

- 830. Biomechanical Analysis of Physical Activity**
Fall. 3(2-2) Interdepartmental with Biomechanics.
Kinematic analysis of mechanical and anatomical characteristics in physical activity and sport skills.
QA: HCP 853
- 831. Advanced Biomechanics of Physical Activity**
Spring of odd-numbered years. 3(3-0)
Interdepartmental with Biomechanics.
P: PES 830.
Three-dimensional analyses of human motion in sport activities. Emphasis on maturation level, performance level, and the causes and prevention of injuries.
QP: HCP 853 QA: HCP 854
- 840. Psychosocial Aspects of Physical Activity**
Fall. 3(3-0)
Social psychology of sport and physical activity.
QA: HCP 835, HCP 836
- 845. Sociocultural Practices in Sport**
Spring of even-numbered years. 3(3-0)
Critical, conflict, and feminist theories on dominant ideologies and social practices in sport.
- 851. Curriculum and Instruction in Physical Activity Programs**
Spring of odd-numbered years. 3(3-0)
P: PES 450.
Curriculum theory and models in physical education and exercise science. Interaction of curriculum and instructional decision making in physical education and exercise science.
QA: HCP 863, HCP 867
- 852. Evaluation of Physical Activity Programs**
Spring of even-numbered years. 3(3-0)
P: PES 450.
Skills and knowledge necessary to design, implement, analyze, interpret, and report program evaluations in physical education and exercise science.
QA: HCP 864
- 853. Athletic Administration in Higher Education**
Spring. 3(3-0)
Administrative theory, structure, and budget. Facilities, equipment, and marketing. Legal, medical, and safety aspects.
QA: HCP 860
- 860. Growth and Motor Behavior**
Fall. 3(3-0)
Developmental skill sequences and behavior across the lifespan. Correlates of growth, maturation, and motor behavior. Individual and gender differences.
QA: HCP 816, HCP 817
- 861. Growth, Maturation, and Physical Activity**
Spring of odd-numbered years. 3(3-0)
P: PES 860.
Physical growth, biological maturation, and motor performance. Development of tissues and organs. Development of motor components. Influences of gender and age on growth and performance. Methods of assessment.
QA: HCP 816, HCP 817
- 862. Motor Skill Learning**
Spring of even-numbered years. 3(3-0)
P: PES 860.
Learning and performance theory applied to gross motor skills. Conditions influencing skill acquisition. Emphasis on neuropsychological and human performance models.
QA: HCP 819
- 865. Curriculum and Instruction in Adapted Physical Education**
Fall of even-numbered years. 3(3-0)
Design of curricula and implementation of instruction in physical education for students with disabilities.
QA: HCP 845A
- 866. Research on Sports for Athletes with Disabilities**
Fall of odd-numbered years. 3(3-0)
Performance capabilities of athletics with disabilities. Research on areas such as exercise physiology, sport biomechanics, sport psychology, sport sociology, motor development, and motor learning.
QA: HCP 845B
- 867. Practicum in Adapted Physical Activity**
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course.
C: PES 865 or PES 866 or concurrently. R: Approval of department.
Supervised practice in teaching physical activities and/or coaching sports for persons with disabilities.
QA: HCP 845C
- 870. Physical Activity and Well-Being**
Fall. 3(3-0)
Relationship of physical activity to human well-being. Influence of growth, biological maturity, aging, body composition, nutrition, training, and rest on health and performance.
- 871. Research Methods in Physical Education and Exercise Science**
Spring. 3(3-0)
R: Open only to graduate students in Physical Education and Exercise Science.
Research and analytical methodology including survey, qualitative, historical, philosophical, descriptive, meta-analytical, creative, and experimental methods.
QA: HCP 802
- 882. Topics in Physical Education and Exercise Science (MTC)**
Fall, Spring, Summer. 2 to 3 credits. A student may earn a maximum of 9 credits in all enrollments for this course.
Selected topics in areas such as physiology of exercise, biomechanics, motor behavior, psychosocial aspects of activity, program design and evaluation, and athletic training.
- 890. Independent Study in Physical Education and Exercise Science**
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
R: Open only to master's students. Approval of department.
Individual study in an area of physical education and exercise science under faculty supervision.
- 893. Internship in Physical Education and Exercise Science**
Fall, Spring, Summer. 2 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
R: Open only to graduate students in Physical Education and Exercise Science.
Supervised internship in sports medicine, athletic administration, coaching, or education agencies. Capstone experience option in master's degree program.
- 894. Field Experiences in Physical Education and Exercise Science**
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
R: Approval of department.
Supervised graduate practicum in schools or other settings.
- 897. Project in Physical Education and Exercise Science**
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course.
R: Open only to graduate students in Physical Education and Exercise Science.
Project experience under the guidance and supervision of MSU faculty. Development of products such as technical reports, instructional media, or curriculum materials to address an educationally significant problem. Capstone experience option in master's
- 899. Master's Thesis Research**
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
P: PES 871.
QP: HCP 802
- 910. Current Issues in Exercise Physiology**
Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.
P: PES 810.
Selected issues in exercise physiology and related fields of study.
- 930. Current Issues in Biomechanical Aspects of Physical Activity**
Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.
Interdepartmental with Biomechanics.
P: PES 830.
Selected issues of biomechanical analyses of sport and physical activity.
- 940. Current Issues in Psychosocial Aspects of Physical Activity**
Fall. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.
Selected issues in the psychology and sociology of sport and physical activity.
- 950. Current Issues in the Design and Evaluation of Physical Activity Programs**
Fall. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.
Selected issues in the design and evaluation of physical activity programs.
- 960. Current Issues in Motor Behavior**
Spring. 3(3-0) A student may earn a maximum of 9 credits in all enrollments for this course.
P: PES 860.
Selected issues in motor development, motor learning, adapted physical education, and related fields of study.
- 990. Independent Study in Physical Education and Exercise Science**
Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 6 credits in all enrollments for this course.
R: Open only to doctoral students. Approval of department.
Individual study in an area of physical education and exercise science under faculty supervision.
- 995. Research Practicum in Physical Education and Exercise Science**
Fall, Spring, Summer. 1 to 4 credits. A student may earn a maximum of 4 credits in all enrollments for this course.
R: Open only to doctoral students in College of Education. Approval of department.
Supervised research practicum. Design, execution, analysis, presentation, critique, and revision of research projects.
- 999. Doctoral Dissertation Research**
Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 36 credits in all enrollments for this course.
R: Open only to doctoral students.

PHYSICS

PHY

**Department of Physics
College of Natural Science**

170. Investigations in Physics
Fall. 3(0-6)

R: Approval of department.
Experiments in optics, electronics, sound and mechanics; analysis of data using computers, library research and oral presentations.

**Descriptions—Physics
of
Courses**

181B. Basic Physics I, CBI

Fall, Spring, Summer. 3 credits.
P: MTH 132 or concurrently. R: Not open to students with credit in LBS 164 or PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B.
Newton's laws of motion, conservation of angular momentum, energy conservation, thermal physics, waves, and sound. Competency based instruction.
QP: MTH 112 QA: PHY 281, PHY 237B, PHY 237, PHY 287, PHY 287B, PHY 291B, PHY 291H

182B. Basic Physics II, CBI

Fall, Spring, Summer. 3 credits.
P: LBS 164 or PHY 181B or PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B. R: Not open to students with credit in LBS 267 or PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 294H. Electricity and magnetism, optical phenomena, interference and diffraction of light, atomic and subatomic topics. Competency based instruction.
QP: PHY 281 or PHY 237 or PHY 237B or PHY 287 or PHY 287B or PHY 291B or PHY 291H, LBS 267 QA: PHY 282, PHY 283B, PHY 238, PHY 238B, PHY 239, PHY 239B, PHY 288, PHY 288B, PHY 289, PHY 289B, PHY 292B, PHY 292H, LBS 263

183. Physics for Scientists and Engineers I
Fall, Spring. 4(5-0)

P: MTH 132 or concurrently. R: Not open to students with credit in PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B or LBS 164.
Mechanics, Newton's laws, momentum, energy conservation laws, rotational motion, oscillation, gravity, waves.
QA: PHY 287, PHY 287B, PHY 291H, PHY 237, PHY 281, PHY 291B, PHY 237B, PHY 291H, LBS 261

183A. Physics I, CBI

Fall, Spring, Summer. 1 credit.
P: PHY 181B. R: Not open to students with credit in PHY 183 or PHY 183B or PHY 231 or PHY 231B or PHY 193H or LBS 164.
Topics from: frames of reference, special relativity, rocket equation, forced oscillations, resonances, fluid motion, numerical solutions, moments of inertia, gyroscopic motion. This course plus PHY 181B is equal to PHY 183B.
QP: PHY 281 QA: PHY 287A

183B. Physics for Scientists and Engineers I, CBI

Fall, Spring, Summer. 4 credits.
P: MTH 132 or concurrently. R: Not open to students with credit in PHY 231 or PHY 183 or PHY 231B or PHY 193H or PHY 181B or LBS 164.
Mechanics, Newton's laws, momentum, energy conservation laws, rotational motion, oscillation, gravity, waves. Competency based instruction.
QA: PHY 287, PHY 287B, PHY 237, PHY 237B, PHY 281, PHY 291B, PHY 291H

184. Physics for Scientists and Engineers II

Fall, Spring. 4(5-0)
P: PHY 181B or PHY 183 or PHY 183B or PHY 193H or LBS 164; MTH 133 or concurrently. R: Not open to students with credit in LBS 267 or PHY 182B or PHY 184B or PHY 232 or PHY 232B or PHY 294H. Electricity and magnetism, electromagnetic waves, light and optics, interference and diffraction.
QP: PHY 289, PHY 289B, PHY 239, PHY 239B, PHY 287, PHY 287B, PHY 237, PHY 237B, PHY 287A QA: PHY 288, PHY 288B, PHY 238, PHY 238B, PHY 292H, PHY 292B, PHY 282

184A. Physics II, CBI

Fall, Spring, Summer. 1 credit.
P: PHY 182B. R: Not open to students with credit in PHY 184 or PHY 184B or PHY 294H or PHY 232B. Topics from: standing wave phenomena, atoms, electromagnetic fields, alternating currents, optics, quantum mechanics, elementary particles. This course plus PHY 182B is equivalent to PHY 184B.
QP: PHY 281 QA: PHY 288B, PHY 289B, PHY 288A, PHY 289A

184B. Physics for Scientists and Engineers II, CBI

Fall, Spring, Summer. 4 credits.
P: PHY 181B or PHY 183 or PHY 193A or PHY 183B or PHY 193H or LBS 164; MTH 133 or concurrently. R: Not open to students with credit in LBS 267 or PHY 182B or PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 294H. Electricity and magnetism, electromagnetic waves, light and optics, interference and diffraction. Competency based instruction.
QA: PHY 288, PHY 288B, PHY 238, PHY 238B, PHY 292H, PHY 292B, PHY 282

191. Physics Laboratory for Scientists, I
Spring. 1(0-3)

P: PHY 181B or PHY 183 or PHY 183A or PHY 183B or PHY 193H or LBS 164 or concurrently. R: Not open to students with credit in PHY 251.
Error analysis, exercises in motion, forces, conservation laws and optics.
QA: PHY 257, PHY 297

192. Physics Laboratory for Scientists, II
Fall. 1(0-3)

P: PHY 184 or PHY 184B or PHY 191 or PHY 294H or LBS 267 or concurrently. R: Not open to students with credit in PHY 252.
Electric and magnetic fields, circuits, wave optics, and radioactivity.
QA: PHY 298, PHY 299, PHY 258, PHY 259

193H. Honors Physics I—Mechanics
Spring. 3(4-0)

P: MTH 133 or MTH 153H or concurrently.
Mechanics and waves.
QP: MTH 113 QA: PHY 291H, PHY 287, PHY 287B, PHY 237, PHY 237B, PHY 281, LBS 261

205. Directed Studies

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course.
R: Approval of department.
Guided individualized study in an area of physics.

215. Thermodynamics and Modern Physics
Fall, Spring. 3(4-0)

P: PHY 184 or PHY 184A or PHY 184B or PHY 294H or LBS 267. R: Not open to students with credit in PHY 215B.
Thermodynamics, atomic physics, quantized systems, nuclear physics, solids, elementary particles.

215B. Thermodynamics and Modern Physics, CBI

Fall, Spring, Summer. 3 credits.
P: PHY 184 or PHY 184A or PHY 184B or PHY 294H or LBS 267. R: Not open to students with credit in PHY 215.
Thermodynamics, atomic physics, quantized systems, nuclear physics, solids, elementary particles. Competency based instruction.
QA: PHY 364, PHY 364B, PHY 365B, PHY 391

231. Introductory Physics I

Fall, Spring. 3(4-0)
P: MTH 116 or concurrently. R: Not open to students with credit in PHY 181B or PHY 183 or PHY 183B or PHY 193H or PHY 231B or LBS 164.
Mechanics, Newton's Laws, momentum, energy, conservation laws, thermodynamics, waves, sound.
QP: MTH 109 QA: PHY 237, PHY 237B, PHY 281, PHY 287, PHY 287B, PHY 291B, PHY 291H

231B. Introductory Physics I, CBI

Fall, Spring, Summer. 3 credits.
P: MTH 116 or concurrently. R: Not open to students with credit in PHY 181B or PHY 183 or PHY 183B or PHY 193H or PHY 231 or LBS 164.
Mechanics, Newton's laws, momentum, energy, conservation laws, thermodynamics, waves, sound. Competency based instruction.
QP: MTH 109 QA: PHY 237, PHY 237B, PHY 281, PHY 287, PHY 287B, PHY 291B, PHY 291H

232. Introductory Physics II

Fall, Spring. 3(4-0)
P: PHY 181B or PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B or LBS 164. R: Not open to students with credit in PHY 184 or PHY 184B or PHY 232B.
Electricity and magnetism; optics; atomic, nuclear, and subnuclear physics.
QP: PHY 237 or PHY 237B or PHY 287B or PHY 281 or PHY 291B or PHY 291 QA: PHY 238, PHY 239, PHY 238B, PHY 239B, PHY 288, PHY 288B, PHY 289, PHY 289B, PHY 292H, LBS 263

232B. Introductory Physics II, CBI

Fall, Spring, Summer. 3 credits.
P: PHY 181B or PHY 183 or PHY 183B or PHY 193H or PHY 231 or PHY 231B or LBS 164. R: Not open to students with credit in PHY 184 or PHY 184B or PHY 232.
Electricity and magnetism; optics; atomic, nuclear, and subnuclear physics. Competency based instruction.
QP: PHY 237 or PHY 237B or PHY 287 or PHY 287B or PHY 281 or PHY 291B or PHY 291H QA: PHY 238, PHY 239, PHY 238B, PHY 239B, PHY 288, PHY 289, PHY 288B, PHY 289B, PHY 292H

233B. Calculus Concepts in Physics I, CBI

Fall, Spring, Summer. 2 credits.
P: PHY 231 or PHY 231B; MTH 132 or concurrently.
Kinematics, dynamics, applications of Newton's laws. Competency based instruction. PHY 231B plus PHY 233B is equivalent to PHY 183B.
QP: MTH 112, PHY 237 QA: PHY 284, PHY 287, PHY 287B, PHY 291B, PHY 291H, PHY 285

234B. Calculus Concepts in Physics II, CBI

Fall, Spring, Summer. 2 credits.
P: PHY 232 or PHY 232B; MTH 133 or concurrently.
Electricity and magnetism. Competency based instruction. PHY 232B plus PHY 234B equals PHY 184B.
QP: MTH 113, PHY 238, PHY 239, PHY 284 QA: PHY 285, PHY 286, PHY 288, PHY 288B, PHY 289, PHY 289B, PHY 292B

251. Introductory Physics Laboratory I

Fall, Spring, Summer. 1(0-3)
P: PHY 183 or PHY 183B or PHY 231 or PHY 231B or concurrently. R: Not open to students with credit in PHY 191.
Laboratory exercises involving simple mechanical systems.
QA: PHY 257, PHY 297

252. Introductory Physics Laboratory II

Fall, Spring, Summer. 1(0-3)
P: PHY 251 or PHY 191 or LBS 164L. R: Not open to students with credit in PHY 192.
Laboratory exercises involving simple electromagnetic and optical systems.
QA: PHY 258, PHY 259, PHY 298, PHY 299

294H. Honors Physics II—Electromagnetism

Fall. 3(4-0)
P: PHY 193H; MTH 234 or MTH 254H or concurrently.
Electricity and magnetism, electromagnetic waves and optics.
QP: MTH 214 QA: PHY 292H, PHY 288, PHY 288B, PHY 238, PHY 238B, PHY 282, LBS 263

305. Directed Studies

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 3 credits in all enrollments for this course.
P: PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 294H; R: Approval of department.
Guided individualized study in an area of physics.
QA: PHY 304

321. Classical Mechanics I

Spring, Summer. 3(3-0)
P: PHY 215 or PHY 294H or concurrently, MTH 235 or MTH 255H or concurrently.
The mechanics of point particles as application of Newton's laws. Conservation of energy and momentum. Central force fields.
QP: MTH 310, PHY 291H, PHY 289 QA: PHY 427, PHY 428

- 331. Optics I**
Spring, 3(2-3)
P: PHY 192, PHY 215.
Lenses, aberrations, apertures, and stops. Diffraction, interferometry, spectroscopy, fiber optics.
QP: PHY 289, PHY 299, PHY 289B QA: PHY 438, PHY 439
- 351B. Computational Physics, CBI**
Fall, Spring, Summer, 3 credits.
P: CPS 130 or CPS 131 or CPS 230; PHY 215 or PHY 215B.
Computer applications in physics research: printer graphics, Schrodinger equation solution, physics-symbol processing, physics information retrieval. Analysis of typical research data. Competency based instruction.
QP: PHY 289 or PHY 289B or PHY 293H QA: PHY 351
- 357B. Topics in Contemporary Physics (CBI)**
Fall, Spring, Summer, 3 credits.
P: PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 294H. R: Not open to students in Department of Physics and Astronomy.
Atoms and nuclei, weak decay interaction, weak bosons, strong interaction, conservation laws, quarks and gluons. Competency based instruction.
QP: PHY 239 or PHY 239B or PHY 289 or PHY 289B QA: PHY 357
- 390. Physics Journal Seminar**
Spring, 1(3-0)
R: Open only to juniors in Physics.
Written and oral reports on selected articles in the current literature. Critique of presentations by peers.
QA: PHY 399
- 405. Directed Studies**
Fall, Spring, Summer, 1 to 3 credits. A student may earn a maximum of 5 credits in all enrollments for this course.
P: PHY 184 or PHY 184B or PHY 232 or PHY 232B or PHY 294H; R: Approval of department.
Guided independent study of special topics for seniors.
QA: PHY 404
- 410. Thermal and Statistical Physics**
Spring, 3(3-0)
P: PHY 471.
Equilibrium statistical mechanics and thermodynamics, kinetic theory, phase transformations.
QP: MTH 310, PHY 427, PHY 391 QA: PHY 395, PHY 396
- 411. Conceptual Physics**
Spring, Summer, 4(3-3)
P: MTH 116. R: Not open to Physics or Astrophysics students.
Physical phenomena evident in the world around us: mechanics, heat, properties of matter, waves and sound, electricity and magnetism, light, atmosphere and hydrosphere, and naked eye astronomy.
QP: MTH 109 QA: PHS 203
- 422. Classical Mechanics II**
Fall, Summer, 3(3-0)
P: PHY 321, MTH 235 or MTH 255H.
Analytic mechanics. Dynamics of systems of particles. Hamiltonian and Lagrangian mechanics. Vibrations and normal modes.
QP: PHY 427 QA: PHY 428, PHY 429
- 423B. Special Relativity, CBI**
Summer, 3 credits.
P: PHY 321, PHY 481.
Concepts of special relativity applied to coordinate transformations, mechanics, and electrodynamics. Competency based instruction.
QP: PHY 427, PHY 447
- 425B. Mathematical Physics, CBI**
Summer, 3 credits.
P: PHY 321, PHY 481.
Fourier series and complex variables as applied to problems in quantum mechanics, electrodynamics, and mechanics. Competency based instruction.
QA: PHY 817
- 432. Optics II**
Fall, 3(2-3)
P: PHY 331.
Experimental projects involving advanced topics in optics. Holography, spatial filtering, study of physical systems using optical devices.
QP: PHY 438, MTH 334 QA: PHY 439
- 440. Electronics**
Spring, 4(3-3)
P: PHY 184 or PHY 184B or PHY 294H; PHY 192; MTH 235 or MTH 255H.
Concepts of electronics used in investigating physical phenomena. Circuits, amplifiers, diodes, LEDs, transistors.
QP: MTH 310, PHY 288, PHY 288B, PHY 292H, PHY 298 QA: PHY 419
- 451. Advanced Laboratory**
Fall, 3(0-6)
P: PHY 331 or PHY 440.
General research techniques, design of experiments, and the analysis of results based on some historical experiments in modern physics.
QP: PHY 438 or PHY 439 or PHY 419 QA: PHY 457G
- 452. Advanced Projects Laboratory**
Spring, 3(0-6)
P: PHY 331 or PHY 440; PHY 451.
A projects laboratory that builds on optics and electronics courses.
QP: PHY 457G QA: PHY 457S, PHY 457N, PHY 420
- 471. Quantum Physics I**
Fall, 3(3-0)
P: PHY 215 or PHY 215B; MTH 235 or MTH 255H; PHY 321.
Schrodinger equation, hydrogen atom, harmonic oscillator, and other one-dimensional systems.
QP: PHY 391 QA: PHY 492, PHY 493
- 472. Quantum Physics II**
Spring, 3(3-0)
P: PHY 471.
Matrix formulation of quantum mechanics, perturbation theory, scattering.
QP: PHY 492 QA: PHY 493
- 480. Computational Physics**
Spring of odd-numbered years, 3(3-0)
P: CPS 130 or CPS 131 or CPS 230.
Applications of scientific computational techniques to solutions of differential equations, matrix methods, and Monte Carlo methods used in physics.
- 481. Electricity and Magnetism I**
Fall, Summer, 3(3-0)
P: MTH 234 or MTH 254H. R: Open only to juniors or seniors.
Electrostatics, dielectrics, magnetic fields of steady state currents, Faraday law of induction.
QP: MTH 310 QA: PHY 447, PHY 448
- 482. Electricity and Magnetism II**
Spring, 3(3-0)
P: PHY 481.
Maxwell's equations, scalar and vector potentials, electromagnetic plane waves.
QP: PHY 447 QA: PHY 448, PHY 449
- 490. Senior Thesis**
Fall, Spring, Summer, 1 to 4 credits. A student may earn a maximum of 5 credits in all enrollments for this course.
R: Open only to seniors. Approval of department.
Design, carry out, and analyze an original experiment or computation. A written and oral report is required.
QA: PHY 406
- 491. Atomic, Molecular, and Condensed Matter Physics**
Fall, 3(3-0)
P: PHY 410, PHY 471.
Many-electron atoms. Molecules, crystal structure, lattice dynamics. Band models of metals and semiconductors. Transport properties.
QP: PHY 491, PHY 395 QA: PHY 496
- 492. Nuclear and Elementary Particle Physics**
Spring, 3(3-0)
P: PHY 472.
Properties of nuclei, nuclear models, nuclear reactions. High-energy accelerators. Weak, electromagnetic and strong interactions. Symmetries and conservation laws. Elementary particle spectrum, quarks, gluons.
QP: PHY 492 QA: PHY 497, PHY 498
- 800. Research Methods**
Fall, Spring, Summer, 3(3-0) A student may earn a maximum of 6 credits in all enrollments for this course.
R: Open only to graduate students in Astronomy and Astrophysics and in Physics.
Design and setup of experiments in various faculty research areas. Data collection and analysis. Study and practice of theoretical methods.
QA: PHY 800
- 820. Classical Mechanics**
Fall, 3(3-0)
Two-body central force problem, Hamilton's principle, Lagrangian and Hamiltonian equations of motion, variational methods, small oscillations, classical fields.
QA: PHY 857, PHY 858
- 831. Statistical Mechanics**
Spring, 3(3-0)
Equilibrium statistical mechanics and thermodynamics. Boltzmann transport equations and hydrodynamics. Brownian and Langevin motion.
QA: PHY 871
- 832. Topics in Statistical Mechanics (MTC)**
Fall, 3(3-0) A student may earn a maximum of 12 credits in all enrollments for this course.
P: PHY 831.
Advanced topics in statistical matter physics and nuclear physics.
QP: PHY 871
- 841. Classical Electrodynamics I**
Fall, 3(3-0)
Electrostatics, magnetostatics, time-varying fields and Maxwell's equations. Gauge transformations. Poynting's theorem and conservation laws.
QA: PHY 847, PHY 848
- 842. Classical Electrodynamics II**
Spring, 3(3-0)
P: PHY 841.
Plane electromagnetic waves, polarization states, reflection, refraction. Wave guides and resonant cavities. Radiating systems, dipole fields, radiated power. Special theory of relativity.
QP: PHY 847 QA: PHY 848, PHY 849
- 851. Quantum Mechanics I**
Fall, 3(3-0)
R: Open only to graduate students in College of Engineering and College of Natural Science.
Axioms of quantum and wave mechanics, applications to spherically symmetric potentials. Hydrogen atom, harmonic oscillator, matrix mechanics, angular momentum theory, rotations.
QA: PHY 837, PHY 838
- 852. Quantum Mechanics II**
Spring, 3(3-0)
P: PHY 851.
Approximation methods, perturbation theory, atomic physics applications, scattering theory, identical particles, Pauli principle, Bose and Einstein statistics, Hartree-Fock approximation, collisions of identical particles, radiation.
QP: PHY 837 QA: PHY 838, PHY 839
- 853. Advanced Quantum Mechanics**
Fall, 3(3-0)
P: PHY 852.
Quantum description of relativistic particles and fields. Dirac equation, interpretation of negative energy states, Lagrangian field theory, quantization of free fields, interactions, perturbation theory, S-matrix, and Feynman rules.
QP: PHY 839 QA: PHY 867, PHY 868

**Descriptions—Physics
of
Courses**

854. Quantum Electrodynamics

Spring of even-numbered years. 3(3-0)
P: PHY 853.
Application of quantum field theory to the interaction of electrons and photons: pair annihilation, Compton scattering, Bound states, renormalization theory.
QA: PHY 868, PHY 869

871. Condensed Matter Physics

Spring. 3(3-0)
P: PHY 852.
Structure and vibrations of solids. Electrons in solids, electron gas, Bloch's theorem. Cohesion. Electron states in solids. Electronic properties of solids, electron transport, conductivity, semiconductors. Cooperative phenomena.
QP: PHY 839 QA: PHY 883

881. Subatomic Physics

Fall. 3(3-0)
P: PHY 851.
Application of conservation laws and physical principles to basic quantum mechanical problems in MeV energy range and femtometer size range. Application to nuclear data.
QP: PHY 838 QA: PHY 881

891. Elementary Particle Physics

Spring. 3(3-0)
P: PHY 853.
Nonabelian gauge theory, spontaneously broken gauge theory, electroweak interaction, QCD, W and Z boson coupling to quarks and leptons, charm, top and bottom quarks, particle generations.
QP: PHY 867 QA: PHY 927, PHY 928

899. Master's Thesis Research

Fall, Spring, Summer. 1 to 6 credits. A student may earn a maximum of 24 credits in all enrollments for this course.
R: Open only to graduate students in Physics.

QA: PHY 899

972. Topics in Condensed Matter Physics (MTC)

Fall, Spring. 3(3-0) A student may earn a maximum of 12 credits in all enrollments for this course.
P: PHY 831, PHY 852, PHY 871.
Advanced topics in many-body problems, disordered solids, superfluidity superconductivity magnetism, or macroscopic systems.
QP: PHY 883 QA: PHY 941

980. Advanced Reading in Physics

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 4 credits in all enrollments for this course.
R: Approval of department.

QA: PHY 984

982. Topics in Nuclear Physics (MTC)

Fall, Spring. 3(3-0) A student may earn a maximum of 12 credits in all enrollments for this course.
P: PHY 852, PHY 881.
Heavy ion reactions or nuclear structure.
QP: PHY 881, PHY 839 QA: PHY 951, PHY 952

992. Quantum Chromodynamics (MTC)

Fall. 3(3-0) A student may earn a maximum of 12 credits in all enrollments for this course.
P: PHY 891.
Hadron-hadron interactions, interaction of hadrons with leptons.
QP: PHY 927 QA: PHY 928, PHY 929

999. Doctoral Dissertation Research

Fall, Spring, Summer. 1 to 24 credits. A student may earn a maximum of 99 credits in all enrollments for this course.
R: Open only to graduate students in Physics.

QA: PHY 999

PHYSIOLOGY

**Department of Physiology
College of Human Medicine
College of Natural Science
College of Osteopathic Medicine
College of Veterinary Medicine**

250. Introductory Physiology

Fall, Spring. 4(4-0)
R: Not open to students in Physiology.
Function, regulation and integration of organs and organ systems of higher animals emphasizing human physiology.

323. Physiology and Hygiene of the Eye

Fall of odd-numbered years, Summer of even-numbered years. 3(3-0)
R: Not open to Physiology majors.
Basic anatomy, physiology, and hygiene of the visual system: normal and abnormal visual function, methods of correction, and educational implications.
QA: PSL 323

410. Computational Problem Solving in Physiology

Fall, Spring. 3(3-0)
P: PSL 432. R: Approval of department.
Quantitative analysis of physiological data: mathematical models, curve fitting, data analysis and interpretation. Problem solving involving exponential and logistic growth. Cerebral blood flow, convective cooling, oxygen consumption, thermoregulation, other applications.
QP: PSL 432 QA: PSL 410

431. Human Physiology I

Fall. 3(3-0)
P: BS 111, CEM 142.
Neural function including autonomic nervous system, physiological control systems, endocrinology, reproduction and digestive function.
QP: BS 210, BS 211 QA: PSL 431

432. Human Physiology II

Spring. 3(3-0)
P: PSL 431.
Continuation of PSL 431. Function and regulation of the cardiovascular, respiratory, and renal systems. Control of tissue blood flow, blood pressure, blood gases, body fluid volume and electrolytes.
QP: PSL 431 QA: PSL 432

440. Topics in Cell Physiology

Fall, Spring. 2(2-0)
P: PSL 432. R: Open only to Physiology majors.
Critical discussion and evaluation of a selected problem of mammalian cell physiology including cell biophysics, molecular biology of the cell.
QP: PSL 431, PSL 432

441. Topics in Endocrinology

Fall, Spring. 2(2-0)
P: PSL 432. R: Open only to Physiology majors.
Selected topic on the role of hormones in the regulation of growth, metabolism, differentiation.
QP: PSL 431, PSL 432

442. Topics in Cardiovascular Physiology

Fall. 2(2-0)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in blood flow physiology.
QP: PSL 431, PSL 432

443. Topics in Respiratory Physiology

Fall of odd-numbered years. 2(2-0)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in the physiology of gas exchange and lung mechanics.
QP: PSL 431, PSL 432

444. Topics in Renal Physiology

Spring of odd-numbered years. 2(2-0)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in the function of the kidney, regulation of salt and water balance.
QP: PSL 431, PSL 432

PSL

445. Topics in Environmental Physiology

Spring of even-numbered years. 2(2-0)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in environmental physiology with an emphasis on thermoregulation.
QP: PSL 431, PSL 432

446. Topics in Visual Physiology

Fall of even-numbered years. 2(2-0)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in the functioning of the visual system in health and disease.
QP: PSL 431, PSL 432

447. Topics of Brain Function

Fall. 2(2-0)
P: PSL 432. R: Open only to Physiology majors.
Selected topic on the functioning of the mammalian brain.
QP: PSL 431, PSL 432

448. Topics in Gastrointestinal Physiology

Fall. 2(2-0)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in the physiology of the digestive system.
QP: PSL 431, PSL 432

449. Developmental Neurophysiology

Fall. 2(2-0)
P: PSL 432. R: Open only to Physiology majors.
Development of the nervous system in invertebrate and vertebrate animals.
QP: PSL 431, PSL 432

450. Laboratory in Human Physiology

Fall. 2(1-3)
P: PSL 432. R: Open only to Physiology majors.
Demonstration of fundamental physiological processes. Sensory input response. Data collection and analysis.
QP: PSL 431, PSL 432 QA: PSL 433

475. Capstone Laboratory in Physiology

Spring. 2(1-3)
P: PSL 432. R: Open only to Physiology majors.
Laboratory exercises in animal physiology including osmoregulation, receptor mediated regulation, nervous and hormonal control of function.
QP: PSL 431, PSL 432

480. Special Problems

Fall, Spring, Summer. 1 to 3 credits. A student may earn a maximum of 5 credits in all enrollments for this course.
P: PSL 432. R: Open only to Physiology majors.
Independent study under the auspices of a faculty member.
QA: PSL 480

501. Introductory Medical Physiology

Fall. 3(3-0)
R: Graduate-professional students in colleges of Human and Osteopathic Medicine.
Physiological basis of medical practice.

511. Veterinary Physiology

Spring. 5(5-0)
R: Open only to graduate-professional students in College of Veterinary Medicine.
Physiology of the nervous, cardiovascular, renal, respiratory, digestive, endocrine, and reproductive systems. Homeostasis.
QA: PSL 500B, PSL 500C

811. Cellular and Neurophysiology

Fall. 6(6-0) Interdepartmental with Zoology.
P: BCH 462, PSL 432.
Advanced bioenergetics, transport, regulation of metabolic reactions, specialized cell functions, and neurophysiology.
QP: PSL 431, PSL 432 or PSL 401, PSL 402 QA: PSL 811, PSL 812

812. Advanced Systems Physiology

Spring. 6(6-0)
P: PSL 811.
Cardiovascular, renal, respiratory, endocrine, reproductive, and gastrointestinal physiology.
QP: PSL 811 QA: PSL 812, PSL 813