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 or after having taken PHYSICS 120(ER) or PHYSICS 209(ER).
General Education Requirements: NS
Last Taught: Spring 2022, Fall 2021, Spring 2021, Fall 2020.
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: Spring 2022, Fall 2021, Spring 2021, Fall 2020.
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 2021, Fall 2020, Fall 2019, Spring 2019.
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: Spring 2022, Fall 2021, Summer 2021, Spring 2021.
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: Spring 2022, Fall 2021, Summer 2021, Spring 2021.
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 max 5 cr toward graduation.
General Education Requirements: NS
Last Taught: Spring 2022, Fall 2021, Summer 2021, Spring 2021.
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 max 5 cr toward graduation.
General Education Requirements: NS+
Last Taught: Spring 2022, Fall 2021, Summer 2021, Spring 2021.
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+
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 2021, Fall 2019, Fall 2017, Fall 2015.
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.
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: Spring 2022, Fall 2021, Summer 2021, Spring 2021.
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: Spring 2022, Fall 2021, Summer 2021, Spring 2021.
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: Spring 2022, Fall 2021, Summer 2021, Spring 2021.
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: Spring 2022, Fall 2021, Summer 2021, Spring 2021.
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
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: Physics 209(P); Math 233(C).
Course Rules: May be retaken w/chg in topic.
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).
Course Rules: May be retaken w/chg in topic.
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.
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/](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/](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 2022, Spring 2020, Fall 2017, Fall 2015.
**Current Offerings:** [https://catalog.uwm.edu/course-search/](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:** Spring 2022, Fall 2021, Spring 2021, Fall 2020.
**Current Offerings:** [https://catalog.uwm.edu/course-search/](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 2022, Spring 2021, Spring 2020, Spring 2019.
**Current Offerings:** [https://catalog.uwm.edu/course-search/](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 2022, Spring 2021, Spring 2020, Spring 2019.
**Current Offerings:** [https://catalog.uwm.edu/course-search/](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/](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 2021, Fall 2020, Fall 2019, Fall 2018.
**Current Offerings:** [https://catalog.uwm.edu/course-search/](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/](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:** Spring 2022, Summer 2020, Spring 2020, Fall 2017.
**Current Offerings:** [https://catalog.uwm.edu/course-search/](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/](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/](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 2022, Spring 2021.
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 2022, Spring 2021.
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 2022, Spring 2021.
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 2021, 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 2021, 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 2022, Spring 2021.
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 2022, Spring 2021.
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 2021.
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 2021.
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 2022.
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 2022.
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.
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.
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 2021.
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 2021.
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).
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).
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: Spring 2022, Fall 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: Spring 2022, Fall 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; Schroedinger equation in 1, 2, and 3 dimensions; systems of many particles; symmetries; angular momentum.
Prerequisites: jr st; Physics 441(P).
Last Taught: Fall 2021, Fall 2020.
Current Offerings: https://catalog.uwm.edu/course-search/

PHYSICS 531G 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 2021, Fall 2020.
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 2022, Spring 2021.
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 2022, Spring 2021.
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 spectographs, 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 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: 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 2021, Fall 2019.
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 2021, Fall 2019.
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: Fall 2021, Spring 2019.
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: Fall 2021, Spring 2019.  
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 2022, Spring 2020, Fall 2017, Fall 2015.  
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 2021, Fall 2019, Fall 2016, Spring 2015.  
Current Offerings: https://catalog.uwm.edu/course-search/  

PHYSICS 716 Advanced Topics in Statistical Physics  
3 cr. Graduate.  
Lagrangian 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).  
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.  
Current Offerings: https://catalog.uwm.edu/course-search/
Current Offerings:

**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).
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 2021, Fall 2020, Fall 2019, Fall 2018.
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).
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, ll-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).
Current Offerings: https://catalog.uwm.edu/course-search/

**PHYSICS 770 Electron Microscopy**
3 cr. Graduate.
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).
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
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 2021, Fall 2016, Spring 2015, Spring 2012.
Current Offerings: https://catalog.uwm.edu/course-search/

**PHYSICS 802 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: https://catalog.uwm.edu/course-search/

**PHYSICS 807 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: Spring 2022, Fall 2019, Spring 2018, Spring 2014.
Current Offerings: https://catalog.uwm.edu/course-search/

PHYSICS 818 Advanced Topics in Gravitational Physics
3 cr. Graduate.
Prerequisites: grad st; Physics 717(P).
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.
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 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: 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 2022, Fall 2021, Summer 2021, Spring 2021.
Current Offerings: https://catalog.uwm.edu/course-search/

PHYSICS 999 Independent Reading
1-9 cr. Graduate.
For the benefit of graduate students unable to secure needed content in regular courses.
Prerequisites: grad st, cons instr.
Last Taught: Spring 2022, Fall 2021, Fall 2020, Spring 2020.
Current Offerings: https://catalog.uwm.edu/course-search/