

# 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:** Fall 2019, Spring 2015, Fall 2014, Spring 2014.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

## 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:** Math Placement Level 10 or consent of instructor.

**Course Rules:** May not be taken conc with or after having taken PHYSICS 120(ER) or PHYSICS 209(ER).

**General Education Requirements:** NS

**Last Taught:** Fall 2020, Spring 2020, Fall 2019, Spring 2019.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

## 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:** Fall 2020, Spring 2020, Fall 2019, Spring 2019.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

## 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 2020, Fall 2019, Spring 2019, Fall 2018.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

## 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

**Last Taught:** Fall 2020, Summer 2020, Spring 2020, Fall 2019.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

## 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+

**Last Taught:** Fall 2020, Summer 2020, Spring 2020, Fall 2019.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

## 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

**Last Taught:** Fall 2020, Summer 2020, Spring 2020, Fall 2019.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

## 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+

**Last Taught:** Fall 2020, Summer 2020, Spring 2020, Fall 2019.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

## 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+

**Last Taught:** Spring 2014, Spring 2013, Spring 2012, Spring 2011.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

## 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 2019, Fall 2017, Fall 2015, Fall 2014.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

## PHYSICS 199 Independent Study

1-3 cr. Undergraduate.

For further information, consult dept chair.

**Prerequisites:** 2.0 GPA; consent of instructor, department chair, and Assistant Dean for Student Academic Services.

**Course Rules:** May be retaken to 6 cr max.

**Last Taught:** Spring 2016, Spring 2008, Fall 2003.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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**Last Taught:** Fall 2020, Summer 2020, Spring 2020, Fall 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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**Last Taught:** Fall 2020, Summer 2020, Spring 2020, Fall 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 5 cr max toward graduation.**General Education Requirements:** NS+**Last Taught:** Fall 2020, Summer 2020, Spring 2020, Fall 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 5 cr max toward graduation.**General Education Requirements:** NS+**Last Taught:** Fall 2020, Summer 2020, Spring 2020, Fall 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 2018, Fall 2017, Fall 2016, Fall 2015.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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+**Last Taught:** Spring 2018, Spring 2017, Spring 2016.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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).**Last Taught:** Spring 2008, Fall 2006, Fall 2005, Fall 2004.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>

**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.

**Last Taught:** Fall 1994, Fall 1991, Spring 1991, Fall 1990.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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.

**Last Taught:** Spring 2011, Fall 2004, Spring 2003, Spring 2002.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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:** Spring 2020, Fall 2017, Fall 2015, Fall 2010.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**PHYSICS 309 Physics III: Modern Physics**

3 cr. Undergraduate.

Elementary quantum physics, atomic and molecular physics, solid state and nuclear physics.

**Prerequisites:** jr st; B- or better in either PHYSICS 210(NP) or PHYSICS 220(NP); B- or better in MATH 233; MATH 234(C) or ELECENG 234(C); or consent of instructor.

**Course Rules:** Not open for cr to students who have cr in PHYSICS 341.

**General Education Requirements:** QLB

**Last Taught:** Fall 2020, Spring 2020, Fall 2019, Spring 2019.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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:** Spring 2020, Spring 2019, Fall 2017, Fall 2016.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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 2020, Spring 2019, Spring 2018, Spring 2017.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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:** Counts as repeat of Physics 499 w/same topic.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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:** B- or better in either Physics 210(NP) or Physics 220(NP); B- or better in Math 233(P); Math 234(C) or ElecEng 234(C); or cons instr.

**Last Taught:** Fall 2020, Fall 2019, Fall 2018, Spring 2018.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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 9 cr max. No cr toward major.

**General Education Requirements:** NS

**Last Taught:** Fall 2017, Fall 2016, Fall 2013, Fall 2011.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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:** Summer 2020, Spring 2020, Fall 2017, Spring 2017.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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:** <https://catalog.uwm.edu/course-search/>

**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 2020, Fall 2015.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**PHYSICS 408G 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 2020, Fall 2015.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 2020, Fall 2019, Spring 2019, Fall 2018.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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).**Last Taught:** Spring 2020, Spring 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 411G Mechanics**

4 cr. Undergraduate/Graduate.

Kinematics, vector analysis, conservation laws, oscillations, variational methods, chaos, Lagrangian and Hamiltonian mechanics.

**Prerequisites:** jr st; Physics 210(NP).**Last Taught:** Spring 2020, Spring 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 2020.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 420G 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 2020.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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, C or better in PHYSICS 420(P); or grad st.**Course Rules:** Counts as repeat of 2 cr of PHYSICS 421.**Last Taught:** Spring 2020, Spring 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 422G 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, C or better in PHYSICS 420(P); or grad st.**Course Rules:** Counts as repeat of 2 cr of PHYSICS 421.**Last Taught:** Spring 2020, Spring 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 2020.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 441G 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 2020.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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; C or better in PHYSICS 441(NP); or grad st.**Last Taught:** Spring 2020, Spring 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 442G 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; C or better in PHYSICS 441(NP); or grad st.**Last Taught:** Spring 2020, Spring 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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:** <https://catalog.uwm.edu/course-search/>

**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 Prog.

**Course Rules:** May be retaken w/chg in topic.

**Last Taught:** Fall 2014, Spring 1998.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**PHYSICS 497G 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 Prog.

**Course Rules:** May be retaken w/chg in topic.

**Last Taught:** Fall 2014, Spring 1998.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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.

**Last Taught:** Fall 2010, Spring 2010, Fall 2009, Spring 2009.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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 prereqs may be assigned to specific topic.

**Course Rules:** May be retaken w/chg in topic.

**Last Taught:** Spring 2013, Spring 2011, Spring 2007, Spring 2004.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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 2020, Fall 2019.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**PHYSICS 501G 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 2020, Fall 2019.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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).

**Last Taught:** Spring 2007, Spring 2006.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**PHYSICS 502G 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).

**Last Taught:** Spring 2007, Spring 2006.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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 2020, Spring 2020.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**PHYSICS 515G 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 2020, Spring 2020.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**PHYSICS 517G 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.

**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**PHYSICS 531 Principles of Quantum Mechanics I**

3 cr. Undergraduate/Graduate.

Vector and Hilbert spaces; Schrodinger equation in 1, 2, and 3 dimensions; systems of many particles; symmetries; angular momentum.

**Prerequisites:** jr st; Physics 441(P).**Last Taught:** Fall 2020, Fall 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 531G Principles of Quantum Mechanics I**

3 cr. Undergraduate/Graduate.

Vector and Hilbert spaces; Schrodinger equation in 1, 2, and 3 dimensions; systems of many particles; symmetries; angular momentum.

**Prerequisites:** jr st; Physics 441(P).**Last Taught:** Fall 2020, Fall 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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).**Last Taught:** Spring 2020, Spring 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 532G 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).**Last Taught:** Spring 2020, Spring 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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).**Last Taught:** Fall 2011, Fall 2009.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 541G 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).**Last Taught:** Fall 2011, Fall 2009.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 2020, Fall 2018.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 551G 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 2020, Fall 2018.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 spectrographs, chemical reactions at surfaces, outgassing.

**Prerequisites:** jr st; Physics 441(P).**Last Taught:** Spring 2011, Fall 2003.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 575G 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 spectrographs, chemical reactions at surfaces, outgassing.

**Prerequisites:** jr st; Physics 441(P).**Last Taught:** Spring 2011, Fall 2003.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 606 Molecular, Cellular, and System Biophysics**

3 cr. Undergraduate.

Cell structure and the molecular basis of life. Molecular and cellular interactions. Supracellular organization, signaling, and communication. Selfsimilarity and cooperativity.

**Prerequisites:** jr st, Physics 210(P), & writ cons instr; or grad st.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 610 The Art and Science of Teaching Physics**

1 cr. Undergraduate/Graduate.

Participants critique lectures, videotapes of experienced teachers, each other; address conceptual problems facing beginning students; gain familiarity with demonstrations, classroom technology; discuss their own classes.

**Prerequisites:** appt as undergrad TA or grad st.**Last Taught:** Fall 2019, Fall 2018.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 610G The Art and Science of Teaching Physics**

1 cr. Undergraduate/Graduate.

Participants critique lectures, videotapes of experienced teachers, each other; address conceptual problems facing beginning students; gain familiarity with demonstrations, classroom technology; discuss their own classes.

**Prerequisites:** appt as undergrad TA or grad st.**Last Taught:** Fall 2019, Fall 2018.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 651 Introduction to Solid State Physics II**

3 cr. Undergraduate/Graduate.

Transport, superconductivity, dielectric properties, ferroelectric crystals, magnetism, magnetic resonance, optical phenomena in insulators, nanostructures, non-crystalline solids, point defects, alloys, dislocations.

**Prerequisites:** jr st; Physics 551(P).**Last Taught:** Spring 2019, Spring 2015.**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**PHYSICS 651G Introduction to Solid State Physics II**

3 cr. Undergraduate/Graduate.

Transport, superconductivity, dielectric properties, ferroelectric crystals, magnetism, magnetic resonance, optical phenomena in insulators, nanostructures, non-crystalline solids, point defects, alloys, dislocations.

**Prerequisites:** jr st; Physics 551(P).**Last Taught:** Spring 2019, Spring 2015.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 670 Electron Microscopy Laboratory**

3 cr. Undergraduate/Graduate.

Diffraction, imaging, and spectroscopy methods for study of morphology, crystallinity, and composition of solids in a transmission electron microscope.

**Prerequisites:** sr st; Physics 551(P) or cons instr.**Last Taught:** Fall 2012, Fall 2009.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 670G Electron Microscopy Laboratory**

3 cr. Undergraduate/Graduate.

Diffraction, imaging, and spectroscopy methods for study of morphology, crystallinity, and composition of solids in a transmission electron microscope.

**Prerequisites:** sr st; Physics 551(P) or cons instr.**Last Taught:** Fall 2012, Fall 2009.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 698 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.**Last Taught:** Summer 2010, Summer 2009.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 698G 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.**Last Taught:** Summer 2010, Summer 2009.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 699 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; 2.0 GPA; consent of instructor, department chair, and Assistant Dean for Student Academic Services.**Course Rules:** May be retaken with change in topic to 6 cr max.**Last Taught:** Summer 2018, Fall 2016, Summer 2015, Fall 2008.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 705 Molecular, Cellular, and System Biophysics**

3 cr. Graduate.

Cell structure and the molecular basis for life. Molecular and cellular interactions. Supracellular organization, signalling, and communication. Self-similarity and cooperativity.

**Prerequisites:** grad st**Last Taught:** Spring 2020, Fall 2017, Fall 2015, Fall 2012.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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 2019, Fall 2016, Spring 2015, Spring 2013.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** Fall 2019, Spring 2019, Spring 2018, Spring 2017.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**PHYSICS 717 Gravitation**

3 cr. Graduate.

General theory of relativity. Metric, covariant derivative, and curvature. Einstein field equations. Newtonian and weak-field limits. Gravitational waves. Experimental tests. Black holes and relativistic stars.

**Prerequisites:** grad st; Physics 517(P).**Last Taught:** Fall 2020, Spring 2018, Fall 2015, Fall 2014.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 2019, Spring 2017, Spring 2015, Spring 2013.**Current Offerings:** <https://catalog.uwm.edu/course-search/>

**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 2020, Spring 2019, Spring 2018, Spring 2017.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 2020, Fall 2019, Fall 2018, Fall 2017.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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,  $\pi$ -meson and strange particle interactions, ultra-high energy phenomena.**Prerequisites:** grad st & Physics 732(P).**Last Taught:** Fall 2011.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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).**Last Taught:** Spring 2014, Spring 2008, Spring 2006, Spring 2002.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 770 Electron Microscopy**

3 cr. Graduate.

Kinematical and dynamical theory of electron diffraction. Transfer function theory of imaging. Electron and x-ray spectroscopies.

Applications to surfaces and interfaces.

**Prerequisites:** grad st; Physics 551(P) or cons instr.**Last Taught:** Fall 2011, Spring 2002.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 775 Surface Physics I**

3 cr. Graduate.

Survey of experimental techniques in surface physics research.

**Prerequisites:** grad st; Physics 515(P) & 575(P).**Last Taught:** Spring 2016, Spring 2012, Fall 2008, Fall 2002.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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**Last Taught:** Spring 2010, Spring 2008.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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.**Last Taught:** Fall 2016, Spring 2015, Spring 2012, Spring 2003.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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.**Last Taught:** Spring 2018, Spring 2013, Spring 2005.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>



**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.**Last Taught:** Fall 2019, Spring 2018, Spring 2014, Fall 2011.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 818 Advanced Topics in Gravitational Physics**

3 cr. Graduate.

Topics depend on student interest. Initial value problem. Spinors and positive mass. Singularity theorems. Modern kaluza-klein theory. Approaches to quantum gravity.

**Prerequisites:** grad st; Physics 717(P).**Last Taught:** Spring 2020, Spring 2016, Spring 2012, Spring 2008.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**PHYSICS 853 Superfluidity**

3 cr. Graduate.

Bose-Einstein condensation. Properties of superfluid 4HE, 3HE and 3HE-4HE mixtures.

**Prerequisites:** grad st; Physics 551(P) & 651(P) or physics 515(P).**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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:** <https://catalog.uwm.edu/course-search/>**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.

**Last Taught:** Fall 2020, Spring 2019, Fall 2018, Spring 2017.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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.**Last Taught:** Spring 2017, Spring 2016, Spring 2015, Spring 2014.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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 2019, Fall 2018, Spring 2017.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**PHYSICS 990 Research**

1-9 cr. Graduate.

**Prerequisites:** grad st & cons instr.**Last Taught:** Fall 2020, Spring 2020, Fall 2019, Summer 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>**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.**Last Taught:** Fall 2020, Spring 2020, Fall 2019, Spring 2019.**Current Offerings:** <https://catalog.uwm.edu/course-search/>