Physics

Physics Major

Students who complete a major in Physics are prepared for careers in industrial and governmental research and development and for graduate study in physics, astronomy, engineering, medicine, materials science, and environmental science. In-depth preparation is also provided for teaching in secondary schools.

Students interested in Physics Education are encouraged to declare a double major in their discipline and in education (i.e., Physics Education (http:// bulletin.ndsu.edu/past-bulletin-archive/2015-16/undergraduate/colleges/human-development-education/education/teaching-specialty-physics) and Physics). Such double majors may be earned by the successful completion of a few additional credits. Students should contact their adviser, the School of Education (https://www.ndsu.edu/education), or the Office of Registration and Records (https://www.ndsu.edu/registrar) for details and are encouraged to declare their primary and secondary majors with the Office of Registration and Records, Ceres Hall 110 (https://www.ndsu.edu/alphaindex/buildings/Building::240).

Optical Science and Engineering Option

This option includes an interdisciplinary optics/photonics sequence of courses taught by the Departments of Physics (https://www.ndsu.edu/physics) and the Department of Electrical and Computer Engineering (https://www.ndsu.edu/ece) using a state-of-the-art optics teaching laboratory. This is the only regional program of its type. Optics and lasers are enabling technologies and are applied in most high-tech experiments, communications, devices, medical diagnostics, media, etc. There are more than 5,000 optics-related companies in the United States alone, but even more important, photonics provides the technical foundation for many more. Optical science and engineering has exploded to encompass nearly all fields of science and technology with a consequent shortage of individuals trained in the field. The optical science and engineering option will enhance any job search.

Physics Minor

A Physics minor consists of 19 credits, of which at least eight credits must be completed at NDSU.

Major Requirements

Major: Physics (Standard)

Degree Type: B.A. or B.S. Required Degree Credits to Graduate: 122

General Education Requirements

First Year Experience (F):		
UNIV 189	Skills For Academic Success (Students transferring in 24 or more credits do not need to take UNIV 189.)	1
Communication (C):		
ENGL 110	College Composition I	3
ENGL 120	College Composition II	3
One Course in Upper Level	Writing: Select from current general education list	3
COMM 110	Fundamentals of Public Speaking	3
Quantitative Reasoning (R	र):	
MATH 165	Calculus I	4
Science & Technology (S):	
PHYS 251	University Physics I	5
& 251L	and University Physics I Laboratory	
PHYS 252	University Physics II	5
& 252L	and University Physics II Laboratory	
Humanities & Fine Arts (A	A): Select from current general education list	6
Social & Behavioral Scier	nces (B): Select from current general education list	6
Wellness (W): Select from current general education list		2
Cultural Diversity (D): Sel	ect from current general education list	
Global Perspectives (G):	Select from current general education list	
Total Credits		41

College Requirements

Bachelor of Science (BS) Degree - An additional 6 credits in Humanities or Social Sciences

Bachelor of Arts (BA) Degree – An additional 12 credits Humanities and Social Sciences^{*} and proficiency at the second year level in a modern foreign language.

* Humanities and Social Sciences may be fulfilled by any course having the following prefix: ADHM, ANTH, ARCH, ART, CJ, CLAS, COMM, ECON, ENGL, FREN, GEOG, GERM, HDFS, HIST, LA, LANG, MUSC, PHIL, POLS, PSYC, RELS, SOC, SPAN, THEA, WGS, or any course from the approved list of general education courses in humanities and social sciences (general education categories A and B). These credits must come from outside the department of the student's major.

Major Requirements - Standard Option

A grade of 'C' or better is required for all PHYS and AST prefix courses.

General Education Requireme	ents	40
College of Science and Mathe	ematics Requirements	6-12
Physics Major Requirements	(Standard Option)	
PHYS 171	Introductory Projects in Physics	1
PHYS 251R	University Physics I Recitation	1
PHYS 252R	University Physics II Recitation	1
PHYS 350	Modern Physics	3
PHYS 360	Modern Physics II	3
PHYS 361	Electromagnetic Theory (or PHYS 370:Electromagnetic Theory - MSUM)	3-4
PHYS 370	Introduction to Computational Physics	3
PHYS 411 & 411L	Optics for Scientists & Engineers and Optics for Scientists and Engineers Lab	4
Select one of the following:		3-4
PHYS 455	Classical Mechanics	
PHYS 330	Intermediate Mechanics (MSUM)	
PHYS 462	Heat & Thermodynamics	3
PHYS 485	Quantum Mechanics I	3
PHYS 486	Quantum Mechanics II	3
PHYS 489	Physics Projects	3
Physics Electives: Select two of	f the following:	6
PHYS 215	Research For Undergraduates	
PHYS 413	Lasers for Scientists and Engineers	
PHYS 415	Elements of Photonics	
PHYS 463	Statistical Mechanics	
PHYS 481	Introduction to Solid State Physics	
MSUM AST	Astronomy courses (300/400-level) with departmental permission	
Related Required Courses		
Mathematics:		
MATH 129	Basic Linear Algebra	2-3
or MATH 429	Linear Algebra	
MATH 166	Calculus II	4
MATH 265	Calculus III	4
MATH 266	Introduction to Differential Equations	3
MATH Electives	400-level (MATH 488 & MATH 489 are recommended)	6
Chemistry: Select one of the following	lowing (150/160 recommended):	4
CHEM 150 & CHEM 160	Principles of Chemistry I and Principles of Chemistry Laboratory I	
CHEM 121 & 121L	General Chemistry I and General Chemistry I Laboratory	
Select one of the following (151	/161 recommended):	4

Total Credits		122-132
Degree Requirements: Potential of one credit to reach 122.		1
CSCI 161	Computer Science II	4
or ECE 173	Introduction to Computing	
CSCI 160	Computer Science I	3-4
Computer Science:		
CHEM 122 & 122L	General Chemistry II and General Chemistry II Laboratory	
CHEM 151 & CHEM 161	Principles of Chemistry II and Principles of Chemistry Laboratory II	

Program Notes

• Except for courses offered only as pass/fail grading, no course may be taken Pass/Fail.

Major Requirements

Major: Physics with Optical Science and Engineering Option

Degree Type: B.A. or B.S. Required Degree Credits to Graduate: 122

General Education Requirements

First Year Experience (F):		
UNIV 189	Skills For Academic Success (Students transferring in 24 or more credits do not need to take UNIV 189.)	1
Communication (C):		
ENGL 110	College Composition I	3
ENGL 120	College Composition II	3
One Course in Upper Level Writing:	Select from current general education list	3
COMM 110	Fundamentals of Public Speaking	3
Quantitative Reasoning (R):		
MATH 165	Calculus I	4
Science & Technology (S):		
PHYS 251	University Physics I	5
& 251L	and University Physics I Laboratory	
PHYS 252	University Physics II	5
& 252L	and University Physics II Laboratory	
Humanities & Fine Arts (A): Select from current general education list		6
Social & Behavioral Sciences (B):	Select from current general education list	6
Wellness (W): Select from current general education list		2
Cultural Diversity (D): Select from	current general education list	
Global Perspectives (G): Select free	om current general education list	
Total Credits		41

College Requirements

Bachelor of Science (BS) Degree – An additional 6 credits in Humanities or Social Sciences

Bachelor of Arts (BA) Degree – An additional 12 credits Humanities and Social Sciences^{*} and proficiency at the second year level in a modern foreign language.

* Humanities and Social Sciences may be fulfilled by any course having the following prefix: ADHM, ANTH, ARCH, ART, CJ, CLAS, COMM, ECON, ENGL, FREN, GEOG, GERM, HDFS, HIST, LA, LANG, MUSC, PHIL, POLS, PSYC, RELS, SOC, SPAN, THEA, WGS, or any course from the approved list of general education courses in humanities and social sciences (general education categories A and B). These credits must come from outside the department of the student's major.

Major Requirements - Optical Science and Engineering Option

A grade of 'C' or better is required for all PHYS prefix courses.

Physics Major Requirements (Optical Science and Engineering Option) 11 PhYS 171 Introductory Physics I Recitation 1 PhYS 251R University Physics I Recitation 1 PhYS 350 Modern Physics 33 PhYS 360 Modern Physics I 33 PhYS 360 Introductor Physics I 34 PhYS 370 Introductor Physics Electromagnetic Theory · MSUM) 34 PhYS 371 Detectromagnetic Theory (PhYS 370: Electromagnetic Theory · MSUM) 34 PhYS 413 Lasers for Scientists at Engineers 3 At111 optics for Scientists at Engineers 34 PhYS 451 Elements of Physics Physics 3 PhYS 452 Classical Mechanics (MSUM) 3 PhYS 452 Quantum Mechanics (MSUM) 3 PhYS 453 Quantum Mechanics (MSUM) 3 PhYS 454 Quantum Mechanics (MSUM) 3 PhYS 456 Quantum Mechanics (MSUM) 3 PhYS 456 Quantum Mechanics (MSUM) 3 PhYS 456 Quantum Mechanics (MSUM) 3 PhYS 4	College of Science and Mathematics Requirements 6		
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PHYS 252R University Physics II Reclation 1 PHYS 350 Modern Physics 3 PHYS 350 Modern Physics II 3 PHYS 350 Introduction to Computational Physics 3 PHYS 370 Introduction to Computational Physics 3 PHYS 411 Optics for Scientists & Engineers 4 At11L and Optics for Scientists & Engineers 3 PHYS 415 Elements of Photonics 3 PHYS 455 Classical Mechanics (MSUM) 7 PHYS 456 Classical Mechanics (MSUM) 7 PHYS 486 Quantum Mechanics I 3 PHYS 486 Quantum Mechanics I 4 Related Required Courses 4 Related Required Courses 4 Mathematics 4 Related Required Courses 3 MATH 128 Linear Algebra 3 MATH 128 Linear Algebra 3	PHYS 251R	University Physics I Recitation	1
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or MATH 429 Linear Algebra MATH 166 Calculus II 4 MATH 265 Calculus III 4 MATH 266 Introduction to Differential Equations 4 CHEM 150 Principles of Chemistry I Laboratory I 4 CHEM 121 General Chemistry I Laboratory 4 Select one of the following (151/161 recommended): 4 4 CHEM 151 Principles of Chemistry II Laboratory II 4 CHEM 151 and General Chemistry II Laboratory II 4 CHEM 122 General Chemistry II Laboratory II 1 CHEM 123 and General Chemistry II Laboratory II 1 CHEM 124 and General Chemistry II Laboratory	MATH 129	Basic Linear Algebra	2-3
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Chemistry: Select one of the following (150/160 recommended): 4 CHEM 150 Principles of Chemistry I & CHEM 160 and Principles of Chemistry Laboratory I CHEM 121 General Chemistry I & 121L and General Chemistry I and General Chemistry I Laboratory 4 CHEM 121 General Chemistry I Laboratory Select one of the following (151/161 recommended): 4 CHEM 151 Principles of Chemistry ILaboratory II & CHEM 151 eneral Chemistry I Laboratory II CHEM 161 and Principles of Chemistry Laboratory II CHEM 122 General Chemistry ILaboratory II CHEM 122 General Chemistry II Laboratory Degree Requirements: Potential of one credit to reach 122 1 Total Credits 122-132 Recommended Electives for Optical and Engineering Option 4 ECE 311 Circuit Analysis II 4 ECE 321 Electronics II 2 ECE 417 Optical Signal Transmission 3 ECE 483 Instrumentation for Engineers 3	MATH Electives	(400-level (MATH 452, MATH 481, and/or MATH 488 are recommended)	6
CHEM 150 Principles of Chemistry I & CHEM 160 and Principles of Chemistry Laboratory I CHEM 121 General Chemistry I & 121L and General Chemistry I Laboratory Select one of the following (151/161 recommended): 4 CHEM 151 Principles of Chemistry II & CHEM 161 and Principles of Chemistry II & CHEM 161 and Principles of Chemistry II & CHEM 161 and Principles of Chemistry II & CHEM 122 General Chemistry II & CHEM 122 General Chemistry II Laboratory Pegree Requirements: Potential of one credit to reach 122 1 Total Credits 1 Recommended Electives for Optical and Engineering Option 4 ECE 311 Circuit Analysis II ECE 417 Optical Signal Transmission 3 ECE 483 Instrumentation for Engineers 3	Chemistry: Select one of the following	g (150/160 recommended):	4
CHEM 121 General Chemistry I & 121L and General Chemistry I Laboratory Select one of the following (151/161 recommended): 4 CHEM 151 Principles of Chemistry II & CHEM 151 and Principles of Chemistry Laboratory II CHEM 122 General Chemistry II Laboratory CHEM 122 General Chemistry II Laboratory CHEM 122 General Chemistry II Laboratory Degree Requirements: Potential of one credit to reach 122 1 Total Credits 122-132 Recommended Electives for Optical and Engineering Option 4 ECE 311 Circuit Analysis II ECE 321 Electronics II 2 ECE 417 Optical Signal Transmission 3 ECE 483 Instrumentation for Engineers 3	CHEM 150 & CHEM 160	Principles of Chemistry I and Principles of Chemistry Laboratory I	
& 121L and General Chemistry I Laboratory Select one of the following (151/161 recommended): 4 CHEM 151 Principles of Chemistry II & CHEM 151 and Principles of Chemistry Laboratory II & CHEM 161 and Principles of Chemistry Laboratory II CHEM 122 General Chemistry II Laboratory M 122L and General Chemistry II Laboratory Degree Requirements: Potential of one credit to reach 122 1 Total Credits 122-132 Recommended Electives for Optical and Engineering Option 4 ECE 311 Circuit Analysis II 4 ECE 321 Electronics II 2 ECE 417 Optical Signal Transmission 3 ECE 483 Instrumentation for Engineers 3	CHEM 121	General Chemistry I	
Select one of the following (151/161 recommended): 4 CHEM 151 Principles of Chemistry II & CHEM 161 and Principles of Chemistry Laboratory II CHEM 122 General Chemistry II Laboratory & 122L and General Chemistry II Laboratory Degree Requirements: Potential of one credit to reach 122 1 Total Credits 122-132 Recommended Electives for Optical and Engineering Option 4 ECE 311 Circuit Analysis II 4 ECE 321 Electronics II 2 ECE 417 Optical Signal Transmission 3 ECE 483 Instrumentation for Engineers 3	& 121L	and General Chemistry I Laboratory	
CHEM 151 Principles of Chemistry II & CHEM 161 and Principles of Chemistry Laboratory II CHEM 122 General Chemistry II & 122L and General Chemistry II Laboratory Degree Requirements: Potential of one credit to reach 122 1 Total Credits 122-132 Recommended Electives for Optical and Engineering Option 4 ECE 311 Circuit Analysis II 4 ECE 321 Electronics II 2 ECE 417 Optical Signal Transmission 3 ECE 483 Instrumentation for Engineers 3	Select one of the following (151/161)	recommended):	4
& CHEM 161 and Principles of Chemistry Laboratory II CHEM 122 General Chemistry II & 122L and General Chemistry II Laboratory Degree Requirements: Potential of one credit to reach 122 1 Total Credits 122-132 Recommended Electives for Optical and Engineering Option 4 ECE 311 Circuit Analysis II 4 ECE 321 Electronics II 2 ECE 417 Optical Signal Transmission 3 ECE 483 Instrumentation for Engineers 3	CHEM 151	Principles of Chemistry II	
CHEM 122 General Chemistry II & 122L and General Chemistry II Laboratory Degree Requirements: Potential of one credit to reach 122 1 Total Credits 122-132 Recommended Electives for Optical and Engineering Option 4 ECE 311 Circuit Analysis II 4 ECE 321 Electronics II 2 ECE 417 Optical Signal Transmission 3 ECE 483 Instrumentation for Engineers 3	& CHEM 161	and Principles of Chemistry Laboratory II	
& 122L and General Chemistry II Laboratory Degree Requirements: Potential of one credit to reach 122 1 Total Credits 122-132 Recommended Electives for Optical and Engineering Option 4 ECE 311 Circuit Analysis II 4 ECE 321 Electronics II 2 ECE 417 Optical Signal Transmission 3 ECE 483 Instrumentation for Engineers 3	CHEM 122	General Chemistry II	
Degree Requirements: Potential of one credit to reach 122 1 Total Credits 122-132 Recommended Electives for Optical and Engineering Option 4 ECE 311 Circuit Analysis II 4 ECE 321 Electronics II 2 ECE 417 Optical Signal Transmission 3 ECE 483 Instrumentation for Engineers 3	& 122L	and General Chemistry II Laboratory	
Total Credits122-132Recommended Electives for Optical and Engineering Option4ECE 311Circuit Analysis II4ECE 321Electronics II2ECE 417Optical Signal Transmission3ECE 483Instrumentation for Engineers3	Degree Requirements: Potential of	one credit to reach 122	1
Recommended Electives for Optical Engineering OptionECE 311Circuit Analysis II4ECE 321Electronics II2ECE 417Optical Signal Transmission3ECE 483Instrumentation for Engineers3	Total Credits		122-132
ECE 311Circuit Analysis II4ECE 321Electronics II2ECE 417Optical Signal Transmission3ECE 483Instrumentation for Engineers3	Recommended Electives for Optica	al and Engineering Option	
ECE 321Electronics II2ECE 417Optical Signal Transmission3ECE 483Instrumentation for Engineers3	ECE 311	Circuit Analysis II	4
ECE 417Optical Signal Transmission3ECE 483Instrumentation for Engineers3	ECE 321	Electronics II	2
ECE 483 Instrumentation for Engineers 3	ECE 417	Optical Signal Transmission	- 3
	ECE 483	Instrumentation for Engineers	3

Program Notes

• Except for courses offered only as pass/fail grading, no course may be taken Pass/Fail.

Minor Requirements

Physics Minor

Minor Requirements

Required Credits: 19

Required Courses

Total Credits		19
ME 221 and ME 222 n	may be substituted for PHYS 251 and PHYS 251L	
Any 300-400 level Phy	ysics course	
PHYS 215	Research For Undergraduates	
PHYS 252R	University Physics II Recitation	
PHYS 251R	University Physics I Recitation	
PHYS 251L	University Physics I Laboratory	
PHYS 171	Introductory Projects in Physics	
Electives: Select 7 cred	lits from the following:	7
PHYS 350	Modern Physics	3
PHYS 252L	University Physics II Laboratory	1
PHYS 252	University Physics II	4
PHYS 251	University Physics I	4

Total Credits

Minor Requirements and Notes

• A minimum of 8 credits must be taken at NDSU.

Freshman		
Fall	Credits Spring	Credits
PHYS 171	1 PHYS 251	4
UNIV 189	1 PHYS 251L	1
MATH 165	4 PHYS 251R	1
CHEM 150	3 MATH 129	2
CHEM 160	1 MATH 166	4
ENGL 110 ^{credit} automatically granted if you earn a "C" in ENGL 120	3 CHEM 151	3
ENGL 120 ^{can enroll in ENGL 120 if ACT} score > 17	3 CHEM 161	1
Wellness Elective	2	
	18	16
Sophomore		
Fall	Credits Spring	Credits
PHYS 252	4 CSCI 161	4
PHYS 252L	1 PHYS 350	3
PHYS 252R	1 MATH 266	3
MATH 265	4 COMM 110	3
CSCI 160	4 Humanities/Fine Arts Elective	3
Humanities/Fine Arts Elective	3 Social/Behavioral Science Elective	3
	17	19
Junior		
Fall	Credits Spring	Credits
PHYS 360	3 PHYS 370	3
		0

PHYS 485	3 ENGL 324	3
MATH 4XX Math Elective	3 MATH 4XX Math Elective	3
Social/Behavioral Science Elective	3 Humanities/Fine Arts Elective	3
	15	15
Senior		
Fall	Credits Spring	Credits
PHYS 361	3 PHYS 489	3
PHYS 462	3 PHYS 463	3
PHYS 411	3 Physics Elective	3
PHYS 411L	1 Free Elective	3
Social/Behavioral Science Elective	3	
	13	12

Total Credits: 125