PHYSICS (PHYSICS)

PHYSICS 100 Quantitative Preparation for Physics
2 cr. Undergraduate.
Introductory course in general physics designed for the student with little or no previous science training.
Prerequisites: Math Placement Level 10.
Course Rules: Fee for 3 cr assessed. Not open to students w/cr in Physics 110(ER), 120(ER), or 209(ER).
Last Taught: Spring 2015, Fall 2014, Fall 2013.
Current Offerings: http://uwm.edu/schedule

PHYSICS 107 Physics in Everyday Life
3 cr. Undergraduate.
Selected topics for citizens in a technological world. Emphasis on those aspects of science important to an understanding of our surroundings.
For non-science majors.
Prerequisites: none.
Course Rules: May not be taken conc with or after having taken Physics 120(ER) or 209(ER).
General Education Requirements: NS
Current Offerings: http://uwm.edu/schedule

PHYSICS 108 Laboratory for Physics in Everyday Life
1 cr. Undergraduate.
Experiments correlated with Physics 107.
Prerequisites: Physics 107(C).
General Education Requirements: NS+
Last Taught: Spring 2018, Fall 2017, Spring 2016, Fall 2016.
Current Offerings: http://uwm.edu/schedule

PHYSICS 110 Physics for the Health Professions
4 cr. Undergraduate.
An introductory course without laboratory for students in health-related pre-professional programs. Topics include mechanics, fluids, heat, sound, electricity, magnetism, electrical devices, optics, and radioactivity. 3 hrs lec, 1 hr dis.
Prerequisites: H.S. general science; Math Placement Level 20.
Course Rules: May not be taken conc with or after having taken Physics 120(ER) or 209(ER).
General Education Requirements: NS
Last Taught: Fall 2017, Fall 2016, Spring 2016, Fall 2015.
Current Offerings: http://uwm.edu/schedule

PHYSICS 120 General Physics I (Non-Calculus Treatment)
4 cr. Undergraduate.
Mechanics, wave motion, heat, and sound. 3 hrs lec, 2 hrs dis.
Prerequisites: Math Placement Level 30 or grade of C or better in Physics 100(P); HS trig or Physics 100 strongly recom.
Course Rules: Any combination of Physics 120, 121, 209, 214, 219 carries max 5 cr toward graduation.
General Education Requirements: NS
Current Offerings: http://uwm.edu/schedule

PHYSICS 121 General Physics Laboratory I (Non-Calculus Treatment)
1 cr. Undergraduate.
Experiments correlated with lecture material of Physics 120.
Prerequisites: Physics 120(C).
Course Rules: Any combination of Physics 120, 121, 209, 214, 219 carries max 5 cr toward graduation.
General Education Requirements: NS+
Current Offerings: http://uwm.edu/schedule

PHYSICS 122 General Physics II (Non-Calculus Treatment)
4 cr. Undergraduate.
Electricity, optics, modern physics. 3 hrs lec; 2 hrs dis.
Prerequisites: Physics 120(NP).
Course Rules: Any combination of Physics 122, 123, 210, 215, 220 carries 5 cr max toward graduation.
General Education Requirements: NS
Current Offerings: http://uwm.edu/schedule

PHYSICS 123 General Physics Laboratory II (Non-Calculus Treatment)
1 cr. Undergraduate.
Experiments on topics related to the lecture material of Physics 122.
Prerequisites: Physics 122(C).
Course Rules: Any combination of Physics 122, 123, 210, 215, 220 carries 5 cr max toward graduation.
General Education Requirements: NS+
Current Offerings: http://uwm.edu/schedule

PHYSICS 185 Basic Physics for Teachers
3 cr. Undergraduate.
Simple machines; work, energy and power; heating and cooling; static electricity and elementary electrical circuits; waves. 2 hrs lec; 2 hrs lab/ dis.
Prerequisites: Math 175(P) & cons instr.
Course Rules: Not open for cr to students with cr in Physics courses numbered 110 or above.
General Education Requirements: NS
Current Offerings: http://uwm.edu/schedule

PHYSICS 194 First-Year Seminar
3 cr. Undergraduate.
The specific topics are announced in the Schedule of Classes each time the class is offered.
Prerequisites: none.
Course Rules: Open only to freshmen. Students may earn cr in just one L&S First-Year Sem (course numbers 192, 193, 194).
General Education Requirements: NS
Last Taught: Fall 2017, Fall 2015, Fall 2014, Fall 2013.
Current Offerings: http://uwm.edu/schedule

PHYSICS 199 Independent Study
1-3 cr. Undergraduate.
For further information, consult dept chair.
Prerequisites: 2.5 gpa; writ cons instr, dept chair & asst dean for SAS.
Course Rules: May be retaken to 6 cr max.
Current Offerings: http://uwm.edu/schedule
PHYSICS 209 Physics I (Calculus Treatment) 4 cr. Undergraduate. Selected topics in mechanics, wave motion, sound, and heat. 3 hrs lec, 2 hrs dis. 
Prerequisites: Math 227(C), 228(C), or 232(C). 
Course Rules: Any combination of Physics 120, 121, 209, 214, 219 carries max 5 cr toward graduation. 
General Education Requirements: NS

Current Offerings: http://uwm.edu/schedule

PHYSICS 210 Physics II (Calculus Treatment) 4 cr. Undergraduate. Continuation of Physics 209. Electromagnetic field theory and optics. 3 hrs lec, 2 hrs dis. 
Prerequisites: grade of C- or better in Physics 209(NP); Math 229(C) or 233(C). 
Course Rules: Any combination of Physics 122, 123, 210, 215, 220 carries max 5 cr toward graduation. 
General Education Requirements: NS

Current Offerings: http://uwm.edu/schedule

PHYSICS 214 Lab Physics I (Calculus Treatment) 1 cr. Undergraduate. Experiments in mechanics, wave motion, heat, and thermodynamics. 3 hrs lab. 
Prerequisites: Physics 209(C). 
Course Rules: Any combination of Physics 120, 121, 209, 214, 219 carries max 5 cr toward graduation. 
General Education Requirements: NS+

Current Offerings: http://uwm.edu/schedule

PHYSICS 215 Lab Physics II (Calculus Treatment) 1 cr. Undergraduate. Experiments in electricity, magnetism, and optics. 3 hrs lec. 
Prerequisites: Physics 210(C). 
Course Rules: Any combination of Physics 122, 123, 210, 215, 220 carries max 5 cr toward graduation. 
General Education Requirements: NS+

Current Offerings: http://uwm.edu/schedule

PHYSICS 219 Physics I: Calculus-Based, Studio Format 5 cr. Undergraduate. Basic kinematics; Newton. Selected topics in mechanics, wave motion, sound, and heat. 8 hrs lec/lab.

Prerequisites: Math 227(C), 228(C), or 232(C). 
Course Rules: Not open to students w/cr in Physics 209. Any combination of Physics 120, 121, 209, 214, 219 carries max 5 cr toward graduation. 
General Education Requirements: NS+

Last Taught: Fall 2017, Fall 2016, Fall 2015. 
Current Offerings: http://uwm.edu/schedule

PHYSICS 220 Physics II: Calculus-Based, Studio Format 5 cr. Undergraduate. Electromagnetic field theory and optics. 
Prerequisites: grade of C or better in Physics 219(NP); Math 229(C) or 233(C). 
Course Rules: Not open to students w/cr in Physics 210. Any combination of Physics 122, 123, 210, 215, 220 carries max 5 cr toward graduation. 
General Education Requirements: NS+

Current Offerings: http://uwm.edu/schedule

PHYSICS 265 Physics and the Energy Problem 3 cr. Undergraduate. Study of how the laws of physics (particularly 1st and 2nd Laws of Thermodynamics) limit society’s options in dealing with scarcity of utilizable energy. 
Prerequisites: H.S. algebra; Physics 107(P), 110(P), 120(P), or 209(P). 
Current Offerings: http://uwm.edu/schedule

PHYSICS 270 Introduction to Computational Physics 3 cr. Undergraduate. Use of computers to solve physics problems, including particle collisions, chaotic systems, planetary motion, and other topics related to relativity and quantum mechanics. 
Prerequisites: Physics 209(P); Math 233(C). 
Current Offerings: http://uwm.edu/schedule

PHYSICS 289 Internship in Physics, Lower Division 1-6 cr. Undergraduate. Application of basic principles of physics in a research, business, organizational, educational, political, or other appropriate setting. 
Prerequisites: intro course in physics; 2.25 gpa; cons supervising faculty member. 
Course Rules: One cr earned for academic work based on 40 hours in internship. May be retaken to 6 cr max. 
Current Offerings: http://uwm.edu/schedule

PHYSICS 296 UROP Apprenticeship 1-3 cr. Undergraduate. Undergraduate research participation in a project developed with a supervising member of the faculty or staff. 
Prerequisites: acceptance into UROP; prior or conc reg in UROP seminar. 
Course Rules: One cr for 45 hrs research. May be retaken to 9 cr max in any combination of UROP apprenticeship courses. 
Last Taught: Spring 2018, Spring 2017, Fall 2016, Fall 2014. 
Current Offerings: http://uwm.edu/schedule

PHYSICS 297 Study Abroad: 1-12 cr. Undergraduate. Designed to enroll students in UWM sponsored program before course work level, content, and credits are determined and/or in specially prepared program course work. 
Prerequisites: acceptance for Study Abroad Prog. 
Course Rules: May be retaken w/chg in topic. 
Last Taught: Spring 2015, Summer 2011, Spring 2010, Fall 2009. 
Current Offerings: http://uwm.edu/schedule
PHYSICS 299 Ad Hoc:
1-6 cr. Undergraduate.
Course created expressly for offering in a specified enrollment period. Requires only dept & assoc dean approval. In exceptional circumstances, can be offered in one add'l sem.
**Prerequisites:** none; add'l prereqs may be assigned to specific topic.
**Course Rules:** May be retaken w/chg in topic.
Current Offerings: [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 305 Medical Physics
3 cr. Undergraduate.
Applications of physics to living systems & medical diagnostics. 3 hrs lec.
**Prerequisites:** grade of B+ or better in Physics 209(P). (Conc reg in Physics 210 strongly recom).
**Course Rules:** Primarily for premed students and others in the medical & biological sciences. Approved for Premed Stds Cert Prog.
Current Offerings: [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 306 Introduction to Biophysics
3 cr. Undergraduate.
Physical foundations of cellular phenomena; physical laws of complex biological systems; imaging and instrumentation for biophysics. 3 hrs lec.
**Prerequisites:** Physics 122(P) or 210(P); Chemistry 104(P) or 105(P).
**Course Rules:** Approved for Premed Stds Cert Prog.
Last Taught: Fall 2017, Fall 2015, Fall 2010, Spring 2009.
Current Offerings: [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 309 Physics III: Modern Physics
3 cr. Undergraduate.
Elementary quantum physics, atomic and molecular physics, solid state and nuclear physics.
**Prerequisites:** Physics 210(NP); Math 234(C).
**Course Rules:** Not open for cr to students who have had Physics 341.
**General Education Requirements:** QLB
Last Taught: Spring 2018, Fall 2017, Spring 2017, Fall 2016.
Current Offerings: [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 317 Thermodynamics
3 cr. Undergraduate.
Classical thermodynamics, including entropy, the use of thermodynamic potentials, and applications to pressure-volume and other systems. Some basic statistical physics may be included.
**Prerequisites:** Physics 210(NP).
**Last Taught:** Fall 2017, Fall 2016, Spring 2016, Spring 2015.
Current Offerings: [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 325 Optics
4 cr. Undergraduate.
Geometric and physical optics, image formation, interference, diffraction, polarization, optical instruments, resolving power, coherence, lasers, holography. Selected experiments in optics. Studio-format course.
**Prerequisites:** Math 234(P) & Physics 309(C) or cons instr.
**Course Rules:** Counts as repeat of Physics 325 & 2 cr of Physics 410.
**Last Taught:** Spring 2018, Spring 2017, Spring 2016, Spring 2015.
Current Offerings: [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 351 Basics of Condensed Matter Physics
3 cr. Undergraduate.
Basic principles of condensed-matter physics. Crystals and amorphous materials; bonding; magnetic, thermal, and transport properties; band theory.
**Prerequisites:** Physics 309(P) or Chem 311(P).
**Course Rules:** May be retaken w/chg in topic.
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 370 Analytical and Numerical Methods in Physics
3 cr. Undergraduate.
Solutions to various physics problems. Applications (both analytical and numerical) from mechanics, electrodynamics, quantum mechanics, astrophysics, condensed matter physics.
**Prerequisites:** Physics 210(NP); Math 234(C) or ElecEng 234(C); or cons instr.
**Last Taught:** Spring 2018, Spring 2017, Fall 2015, Fall 2014.
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 381 Honors Seminar: 3 cr. Undergraduate.
Selected topics concerning history and the nature of physics as an intellectual discipline.
**Prerequisites:** soph st; Honors 200(P); cons Honors College dir.
**Course Rules:** May be retaken w/chg in topic to 6 cr max; non-repeatable for change of grade.
**General Education Requirements:** NS
**Last Taught:** Fall 2017, Fall 2016, Fall 2013, Fall 2011.
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 391 Undergraduate Research Participation
1-6 cr. Undergraduate.
Independent research for undergraduates on faculty-supervised research projects.
**Prerequisites:** Physics 309(P)); 3.25 GPA in physics courses; cons instr.
**Course Rules:** May be retaken w/chg in topic to 6 cr max; non-repeatable for change of grade.
**Last Taught:** Fall 2017, Spring 2017, Fall 2016, Spring 2016.
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 406 Introduction to Infrared Microspectroscopy
3 cr. Undergraduate.
Microscopy and spectroscopy methods for identification of chemical composition introducing interdisciplinary opportunities in fundamental and industrial applications.
**Prerequisites:** Bio Sci 150(P) & 152(P); or Physics 209(P) & 210(P); or Chem 102(P) & 104(P); or Chem 105(P).
**Last Taught:** Spring 2017, Spring 2016, Spring 2015, Spring 2014.
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 408 Experiments in Linear Electronics
3 cr. Undergraduate/Graduate.
Transistor and integrated circuit characteristics; electronic measurement and control.
**Prerequisites:** jr st, Physics 210(P).
**Course Rules:** No cr for students w/cr in ElecEng 330(R).
**Last Taught:** Fall 2015, Spring 2014, Spring 2012, Fall 2008.
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)
PHYSICS 409 Modern Physics Laboratory
3 cr. Undergraduate.
Selected experiments in modern physics using advanced lab instrumentation.
Prerequisites: jr st; Physics 309(P) or cons instr.
Last Taught: Spring 2018, Fall 2017, Fall 2016, Fall 2014.
Current Offerings: http://uwm.edu/schedule

PHYSICS 411 Mechanics
4 cr. Undergraduate/Graduate.
Kinematics, vector analysis, conservation laws, oscillations, variational methods, chaos, Lagrangian and Hamiltonian mechanics.
Prerequisites: jr st; Physics 210(NP).
Current Offerings: http://uwm.edu/schedule

PHYSICS 420 Electricity and Magnetism I
3 cr. Undergraduate/Graduate.
Electrostatics, capacitance, boundary value problems, multipole expansion, dielectrics, magnetostatics, vector potential, magnetic properties of matter, motional emf, inductance, Maxwell's equations in differential form.
Prerequisites: jr st; Physics 210(NP); a grade of B- or better in Math 321(P); or Math 321(P) and a grade of B- or better in Physics 370(P); or grad st.
Course Rules: Counts as repeat of 2 cr of Physics 421.
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

PHYSICS 422 Electricity and Magnetism II
3 cr. Undergraduate/Graduate.
Conservation laws in electrodynamics, Maxwell's stress tensor, electromagnetic waves, absorption, dispersion, reflection and transmission of plane electromagnetic waves, wave guides, retarded potentials, radiation, electrodynamics and relativity.
Prerequisites: jr st; Physics 420(P); or grad st.
Course Rules: Counts as repeat of 2 cr of Physics 421.
Current Offerings: http://uwm.edu/schedule

PHYSICS 441 Introduction to Quantum Mechanics I
4 cr. Undergraduate/Graduate.
Historical background and experimental basis, De Broglie waves, correspondence principle, uncertainty principle, Schroedinger equation; hydrogen atom, electron spin, Pauli Principle, applications of wave mechanics.
Prerequisites: jr st; Physics 309(NP); Math 321(C).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

PHYSICS 442 Introduction to Quantum Mechanics II
3 cr. Undergraduate/Graduate.
Continuation of Physics 441, emphasizing perturbation theory and applications to multi-electron systems, including atoms, molecules, and solids.
Prerequisites: jr st; Physics 441(NP).
Current Offerings: http://uwm.edu/schedule

PHYSICS 489 Internship in Physics, Upper Division
1-6 cr. Undergraduate.
Application of advanced principles of physics in a research, business, organizational, educational, political, or other appropriate setting.
Prerequisites: jr st; 300-level or above course in Physics; 2.25 gpa; cons supervising faculty member.
Course Rules: One cr earned for academic work based on 40 hrs in internship. May be retaken to 6 cr max.
Current Offerings: http://uwm.edu/schedule

PHYSICS 497 Study Abroad:
1-12 cr. Undergraduate/Graduate.
Designed to enroll students in UWM sponsored program before course work level, content, and credits are determined and/or in specially prepared program course work.
Prerequisites: jr st; acceptance for Study Abroad Program.
Course Rules: May be retaken w/chg in topic.
Current Offerings: http://uwm.edu/schedule

PHYSICS 498 Undergraduate Physics Seminar
1 cr. Undergraduate.
Talks by faculty, visitors, and students on topics of current interest in physics, astronomy, and other science and engineering fields.
Prerequisites: sr st; Physics 411(C), 421(C), or 441(C).
Course Rules: Cr/no cr only.
Current Offerings: http://uwm.edu/schedule

PHYSICS 499 Ad Hoc:
1-6 cr. Undergraduate.
Course created expressly for offering in a specified enrollment period. Requires only dept & assoc dean approval. In exceptional circumstances, can be offered in one add'l sem.
Prerequisites: jr st; add'l prerequisites may be assigned to specific topic.
Course Rules: May be retaken w/chg in topic.
Current Offerings: http://uwm.edu/schedule

PHYSICS 501 Special Topics: Mathematical Models of Physical Problems I
3 cr. Undergraduate/Graduate.
Selected topics in mathematics for study of the techniques and procedures for stating physical problems in mathematical terms and the physical interpretation of mathematical solutions.
Prerequisites: jr st; Physics 210(P); Math 234(P).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

PHYSICS 502 Special Topics: Mathematical Models of Physical Problems II
3 cr. Undergraduate/Graduate.
More selected topics in mathematical models.
Prerequisites: jr st; Physics 210(P); Math 234(P). Physics 501(R).
Current Offerings: http://uwm.edu/schedule
PHYSICS 515 Statistical Mechanics
3 cr. Undergraduate/Graduate.
Brief survey of thermodynamics; statistical mechanics; classical and quantum gases.
Prerequisites: jr st, Physics 317(P) & 441(P).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

PHYSICS 517 Special Relativity
3 cr. Undergraduate/Graduate.
Relativistic kinematics, the Lorentz transformation, tensor calculus, applications to motion of particles, electromagnetism.
Prerequisites: jr st, Physics 411(R) & 421(R).
Last Taught: Fall 2017, Fall 2014, Spring 2013, Fall 2010.
Current Offerings: http://uwm.edu/schedule

PHYSICS 531 Principles of Quantum Mechanics I
3 cr. Undergraduate/Graduate.
Vector and Hilbert spaces; Schroedinger equation in 1, 2, and 3 dimensions; systems of many particles; symmetries; angular momentum.
Prerequisites: jr st, Physics 441(P).
Last Taught: Fall 2017, Fall 2016, Fall 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

PHYSICS 532 Principles of Quantum Mechanics II
3 cr. Undergraduate/Graduate.
Continuation of 531. Spin; hydrogen atom; variational methods; WKB approximation; perturbation theory; scattering theory; Dirac equation.
Prerequisites: jr st, Physics 531(P).
Current Offerings: http://uwm.edu/schedule

PHYSICS 541 Elementary Particles
3 cr. Undergraduate/Graduate.
Accelerators and detectors; special unitary groups; quark model of hadrons; Feynman diagrams; electromagnetic, weak and strong interactions of quarks and leptons; Higgs boson.
Prerequisites: jr st, Physics 441(P) or cons instr.
Current Offerings: http://uwm.edu/schedule

PHYSICS 551 Introduction to Solid State Physics I
3 cr. Undergraduate/Graduate.
Crystal structure, reciprocal lattice; crystal binding; elastic waves; phonons, lattice vibrations; thermal properties of insulators; free electron Fermi gas. Band structure; semiconductor crystals; Fermi surface.
Prerequisites: jr st, Physics 441(P) or cons instr.
Last Taught: Fall 2016, Fall 2014, Fall 2012, Fall 2010.
Current Offerings: http://uwm.edu/schedule

PHYSICS 575 Vacuum Science and Technology
3 cr. Undergraduate/Graduate.
Viscous and molecular flow, vacuum materials and seals, metal-to-ceramic seals, evaporation and vapor pressures, vacuum pumps, vacuum gauges, mass spectographs, chemical reactions at surfaces, outgassing.
Prerequisites: jr st, Physics 441(P).
Current Offerings: http://uwm.edu/schedule

PHYSICS 586 Molecular, Cellular, and System Biophysics
3 cr. Undergraduate.
Prerequisites: jr st, Physics 210(P), & writ cons instr; or grad st.
Current Offerings: http://uwm.edu/schedule

PHYSICS 590 Special Topics
1-6 cr. Undergraduate/Graduate.
Course Rules: Open only to practicing science teachers with demonstrable expertise in physics. May be retaken to 6 cr max.
Prerequisites: appt as undergrad TA or grad st.
Current Offerings: http://uwm.edu/schedule

PHYSICS 598 Research Experience for Teachers
1-6 cr. Undergraduate/Graduate.
Enrichment of students’ physics background. Work with faculty mentor to develop an innovative teaching program for use in students’ own classroom.
Prerequisites: sr st; current teaching contract.
Course Rules: Open only to practicing science teachers with demonstrable expertise in physics. May be retaken to 9 cr max.
Current Offerings: http://uwm.edu/schedule

PHYSICS 599 Advanced Independent Reading
1-3 cr. Undergraduate.
Independent reading or research under supervision of faculty member. Study proposal required. For further information, consult dept chair or undergrad advising coord.
Prerequisites: jr st, 2.5 GPA; writ cons instr, dept chair, & asst dean for SAS.
Course Rules: May be retaken w/chg in topic to 6 cr max.
Last Taught: Summer 2018, Fall 2016, Summer 2015, Fall 2008.
Current Offerings: http://uwm.edu/schedule
PHYSICS 705 Molecular, Cellular, and System Biophysics  
3 cr. Graduate.  
**Prerequisites:** grad st  
**Last Taught:** Fall 2017, Fall 2015, Fall 2012, Spring 2010.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 706 Biophotonics  
3 cr. Graduate.  
Biophotonics and bioimaging; overview of application of optics in biology and medicine based on the understanding of basic optics, spectroscopy, and imaging theory.  
**Prerequisites:** grad st  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 707 Structural Molecular Biophysics  
3 cr. Graduate.  
Methods in molecular biophysics.  
**Prerequisites:** grad st; major in science-based discipline & Physics 210(P), or writ cons instr.  
**Last Taught:** Fall 2016, Spring 2015, Spring 2013, Spring 2011.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 711 Theoretical Physics-Dynamics  
3 cr. Graduate.  
Lagrange equations, canonical formulation, principle of least action, normal coordinates, rigid bodies, special relativity, mathematical methods.  
**Prerequisites:** grad st; Math 321(C) or 322(C); or 701(C) or 702(C).  
**Last Taught:** Spring 2018, Spring 2017, Spring 2016, Spring 2015.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 716 Advanced Topics in Statistical Physics  
3 cr. Graduate.  
Systems of interacting particles; critical phenomena; transport theory; irreversible processes and fluctuations; model calculations for interacting systems of particles.  
**Prerequisites:** grad st; Physics 515(P), 532(P).  
**Last Taught:** Spring 2016, Spring 2010, Spring 2008, Fall 1999.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 717 Gravitation  
3 cr. Graduate.  
**Prerequisites:** grad st, Physics 517(P).  
**Last Taught:** Spring 2018, Fall 2015, Fall 2014, Fall 2012.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 718 White Dwarfs, Neutron Stars, and Black Holes  
3 cr. Graduate.  
Physics of compact objects; newtonian and relativistic stellar structure and stability; pulsars, x-ray sources; accretion disks; gravitational collapse; stellar-size and supermassive black holes; quasars.  
**Prerequisites:** grad st, Physics 717(P) or cons instr.  
**Last Taught:** Spring 2017, Spring 2015, Spring 2013, Spring 2007.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 720 Electrodynamics I  
3 cr. Graduate.  
Maxwell's equations; Helmholtz theorem; scalar and vector potentials; boundary value problems; plane wave solutions.  
**Prerequisites:** grad st; Physics 711(P).  
**Last Taught:** Spring 2018, Spring 2017, Spring 2016, Spring 2015.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 721 Electrodynamics II  
3 cr. Graduate.  
Wave guides, radiation by charges; radiation reaction; radiation scattering, damping and dispersion; covariant formulation of electrodynamics.  
**Prerequisites:** grad st; Physics 720(P).  
**Last Taught:** Fall 2017, Fall 2016, Fall 2015, Spring 2014.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 731 Quantum Mechanics  
3 cr. Graduate.  
Mathematical formalism of quantum mechanics. Observables and transformation theory, scattering perturbation, other approximation methods.  
**Prerequisites:** grad st; Physics 532(P) & 711(P).  
**Last Taught:** Fall 2004, Fall 2002, Fall 1998, Fall 1993.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 735 High Energy Physics  
3 cr. Graduate.  
Special relativity applied to high energy collisions, experimental techniques, ionization and radiation at high energy, weak interactions theory, ll-meson and strange particle interactions, ultra-high energy phenomena.  
**Prerequisites:** grad st & Physics 732(P).  
**Last Taught:** Fall 2011.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 751 Solid State Theory I  
3 cr. Graduate.  
Phonons, plasmons, magnons, fermion fields and the hartree-fock approximation, and electron many-body techniques and the electron gas.  
**Prerequisites:** grad st; Physics 531(P) & Physics 651(P).  
**Last Taught:** Spring 2018, Fall 2015, Fall 2013, Fall 2011.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 752 Solid State Theory II  
3 cr. Graduate.  
Dynamics of electrons in a magnetic field: energy bands, cyclotron resonance, impurity states, optical absorption and excitons in semiconductor crystals; electrodynamics of metals; green's functions.  
**Prerequisites:** grad st & Physics 532(P) & 751(P).  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)

PHYSICS 770 Electron Microscopy  
3 cr. Graduate.  
**Prerequisites:** grad st; Physics 551(P) or cons instr.  
**Last Taught:** Fall 2011, Spring 2002.  
**Current Offerings:** [http://uwm.edu/schedule](http://uwm.edu/schedule)
PHYSICS 775 Surface Physics I  
3 cr. Graduate.  
Survey of experimental techniques in surface physics research.  
Prerequisites: grad st; Physics 515(P) & 575(P).  
Current Offerings: http://uwm.edu/schedule

PHYSICS 781 Medical Radiation Physics  
3 cr. Graduate.  
Physical principles of the generation, interaction, detection, and measurement of radiation in medical applications; basics of radiation protection.  
Prerequisites: grad st  
Current Offerings: http://uwm.edu/schedule

PHYSICS 782 Physics of Medical Imaging  
3 cr. Graduate.  
Basic theoretical knowledge of the physics of diagnostic radiology using x-rays, magnetic resonance, nuclear medicine, and ultrasounds.  
Prerequisites: grad st  
Current Offerings: http://uwm.edu/schedule

PHYSICS 784 Radiotherapy Physics  
3 cr. Graduate.  
Radiation physics for work as a hospital physicist, including accelerators for radiation therapy, quality characteristics of treatment beams, treatment planning, treatment techniques, quality assurance, oncology.  
Prerequisites: grad st  
Current Offerings: http://uwm.edu/schedule

PHYSICS 786 Medical Physics Practicum  
3 cr. Graduate.  
Training with clinical medical imaging and therapy equipment, and dosimetry instrumentation.  
Prerequisites: grad st; Physics 781(P)  
Current Offerings: http://uwm.edu/schedule

PHYSICS 801 Special Topics in Theoretical Physics:  
2-3 cr. Graduate.  
Discussion of recent research or advanced special topics.  
Prerequisites: grad st & cons instr.  
Course Rules: Retakable w/chg in topic to 9 cr max.  
Current Offerings: http://uwm.edu/schedule

PHYSICS 807 Group Theory and Its Applications to Physics  
3 cr. Graduate.  
Representations of discrete and continuous groups, including rotation groups, unitary groups and crystal point and space groups. Symmetries of elementary particles. Molecular orbitals, energy bands.  
Prerequisites: grad st; Physics 532(P).  
Course Rules: Counts as repeat of Math 807.  
Current Offerings: http://uwm.edu/schedule

PHYSICS 811 Nonlinear Dynamics and Chaos  
3 cr. Graduate.  
Iteration of maps, numerical integration, strange attractors in dissipative systems, fractal dimensions, multifractals, entropy. Chaos in hamiltonian systems, perturbation theory, kam theorem. Quantum chaos.  
Prerequisites: grad st; Physics 711(P).  
Current Offerings: http://uwm.edu/schedule

PHYSICS 817 Gravitation and Cosmology II  
3 cr. Graduate.  
Experimental tests in gravitation. Gravitational waves: generation, detection. Spinning black holes. Cosmology: idealised cosmologies; present state of the universe; nucleosynthesis; inflation; recent developments.  
Prerequisites: grad st; Physics 717(P) or cons instr.  
Current Offerings: http://uwm.edu/schedule

PHYSICS 818 Advanced Topics in Gravitational Physics  
3 cr. Graduate.  
Prerequisites: grad st; Physics 717(P).  
Current Offerings: http://uwm.edu/schedule

PHYSICS 831 Quantum Field Theory I  
3 cr. Graduate.  
Group theory, canonical and path integral quantization, feynman rules, quantum electrodynamics, renormalization, quantum chromodynamics, electroweak theory, spontaneous symmetry breaking.  
Prerequisites: grad st; Physics 732(P).  
Last Taught: Fall 2017, Fall 2013, Spring 2000, Fall 1994.  
Current Offerings: http://uwm.edu/schedule

PHYSICS 852 Superconductivity  
3 cr. Graduate.  
Properties of type I and type II superconductors, bcs and ginzburg-landau theory, vortices, and flux dynamics.  
Prerequisites: grad st; Physics 532(P) & 651(P).  
Last Taught: Spring 2007.  
Current Offerings: http://uwm.edu/schedule

PHYSICS 853 Superfluidity  
3 cr. Graduate.  
Prerequisites: grad st; Physics 551(P) & 651(P) or physics 515(P).  
Current Offerings: http://uwm.edu/schedule

PHYSICS 854 Electron Phonon Interaction  
3 cr. Graduate.  
Wave propagation in metals. Interaction of electrons with the lattice in normal metals, superconductors, and magnetic materials.  
Prerequisites: grad st; Physics 532(P) & 651(P).  
Current Offerings: http://uwm.edu/schedule

PHYSICS 900 Colloquium  
1 cr. Graduate.  
Lectures by staff and visitors on research in various areas of physics.  
Prerequisites: grad st.  
Last Taught: Fall 2017, Fall 2014, Spring 2013, Spring 2012.  
Current Offerings: http://uwm.edu/schedule
PHYSICS 903 Seminar in Theoretical Physics:
1-3 cr. Graduate.
Discussion of special topics of interest to research students in theoretical physics. Retakable w/ chg in topic to 9 cr max. Prereq: grad st & cons instr.
Prerequisites:
Last Taught: Spring 2017, Fall 2016, Spring 2015, Fall 2014.
Current Offerings: http://uwm.edu/schedule

PHYSICS 904 Seminar in Surface Studies:
1-3 cr. Graduate.
Special topics in the chemistry and physics of surface studies. Specific topics and any additional prerequisites announced in Timetable each time course is offered.
Prerequisites: grad st; cons instr.
Course Rules: Retakable w/ chg in topic to 9 cr max.
Current Offerings: http://uwm.edu/schedule

PHYSICS 906 Seminar in Biophysics:
1-3 cr. Graduate.
Special topics in experimental biophysics. Retakable with change in topic to 9 cr max.
Prerequisites: grad st; cons instr.
Last Taught: Spring 2017.
Current Offerings: http://uwm.edu/schedule

PHYSICS 990 Research
1-9 cr. Graduate.
Prerequisites: grad st & cons instr.
Current Offerings: http://uwm.edu/schedule

PHYSICS 999 Independent Reading
1-3 cr. Graduate.
For the benefit of graduate students unable to secure needed content in regular courses.
Prerequisites: grad st, cons instr.
Current Offerings: http://uwm.edu/schedule