0) 846.
Comparative analysis of modulation systems;
optimal relation between bandwidth and signal-
to-noise ratio; telemetry and radar systems.

848. Physical Electronics
Fall. 3(3-0) Approval of depart-
ment.
Types of electron emission; electron motion in
electromagnetic fields; beam focusing; longi-
dudinal and transverse beam waves; concepts of
interaction between electrons and fields; basic
principle of parametric electronics.

849. Microwave Electronics
(815.) Winter. 3(3-0) 835, 848.
Principles of microwave generators, including
klystrons, magnetrons, traveling-wave tubes and
particle accelerators; non-linear electron-wave in-
teractions; crossed-field devices; solid state mi-
crowave electronics.

850. Ionized Gases
Spring. 3(3-0) 835 or PHY 448.
Interdepartmental with the Astronomy Depart-
ment.
Elastic collision processes; Boltzmann equation;
moment equations; basic plasma phenomena;
motion of a charged particle in electrical and
magnetic field; individual and collective charged
particle behavior.

852. Semiconductor Devices
Winter. 3(3-0) 816.
Applications of the diffusion and continuity
equations to semiconductive devices; delineation
of the device terminal properties including tran-
sistor operation.

853. Semiconductor Applications
Spring. 3(3-0) 852.
Equivalent circuits; analysis of circuit operation
including high frequency effects, noise proper-
ities, nonlinear effects.

899. Research
(ECR 899.) Fall, Winter, Spring.
Summer. Variable credit. Approval of depart-
ment.
947. Space Communications
Spring of odd-numbered years. 3(3-0)
Communication theory and switching theory applied to the study of communications in space; rate of information and error probability in pulse modulation systems for long distance communications.

955. Microelectronics I
Fall of odd-numbered years. 3(3-0)
Basic physical principles underlying the operation, design, and fabrication of microelectronic devices.

956. Microelectronics II
Winter of even-numbered years. 3(3-0)
Miniaturized components; thin-film networks; solid-state circuits and operational limitations.

957. Semiconductor Switching Circuits
Spring of even-numbered years. 3(3-2)
Switching design considerations; theory and application of device characteristics in switching circuits. Laboratory experiments using transistors and microcircuits.

975. Quantum Electromagnetics
Winter of odd-numbered years. 3(3-0)
Tensors; four-vector formulation of classical electromagnetics; relativistic electrodynamics; Lagrangian and Hamiltonian—classical and relativistic; Schrodinger’s equation—classical and relativistic; quantification of wave fields, hydrogen atom.

976. Lasers and Masers
Spring of odd-numbered years. 3(3-0)
Coherence, emission, absorption and amplification of radiation; energy levels for optically active materials; threshold, bandwidth, excitation modes and other operating characteristics; applications and recent developments.

989. Waves and Radiations in Plasmas
Fall of even-numbered years. 3(3-0)
Plasma oscillations; interaction, electromagnetic fields with plasmas, wave propagation in magnetotonic media; plasma sheaths; radiation of electric source in incompressive and compressive plasmas, electroacoustic waves, magnetohydrodynamics, research topics in plasmas.

990. Electromagnetic Wave Propagation I
Winter of odd-numbered years. 3(3-0)
Electromagnetic plane waves, collimated beams and pulses, phase velocity, group and signal velocity, velocity of energy transport, propagation of plane waves in inhomogeneous dispersive media, reflection of spherical wave from homogeneous boundaries, propagation in wave guides with complex boundaries.

991. Electromagnetic Wave Propagation II
Spring of odd-numbered years. 3(3-0)
Propagation in monotonically stratified media, propagation in turbulent media (scattering), propagation in stratified media, propagation in quasi-periodic media, Brillouin scattering, pulses in inhomogeneous media, propagation in moving media, complex Doppler effect, coupling between Maxwell equations and continuum equations, depolarization of EM waves.

992. Research
(EGR 995) Fall, Winter, Spring, Summer. Variable credit. Approval of department.
Systems Science

485. Process Optimization Methods
Spring. 3(3-0) MTH 215, knowledge of linear algebra. Interdepartmental with and administered by the Chemical Engineering Department.
Methods for determining optimum design and operating policies of systems of varying complexity. Includes classical methods, mathematical programming and modern methods.

475. Introduction to Operations Research
Winter. 4(4-0) MTH 215, CPS 190. Interdepartmental with and administered by the Agricultural Engineering Department.
Methodology and basics of operations research; formulation and analysis of probabilistic models of inventory, waiting line, and reliability processes; random process simulation and network planning models.

801. Special Problems
Fall, Winter, Spring, Summer. 1 to 4 credits. May reenroll for maximum of 8 credits. Approval of department.

811. System Methodology and Simulation
Fall. 3(3-2) MTH 215, SET 441 or concurrently. Interdepartmental with the Computer Science Department and Social Science (College of).
Formulation of the general control problem; controllability, observability and normality in discrete-state and continuous-state systems; performance functionals, typical control problems.

961. Optimal Control Theory I
Fall. 3(3-0) 827, 828 or approval of department; MTH 420.
Formulation of the general control problem: controllability, observability and normality in discrete-state and continuous-state systems; performance functionals, typical control problems.

962. Optimal Control Theory II
Winter. 3(3-0) 961.
Optimal control theory in continuous-state and discrete-state systems; necessary and sufficient conditions for optimal solutions, geometric interpretations related to calculus of variations; typical applications.

963. Optimal Control Theory III
Spring. 3(3-0) 962 or approval of department.
Topics selected among: computational methods for optimal controls (solution of selected two-point boundary value problems); stochastic control theory; state estimation, Kalman filtering and related statistical methods; differential game theory.
999. Research
Fall, Winter, Spring, Summer. Variable credit. Approval of department.

ENGINEERING

College of Engineering

160. Engineering Communications
Fall, Winter, Spring. 4(1-6) MTH
168 or 111 or concurrently.

Engineering graphics, a means used by engineers to communicate their ideas to others. Frehand sketching, descriptive geometry, and graphical, numerical and computer program solutions.

161. Mechanical Drawing
Fall, Winter, Spring. 2(0-4)
Lettering and use of instruments. Orthographic projection, working drawings, machine sketching and isometric drawing.

162. Mechanical Drawing
Fall, Winter, Spring. 2(0-4) 160 or 161.
Continuation of 161 with emphasis on freehand lettering and sketching; advanced working drawings.

260. Machine Drawing
Fall, Spring. 3(0-6)
Advanced orthographic projection, detail and assembly drawing, sections and conventions, tracings, illustration and other pictorial drawings of mechanical elements.

263. Structural Drawing
Winter. 3(0-6) 160.
Structural steel, reinforced concrete, masonry, and timber detail drawings. Highway drawings and mapmaking.

267. Architectural Drafting I
Fall, Winter, Spring. 3(0-6) 8.
House construction detailing. Analysis and drawing of typical standard details.

266. Descriptive Geometry
Fall. 3(2-2) 160, 161.
Problems involving relations of points, lines, and planes. Intersections, developments, conic, and nonconicagular vectors.

270. Computer Graphics
Spring. 3(3-0) CFS 110 or 120 or LBC 125; EGR 160 or 161; or approval of department.
Use of computer controlled display systems for the solution of multidimensional problems.

364. Architectural Drafting II
Winter. 3(0-6) 267.
Functional standard procedure in the layout of floor plans in traditional and modern houses. Rendered plot plan and required details.

365. House Planning
Fall, Winter, Spring. 3(1-4)
Elementary house architecture. Drawing plans and measuring line methods. Pencil rendering, problems in shade and shadows. House model to scale, optional.

463. Architectural Drafting III
Spring. 3(0-6) 364 or 365.
Traditional and modern elevations. One- and two-point rendered perspective. Functional plans drawn in 364 or 365 required.

ENGLISH

College of Arts and Letters

091. English for Foreign Students—Elementary
Fall, Winter, Spring. Zero credit. (3/3-0) to 15/25-9). English language proficiency examination.
Grammar, conversation, composition, pronunciation, and laboratory in the English language for foreign students on the elementary level.

092. English for Foreign Students—Intermediate
Fall, Winter, Spring. Zero credit. (3/5-0) to 15/25-9). English language proficiency examination.
Grammar, conversation, composition, pronunciation and laboratory in the English language for foreign students on the intermediate level.

093. English for Foreign Students—Advanced
Fall, Winter, Spring. Zero credit. (3/5-0) to 15/25-9). English language proficiency examination.
Grammar, conversation, composition, pronunciation and laboratory in the English language for foreign students on the advanced level.

094. English for Foreign Students—Supplementary
Fall, Winter, Spring. Zero credit. (3/3-0) to 6/10-1). English language proficiency examination.
Composition and pronunciation in the English language for foreign students in need of supplementary work only.

101. Freshman Composition I
Fall, Winter, Spring. 4(3-1)
Practice in writing expository prose.

102. Freshman Composition II
Fall, Winter, Spring. 3(3-2)
Continuation of 101.

200H. Honors Work
Fall, Winter, Spring. 1 to 16 credits.
Approval of department.

201. Nature of Language
Fall, Winter, Spring, Summer. 3(3-0) ATL 113.
Various aspects of language—phonology and orthography; morphology; semantics; and the lexicon; syntax; and dialects—with special reference to American English.

205. Introduction to Shakespeare
Fall, Winter, Spring. 3(3-0) ATL 113.
A study of selected plays illustrating the powers of England's greatest writer.

268. Forms of Literature
Fall, Winter, Spring. 3(3-0) Required of majors and minors. Open to freshmen.
Major forms of prose fiction, designed to reveal artistic problems met and solved by these forms. Prepared for students in advanced literary study by acquainting them with the conventions of various literary forms, by providing a critical vocabulary and by furnishing experience in reading and writing critical evaluations of outstanding literary works from all historical periods.

See page A-2 item 2A.

207. Forms of Literature
Fall, Winter, Spring, Summer. 3(3-0) Required of majors and minors. Open to freshmen.
Major forms of drama, designed to reveal artistic problems met and solved by these forms.

208. Forms of Literature
Fall, Winter, Spring, Summer. 3(3-0) Required of majors and minors. Open to freshmen.
Major forms of poetry, designed to reveal artistic problems met and solved by these forms.

213. Expository Writing
Fall, Winter, Spring, Summer. 3(4-0) ATL 113.
Practice in informative writing to develop mastery of a clear, accurate style and of practical, basic expository forms.

214. Composition for Secondary English Teachers
Fall, Winter, Spring. 4(3-1) ATL 113.
Writing practice in various modes such as personal narrative and description, the familiar essay, drama, poetry, fiction. Exercises in creative dramatics. Discussion of the process of composing and the teaching of oral and written composition in junior and senior high schools.

225A. Fiction Writing
Fall, Winter, Spring, Summer. 4(4-0) 206 and written approval of department.
The writing of short fiction. Classes and individual conferences. Approval to enroll requires a conference with the instructor and will usually be on the basis of manuscripts submitted to him.

225B. Fiction Writing
Fall, Winter, Spring, Summer. 4(4-0) Written approval of department.
The writing of fiction. Classes and individual conferences. Approval to enroll requires a conference with the instructor and will usually be on the basis of manuscripts submitted to him.

229. Poetry Writing
Fall, Winter, Spring. 4(4-0) 206 and written approval of department.
The writing of poetry. Classes and individual conferences. Approval to enroll requires a conference with the instructor and will usually be on the basis of manuscripts submitted to him.

300A. Advanced Fiction Writing (300A)
Fall, Winter, Spring, Summer. 4(4-0) May re-enroll in 300A and/or 300B for a maximum of 15 credits. 225B and written approval of the department.
Advanced work in the writing of fiction. Classes and individual conferences. Approval to enroll requires a conference with the instructor and will usually be on the basis of manuscripts submitted to him.

300B. Advanced Poetry Writing (300B)
Fall, Winter, Spring, Summer. 4(4-0) May re-enroll in 300A and/or 300B for a maximum of 15 credits. 229 and written approval of the department.
Advanced work in the writing of poetry. Classes and individual conferences. Approval to enroll requires a conference with the instructor and will usually be on the basis of manuscripts submitted to him.

301. Literature and the Adolescent
Fall, Winter, Spring. 4(3-1) 206.
Extensive reading of literature appropriate for secondary school students. Discussion of formal literature programs in relation to student's reading needs. Methods of analyzing literature and establishing common and individualized reading programs.