886*. Research on Sports for Athletes with Disabilities  
Fall of odd-numbered years. 3(3-0)  
R: Graduate students  
Performance capabilities of athletes with disabilities with emphasis on areas such as exercise physiology, sport biomechanics, sport psychology, sport sociology, motor development, and motor learning. 
QA: HCP 845B

887*. Practicum in Adopted Physical Activity  
Fall, Spring, Summer. 1 to 4 credits. 
May reenroll for a maximum of 4 credits. 
R: Graduate students. Approval by instructor. 
Supervised practice in teaching physical activities and/or coaching sports for persons with disabilities. 
QA: HCP 846C

870*. Physical Activity and Well-Being  
Fall, Spring, Summer. 2 to 3 credits. 
May reenroll for a maximum of 9 credits. 
R: Graduate students. 
Relationship of physical activity to human well-being. Influence of growth, biological maturity, aging, body composition, nutrition, training, and rest on health and performance. 
QA: HCP 802

882A*. Stress Management Techniques in Athletics  
Summer. 3(0-0)  
R: Graduate students  

890*. Independent Study in Physical Education and Exercise Science  
Fall, Spring, Summer. 1 to 6 credits. 
May reenroll for a maximum of 6 credits. 
R: Graduate students. 
Independent study of topics in physical education and exercise science. 

893*. Internship in Physical Education and Exercise Science  
Fall, Spring, Summer. 2 to 6 credits. 
May reenroll for a maximum of 6 credits. 
R: Graduate students. 
Supervised graduate practice and observations in physical education and exercise science in schools and other settings. 

894*. Field Experiences in Physical Education and Exercise Science  
Fall, Spring, Summer. 1 to 6 credits. 
May reenroll for a maximum of 6 credits. 
R: Graduate students. 
Supervised graduate practice and observations in physical education and exercise science in schools and other settings. 

897*. Project in Physical Education and Exercise Science  
Fall, Spring, Summer. 1 to 4 credits. 
May reenroll for a maximum of 4 credits. 
R: Graduate students. Must complete a total of 6 credits to receive a grade. Project experience under the guidance and supervision of MSU faculty. 

899*. Master's Thesis Research  
Fall, Spring, Summer. 1 to 6 credits. 
May reenroll for a maximum of 6 credits. 
P: PES 871. R: Graduate students. Must complete a total of 6 credits to receive a grade. 

QP: HCP 802

910*. Current Issues in Exercise Physiology  
Spring. 3(0-0) May reenroll for a maximum of 9 credits. 
R: Graduate students. 
Selected issues in exercise physiology and related fields of study. 

930*. Current Issues in Biomechanical Aspects of Physical Activity  
Spring. 3(0-0) May reenroll for a maximum of 9 credits. 
P: PES 830. R: Graduate students. 
Selected issues of biomechanical analyses of sport and physical activity. 

940*. Current Issues in Psychosocial Aspects of Physical Activity  
Fall. 3(0-0) May reenroll for a maximum of 9 credits. 
R: Graduate students. 
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(0-0) May reenroll for a maximum of 9 credits. 
R: Graduate students. 
Selected issues in program design and evaluation with an emphasis on programs of physical activity. 

960*. Current Issues in Motor Behavior  
Spring. 3(0-0) May reenroll for a maximum of 9 credits. 
R: Graduate student. 
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. 
May reenroll for a maximum of 6 credits. 
R: Doctoral students. 
Independent study of topics in physical education and exercise science. 

995*. Research Practicum in Physical Education and Exercise Science  
Fall, Spring, Summer. 1 to 4 credits. 
May reenroll for a maximum of 4 credits. 
R: Open only to doctoral students. 
Supervised research practicum. Design, execution, analysis, presentation, critique, and revision of research projects. 

999*. Doctoral Dissertation Research  
Fall, Spring, Summer. 1 to 6 credits. 
May reenroll for a maximum of 24 credits. 
R: Doctoral students. 

PHYSICAL EDUCATION AND EXERCISE SCIENCE

918*. Seminar in Inorganic Chemistry  
Fall, Spring. 1(1-0) May reenroll for a maximum of 3 credits. 
R: Graduate students. 
Natural Science Chemistry. 
Discussions of recent advances in inorganic chemistry and reports by graduate students. 
QA: CEM 918

991*. Quantum Chemistry and Statistical Thermodynamics I  
Fall. 3(0-0)  
Mathematical background for quantum chemistry and statistical thermodynamics. Principles of quantum chemistry and applications to chemical problems. Perturbation functions, spectroscopic measurements and thermodynamic applications. 
QA: CEM 987 CEM 981 CEM 985

998*. Seminar in Physical Chemistry  
Fall, Spring. 1(1-0) May reenroll for a maximum of 3 credits. 
R: Graduate students. 
Natural Science Chemistry. 
Discussions of recent advances in physical chemistry and reports by graduate students. 
QA: CEM 998

PHYSICS

170*. Investigations in Physics  
Fall. 3(0-6)  
Experiments in optics, electronics, sound and mechanics. Analysis of data and computer research and oral presentations. 

181B*. Basic Physics I, CBI  
Fall, Spring, Summer. 3(-)  
P: PHY 132 or concurrently. R: Not open to students with credit in PHY 231 or PHY 231B or PHY 183 or PHY 183B or PHY 193. 
Newton's laws of motion, conservation of angular momentum, energy conservation, thermal physics, waves, and sound. Competency based instruction. 
QP: MT 112. QA: PHY 281 PHY 287 PHY 289 PHY 297 PHY 299 PHY 299B

182B*. Basic Physics II, CBI  
Fall, Spring, Summer. 3(-)  
P: PHY 181B or PHY 183 or PHY 183B or PHY 231 or PHY 231B. R: Not open to students with credit in PHY 232 or PHY 232B or PHY 194 or PHY 194B or PHY 294. 
Electricity and magnetism, optical phenomena, interference and diffraction of light, atomic and subatomic topics. Competency based instruction. 
QP: PHY 281 OR PHY 237B OR PHY 297 PHY 299 PHY 299B

183. Physics for Scientists and Engineers I  
Fall, Spring. 4(5-0)  
P: PHY 132 or concurrently. R: Not open to students with credit in PHY 158, PHY 231, PHY 231B. 
Mechanics, Newton's laws, momentum, energy conservation laws, rotational motion, oscillation, gravity, waves. 
QA: PHY 297 PHY 287 PHY 291H PHY 237 PHY 297

183A*. Physics I, CBI  
Fall, Spring, Summer. 1(-)  
P: PHY 181B. R: Not open to students with credit in PHY 183 or PHY 183B. 
Topics from: frames of reference, special relativity, electric field, electric forces, oscillations, resonances, fluid motion, numerical solutions, moments of inertia, gycronic motion. This course plus PHY 181B is equal to PHY 183B. 
QP: PHY 281 QA: PHY 287A

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E-150 Courses with an asterisk (*) have not been approved by the University Committee on Curriculum.
Courses are subject to revision and final approval.

PHYSICS

410*. Thermal and Statistical Physics Spring. 3(0-0)
Fall: P: PHY 411.
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(3-0)
P: MTH 116. R: Not open to Physics or Astronomy 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: PHYS 203

422*. Classical Mechanics II Fall, Summer. 3(0-0)
P: PHY 321, MTH 235 or MTH 255H.
QP: PHY 427 QA: PHY 428 PHY 429

423B*. Special Relativity, CBI Summer. 3-
P: PHY 321, PHY 481.
Concepts of special relativity applied to coordinate transformations, mechanics, and electromagnetism. Competency based instruction.
QP: PHY 457 PHY 447

425B*. Mathematical Physics, CBI Summer. 3-
P: PHY 281, 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(0-0)
P: PHY 331.
Experiments: Project involving advanced topics in optics. Holoscopy, spatial filtering, study of physical systems using optical devices.
QP: PHY 436 MTH 334 QA: PHY 439

440*. Electronics Fall. 4(3-0)
P: PHY 184 or PHY 184H or PHY 249H; PHY 192; MTH 235 or MTH 255H.
Concepts of electronics used in investigating physical phenomena. Circuits, amplifiers, diodes, LEDs, etc.
QP: MTH 310 PHY 268/PHY 268S/PHY 292HPH 298 QA: PHY 419

451*. Advanced Laboratory Fall. 3(0-0)
P: PHY 331 or PHY 440.
General research techniques, design of experiments, and the analysis of results based upon some historical experiments in modern physics.
QP: PHY 438 ORPHY 439 ORPHY 419 QA: PHY 457G

452*. Advanced Projects Laboratory Spring. 3(0-0)
P: PHY 331, PHY 440.
A project oriented laboratory that builds on optics and electronics courses.
QP: PHY 457G QA: PHY 457 PH 457N PHY 420

471*. Quantum Physics I Fall. 3(0-0)
P: PHY 215 or PHY 215B; MTH 235 or MTH 255H; PHY 321.
Schrödinger equation, hydrogen atom, harmonic oscillator, and other one-dimensional systems.
QP: PHY 391 QA: PHY 492 PHY 493

472*. Quantum Physics II Spring. 3(0-0)
Matrix formulation of quantum mechanics, perturbation theory, scattering.
QP: PHY 492 QA: PHY 493

480*. Computational Physics Spring of even-numbered years. 3(0-0)
P: CSE 130 or CSE 131 or CSE 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(0-0)
P: MTH 234 or MTH 254H. R: Open only to juniors or seniors.
Electricity, magnetism, 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(0-0)
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, Summer. 1 to 4 credits.
May enroll for a maximum of 5 credits. 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(0-0)
P: PHY 390.
Many-electron atoms. Molecules, crystal structure, lattice dynamics. Bond models of metals and semiconductors. Transport properties.
QP: PHY 491 PHY 495 QA: PHY 496

492*. Nuclear and Elementary Particle Physics Spring. 3(0-0)
P: PHY 472.
QP: PHY 492 QA: PHY 497 PHY 498

800*. Research Methods Fall, Spring, Summer. 3(0-0)
May enroll for a maximum of 6 credits. 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(0-0)
Two-body central force problem, Hamilton's principle, Lagrangian and Hamiltonian equations of motion, variational methods, small oscillations, classical fields.
QP: PHY 827 PHY 828

831*. Statistical Mechanics Spring. 3(0-0)
Equilibrium statistical mechanics and thermodynamics. Relativistic transport equations and hydrodynamics, Brownian and Langevin motion.
QA: PHY 871

832*. Topics in Statistical Mechanics (MTC) Fall. 3(0-0)
May enroll for a maximum of 12 credits.
QP: PHY 831

832A*. Chaos and Nonlinear Dynamics in Statistical Mechanics Spring. 3(0-0)
P: PHY 831.
Application of statistical mechanics principles to nonlinear dynamics and chaos.
QP: PHY 871

832B*. Phase Transitions and Critical Phenomena in Statistical Mechanics 3(3-0)
P: PHY 831.
Application to critical phenomena. Phase transitions, Landau theory, scaling.
QP: PHY 871

832C*. Linear Response Theory in Quantum Statistical Systems 3(3-0)
P: PHY 831.
Linear response theory in quantum statistical systems. Applications to magnetism, electrical and optical response functions. Fluctuations.
QP: PHY 871

832D*. Superfluidity and Superconductivity in Statistical Mechanics 3(3-0)
P: PHY 831.
Applications to superfluidity and superconductivity.
QP: PHY 871

841*. Classical Electrodynamics I Fall. 3(0-0)
QP: PHY 847 PHY 848

842*. Classical Electrodynamics II Spring. 3(0-0)
P: PHY 841.
QP: PHY 847 QA: PHY 849 PHY 849

853*. Advanced Quantum Mechanics Fall. 3(0-0)
P: PHY 862.
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 859 QA: PHY 867 PHY 868

854*. Quantum Electrodynamics Spring of odd-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.
QP: PHY 868 PHY 869

871*. Condensed Matter Physics Spring. 3(3-0)
P: PHY 882.
QP: PHY 889 QA: PHY 883

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981*. Subatomic Physics
Fall, 3(0-0)  P: PHY 451
Application of conservation laws and physical principles to basic quantum mechanical problems in MeV energy range and femtometer size range. Application to nuclear data.
QA: PHY 981

982*. Topics in Nuclear Physics(MTC)
Spring, 3(3-0)  P: PHY 881, PHY 852
A special topics course in nuclear physics.
QA: PHY 981

982A*. Topics in Nuclear Physics: Heavy Ion Reactions
Spring, 3(3-0)  P: PHY 881, PHY 852
Scattering, particle transfer, resonance reactions, fission, time-dependent Hartree-Fock, Vlasov equation, nuclear transmutations, particle production, nuclear liquid-gas phase transition, quark-gluon plasma.
QA: PHY 881, PHY 871

982B*. Topics in Nuclear Physics: Nuclear Structure
Spring, 3(3-0)  P: PHY 881, PHY 852
Special topics course in nuclear structure, nuclear forces, nuclear matter, nuclear structure models, and few-nucleon systems.
QA: PHY 881

992*. Quantum Chromodynamics(MTC)
Spring, 3(3-0)  P: PHY 881, PHY 852
Current topics in quantum chromodynamics, hadron-hadron interactions, interaction of hadrons with leptons.
QA: PHY 927

992A*. Quantum Chromodynamics: Hadron Interactions
Spring, 3(3-0)  P: PHY 881, PHY 852
Current topics in quantum chromodynamics, hadron-hadron interactions, interaction of hadrons with leptons.
QA: PHY 927

992B*. Quantum Chromodynamics: Lepton-Hadron Interactions
Spring, 3(3-0)  P: PHY 881, PHY 852
Current topics in quantum chromodynamics, hadron-hadron interactions, interaction of hadrons with leptons.
QA: PHY 927

999*. Doctoral Dissertation Research
Fall, Spring, Summer. 0(-0)
May reenroll for a maximum of 96 credits.
R: Physics
QA: PHY 999

PHYSIOLOGY

250. Introductory Physiology
Fall, Spring. 4(4-0)
Function, regulation and integration of organs and organ systems of higher animals emphasizing human physiology.

337*. 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: PSI 325

410*. Computational Problem Solving in Physiology
Fall, Spring. 3(0-0)
P: PSL 432
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, etc.
QA: PSL 410

431*. Human Physiology I
Fall. 3(0-0)
P: B S 111, CEM 142
Neutral function including autonomic nervous system, physiological control systems, endocrinology, reproduction and digestive function.
QA: B S 210

432*. Human Physiology II
Spring. 3(0-0)
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.
QA: PSL 432

446*. Topics in Cell Physiology
Fall, Spring. 2(02-00)
P: PSL 432. R: Open only to Physiology majors.
Critical discussion and evaluation of a selected problem of mammalian cell physiology including cell biochemistry, molecular biology of the cell.
QA: PSL 431

447*. Topics in Endocrinology
Fall, Spring. 2(02-00)
P: PSL 432. R: Open only to Physiology majors.
Selected topic on the role of hormones in the regulation of growth, metabolism, differentiation.
QA: PSL 431

448*. Topics in Cardiovascular Physiology
Fall, 2(02)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in blood flow physiology.
QA: PSL 431

449*. Topics in Respiratory Physiology
Fall of odd-numbered years. 2(02-00)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in the physiology of gas exchange and lung mechanics.
QA: PSL 431

454*. Topics in Renal Physiology
Spring of even-numbered years. 2(02-00)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in the function of the kidney, regulation of salt and water balance.
QA: PSL 431

455*. Topics in Environmental Physiology
Spring of odd-numbered years. 2(02-00)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in environmental physiology with an emphasis on thermoregulation.
QA: PSL 431

466*. Topics in Visual Physiology
Fall of even-numbered years. 2(02-00)
P: PSL 432. R: Open only to Physiology majors.
Selected topic in the functioning of the visual system in health and disease.
QA: PSL 431