DEPARTMENT OF PHYSICS AND ASTRONOMY

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AREAS OF STUDY & DEGREES

B.S. Physics

Minors:
Physics
Astronomy
Engineering

FACULTY

Regents Professors
Thomas O. Callaway (1998 - 1999)
Harry D. Downing (2013 - 2014)
Norman L. Markworth (2000 - 2001)
Professors
W. Dan Bruton, Robert W. Gruebel
Associate Professors
Robert B. Friedfeld, Joseph A. Musser, Walter L. Trikosko
Assistant Professors
Christopher J. Aul, Hector A. Ochoa
Lecturers
Edward J. Michaels, Ali A. Piran

OBJECTIVES

The courses in physics, astronomy and engineering are designed to acquaint students with the general all-embracing principles that are the foundations of the present understanding of physics, astronomy and engineering, and to furnish experiences in lecture and laboratory that will develop scientific attitudes, insights and techniques. The department seeks to prepare students for graduate study or to provide students preparing to teach at the pre-college level with a background appropriate with their needs; to provide students with the physics and engineering background required for work in engineering, related sciences and medicine; and to assist non-science majors in developing an insight into the physical aspects of our environment and the extensive scientific activity of our society.

DEFINITION OF MAJORS AND MINORS

Programs for physics majors and minors vary with the student's goals and interests. The recommended curriculum for the student preparing for graduate study in physics or employment as a professional physicist is detailed below. Students interested in both physics and engineering may wish to consider the Physics-Engineering Dual Degree Program or Engineering Physics Program described in the next section of this bulletin. The minimum course requirements for a major in physics consist of 37 hours of physics, astronomy and engineering, of which 20 hours must be advanced. This must include PHY 241, 242, 321 (or EGR 321), 333, 347, 430, 431, 440, 441 and 470, plus three hours from PHY 250 (or EGR 250), 262 (or EGR 215), 343 (or EGR 343), AST 305 or 335, or special problems (PHY 475 or 476). CHE 133 and 134 also are required.

The requirements for a minor in physics are 18 semester hours and must include PHY 241 (or 131 with department permission), 242 (or 132 with department permission), and 333 plus six hours (two must be advanced) from the following courses: PHY 110, 250 (or EGR 250), 321 (or EGR 321), 262 (or EGR 215), 343 (or EGR 343), 347, 430, 431, 440, 441, 470, 475 (or 476) or AST 105, 305 or 335. All programs must be approved on the degree plan by the chair of the department. Majors, minors and those seeking teacher certification should consult with an adviser in the Department of Physics and Astronomy at their earliest opportunity to plan their program with the proper sequencing of courses.

Astronomy Minor

The astronomy minor has been developed for students who have interests in astronomy beyond the introductory level. The course of study includes introductory physics, introductory astronomy, observational astronomy and astrophysics. A student majoring in physics may minor in astronomy, but courses that are applied to the minor cannot be applied to the major at the same time unless the student has a second minor from a different department.

The requirements for the minor in astronomy are PHY 241 (or 131 with department permission), 242 (or 132 with department permission), AST 105, 305 and 335. All minor programs must be approved on the degree plan by the chair of the department.

Engineering Minor (18 hours)

The engineering minor includes courses in introductory engineering, statics, dynamics, electrical circuits and devices, and digital systems. This minor can prepare students for employment or continued study in the areas of mechanical, electrical and civil engineering. (This minor does not qualify a student to take the professional engineering exam.)

A minor in engineering requires a minimum of 18 hours of engineering course work. The requirements for the minor in engineering are EGR 111 or 112, 215, 250, 321 and 343. All minor programs must be approved on the degree plan by the chair of the department.

A student majoring in physics may minor in engineering, but courses that are applied to the minor cannot be applied to the major at the same time unless the student has a second minor from a different department.

Teacher Certification Programs

Requirements for certification in the physical sciences are listed in the Teacher Certification section of this bulletin.

PHYSICS FRESHMAN SCHOLARSHIPS AND FINANCIAL AID

In addition to those opportunities provided through the Office of Student Financial Assistance, the Department of Physics and Astronomy offers a number of scholarships to well-qualified students majoring in physics or engineering physics. Inquiries regarding scholarships should be directed to the chair of the physics and astronomy department. Beginning freshmen are advised to make application for a scholarship during their senior year in high school. Part-time employment opportunities within the department are usually available to physics majors and minors, astronomy minors, engineering physics majors, and engineering minors who have completed, with good academic records, a portion of their physics, astronomy and engineering courses.

STUDENT ORGANIZATION

The Society of Physics Students at SFA has been extremely active since the 1970s. The club is a support organization involved with activities that serve the department, the university and the local public. These activities include public viewing sessions at the SFA Observatory, STEM Day and Physics Magic Shows for underprivileged children. Since 1990, the club has won 23 national Outstanding Chapter awards. Twelve to 16 students each semester attend SPS Zone 13 meetings held in conjunction with the Texas Sections of the American Association of Physics Teachers and the American Physical Society.

RECOMMENDED CURRICULUM FOR MAJORS IN PHYSICS

During the summer prior to beginning the program outlined below, students unprepared for MTH 233 are encouraged to enroll for preparatory mathematics courses equivalent to MTH 133, 138 and 139. Students who cannot obtain the preparatory mathematics before beginning this program may, in consultation with the physics faculty, work out an alternate plan, that leads to the B.S. degree with a major in physics.

Students majoring in physics regularly minor in mathematics. Many elect to pursue a double major in physics and mathematics. The following recommended curriculum includes courses meeting the requirements for a major in physics and a minor in mathematics. To obtain a double major in physics and mathematics, students should take additional mathematics courses in place of electives to meet the requirements listed in the Department of Mathematics and Statistics.

Major in Physics, Minor in Mathematics (120 hours)

Recommended Curriculum For Professional Physics Option

Freshman Year (29-30 hours)

PHY 108	3	*PHY 241	4
CHE 133	4	CHE 134	4
MTH 233	4	MTH 234	4
Required English	3	Required English	3
	14		**15**

Sophomore Year (32 hours)

*PHY 242	4	PHY 321	4
MTH 333	4	CSC 102	3
HIS 133	3	HIS 134	3
Elective	3	Core Req.	6
	14		**16**

Junior Year (31-33 hours)

PHY 333	4	PHY 430 or 441	3-4
PSC 141	3	PSC 142	3
MTH 317	3	MTH 337	3
Core Req.	3	Core Req.	3

Elective	3	Elective	3
	16		**15-16**

Senior Year (25-28 hours)

PHY 347	3	PHY 440	3
PHY 431	3	PHY 430 or 441	3-4
Core Req.	3	PHY 470	2
Electives	6	Electives	6
	15		**14-15**

For the electives listed, three to four hours must be department electives from PHY 250, 262, 343, 475, 476, AST 305 or 335.

**Not open to students with junior and senior physics major or minor standing without approval of the chair of the department.*

COURSE CREDIT

Unless otherwise indicated, courses are three-semester hours credit, three hours lecture per week.

CO-REQUISITE AND PREREQUISITE COURSES

Physics, astronomy and engineering courses that are co-requisites must be taken together during the same semester. Separate grades will be awarded for these courses unless otherwise specified in the course description. Withdrawal from one co-requisite course requires the dropping of the other course. A student is not required to repeat a co-requisite course for which he/she has received a passing grade.

A minimum grade of C or departmental approval is required in all prerequisite courses to a physics, astronomy or engineering course.

COURSES IN PHYSICS (PHY)

100. Physics in Society - Three semester hours, two hours lecture, two hours lab per week. This course covers the most interesting and important topics in physics of the 21st century and the use of scientific skills and critical thinking in science. The course stresses conceptual understanding with applications to current events. Topics may include green energy, medical physics, nuclear weapons and global warming. This course does not meet graduation requirements for students with majors in the College of Sciences and Mathematics. Lab fee required.

101. General Physics I - (PHYS 1305) - Presentation with a minimum of mathematics of the basic concepts of mechanics, light and sound. May not be used to meet graduation requirements by students majoring in the College of Sciences and Mathematics (except for students majoring in Computer Information Systems or Information Technology). Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 101L.

101L. General Physics I Laboratory - (PHYS 1105) - One semester hour, two hours lab per week. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 101. Lab fee required.

102. General Physics II - (PHYS 1307) - Continuation of PHY 101; presenting with a minimum of mathematics the basic concepts of heat, electricity, magnetism and certain aspects of modern physics. May not be used to meet graduation requirements by students majoring in the College of Sciences and Mathematics (except for students majoring in Computer Information Systems or Information Technology). Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 102L.

102L. General Physics II Laboratory - (PHYS 1107) - One semester hour, two hours lab per week. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 102. Lab fee required.

108. Introduction to Engineering/Physics - Three semester hours, two hours lecture and two hours lab per week. Introductory course on engineering/physics analysis with practice in analyzing and solving problems in physics and engineering. Includes use of computational devices and methods. Lab fee required.

110. Fundamentals of Electronics - Introductory study of fundamental electrical circuits, including DC and AC circuits, filter networks, amplifiers, diodes, transistors, and logic gates. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 110L.

110L. Fundamentals of Electronics Laboratory - One semester hour, three hours lab per week. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 110. Lab fee required.

118. Acoustical Physics - Three semester hours, two hours lecture, two hours lab per week. Topics covered include waves, resonance, frequency, pitch, waveform, hearing, intervals, scales, strings, air columns, rods, plates, vocal apparatus and instruments. Lab fee required.

125. Introductory Physical Science - Four semester hours, three hours lecture, two hours lab per week. Introduction to properties of matter, kinematics, dynamics and chemical bonding. Presentation of selected topics in a manner that will integrate principles of physics and chemistry. Lab fee required.

131. Mechanics and Heat (PHYS 1301) - Fundamental principles of mechanics and heat. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Prerequisites: MTH 133 and 138, or permission from the department chair. Co-requisite: PHY 131L.

131L. Mechanics and Heat Laboratory (PHYS 1101) - One semester hour, three hours lab per week. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 131. Lab fee required.

132. Electricity, Sound and Light (PHYS 1302) - Basic electrical and magnetic phenomena, wave motion, sound and light. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Prerequisite: PHY 131. Co-requisite: PHY 132L.

132L. Electricity, Sound and Light Laboratory (PHYS 1102) - One semester hour, three hours lab per week. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 132. Lab fee required.

214. Selected Topics - Non-advanced. One to four hours. Material covered will vary from semester to semester and will be announced. May be repeated for additional credit in a different topic.

241. Technical Physics I (PHYS 2325) - Presentation of the principles of mechanics and heat. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisites: MTH 233, PHY 241L.

241L. Technical Physics I Laboratory (PHYS 2125) - One semester hour, three hours lab per week. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 241. Lab fee required.

242. Technical Physics II (PHYS 2326) - Presentation of the principles of sound, electricity, magnetism and optics. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Prerequisites: MTH 233, PHY 241. Co-requisite: PHY 242L.

242L. Technical Physics II Laboratory (PHYS 2126) - One semester hour, three hours lab per week. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 242. Lab fee required.

250. Engineering Statics - Four semester hours, three hours lecture, three hours lab per week. Prerequisites: MTH 234 and PHY 241. (Same as EGR 250.) Lab fee required.

262. Electrical Circuits and Devices - Basic AC, DC and digital circuits and their applications in instrumentation. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Prerequisites: PHY 132 (or 242) and MTH 233. Co-requisite: PHY 262L (Same as EGR 215.)

262L. Electrical Circuits and Devices Laboratory - One semester hour, three hours lab per week. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 262. Lab fee required. (Same as EGR 215L.)

315. A, B. Selected Topics - One to four hours. Material covered varies from semester to semester and will be announced. May be repeated for additional credit in a different topic. Prerequisite: eight hours from any of the sciences.

321. Engineering Dynamics - Four semester hours, three hours lecture, three hours lab per week. Prerequisite: PHY 241 and MTH 234 (Same as EGR 321). Lab fee required.

333. Modern Physics - Introduction to relativity, quantum phenomena, atomic and nuclear physics. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Prerequisites: PHY 132 (or 242) and MTH 233. Co-requisite: PHY 333L.

333L. Modern Physics Laboratory - One semester hour, three hours lab per week. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: PHY 333. Lab fee required.

343. Electronics - Three semester hours, two hours lecture, three hours lab per week. Design and integration of basic circuits into electronic instrumentation. Prerequisite: PHY 132 (or 242). Lab fee required. (Same as EGR 343.)

347. Mathematical Applications in Physics I - Formulation and solution of physical problems using vector analysis, partial differential equations, complex variables and transforms. Prerequisites: PHY 132 (or 242) and MTH 234.

410. Experimental Techniques of Physics - Four semester hours, three hours lecture and two hours lab per week. Presentation of the experimental techniques used to measure the physical observables associated with matter, mechanics, waves, sound, light, electricity and magnetism. Lab fee required.

430. Thermodynamics - Includes the kinetic theory of gases, Maxwell-Boltzmann statistics, Fermi-Dirac statistics, the Debye Approximation, magnetic cooling and the theory of heat engines. Prerequisite: PHY 333.

431. Introductory Quantum Mechanics - DeBroglie wave, Schroedinger formulation, step and barrier potentials, perturbation theory, harmonic oscillator, annihilation and creation operations, commutation relations, representations. Prerequisite: PHY 333.

440. Introduction to Electricity and Magnetism - Electrical and magnetic field theory, properties of dielectrics and magnetic materials. Prerequisites: PHY 132 (or 242) and MTH 234.

441. Optics - Four semester hours, three hours lecture, three hours lab per week. Fundamentals of physical and geometrical optics, including polarization and diffraction. Prerequisite: PHY 440. Lab fee required.

470. Undergraduate Research and Technical Presentations - Two semester hours. An individual instruction course involving undergraduate research and technical presentations. The purpose of this course is to give the student experience in research and preparation of oral presentations on scientific research. Prerequisite: junior or senior major status or permission of department chair.

475. Special Problems - One to four hours. For undergraduate credit only. Experimental or theoretical independent study in research. Prerequisite: 12 semester hours of physics.

476. Special Problems - One to four hours. For undergraduate credit only. A continuation of PHY 475. Prerequisite: PHY 475.

485. Internship in Physics and Engineering - One to three hours. Supervised on-the-job training in one or more facets of the field of physics or engineering. Internships are to be arranged by students and approved by instructor. This course is an elective and cannot be used to satisfy any of the course requirements for a major or minor in physics.

*May be offered as an Internet course.

COURSES IN ASTRONOMY (AST)

105. Classical and Modern Astronomy - Introductory study of planetary astronomy, astrophysics and cosmology. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: AST 105L.

105L. Classical and Modern Astronomy Laboratory - One semester hour, two hours lab per week, including night viewing sessions by arrangement. Lecture and laboratory grades are computed into one grade and the same grade is recorded for both lecture and lab. Co-requisite: AST 105. Lab fee required.

305. Observational Astronomy - Three semester hours, two hours lecture and three hours lab per week. Fundamentals of practical sky observing include

visual, photographic and photometric techniques using the research telescopes at the SFA Observatory. Prerequisites: MTH 133, 138. Lab fee required.

335. Astrophysics - Properties of light, stellar evolution and galactic dynamics are treated in a quantitative manner. Prerequisites: PHY 132 (or 242) and MTH 233.

*Frequently has section offered as an Internet course.

ENGINEERING PHYSICS, PRE-ENGINEERING AND PHYSICS-ENGINEERING DUAL DEGREE PROGRAMS

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Engineering Physics Major

The Engineering Physics program is the study of the combined disciplines of physics, engineering and mathematics in order to develop an understanding of the interrelationships of these three disciplines. The educational objective is to address the needs of students seeking innovative careers in high-tech areas where multiple engineering disciplines merge (e.g. electro-mechanical industries). The majority of graduates of the program enter industry in diverse areas such as mechanical controls, digital and analog electronics, nuclear instrumentation, software development, and manufacturing process control. Others choose to attend graduate school in either engineering or physics programs.

Pre-Engineering

Students wishing to major in any of the many branches of engineering may take their first two years in pre-engineering at SFA and transfer to a college of engineering for their final two years to complete their course of study.

Dual Degree

The Physics-Engineering Dual Degree Program provides an option through which SFA students may complete requirements for a major in physics, a minor in mathematics and the core of courses that are part of the Pre-Engineering Program. Students who complete the dual degree curriculum outlined below will receive a B.S. degree in physics from SFA upon transferring back sufficient semester hours (approximately 30) from the upper-division engineering program. (Of these 30 hours, six hours must be advanced engineering hours. The remainder may be core courses and electives.) Upon completion of the Engineering Program, the student will receive a B.S. degree in engineering.

Students in any of these programs should consult with their advisers to adjust the programs outlined below to meet the variations in requirements particular to the branch of engineering and the terminal university.

Student Organization

The Engineering Student Organization was started in 2015 alongside the new Engineering Physics degree offered at SFA. This is a group of individuals who share an interest in engineering and participate in engineering projects stemming from the department, university and in public-outreach settings. Activities include involvement with major engineering societies' project-based competitions, like those held by the American Society of Mechanical Engineers and the Institute of Electrical and Electronics Engineers. The organization also is home to student-led projects, study groups for engineering courses and opportunities to interact with faculty members on research endeavors.

Engineering Physics Curriculum

Freshman Year (33 hours)

EGR 111	3	EGR 112	3
MTH 140	4	MTH 233	4
PHY 108	3	PHY 241	4
HIS 133	3	HIS 134	3
Req. English	3	Req. English	3
	16		**17**

Sophomore Year (32 hours)

PHY 242	4	EGR 215	4
MTH 234	4	MTH 333	4
PSC 141	3	PSC 142	3
CSC 102	3	CHE 133	4
Core Req..	3		
	17		**15**

Junior Year (28 hours)

EGR 250	4	EGR 321	4
PHY 347	3	MTH 337	3
PHY 333	4	PHY 440	3
CHE 134	4	Core Req.	3
	15		**13**

Senior Year (28 hours)

Emphasis Course #1	3	Emphasis Course #3	3
Emphasis Course #2	3	Emphasis Course #4	3
EGR 343	3	EGR 470	2
EGR 460	2	ENG 273	3
Core Req.	3	Core Req.	3
	14		**14**

Students may choose one of the following emphasis tracks for their senior year:

Mechanical Engineering Emphasis Courses

AGM 325	Computer Aided Drafting
EGR 305	Mechanics of Materials
EGR 345	Fluid Mechanics
PHY 430	Thermodynamics

Electrical Engineering Emphasis Courses

EGR 314	Control Systems
EGR 344	Microcomputer Interfacing
EGR 370	Linear Circuit Analysis
PHY 441 or 431	Optics or Quantum Mechanics

*Note: Students who are qualified to take calculus their first semester at SFA can choose to replace MTH 140 and PHY 108 with other courses to bring the degree total to 120 credit hours. Students are encouraged to take math and chemistry courses during the summer to reduce fall and spring semester loads and to decrease the time required for a degree.

Pre-Engineering Curriculum

Freshman Year (33 hours)

PHY 108	3	PHY 241	4
MTH 233	4	MTH 234	4
EGR 111	3	EGR 112	3
HIS 133	3	HIS 134	3
Required English	3	Required English	3
	16		**17**

Sophomore Year (32 hours)

EGR 250	4	EGR 215	4
PHY 242	4	EGR 321	4
MTH 333	4	CSC 102	3
*Elective or Political Sci	3	*Elective or Political Sci	3
		Core Req.	3
	15		**17**

Summer Sessions

MTH 337, CHE 133 and 134 and *Electives, history or political science

Physics-Engineering Dual Degree Curriculum

Freshman Year (33 hours)

PHY 108	3	PHY 241	4
MTH 233	4	MTH 234	4
EGR 111	3	EGR 112	3
Required English	3	Required English	3
HIS 133	3	HIS 134	3
	16		**17**

Sophomore Year (32 hours)

EGR 250	4	EGR 215	4
PHY 242	4	EGR 321	4
MTH 333	4	CSC 102	3
PSC 141	3	PSC 142	3
		Core Req.	3
	15		**17**

Junior Year (33 hours)

PHY 347	3	PHY 440	3
PHY 333	4	MTH 337	3
MTH 317	3	Core Req.	3
Core Req.	3	Core Req.	3
*Electives or Core Req.	3	*Electives	3
		PHY 470	2
	16		**17**

Summer Sessions

CHE 133, 134 and required social science

*Students pursuing the specific engineering degree may include the following among their electives:

- Petroleum Engineer: GOL 131, 132
- Chemical Engineer: CHE 231, 331, 332
- Biochemical Engineer: BIO 131, 133; CHE 231, 331, 332

SFA has a formal agreement with Lamar University on a Dual Degree Physics-Engineering Program and articulation agreements with Texas A&M University and the University of Texas at Tyler on the transfer of courses from SFA to TAMU and UTT. Details of the programs can be obtained from the pre-engineering adviser at SFA. Students should contact terminal engineering schools about the compatibility of the above-suggested curriculum with their program.

COURSES IN ENGINEERING (EGR)

Unless otherwise indicated, courses listed below are three-semester hours credit, three hours lecture per week.

111. Foundations in Engineering I - Three semester hours, two hours lecture, two hours lab per week. Introduction to the engineering profession, ethics and disciplines; development of skills in teamwork, problem solving, logic processing, algorithm development, estimation, design and drawing; emphasis on computer applications and design. Software used: Microsoft Office and Windows, AutoCAD and the Internet. Lab fee required.

112. Foundations in Engineering II - Three semester hours, two hours lecture, two hours lab per week. Development of skills in problem solving, design, analysis, estimation and teamwork; utilization of computer tools for documentation and presentation; introduction to logic processing and computer programming; introduction to accounting and conservation principles in engineering. Software used: Microsoft Office and Windows, AutoCAD and the Internet. Lab fee required.

215. Principles of Electrical Engineering - Basic AC, DC, and digital circuits and their applications in instrumentation. Lecture and laboratory grades are computed into one grade, and the same grade is recorded for both lecture and lab. Prerequisites: EGR 112 or PHY 242 and MTH 233. Co-requisite: EGR 215L. (Same as PHY 262).

215L. Principles of Electrical Engineering Laboratory - One semester hour, three hours lab per week. Lecture and laboratory grades are computed into one grade, and the same grade is recorded for both lecture and laboratory. Co-requisite: EGR 215. Lab fee required. (Same as PHY 262L.)

250. Engineering Statics - Four semester hours, three hours lecture, three hours lab per week. Prerequisites: MTH 234 and PHY 241. (Same as PHY 250.) Lab fee required.

305. Mechanics of Materials - Topics include stress and strain, uniaxially loaded members, centroids and area moments of inertia, normal and shear stresses, beam deflections, buckling of columns, pressure vessels, combined stresses and failure criteria. Prerequisite: EGR 250 or PHY 250.

314. Control Systems - Introduction to automatic control systems; mathematical models of physical systems; block diagrams and signal flow graphs; transient and steady state responses; PID controllers; stability of linear feedback systems; root-locus and Routh's criteria; frequency response methods; polar, Nyquist and Bode plots; stability margins and state-variable formulation. Prerequisite: EGR 215 or PHY 262.

321. Engineering Dynamics - Four semester hours, three hours lecture, three hours lab per week. Prerequisite: PHY 241 and MTH 234. (Same as PHY 321). Lab fee required.

343. Electronics - Three semester hours, two hours lecture, three hours lab per week. Design and integration of basic circuits into electronic instrumentation. Prerequisite: PHY 132 (or 242). Lab fee required. (Same as PHY 343.)

344. Microcomputer Interfacing – Three semester hours, two hours of lecture and three hours of lab per week. Microprocessor architecture, programming and interfacing. Introduction to assembly language programming, microcomputers, microcontrollers, instruction set, chip interfacing, addressing modes, interrupts, input/output and communication. Prerequisite: EGR 343 or PHY 343.

345. Fluid Mechanics - The course covers basic concepts of a fluid and the fundamentals and applications of ideal and real fluid flow. Topics include fluid statistics, conversation principles, the Bernoulli equation, fluid flow in pipes, open channel flow and fluid flow measurement devices. Prerequisite: EGR 321 or PHY 321.

370. Linear Circuit Analysis - Transient circuit analysis, circuit analysis and design using the Laplace transform; convolution in time domain and frequency domain; transfer functions; frequency response and Bode plots; passive and active filter design; Fourier Transform; two-port circuits and balanced three-phase AC circuits. Prerequisite: EGR 215 or PHY 262.

460. Engineering Capstone Design - Two semester hours. A capstone design project is taken up to the point of prototype construction, testing and hardware specification. The specific skills and knowledge needed by practicing engineers in the product realization process are emphasized and developed. Prerequisites: 12 semester hours of engineering or physics.

470. Undergraduate Research and Technical Presentation - Two semester hours. The capstone project initiated in EGR 460 is taken from a prototype to a finished project. The project then undergoes laboratory testing and evaluation. Students present their results on a research poster and in oral presentations. Prerequisite: EGR 460.

475. Special Problems - One to four semester hours. Experimental or theoretical independent study in research. Not available for graduate credit. Prerequisites: 12 semester hours of engineering or physics.

476. Special Problems - One to four semester hours. A continuation of EGR 475. Experimental or theoretical independent study in research. Not available for graduate credit. Prerequisites: 12 semester hours of engineering or physics.