

# Chemistry, Geosciences, and Physics

Dr. Ryan Morgan, Department Head  
 Department of Chemistry, Geosciences & Physics  
 Science Building, Room 117  
 Box T-0540  
 Stephenville, Texas 76402  
 (254) 968-9894  
 rmorgan@tarleton.edu  
 www.tarleton.edu/chgp (<http://www.tarleton.edu/chgp/>)

The Department of Chemistry, Geosciences, and Physics provides rigorous, high-caliber programs with experts dedicated to student mastery. Located only an hour southwest of Fort Worth in the heart of Stephenville, campus is nestled in the Hill Country of Texas, with access to nearby facilities and research opportunities in DFW, Austin, Waco, Abilene, and College Station.

Learning reaches beyond the classroom at Tarleton, and we are proud of our traditions of friendliness and of treating students with respect and individual attention. We take pride in our small advanced classes which provided access to our faculty in a one-on-one environment. Tarleton's faculty members are dedicated to your needs and they make every effort to be responsive and progressive.

These traits are also present in Tarleton's Department of Chemistry, Geosciences and Physics, which offers Bachelor of Science degrees in Physics (<https://www.tarleton.edu/degrees/bachelors/bs-physics/>), Chemistry (<https://www.tarleton.edu/degrees/bachelors/bs-chemistry/>), Environmental Science (<https://www.tarleton.edu/degrees/bachelors/environmental-science/>), or Geosciences (<https://www.tarleton.edu/degrees/bachelors/bs-geoscience/>), as well as Master of Science degrees in Environmental Science (<https://www.tarleton.edu/degrees/masters/ms-environmental-science/>) and Geosciences (<https://www.tarleton.edu/degrees/masters/ms-geoscience/>).

Tarleton's Chemistry, Geosciences, and Physics Department emphasizes the personal bond between student and faculty mentor. Through personalized advising, we encourage you to identify your preferences in choosing a degree program that will prepare you professionally and challenge you academically.

## The Bachelor of Science Degree in Chemistry

Chemistry is for students with the desire to be a part of the future and the drive to test established thought. Students who like to work with both their hands and their minds will enjoy the challenge and excitement of this creative science. Chemists work with highly sophisticated instruments, with computers, with basic lab ware and chemicals, and with other people.

Over 60% of all chemists work in industry, producing the products and technologies that shape our everyday lives - pharmaceuticals, textiles, rubber, glass, polymers, paper, conductors, and food. In the industrial environment a chemist may be working in research, inventing or improving a chemical compound or process. Other chemists are involved in manufacturing a product or running experiments to test the quality or safety of products.

More than 20 % of all chemists are engaged in teaching and/or research in schools, colleges, and universities. Chemists in educational institutions enjoy the challenge of communicating the excitement of chemistry to new generations.

Federal, state, and local governments employ about 10 % of the chemistry work force. These chemists work in a variety of governmental agencies on issues dealing with science and technology, health care, the environment, defense, and industry. Individuals with degrees in chemistry are also found working in many diverse fields such as medicine, technical writing, law, information science, agriculture, health and safety, instrumentation, sales and personnel work, management, manufacturing, library science, engineering, environmental protection, forensics, materials science, and as small business owners.

Many chemistry graduates enter the job market directly; however, approximately 60% of graduates elect post-graduate study. Approximately 10,000 men and women receive an undergraduate degree in chemistry annually; however, this number has dropped somewhat in recent years, and the National Science Foundation has expressed much concern about whether there will be sufficient numbers of trained chemists in the future.

The demand for chemists remains strong in the 21st century as society moves into a more highly developed technological age dependent on materials and the science that produces them.

Accredited by the American Chemical Society, the Bachelor of Science degree in Chemistry prepares students for graduate studies or careers in the scientific community or academia.

## The Bachelor of Science Degree in Chemistry

### Required Courses

**Placement for Calculus 1 is by the CLMPE placement exam, or by college credit for MATH 1316 or MATH 2412. Contact Tarleton's Center for Academic Testing for test information and locations.**

General Education Requirements ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> ):	43	
CHEM 1311 [shared]	College Chemistry I (Lecture)	
CHEM 1111 [shared]	College Chemistry I (Laboratory)	
CHEM 1312 [shared]	College Chemistry II (Lecture)	
CHEM 1112 [shared]	College Chemistry II (Laboratory)	
CHEM 2323	Organic Chemistry I	3
CHEM 2123	Organic Chemistry I Laboratory	1
CHEM 2325	Organic Chemistry II	3
CHEM 2125	Organic Chemistry II Laboratory	1
CHEM 3407	Quantitative Analysis	4
CHEM 3423 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Physical Chemistry I	4
CHEM 4160	Professional Lab Safety Techniques and Ethics in Chemistry	1
CHEM 4408	Instrumental Analysis	4
ENGL 1301 [shared] [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Composition I	
ENGL 1302 [shared] [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Composition II	
ENGL 3309 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Technical Writing and Document Design	3
MATH 2413 [shared]	Calculus I	

MATH 2414	Calculus II	4
<b>Total Hours</b>		<b>71</b>
<b>Additional Required Courses for Concentrations</b>		
<b>Biochemistry</b>		
BIOL 1406	Biology for Science Majors	4
BIOL 1407	Biology for Science Majors II	4
BCIS or COSC Elective		3
BIOL 3407	Microbiology	4
BIOL 3303	Genetics	3
BIOL 3103	Genetic Techniques	1
BIOL 3413	Molecular Biology	4
CHEM 4327	Structural Organic Analysis	3
or CHEM 4345	Medicinal Chemistry	
CHEM 4328	Inorganic Chemistry	3
CHEM 3324	Physical Chemistry II	3
CHEM 4374	Biochemistry I	3
CHEM 4375	Biochemistry II	3
BIOL 4378	Biochemistry Lab	3
PHYS 1401	College Physics I	4
PHYS 1402	College Physics II	4
<b>Total Hours</b>		<b>49</b>
<b>Forensic Chemistry</b>		
CRIJ 1301	Introduction to Criminal Justice	3
CRIJ 1306	Court Systems and Practices	3
BIOL 1406	Biology for Science Majors	4
BIOL 3407	Microbiology	4
MATH 3450	Principles of Bio-Statistics	4
CHEM 4327	Structural Organic Analysis	3
CHEM 4374	Biochemistry I	3
CHEM 4378	Biochemistry Lab	3
CRIJ 3305	Criminology	3
CHEM 4328	Inorganic Chemistry	3
CRIJ 3315	Rules of Criminal Evidence	3
CRIJ 4316 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Methods of Criminal Justice Research	3
Advanced CHEM elective		2
PHYS 1401	College Physics I	4
PHYS 1402	College Physics II	4
COMM 2302 [shared]	Business and Professional Speaking	
<b>Total Hours</b>		<b>49</b>
<b>Interdisciplinary</b>		
Select one of the following:		4
GEOL 1403	Physical Geology	
GEOL 1404	Historical Geology	
GEOL 1407	Introduction to Environmental Science	
BIOL 1406	Biology for Science Majors	
BIOL 1407	Biology for Science Majors II	
Supporting field (14 Hours Advanced) <sup>1</sup>		21
Advanced Electives		8
Advanced CHEM Electives		1
PHYS 1401	College Physics I	4
PHYS 1402	College Physics II	4
COMM 2302 [shared]	Business and Professional Speaking	
CHEM 4328	Inorganic Chemistry	3
CHEM 3124	Physical Chemistry II Laboratory	1
CHEM 3324	Physical Chemistry II	3
<b>Total Hours</b>		<b>49</b>
<b>Pre-Health</b>		
BIOL 1406	Biology for Science Majors	4
BIOL 1407	Biology for Science Majors II	4
ECON 2301 [shared]	Principles of Macroeconomics	
PSYC 2301	General Psychology	3
or PSYC 2314	Life Span Growth & Development	
BIOL 3407	Microbiology	4

BIOL 3303	Genetics	3
BIOL 3103	Genetic Techniques	1
BIOL 3413	Molecular Biology	4
MATH 3450	Principles of Bio-Statistics	4
CHEM 4345	Medicinal Chemistry	3
CHEM 4374	Biochemistry I	3
CHEM 4375	Biochemistry II	3
Advanced CHEM Electives		5
PHYS 1401	College Physics I	4
PHYS 1402	College Physics II	4
COMM 2302 [shared]	Business and Professional Speaking	
<b>Total Hours</b>		<b>49</b>

### Professional Chemistry

Advanced Electives		6
BIOL 1406	Biology for Science Majors	4
BIOL 1407	Biology for Science Majors II	4
CHEM 4327	Structural Organic Analysis	3
CHEM 4328	Inorganic Chemistry	3
CHEM 4374	Biochemistry I	3
CHEM 4378	Biochemistry Lab	3
CHEM 3324	Physical Chemistry II	3
CHEM 3124	Physical Chemistry II Laboratory	1
CHEM 4086	Chemistry Problems: Undergraduate Research	1-4
Electives		4
Advanced Chemistry Electives		6
COMM 2302 [shared]	Business and Professional Speaking	
PHYS 2425	University Physics I	4
PHYS 2426	University Physics II	4
<b>Total Hours</b>		<b>49</b>

### Environmental Chemistry

GEOL 1403	Physical Geology	4
GEOL 1407	Introduction to Environmental Science	4
BIOL 1406	Biology for Science Majors	4
EASC 3350	Environmental Science	3
BIOL 3407	Microbiology	4
MATH 3450	Principles of Bio-Statistics	4
SOIL 3101	Soil Science Laboratory	1
SOIL 3301	Soil Science	3
EASC 4313 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Environmental Techniques	3
CHEM 4327	Structural Organic Analysis	3
CHEM 4328	Inorganic Chemistry	3
CHEM 4477	Environmental Chemistry	4
Advanced Chemistry Elective		1
COMM 2302 [shared]	Business and Professional Speaking	
PHYS 1401	College Physics I	4
PHYS 1402	College Physics II	4
<b>Total Hours</b>		<b>49</b>

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Possible support fields include biology, geoscience, physics, business administration, and other fields approved by department heads involved

## The Bachelor of Science Degree in Environmental Science

Our environmental science bachelor's degree takes a multidisciplinary, integrated approach to understanding biological, geological, and human factors that affect environmental quality. Through broad coursework and hands-on learning experiences, you can explore and discover your environmental interests while preparing for a wide variety of jobs in environmental sciences. You can also specialize in an area of environmental sciences by choosing one of three concentrations:

- Science
- Geospatial Information Science (GIS)
- Policy

Our curriculum offers diverse opportunities to gain practical understanding of land and water resources, human impacts on the environment, and environmental law and policies. As an environmental science major at Tarleton, you will gain marketable skills in effective environmental management to protect the health and future of our planet and our people.

- Science. Designed for students interested in pursuing careers with environmental consulting companies or conducting environmental assessments of land and water resources. Excellent for students interested in pursuing a graduate degree in environmental science or going directly into the field.

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- Geospatial Information Science. For students interested in land-use planning or in analyzing environmental interactions. Excellent program for students interested in environmental education or work with environmental monitoring organizations. Includes an option for a GIS certification while exploring ecological, social, and economic interactions across the landscape.
- Environmental Policy. For students interested in environmental law, in investigating the impacts of government policies on environmental conditions, and in assessing impacts of resource use and pollution on human communities. Also for business professionals involved in developing or implementing environmentally sound business practices. Includes an in-depth exploration of environmental policies, environmental law, environmental sociology, and environmental economics.

### The Bachelor of Science Degree in Environmental Sciences

#### Required Courses

General Education Requirements ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )		43
SCMA 1100 [shared]	Transitioning to University Studies in Sciences & Mathematics	
SOCI 1301 [shared]	Introductory Sociology	
BIOL 1406 [shared]	Biology for Science Majors	
BIOL 1407	Biology for Science Majors II	4
CHEM 1311 & CHEM 1111 [shared]	College Chemistry I (Lecture) and College Chemistry I (Laboratory)	
GOVT 2305 [shared]	Federal Government (Federal Constitution and Topics)	
GOVT 2306 [shared]	Texas Government (Texas Constitution and Topics)	
Select one of the following [shared]:		
COMM 1311	Introduction to Speech Communication	
COMM 1315	Public Speaking	
COMM 2302	Business and Professional Speaking	
EASC 4313 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Environmental Techniques	3
ENVS 2451	Introduction to Geographic Information Systems	4
ENVS 1302	Science, Technology, and the Environment	3
ENVS 3307	Systems Thinking	3
EASC 3350	Environmental Science	3
ENVS 3315	Sustainability	3
GEOL 1403	Physical Geology	4
GEOL 1407	Introduction to Environmental Science	4
MATH 2412 [shared]	Precalculus Math	
MATH 3450	Principles of Bio-Statistics	4
PHIL 2303	Introduction to Logic	3
POLS 3310 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Environmental Policy	3
ENVS 4380	Environmental Science Capstone	3
<b>Total Hours</b>		<b>87</b>

#### Additional Required Courses for Concentrations

##### Science

CHEM 1312 & CHEM 1112	College Chemistry II (Lecture) and College Chemistry II (Laboratory)	4
CHEM 4477	Environmental Chemistry	4
Advanced BIOL 3XXX or 4XXX <sup>1</sup>		4
Choose Two:		6
SOCI 3312	Environmental Sociology	
WSES 4306	Water Resources Policy and Management	
PHIL 4305	Environmental Ethics	
POLS 4310 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	International Environmental Issues	
POLS 4311 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Environmental Law	
GEOL 3310	Geomorphology	3
ENGT 4360	Hazardous Waste Management	3
Advanced EASC 3XXX or 4XXX <sup>1</sup>		6
Advanced Elective in BIOL, ENVS, EASC, CHEM, GEOG, SOIL or GEOL 3XXX or 4XXX <sup>1</sup>		3
<b>Total Hours</b>		<b>33</b>

##### Environmental Policy

ECON 1301	Introduction To Economics	3
ENVS 3323	Ethical Issues in Agriculture and the Natural Resources	3
POLS 4310 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	International Environmental Issues	3
POLS 4311 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Environmental Law	3
SOCI 3312	Environmental Sociology	3

SOCI 4313	Globalization	3
COMM 3305	Environmental Communication	3
ECON 3304	Environmental Economics	3
SOCI 4306	Water Policy	3
ENVS 4350	Energy and the Environment	3
ENGT 4360	Hazardous Waste Management	3
<b>Total Hours</b>		<b>33</b>

### Geospatial Information Science

GEOG 2301	The Geography of Texas	3
GEOG 3450	Intermediate Geographic Information Systems	4
GEOG 4450	Advanced Geographic Information Systems	4
EASC 3360	Remote Sensing	3
GEOG 4451	Applied Remote Sensing	4
GEOL 3310	Geomorphology	3
SOCI 3312	Environmental Sociology	3
SOCI 4313	Globalization	3
Advanced Elective in BIOL, ENVS, EASC, CHEM, GEOG, SOIL, POLS, SOCI, or GEOL 3XXX or 4XXX <sup>1</sup>		6
<b>Total Hours</b>		<b>33</b>

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In the event a course is listed in multiple elective areas, credit will be awarded for the course in only one of the areas.

## The Bachelor of Science Degree in Geoscience

This degree emphasizes the study of the physical, chemical, and biological processes of the Earth, from its deep interior to the surface. Geoscience majors also study topics such as:

- Rivers/beaches
- Volcanoes
- Glaciers
- Earthquakes/plate tectonics
- Global Climate Change
- Soils/sediments

Each of these paths is tailored for helping the student reach their desired career goals, and our geoscience faculty advisers will assist the student in making the most of their degree. Each of these concentrations is described below:

- **Geology:** (<https://www.tarleton.edu/degrees/bachelors/bs-geoscience/documents/geoscience-geology.pdf>) Majors concentrate on the standard geological sciences, and most graduate and go to work in the oil field. Some will go on the graduate work in sedimentology, stratigraphy, paleontology, environmental science and seismic work, to name a few. Those who get their master's will often work for major oil companies, but could go on to teach and work other field oriented jobs, depending on their concentration.
- **Environmental Science:** (<https://www.tarleton.edu/degrees/bachelors/bs-geoscience/documents/geoscience-environmental.pdf>) This degree combines chemistry, geology, and biological sciences. Most people who graduate with this degree will either go on to graduate studies or directly into the field working remediation and environmental assessment jobs.
- **Petroleum Geology:** (<https://www.tarleton.edu/degrees/bachelors/bs-geoscience/documents/geoscience-petroleum.pdf>) This degree is designed to aid those students going directly into petroleum work. Courses are much more intensive. Most majors will go on to do a master's degree, then work in the petroleum field.
- **Hydrogeology:** (<https://www.tarleton.edu/degrees/bachelors/bs-geoscience/documents/geoscience-hydrogeology.pdf>) Another highly intensive degree, this is intended for those who wish to work on our water resources. Majors will go on to work in waterways and groundwater assessment.
- **Earth Science:** (<https://www.tarleton.edu/degrees/bachelors/bs-geoscience/documents/geoscience-earthscience.pdf>) A very diverse route for those who want a rounded science experience or want to explore the different earth science fields. Many will go on to get alternative teacher certification from the state of Texas, or go on to graduate study in oceanography or meteorology.

### Accelerated Bachelor-to-Master of Science Concentration

Students in the BS/MS 5 YR concentration must apply for and be accepted into the MS program in order to complete this degree concentration. The application process will occur during year 3 of the BS program. Students in the BS/MS 5 YR concentration must maintain a 3.0 undergraduate cumulative GPA. Transfer students must complete a minimum of two full-time semesters and 24 hours at Tarleton State University. If students decide that they do not want to complete or are not accepted into the MS program, they can transition to the BS degree in Geosciences.

## The Bachelor of Science Degree in Geoscience

### Required Courses

General Education Requirements ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> ):		<b>42-43</b>
CHEM 1311 [shared]	College Chemistry I (Lecture)	
CHEM 1111 [shared]	College Chemistry I (Laboratory)	
CHEM 1312 [shared]	College Chemistry II (Lecture)	
CHEM 1111 [shared]	College Chemistry I (Laboratory)	
GEOL 1403	Physical Geology	4
GEOL 1100 [shared]	Transitioning to University Studies in Geosciences	
<b>Total Hours</b>		<b>46</b>

**Additional Required Courses for Concentrations****Earth Science**

BIOL 1406	Biology for Science Majors	4
BIOL 1407	Biology for Science Majors II	4
GEOL 1404	Historical Geology	4
GEOL 1407	Introduction to Environmental Science	4
GEOL 3400	Crystallography and Mineralogy	4
GEOL 3310	Geomorphology	3
GEOL 4305 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Field Geology	3
EASC 2451	Introduction to Geographic Information Systems	4
EASC 3320	Astronomy	3
EASC 3330	Meteorology	3
EASC 3340	Oceanography	3
EASC 4313 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Environmental Techniques	3
MATH 1314 [shared] or MATH 2412	College Algebra Precalculus Math	
Choose three of the following:		9-11
GEOL 3406	Igneous and Metamorphic Petrology	
GEOL 3405	Paleontology	
GEOL 3413	Stratigraphy and Sedimentology	
GEOL 3412 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Structural Geology	
GEOL 3314	Geochemistry	
GEOL 3320	Hydrogeology	
GEOL 4311	Economic Geology	
GEOL 4312	Petroleum and Subsurface Geology	
Select two of the following:		7-8
MATH 1316	Plane Trigonometry	
MATH 2413	Calculus I	
MATH 2414	Calculus II	
MATH 3450	Principles of Bio-Statistics	
Advanced Electives		16
<b>Total Hours</b>		<b>74</b>

**Environmental Science**

SOIL 3301 & SOIL 3101	Soil Science and Soil Science Laboratory	4
ENVS 3302 or SOIL 3412	Soils, Land Use, and The Environment Soil Genesis, Morphology, and Classification	3-4
Select two of the following:		8
CHEM 2323 & CHEM 2123	Organic Chemistry I and Organic Chemistry I Laboratory	
CHEM 3407	Quantitative Analysis	
CHEM 4408	Instrumental Analysis	
CHEM 4477	Environmental Chemistry	
GEOL 1407	Introduction to Environmental Science	4
GEOL 3400	Crystallography and Mineralogy	4
GEOL 3314	Geochemistry	3
GEOL 4305 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Field Geology	3
GEOL 3310	Geomorphology	3
Select three of the following:		9-10
GEOL 3413	Stratigraphy and Sedimentology	
EASC 3330	Meteorology	
GEOL 3320	Hydrogeology	
EASC 3340	Oceanography	
EASC 2451	Introduction to Geographic Information Systems	4
EASC 3350	Environmental Science	3
EASC 4313 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Environmental Techniques	3
MATH 3450	Principles of Bio-Statistics	4
Select two of the following:		7-8
MATH 1316 or MATH 2412	Plane Trigonometry Precalculus Math	
MATH 2413	Calculus I	
MATH 2414	Calculus II	

BIOL 1406	Biology for Science Majors	4
BIOL 1407	Biology for Science Majors II	4
BIOL 4401	Ecology	4
<b>Total Hours</b>		<b>74-75</b>

### Geology

Select one of the following:		8
BIOL 1406 & BIOL 1407	Biology for Science Majors and Biology for Science Majors II	
PHYS 1401 & PHYS 1402	College Physics I and College Physics II	
PHYS 2425 & PHYS 2426	University Physics I and University Physics II	
Electives (12 Hours Advanced GEOS or EASC)		15
GEOL 1404	Historical Geology	4
GEOL 3400	Crystallography and Mineralogy	4
GEOL 3406	Igneous and Metamorphic Petrology	4
GEOL 3405	Paleontology	4
GEOL 3413	Stratigraphy and Sedimentology	4
GEOL 3412 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Structural Geology	4
GEOL 4305 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Field Geology	3
EASC 2451	Introduction to Geographic Information Systems	4
EASC 4313 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Environmental Techniques	3
Select three of the following:		9
GEOL 3310	Geomorphology	
GEOL 3314	Geochemistry	
GEOL 3320	Hydrogeology	
GEOL 4311	Economic Geology	
GEOL 4312	Petroleum and Subsurface Geology	
Select two of the following:		8
MATH 2412	Precalculus Math	
MATH 2413	Calculus I	
MATH 2414	Calculus II	
MATH 3450	Principles of Bio-Statistics	
<b>Total Hours</b>		<b>74</b>

### Hydrogeology

Select two of the following:		8
CHEM 2323 & CHEM 2123	Organic Chemistry I and Organic Chemistry I Laboratory	
CHEM 3407	Quantitative Analysis	
CHEM 4408	Instrumental Analysis	
CHEM 4477	Environmental Chemistry	
GEOL 1407	Introduction to Environmental Science	4
EASC 2451	Introduction to Geographic Information Systems	4
EASC 3350	Environmental Science	3
SOIL 3301 & SOIL 3101	Soil Science and Soil Science Laboratory	4
EASC 4313 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Environmental Techniques	3
GEOL 3400	Crystallography and Mineralogy	4
GEOL 3406	Igneous and Metamorphic Petrology	4
GEOL 3310	Geomorphology	3
GEOL 3413	Stratigraphy and Sedimentology	4
GEOL 3314	Geochemistry	3
GEOL 3320	Hydrogeology	3
GEOL 4305 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Field Geology	3
PHYS 1401 or PHYS 2425	College Physics I University Physics I	4
PHYS 1402 or PHYS 2426	College Physics II University Physics II	4
MATH 3450	Principles of Bio-Statistics	4
MATH 2412 [shared]	Precalculus Math	
MATH 2413	Calculus I	4
MATH 2414	Calculus II	4

Advanced GEOS or EASC Electives		4
<b>Total Hours</b>		<b>74</b>
<b>Petroleum Geology</b>		
<b>Placement for Calculus 1 is by the CLMPE placement exam, or by college credit for MATH 1316 or MATH 2412. Contact Tarleton's Center for Academic Testing for test information and locations.</b>		
EASC 2451	Introduction to Geographic Information Systems	4
GEOL 1404	Historical Geology	4
GEOL 3400	Crystallography and Mineralogy	4
GEOL 3405	Paleontology	4
GEOL 3412 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Structural Geology	4
GEOL 3314	Geochemistry	3
GEOL 3406	Igneous and Metamorphic Petrology	4
GEOL 3413	Stratigraphy and Sedimentology	4
GEOL 4316	Well Log Analysis	3
GEOL 4305 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Field Geology	3
GEOL 4311	Economic Geology	3
GEOL 4312	Petroleum and Subsurface Geology	3
GEOL 4317	Seismic Interpretation	3
PHYS 1401 or PHYS 2425	College Physics I University Physics I	4
PHYS 1402 or PHYS 2426	College Physics II University Physics II	4
MATH 1342	Elementary Statistical Methods	3
MATH 2413 [shared]	Calculus I	
MATH 2414	Calculus II	4
GEOL 4600	Field Camp	6
Advanced GEOL or EASC Electives		7
<b>Total Hours</b>		<b>74</b>
<b>Accelerated Bachelor-to-Master of Science Degree in Geoscience</b>		
<b>Placement for Calculus 1 is by the CLMPE placement exam, or by college credit for MATH 1316 or MATH 2412. Contact Tarleton's Center for Academic Testing for test information and locations.</b>		
<b>Select one of the following:</b>		<b>8</b>
PHYS 1401 & PHYS 1402	College Physics I and College Physics II	
PHYS 2425 & PHYS 2426	University Physics I and University Physics II	
GEOL 1403	Physical Geology	4
GEOL 1404	Historical Geology	4
GEOL 3400	Crystallography and Mineralogy	4
GEOL 3405	Paleontology	4
GEOL 3406	Igneous and Metamorphic Petrology	4
GEOL 3412 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Structural Geology	4
GEOL 4305 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Field Geology	3
EASC 2451	Introduction to Geographic Information Systems	4
EASC 4313 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )]	Environmental Techniques	3
<b>Select Three of the following:</b>		<b>9</b>
GEOL 3310	Geomorphology	
GEOL 3314	Geochemistry	
GEOL 3320	Hydrogeology	
GEOL 4311	Economic Geology	
GEOL 4312	Petroleum and Subsurface Geology	
GEOL 4315	Sedimentary Petrology	
GEOL 4316	Well Log Analysis	
GEOL 4317	Seismic Interpretation	
GEOL 4320	Paleoecology	
MATH 2413	Calculus I	4
MATH 2414	Calculus II	4
GEOL 4600	Field Camp	6
Advanced GEOS or EASC Electives		9
<b>Total Hours</b>		<b>74</b>

## Physics

Physics is the science that investigates and tries to understand the basic laws of nature. In this pursuit, it deals with the entire range of natural phenomena from the smallest domain of sub-nuclear particles to the largest domain of distant objects in the universe. This breadth of interests is reflected in the type of work pursued by physicists. Some are interested in research on problems that are at the frontiers of knowledge. Some apply this newly acquired knowledge to make practical advances in fields like engineering. Still others use the knowledge of physics as a basis for careers in medicine, law, teaching or administration. The Tarleton physics program is one of the best equipped undergraduate programs in Texas with state-of-the-art undergraduate research facilities including a 32" robotic telescope and 1 MV tandem particle accelerator. The physics program provides several different tracks including medical physics for students interested in medicine, dentistry, or medical physics and an astronomy track so that students can tailor the program to meet their educational goals. By adding two or three additional courses with a support area of mathematics or computer science, a student in the classical can obtain a second bachelors degree in their support area. For students interested in teaching at the high school level, secondary (grades 8-12) certification in either Physical Science or Math/Physics is available. Through Tarleton's membership in the Texas Electronic Coalition for Physics and students may take upper-level elective physics courses from professors across the Texas A&M System. Through Tarleton's membership in the Nuclear Power Institute students may take nuclear engineering courses from Texas A&M's nuclear engineering department to prepare the student for entry into nuclear engineering graduate program.

### Joint B.S. Degree in Physics

#### Field of Study Courses

Field of Study 18 hrs (at least 6 hrs Advanced)	18
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#### Other Required Courses

General Education Requirements ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )	43
PHYS 2425 [shared] University Physics I	
PHYS 2426 [shared] University Physics II	
PHYS 3331 Mechanics I	3
PHYS 3332 Electromagnetic Field Theory	3
PHYS 3333 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )] Thermodynamics	3
PHYS 3334 Modern Physics I	3
PHYS 4330 Mathematical Methods for Physicists and Engineers	3
PHYS 4335 Quantum Physics	3
PHYS 4337 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )] Nuclear Physics and Techniques	3
PHYS 4340 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )] Advanced Physics Laboratory	3
PHYS 4161 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )] Physics Research Project	1
PHYS 4162 [WI ( <a href="http://catalog.tarleton.edu/academicaffairs/">http://catalog.tarleton.edu/academicaffairs/</a> )] Physics Research Seminar	1
MATH 2413 [shared] Calculus I	
MATH 2414 Calculus II	4
MATH 3433 Calculus III	4
MATH 3306 Differential Equations	3
Advanced Physics Electives - 6 hrs	6
COSC Elective - 3 hrs	3
Electives 13 hours	13

### Academic Advising Guides

Academic Advising Guides area available at the following website:

<https://web.tarleton.edu/majorinfo/>

### Professors

- Dr. Stephen Field
- Dr. Arthur Low
- Dr. Daniel Marble
- Dr. Jimmy McCoy
- Dr. Linda Schultz

### Associate professors

- Dr. Peter Bell
- Dr. Shaukat Goderya
- Dr. Michael Hibbs
- Dr. Rajani Srinivasan
- Dr. Lance Whaley

### Assistant professors

- Dr. Bernat Martinez-Ortega
- Dr. Ryan Morgan
- Dr. Catherine Ronck
- Dr. Christopher Saxon

## Instructors

- Mrs. Joree Burnett
- Mr. Rex Gamble
- Dr. Bimal Pandey
- Mrs. Geetha Sundarrajan

## Chemistry Courses

### CHEM 1111. College Chemistry I (Laboratory). 1 Credit Hour (Lecture: 0 Hours, Lab: 3 Hours).

Basic laboratory experiments supporting theoretical principles presented in CHEM 1311; introduction of the scientific method, experimental design, data collection and analysis, and preparation of laboratory reports. Prerequisite: MATH 1314; Corequisite: CHEM 1311 Lab fee: \$2.

### CHEM 1112. College Chemistry II (Laboratory). 1 Credit Hour (Lecture: 0 Hours, Lab: 3 Hours).

Basic laboratory experiments supporting theoretical principles presented in CHEM 1312; introduction of the scientific method, experimental design, chemical instrumentation, data collection and analysis, and preparation of laboratory reports. Prerequisite: MATH 1314; CHEM 1111 or 1411; Coreq with CHEM 1312 Lab fee: \$2.

### CHEM 1302. Essential Elements of Chemistry. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).

An introduction to the science of chemistry with a broad overview of the essential elements of chemistry and real-life applications. Enrollment in this course is restricted to Interdisciplinary Studies majors. Lab Fee \$2.

### CHEM 1311. College Chemistry I (Lecture). 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).

Fundamental principles of chemistry for majors in the sciences, health sciences, and engineering; topics include measurements, fundamental properties of matter, states of matter, chemical reactions, chemical stoichiometry, periodicity of elemental properties, atomic structure, chemical bonding, molecular structure, solutions, properties of gases, and an introduction to thermodynamics and descriptive chemistry. Prerequisite: MATH 1314.

### CHEM 1312. College Chemistry II (Lecture). 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).

Chemical equilibrium; phase diagrams and spectrometry; acid-base concepts; thermodynamics; kinetics; electrochemistry; nuclear chemistry; an introduction to organic chemistry and descriptive inorganic chemistry. Prerequisite: CHEM 1311 or CHEM 1411, MATH 1314.

### CHEM 1407. Fundamentals of Chemistry. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).

A beginning chemistry course for students in applied sciences who need only one semester of general chemistry. The course includes the structure, properties and changes in matter, quantitative relationships in reactions, solutions, equilibrium, pH, buffers and nuclear chemistry. Not recommended for science majors or pre-professional students in health related fields. Does not meet prerequisite for CHEM 1412 or 2423. Lab fee \$2.

### CHEM 1409. College Chemistry for Engineers. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).

Introduction to important concepts and principles of chemistry with an emphasis on areas considered most relevant in an engineering context. Registration will be restricted to engineering majors only. Engineering students may not receive credit for both CHEM 1409, CHEM 1311 and 1111, and CHEM 1411. Prerequisite: MATH 1314, or MATH 2412, or MATH 2413, or concurrent enrollment. Lab fee: \$2.

### CHEM 2123. Organic Chemistry I Laboratory. 1 Credit Hour (Lecture: 0 Hours, Lab: 4 Hours).

Laboratory portion associated with lecture CHEM 2323 Prerequisites: CHEM 1312 and 1112 or CHEM 1409(for Engineering Majors only) prerequisite or co-enrollment in CHEM 2323 Lab fee: \$2.

### CHEM 2125. Organic Chemistry II Laboratory. 1 Credit Hour (Lecture: 0 Hours, Lab: 4 Hours).

Laboratory portion associated with lecture CHEM 2325 Prerequisite: CHEM 2123; CHEM 2323; prerequisite or co-enrollment in CHEM 2325 Lab fee: \$2.

### CHEM 2323. Organic Chemistry I. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).

The first semester of a year sequence in the chemistry of carbon compounds involving their synthesis, reaction mechanisms, nomenclature, physical and spectral properties. Includes compounds of theoretical, biological, agricultural, and industrial importance. Prerequisites: CHEM 1312 and 1112 or CHEM 1409(for Engineering Majors only).

### CHEM 2325. Organic Chemistry II. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).

A continuation of CHEM 2323. The laboratory includes an introduction to qualitative organic analysis. This course is a prerequisite to all organic chemistry courses at the junior or higher level. Prerequisite: CHEM 2323 (2423).

### CHEM 2423. Organic Chemistry I. 4 Credit Hours (Lecture: 3 Hours, Lab: 4 Hours).

The first semester of a year sequence in the chemistry of carbon compounds involving their synthesis, reaction mechanisms, nomenclature, physical and spectral properties. Includes compounds of theoretical, biological, agricultural, and industrial importance. Prerequisites: CHEM 1312 and 1112 or CHEM 1409(for Engineering Majors only) Lab fee: \$2.

### CHEM 2425. Organic Chemistry II. 4 Credit Hours (Lecture: 3 Hours, Lab: 4 Hours).

A continuation of Organic Chemistry I (CHEM 2323 and CHEM 2123). The laboratory includes an introduction to qualitative organic analysis. This course is a prerequisite to all organic chemistry courses at the junior or higher level. Prerequisites: CHEM 2423 or both CHEM 2323 and CHEM 2123. Lab fee: \$2.

### CHEM 3124. Physical Chemistry II Laboratory. 1 Credit Hour (Lecture: 0 Hours, Lab: 3 Hours).

A laboratory introduction to the microscopic properties of nature, including an introduction to quantum mechanics and its applications to atomic and molecular spectroscopy. Prerequisite: CHEM 3423 Lab fee: \$2.

### CHEM 3314. Geochemistry. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).

A survey of the application of chemical principles to problems of geology. Topics include the origin and distribution of the elements in addition to exploring the behavior and distribution of various elements in igneous, metamorphic, and sedimentary rocks. Basic concepts of thermodynamics, solution chemistry, and isotope geochemistry will be discussed. Credit for both CHEM 3314 and GEOL 3314 will not be awarded. Prerequisites: CHEM 1312 and 1112. Lab fee: \$2.

### CHEM 3324. Physical Chemistry II. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).

An introduction to the microscopic properties of nature, including an introduction to quantum mechanics and its applications to atomic and molecular spectroscopy. Prerequisite: CHEM 3423.

### CHEM 3407. Quantitative Analysis. 4 Credit Hours (Lecture: 2 Hours, Lab: 6 Hours).

A study of the experimental and theoretical principles concerning gravimetric and volumetric analysis. Topics include data treatment, equilibrium, precipitation, neutralization, oxidation, reduction, potentiometry, and introduction to spectroscopy. Prerequisites: A grade of C or better in 8 hours of freshman CHEM; junior classification or approval of department head. Lab fee \$10.

### CHEM 3423. Physical Chemistry I. 4 Credit Hours (Lecture: 3 Hours, Lab: 4 Hours). [WI (<http://catalog.tarleton.edu/academicaffairs/>)]

A study of chemical thermodynamics and its application to chemical equilibrium; the macroscopic properties of matter including real gases, solutions, and phase changes; chemical kinetics. Prerequisites: MATH 2414; PHYS 1402 or 2426 or approval of department head. Lab fee \$10.

### CHEM 4086. Chemistry Problems: Undergraduate Research. 1-4 Credit Hours (Lecture: 0 Hours, Lab: 1-4 Hours).

Conducting an undergraduate research project in Chemistry. May be repeated for credit. A maximum of four hours may be applied toward degree requirements in chemistry. Prerequisite: Approval of department head.

**CHEM 4160. Professional Lab Safety Techniques and Ethics in Chemistry. 1 Credit Hour (Lecture: 1 Hour, Lab: 1 Hour).**

A capstone course intended for a chemistry major to take during their senior year. Lectures will cover the issues of ethics and lab safety in chemistry as well as the societal impacts of chemistry. The lab portion will be devoted to analyzing case studies, doing literature research, and giving professional style presentations. Prerequisite: Student must be within one year of graduation.

**CHEM 4327. Structural Organic Analysis. 3 Credit Hours (Lecture: 1 Hour, Lab: 6 Hours).**

The identification of the principal classes of organic compounds. Prerequisites: CHEM 2425 or both CHEM 2325 and CHEM 2125. Lab fee: \$2.

**CHEM 4328. Inorganic Chemistry. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Discussion of the models of inorganic chemistry including atomic structure, chemical bonding, periodic properties, stereochemistry, reaction mechanisms, and coordination chemistry. Properties of specific elements and families are also presented. Prerequisites: CHEM 2425 or both CHEM 2325 and CHEM 2125, and junior classification or approval of department head.

**CHEM 4329. Polymers. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

A basic study of polymer chemistry, with special emphasis on the effect of the structure of monomers upon the structure of the polymers, is presented. Prerequisites: CHEM 2425 or both CHEM 2325 and CHEM 2125.

**CHEM 4345. Medicinal Chemistry. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

An examination of the principles of drug action including receptor-effector theories and the effects of physico-chemical properties on biological activity. The principles of drug design, synthesis, and metabolism will be presented. Prerequisites: CHEM 2425 or CHEM 2325 and CHEM 2125, and BIOL 1407.

**CHEM 4374. Biochemistry I. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

An introduction to the basic principles of biological chemistry and to fundamental processes of plants, animals, and microorganisms. Credit for both BIOL 4374 and CHEM 4374 will not be awarded. Prerequisites: One semester of organic chemistry (2 semesters recommended), and 8 hours of biological science or approval of department head.

**CHEM 4375. Biochemistry II. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

A detailed survey of intermediary metabolism. The metabolism of carbohydrates, lipids, proteins and nucleic acids, and the regulation of metabolism are emphasized. Credit for both BIOL 4375 and CHEM 4375 will not be awarded. Prerequisites: BIOL/CHEM 4374, or approval of department head.

**CHEM 4378. Biochemistry Lab. 3 Credit Hours (Lecture: 1 Hour, Lab: 6 Hours).**

Principles and applications of basic methodology for the isolation, purification, characterization, and quantitative determination of biologically important compounds. Credit for both BIOL 4378 and CHEM 4378 will not be awarded. Prerequisite: BIOL 4374 or CHEM 4374 or concurrent enrollment, or approval of the department head. Lab fee \$15.

**CHEM 4408. Instrumental Analysis. 4 Credit Hours (Lecture: 2 Hours, Lab: 6 Hours).**

A study of the theory and use of instruments for chemical analysis. Techniques include absorption spectroscopy, nuclear magnetic resonance, atomic absorption, flame emission, mass spectroscopy, chromatography, potentiometry, and polarography. Prerequisites: CHEM 3407 and 1 semester of organic chemistry or approval of department head. Lab fee \$10.

**CHEM 4477. Environmental Chemistry. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

This is an undergraduate course intended for any student who has completed College chemistry 1 and college chemistry II with an interest towards Environmental Science. This course includes both lecture and laboratory components. Lectures will cover topics which provide the understanding of interactions between chemical compounds whether anthropogenic or natural with the ecosystem. This course will provide qualitative and quantitative knowledge on effects of changes in water, soil, air and its effects on the environment. The lab portion includes bench scale and field scale experiments to put theory to practice. Water and soil samples will be collected from different sources and lab made samples will be used to detect and analyze the various types of pollutants and their mitigation methods will be discussed. Prerequisites: CHEM 1312 and 1112. Lab fee: \$2.

## Chemistry, Geoscience & Physics Courses

**CHGP 1100. Transitioning to University Studies in Chemistry, Geoscience & Physics. 1 Credit Hour (Lecture: 1 Hour, Lab: 1 Hour).**

Practical study designed to prepare the student for university life, aid in the development of skills for academic success, promote personal growth and responsibility, and encourage active involvement in the learning process from an individual college perspective.

## Earth Science Courses

**EASC 2310. Earth Systems Science. 3 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

Introduction to the nature and evolution of the Earth, hydrosphere, atmosphere and Solar System. Prerequisite: Enrollment in this course is restricted to Interdisciplinary Studies majors. Lab fee: \$2.

**EASC 2451. Introduction to Geographic Information Systems. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

This is a cross-listed course with GEOG 2451 Intro to GIS. Basic concepts of design, planning and implementation of geographic information systems. Students will learn how to create, manipulate, project, and interpret geographic information. Students are encouraged to take GEOG 1451: Pre-GIS before this course. Lab fee: \$2.

**EASC 3310. Geographic Information Systems for the Sciences. 3 Credit Hours (Lecture: 1 Hour, Lab: 5 Hours).**

Applications of geographic information systems in the geological, environmental, earth, and other sciences. Laboratory exercises will apply GIS programs to geological and environmental problems. Lab fee: \$2.

**EASC 3320. Astronomy. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

A study of astronomical instrumentation and methodologies, a survey of the solar system, star evolution, cosmology and the origins of the universe, and a review of galactic types and histories. Theory reinforced by field experience. Prerequisites: GEOL 1403 and 1404 or approval of department head. Lab fee \$5.

**EASC 3330. Meteorology. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

A study of the Earth's atmosphere and the basic principles of weather analysis, climate and climatic controls, with emphasis on climatic effects on man. Theory reinforced by practical field experience. Prerequisites: GEOL 1403 or approval of department head. Lab fee \$5.

**EASC 3340. Oceanography. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

A study of our oceans from the physical, chemical, biological, and geological aspects. Theory reinforced by practical field experience. Prerequisites: GEOL 1403, 1404, junior classification or approval of department head. Lab fee \$5.

**EASC 3350. Environmental Science. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Integration of existing knowledge of geological, hydrological, and environmental processes associated with environmental management and land-use planning issues; including discussions of surface and subsurface water quality and quantity, soil erosion, solid and liquid waste disposal and flooding. Case studies involving environmental impact analysis. Prerequisites: GEOL 1403, 1407; CHEM 1311 and 1111, or approval of department head.

**EASC 3360. Remote Sensing. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

An introduction to the features and interpretation of remotely sensed images from airborne and satellite platforms. Formats of imagery will include radar, thermal, and multispectral. Focus on interpretation of images for various usages, including agriculture, forestry, geology, urban landscapes, and geography. Prerequisite: Junior classification. Lab fee: \$2.

**EASC 3370. Biogeography. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

Geographical distribution of plants and animals. Explores the concepts of evolutionary change, allopatric and sympatric speciation, vicariance and dispersal and how these processes affect species distributions through time. Covers the effects of topography, physical, and climatic factors which affect species distributions. Combines data and discoveries from a variety of fields, including biology, paleontology, ecology, evolution, and geology. Lab fee: \$2.

**EASC 4086. Problems. 1-3 Credit Hours (Lecture: 0 Hours, Lab: 1-3 Hours).**

A course open to capable Earth Science and Geology students. Topics may vary according to student need. May be repeated for credit, subject to the approval of the department head. Prerequisite: Approval of department head.

**EASC 4313. Environmental Techniques. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours). [WI (<http://catalog.tarleton.edu/academicaffairs/>)]**

A survey of techniques used in environmental investigations focusing on sampling and geochemical methods important to the environmental industry. Topics to be covered may include topographic surveying, geochemical sampling in surface waters and groundwater, soil sampling and site characterization. Prerequisites: GEOL 1403, and MATH 1316, MATH 2412, or MATH 2413 or approval of department head. Lab fee \$2.

**EASC 4384. Earth Science Internship. 3 Credit Hours (Lecture: 1 Hour, Lab: 8 Hours).**

Pre-approved and supervised work experience in an environmental or earth science position in industry or the public sector. Prerequisite: Junior classification and approval of department head. Field experience fee \$50.

**Environmental Science Courses****ENVS 1100. Transitioning to University Studies and Environmental Science. 1 Credit Hour (Lecture: 1 Hour, Lab: 1 Hour).**

Practical study designed to prepare the student for university life, aid in the development of skills for academic success, promote personal growth and responsibility, and encourage active involvement in the learning process from an individual college perspective.

**ENVS 1301. Society, Natural Resources, and the Environment. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

This course provides a broad overview of the role of the environment and natural resources in human society, with particular emphasis on Texas and the United States. A history of the environmental movement is presented. Students study the importance of natural resources in providing basic human necessities, and how these resources are managed. Various careers in environmental science, natural resource management, and wildlife conservation are also discussed.

**ENVS 1302. Science, Technology, and the Environment. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

This course introduces students to the interdisciplinary field of environmental science and explores the interrelationships between science, technology, environment, and society. This class examines the scientific and social origins of environmental problems and evaluates the complex role of technology in creating and resolving these concerns.

**ENVS 2451. Introduction to Geographic Information Systems. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

This is a cross-listed course with GEOG 2451 Intro to GIS. Basic concepts of design, planning and implementation of geographic information systems. Students will learn how to create, manipulate, project, and interpret geographic information. Students are encouraged to take GEOG 1451: Pre-GIS before this course. Lab fee: \$2.

**ENVS 3302. Soils, Land Use, and The Environment. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Interactions among soil physical, chemical, and biological processes affecting soil, water, and environmental quality. Addressed in relation to land use management practices such as erosion control, soil conservation, soil reclamation, riparian buffers, bioswales, and artificial wetlands. Land use planning tools, including WebSoil Survey and GIS will be used. Prerequisites: WSES/ENVS 3401; or WSES/SOIL 3301 and WSES/SOIL 3101.

**ENVS 3305. GIS for Natural Resource Scientists. 3 Credit Hours (Lecture: 2 Hours, Lab: 2 Hours).**

An intermediate course on the use of geographic information systems (GIS) in natural resource management. Builds on concepts learned in introductory GIS course. Laboratory exercises will apply knowledge learned in lectures to solve real world problems in natural resource management using GIS software. Prerequisite: WSES 2451.

**ENVS 3307. Systems Thinking. 3 Credit Hours (Lecture: 2 Hours, Lab: 2 Hours).**

This course focuses on the examination and analysis of complex systems, particularly in the environmental, natural resources, and sustainability fields. Major topics will include system structure, system behavior, feedback loops, stock and flow models, non-linear and emergent properties, self-organization, and the application of systems thinking to problem-solving. A significant component of the course will be development and analysis of computer models of complex systems. Prerequisite: C or better in MATH 1314 or equivalent, or approval of the instructor.

**ENVS 3315. Sustainability. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Explore the varied perspectives of sustainability and analyze factors that contribute to or decrease system sustainability. Investigation of the social, economic, and environmental barriers to achieving sustainable systems and options for overcoming these barriers. Credit will be awarded only for POLS 3315, ENVS 3315, or WSES 3315. Prerequisite: GOVT 2305 or GOVT 2306 or POLS 2304 or approval of the instructor.

**ENVS 3323. Ethical Issues in Agriculture and the Natural Resources. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Students will examine the several major ethical issues facing agriculture and natural resources sciences in our current society. Readings, discussions and lectures will focus on the scientific, capitalistic, and philosophical motivation in common ethical issues. Upon completion of the course, students will be able to construct and dissect ethical arguments and hopefully become more aware of the ethical dilemmas we all face each day. Can receive credit for WSES 3323, ENVS 3323 or ANSC 3323.

**ENVS 3375. Population, Pollution, and Resource Depletion. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Principles and philosophies associated with the development, management, and use of natural resources are studied in the relationship to the ecological and social implications inherent in management alternatives involving the natural environmental and the use of renewable natural resources. Can receive credit for either ENVS 3375 or WSES 3375. Prerequisite: Junior classification.

**ENVS 4084. Environmental Science Internship. 1-6 Credit Hours (Lecture: 1-6 Hours, Lab: 0 Hours).**

Formally arranged and approved on-the-job training with a cooperating sponsor in government or private sector of the environmental field. A minimum of 40 hours of training is required for each hour of academic credit. A maximum of six hours of credit may be earned. Oral and written reports of the experience are required. Prerequisite: Junior or Senior classification and approval of the instructor.

**ENVS 4086. Environmental Problems. 1-3 Credit Hours (Lecture: 1-3 Hours, Lab: 0 Hours).**

Independent study or research of current topics in student's major. Content and credit dependant on depth of study. May be repeated for credit subject to approval of program lead or department head as appropriate.

**ENVS 4088. Undergraduate Research. 1-6 Credit Hours (Lecture: 1-6 Hours, Lab: 0 Hours).**

Fundamental research methods will be addressed through a faculty-directed project. Participation in an abbreviated lecture series may be required. Project components may include a literature review, data collection and analysis, testing, planning, project design, and/or computer modeling. The student may be required to prepare a final report and produce a presentation. Prerequisites: approval of the instructor. Prerequisite: Approval of the instructor.

**ENVS 4090. Special Topics. 1-6 Credit Hours (Lecture: 0-6 Hours, Lab: 0 Hours).**

Selected topics in environmental science. May be repeated for credit when topics vary.

**ENVS 4185. Seminar. 1 Credit Hour (Lecture: 1 Hour, Lab: 0 Hours).**

A review of current problems and developments in environmental arena. Discussions of current literature and research. May be repeated once for credit.

**ENVS 4187. Environmental Science Capstone. 1 Credit Hour (Lecture: 1 Hour, Lab: 0 Hours).**

Integrate and use fundamental concepts learned in previous environmental science courses to research and analyze real-world environmental issues. Oral and written reports on experiential learning, supplemented by appropriate internet and multimedia materials.

**ENVS 4340. Environmental Science Field Study. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

A field course involving visits to environmental science businesses, agencies, and organizations including TCEQ, watershed management organizations, river authorities, energy companies, and environmental advocacy organizations to learn about their work and engage in hands-on assessment activities. Requires an extended field trip at student's expense. Prerequisite: Grade of C or better in either WSES 2405 or BIOL 4401.

**ENVS 4350. Energy and the Environment. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Overview of the relationship between domestic energy supply and its environmental impacts. This class investigates international environmental affairs' impact on the United States' domestic energy sources. Prerequisite: Communication Core Component Area complete.

**ENVS 4380. Environmental Science Capstone. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Integrate and use fundamental concepts learned in previous environmental science courses to research and analyze real-world environmental issues. Oral and written reports on experiential learning, supplemented by appropriate internet and multimedia materials. Prerequisite: Senior Classification.

**ENVS 4390. Special Topics. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).****Geology Courses****GEOL 1100. Transitioning to University Studies in Geosciences. 1 Credit Hour (Lecture: 1 Hour, Lab: 1 Hour).**

An introduction to geosciences, including earth science, environmental science, geology, hydrogeology, and petroleum geology. Practical study designed to prepare the geoscience student for university life, aid in the development of skills for academic success, promote personal growth and responsibility, and encourage active involvement in the learning process.

**GEOL 1403. Physical Geology. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

An introduction to the physical processes that operate in and on the planet Earth. Topics of discussion include: the Earth's structure, rocks and minerals, volcanoes, earthquakes, groundwater, rivers, glaciers, and deserts. Lab fee: \$2.

**GEOL 1404. Historical Geology. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

History of the Earth from the formation of the solar system to the present. Topics include the Earth's development, evolution of life on Earth, changes in the Earth's geography throughout its history, and the tools geologists use to investigate these topics. Lab fee \$10.

**GEOL 1407. Introduction to Environmental Science. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

Introduction to the study of the environment. The course will examine air, water, and soil pollution, and pollution remediation. Energy, mineral resources, and land use will be studied. The course will also emphasize a study of the water supply, water use, and water management. Much of the laboratory will focus on land use planning and environmental pollution remediation. Lab fee: \$2.

**GEOL 1408. Natural Disasters. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

Course focuses on the causes, effects, and mitigation of natural disasters around the world. Topics covered will include: plate tectonics, earthquakes, volcanoes, tsunamis, landslides, meteor impacts, climate change, and major weather events such as tornadoes, floods, and hurricanes. Emphasis will be on methods used by scientists to monitor and study these natural phenomena, as well as the economic and societal impact of and response to the events. Lab fee: \$2.

**GEOL 3310. Geomorphology. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

Study of surface processes in geological environments with emphasis on environmental and engineering applications. Topics include weathering, soil formation and erosion, landslides, and landforms associated with rivers, groundwater, coasts, arid and semi-arid climates. Laboratory emphasizes aerial photo and topographic map interpretation. Prerequisites: GEOL 1403. Lab fee \$10.

**GEOL 3314. Geochemistry. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

A survey of the application of chemical principles to problems of geology. Topics include the origin and distribution of the elements and exploration of the behavior and distribution of various elements in igneous, metamorphic, and sedimentary rocks. Basic concepts of thermodynamics, solution chemistry, and isotope geochemistry will be discussed. Credit for both GEOL 3314 and CHEM 3314 will not be awarded. Prerequisites: CHEM 1312 and 1112. Lab fee: \$2.

**GEOL 3320. Hydrogeology. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

Aquifer characteristics, physical principles of groundwater flow, well analysis, geologic controls on local and regional groundwater movement, water chemistry, groundwater pollution, legal issues in groundwater. Prerequisites: GEOL 1403, CHEM 1312 and 1112, and either MATH 1316, or MATH 2412, or MATH 2413, or approval of department head. Lab fee: \$2.

**GEOL 3400. Crystallography and Mineralogy. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

A study of the basic crystallographic forms, some of the common ore and rock forming minerals. An introduction to Optical Mineralogy. Prerequisite: GEOL 1403. Lab fee \$2.

**GEOL 3405. Paleontology. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

An introduction to the study of fossils. A survey of the systematics, evolution and paleoecology of microfossils and important macrofossil groups. Prerequisite: GEOL 1403, GEOL 1404 Lab fee: \$2.

**GEOL 3406. Igneous and Metamorphic Petrology. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

An introduction to the origin, characteristics, and associations of igneous and metamorphic rocks. Introduction to igneous phase diagrams and metamorphic phase equilibria. Prerequisites: CHEM 1311 and 1111, 1312 and 1112, GEOL 1403, MATH 1314 or higher.

**GEOL 3412. Structural Geology. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours). [WI (<http://catalog.tarleton.edu/academicaffairs/>)]**

A study of the forces and processes resulting in the deformation of and structural features of units in the Earth's crust. Lab work includes solution of problems by descriptive geometry, geologic and topographic maps and cross-sections. Prerequisites: GEOL 1403 and GEOL 1404 Lab fee: \$2.

**GEOL 3413. Stratigraphy and Sedimentology. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

A study of the origin, transportation, and deposition of sediments and the formation of sedimentary rocks. Emphasis on the study of strata and depositional systems and the utilization of sedimentology and stratigraphy in economic geology, environmental geology, hydrogeology and petroleum geology. Prerequisite: GEOL 1403 Lab fee: \$2.

**GEOL 4086. Problems. 1-3 Credit Hours (Lecture: 0 Hours, Lab: 1-3 Hours).**

A course open to capable Geology and Earth Science students. Topics may vary according to student need. May be repeated for credit, subject to the approval of the department head. Prerequisite: Junior classification and approval of department head.

**GEOL 4305. Field Geology. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours). [WI (<http://catalog.tarleton.edu/academicaffairs/>)]**

An introduction to the identification and interpretation of rocks and geological structures in the field. Field and laboratory activities include rock identification and interpretation, surveying with plane table and alidade, measuring and describing geological sections and field mapping with brunton compass, air photos, and topographic maps. Prerequisite: GEOL 1403, and 6 hrs upper level GEOL. Lab fee \$2.

**GEOL 4311. Economic Geology. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

An introduction to the origin, classification, uses, and economics of metallic and nonmetallic mineral deposits. Lab will introduce reflected light microscopy, alteration petrology and simulate a complete mineral deposit exploration program. Prerequisite: GEOL 3406 or concurrent enrollment. Lab fee \$10.

**GEOL 4312. Petroleum and Subsurface Geology. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

Origin and distribution of petroleum. Geochemistry and maturation of organic matter; microbiological and thermal degradation of hydrocarbons, conventional and unconventional petroleum systems; principles of primary and secondary migration; seals; hydrocarbon traps, diagenesis of carbonate and clastic reservoir rocks; use of subsurface geologic data to prepare maps and identify prospects. Prerequisite: GEOL 3312, 3413. Lab fee: \$2.

**GEOL 4315. Sedimentary Petrology. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

Introduction to the physical, chemical, and biologic properties of sedimentary rocks, as revealed by petrographic microscopy, geochemical techniques, and field study. Emphasis is placed on the mineralogy, chemistry, textures, and sedimentary structures that characterize sedimentary rocks, and the relation of these features to their depositional origin and subsequent diagenesis. Prerequisites: GEOL 1403 and GEOL 3413 Lab fee: \$2.

**GEOL 4316. Well Log Analysis. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

Petrophysics and modern well-logging methods. Theory and applications of measurements of physical properties of the formation near the well bore, types of well logging tools, interpretation and use of well log information in petroleum exploration and development Prerequisite: GEOL 3413 Lab fee: \$2.

**GEOL 4317. Seismic Interpretation. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

Examination of seismic interpretation methods with emphasis on the petroleum industry. Topics include basic reflection theory, seismic acquisition and processing (prestack and poststack), incorporation of well data, picking and mapping horizons, structural interpretation, seismic stratigraphy, advanced seismic interpretation techniques, Direct Hydrocarbon Indicator (DHI), and depth conversion. Hands-on interpretation using standard industry software. Prerequisite: GEOL 3312, GEOL 3413. Lab fee: \$2.

**GEOL 4318. Plate Tectonics. 3 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

Plate Tectonics is the unifying theory in modern geology. This course will examine the driving mechanisms of crustal deformation, geophysical and geologic data supporting sea-floor spreading and plate motions, and major type of plate boundaries. We will explore implications of plate tectonics, continental drift, and mountain building, the role of plate tectonic cycle in renewal of Earth's surface, and relation with other geochemical cycles. Readings from original papers. Prerequisite: GEOL 1403, GEOL 3413, Geol 3312 Lab fee: \$2.

**GEOL 4320. Paleocology. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

The ecology of ancient life. The course will focus on defining and identifying community structures through time, exploring the rise and fall of communities and the changing populations within them. Emphasis will be on field and hand-sample identification of community affinities based on sediments and life habit. Prerequisite: GEOL 1404, GEOL 3405, GEOL 3413 Lab fee: \$2.

**GEOL 4600. Field Camp. 6 Credit Hours (Lecture: 0 Hours, Lab: 12 Hours).**

Field course practicing field application of geological techniques. Locations visited and material covered vary by year and host institution. Methods practiced include: field mapping, data collection, measurement of sections, and geologic reporting. Prerequisite: Vary by institution. Lab fee: \$2.

**Physics Courses****PHYS 1302. Essential Elements of Physics. 3 Credit Hours (Lecture: 2 Hours, Lab: 3 Hours).**

This course introduces fundamental physics and astronomy concepts to students planning to become elementary and middle school teachers. Students are expected to design and conduct inquiry based experiments including the development of hypothesis, collection and analysis of data, and the use of appropriate laboratory equipment. Topics include motion, forces, energy, waves, light, electricity, magnetism, stellar and planetary evolution, and the atom. Enrollment in this course is restricted to Interdisciplinary Studies majors. Prerequisite: MATH 1314. Lab fee: \$2.

**PHYS 1401. College Physics I. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

An introduction to mechanics, heat, and wave motion. This course is a trigonometry-based physics course. A student cannot get credit for PHYS 1401 if credit has been previously received for PHYS 2425. Prerequisite: MATH 1316, MATH 2412, MATH 2413 or concurrent enrollment. Lab fee: \$2.

**PHYS 1402. College Physics II. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

An introduction to electricity and magnetism, light, and modern physics. This is a trigonometry-based physics course. Prerequisite: PHYS 1401. A student cannot get credit for PHYS 1402 if credit has previously been received for PHYS 2426. Lab fee: \$2.

**PHYS 1403. Stars and Galaxies. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

A laboratory science course of study in topics of astronomy and astrophysics, including the sun and its source of energy, stellar formation and evolution, black holes, galaxies, cosmology, and the creation and evolution of the universe. Prerequisite: two semesters of high school algebra or MATH 0304. Lab fee: \$2.

**PHYS 1410. Great Ideas of Physics. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

Great Ideas of Physics is a laboratory science course designed to introduce the student to the concepts of physics in an elementary mathematical setting, and to discuss their significance to science, technology, and society. Topics will be drawn from both classical and contemporary physics. Prerequisite: Two semesters of high school algebra or MATH 0304. This course cannot be used for credit toward a degree in physics or mathematics. Lab fee: \$2.

**PHYS 1411. Introductory Astronomy I. 4 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

A laboratory science course of study in the topics of astronomy and astrophysics, including the history of astronomy, Kepler's laws, gravitation, formation of the solar system, asteroids, comets, meteors, a detailed survey of the planets and their evolution, and discussion on the possibility of extraterrestrial life in the universe. Prerequisite: Two semesters of high school algebra or MATH 0304. Lab fee: \$2.

**PHYS 2425. University Physics I. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

This is an introduction to mechanics, heat, and wave motion. This is a calculus-based physics course. Prerequisite: MATH 2413 or concurrent registration. Lab fee: \$2.

**PHYS 2426. University Physics II. 4 Credit Hours (Lecture: 3 Hours, Lab: 3 Hours).**

This is an introduction to electricity, magnetism, optics, and modern physics. Prerequisites: PHYS 2425 and MATH 2414 or concurrent registration. Lab fee: \$2.

**PHYS 3331. Mechanics I. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Particle dynamics in one, two, and three dimensions; conservation laws; dynamics of a system of particles; motion of rigid bodies; central force problems. Prerequisites: PHYS 2426; MATH 3306 and MATH 3433 or concurrent registrations.

**PHYS 3332. Electromagnetic Field Theory. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Electrostatics; Laplace's equation; the theory of dielectrics; magnetostatic fields; electromagnetic induction; magnetic fields of currents; Maxwell's equations. Credit for both ELEN 3332 and PHYS 3332 will not be awarded. Prerequisites: PHYS 2426, MATH 3306 and MATH 3433, or concurrent registrations.

**PHYS 3333. Thermodynamics. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours). [WI (<http://catalog.tarleton.edu/academicaffairs/>)]**

Concept of temperature, equations of state; the first and the second law of thermodynamics; entropy; change of phase; the thermodynamics functions. Prerequisites: PHYS 2426 (Prerequisite); MATH 3433 (Co-requisite).

**PHYS 3334. Modern Physics I. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Foundations of the atomic theory of matter; kinetic theory; elementary particles; radiations; atomic model; atomic structure; atomic spectra and energy levels; quantum theory of radiation; x-rays; special theory of relativity. Prerequisites: PHYS 2426 (Prerequisite); MATH 3433 or MATH 3306 (Corequisite).

**PHYS 3350. Medical Physics I. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

The course will provide an introduction to the physics of human physiological processes as well as the physics used in the design of medical diagnostic tools and techniques. Prerequisite: PHYS 2426 or consent of the instructor.

**PHYS 4086. Special Problems. 1-6 Credit Hours (Lecture: 0 Hours, Lab: 1-3 Hours).**

This course is designed to develop the theoretical or experimental capabilities, or both, of individual senior physics majors. Prerequisites: Senior classification and approval of department head.

**PHYS 4161. Physics Research Project. 1 Credit Hour (Lecture: 1 Hour, Lab: 2 Hours). [WI (<http://catalog.tarleton.edu/academicaffairs/>)]**

Literature survey and preparation for, and initiation of, a research project agreed to between the student and a faculty advisor, to be completed and reported on in the Research Seminar course. Prerequisites: PHYS 3334.

**PHYS 4162. Physics Research Seminar. 1 Credit Hour (Lecture: 1 Hour, Lab: 0 Hours).** [WI (<http://catalog.tarleton.edu/academicaffairs/>)]

An experimental or theoretical project will be continued by the student and the results reported in a seminar. Students who have not yet taken the ETS Physics field test are required to do so while enrolled in Seminar. Prerequisites: PHYS 4161.

**PHYS 4303. Astronomy and Astrophysics. 3 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

A laboratory science course of study in the topics of astronomy and astrophysics, including Planetary Astronomy, Stellar Astrophysics, Galactic Astronomy, Cosmology and Astrobiology. Prerequisites: MATH 2413, PHYS 2425. Lab fee \$8.

**PHYS 4330. Mathematical Methods for Physicists and Engineers. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Mathematical techniques from the following areas: infinite series; integral transforming; applications of complex variables; vectors, matrices, and tensors; special functions; partial differential equations; Green's functions; perturbation theory; integral equations; calculus of variations; and groups and group representatives. Credit for both ENPH 4330 and PHYS 4330 will not be awarded. Prerequisite: MATH 3306, 3433.

**PHYS 4332. Optics. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

Huygen's principle applied to geometric optics; interference; diffraction; polarization; crystal optics; electromagnetic theory of light; interaction of light with matter. Prerequisites: PHYS 2442 and MATH 3306.

**PHYS 4334. Modern Physics II. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

The constitution of the atomic nucleus; natural radioactivity; artificially induced nuclear transmutations; alpha, beta, and gamma decay; nuclear reactions; nuclear structure and nuclear forces; nuclear fission; neutron physics. Prerequisites: PHYS 3334 and MATH 3306 or concurrent registration.

**PHYS 4335. Quantum Physics. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

The Schrodinger equation; one dimensional systems; the Heisenberg uncertainty principle; magnetic moments and angular momentum; two and three dimensional systems; approximation methods; scattering theory. Prerequisite: PHYS 3334 (Prerequisite); MATH 3306 or MATH 3433 (Co-requisite).

**PHYS 4336. Solid State Physics. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).**

The basic ideas of physics are applied to the understanding of the properties of crystalline materials to include the definition of such materials, electrical and thermal conductivity, heat capacity, crystalline binding, the nature of metals, insulators, and semiconductors, dielectric properties, and magnetic properties. Credit for both ELEN 4336 and PHYS 4336 will not be awarded. Prerequisite: PHYS 3334; MATH 3306 or concurrent registration.

**PHYS 4337. Nuclear Physics and Techniques. 3 Credit Hours (Lecture: 3 Hours, Lab: 0 Hours).** [WI (<http://catalog.tarleton.edu/academicaffairs/>)]

The study of nuclear phenomena and properties including mass, stability, magnetic moment, radioactive decay processes and angular momentum. The use of nuclear techniques to analyze problems in other fields of engineering with a special emphasis on the characterization of electronic materials. Prerequisite Course: PHYS 3334.

**PHYS 4340. Advanced Physics Laboratory. 3 Credit Hours (Lecture: 1 Hour, Lab: 4 Hours).** [WI (<http://catalog.tarleton.edu/academicaffairs/>)]

A laboratory course focusing on advanced techniques and experiments drawn from the full range of physics classes. The student will understand the role of experimental design, advanced data analysis and reduction, error analysis, and the use of computers while investigating physical phenomena. Prerequisites: Corequisite: PHYS 3334. Lab fee: \$30.

**PHYS 4350. Medical Physics II. 3 Credit Hours (Lecture: 3 Hours, Lab: 2 Hours).**

The course covers the physics of ionizing radiation and its application in areas of medical physics, radiation safety, and manufacturing. Prerequisite: PHYS 3334 or consent of instructor. Lab fee \$8.

**PHYS 440. Advanced Physics Laboratory. 3 Credit Hours (Lecture: 1 Hour, Lab: 4 Hours).**

A laboratory course focusing on advanced techniques and experiments drawn from the full range of physics classes. The student will understand the role of experimental design, advanced data analysis and reduction, error analysis, and the use of computers while investigating physical phenomena. Co-requisite: PHYS 334.