Shepherd University

WV-HEPC Title 133, Series 11-6: New Program Proposal

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Shepherd University

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Table of Contents

6.1. Summary ............................................................................................................................5

6.2. Program Description ........................................................................................................5
6.2.a. Program Objectives ........................................................................................................5
6.2.b. Program Identification ...................................................................................................8
6.2.c. Program Features ..........................................................................................................8
6.2.c.1. Admissions and Performance Standards .................................................................10
6.2.c.2. Program Requirements ..............................................................................................11
6.2.d. Program Outcomes ........................................................................................................11
6.2.e. Program Content ...........................................................................................................12
6.2.e.1. Content and Length of Program ................................................................................12
6.2.e.2. General Education Component .................................................................................12
6.2.e.3. Minimum General Education Requirement ..............................................................15

6.3. Program Need and Justification ........................................................................................15
6.3.a. Relationship to Institutional Goals/Objectives ...............................................................15
6.3.b. Existing Programs ...........................................................................................................17
6.3.c. Program Planning and Development ............................................................................18
6.3.d. Clientele and Need .........................................................................................................18
6.3.e. Employment Opportunities ...........................................................................................19
6.3.f. Program Impact ...............................................................................................................21
6.3.g. Cooperative Arrangements ............................................................................................22
6.3.h. Alternatives to Program Development .........................................................................22

6.4. Program Implementation and Projected Resource Requirements ...................................22
6.4.a. Program Administration ................................................................................................22
6.4.b. Program Projections .....................................................................................................22
   Form 1: Five-year projection of Program Size ......................................................................23
6.4.c. Faculty Instructional Requirements ..............................................................................24
6.4.d. Library Resources and Instructional Methods ...............................................................24
6.4.e. Support Service Requirements .....................................................................................26
6.4.f. Facilities Requirements ................................................................................................26
6.4.g. Operating Resource Requirements (Form 2) .................................................................27
6.4.h. Source of Operating Resources ...................................................................................29
6.5. Program Evaluation

6.5.a. Evaluation Procedures

6.5.b. Accreditation Status

APPENDICES:

Appendix A: Catalog Course Descriptions: Systems Engineering Concentration

Appendix B: Catalog Course Descriptions: Environmental Engineering Concentration

Appendix C: Course Syllabi

CHEM 207-General Chemistry
CHEM 207L-General Chemistry Lab I
CHEM 209-General Chemistry II
CHEM 209-General Chemistry Lab II
CHEM 333-Environmental Chemistry
CIS 287-Systems Analysis and Design
CIS 390- Operating Systems
CIS/CIT 418-Management Information Systems
CIS/CIT 310-Information Security
CIS 321-Data and File Storage
CPE 482-Real Time and Embedded System Design
CIS 211-Computer Language Concepts
CIS/CIT 388- Database Management Systems
CPE/ENGR 224/225-Electrical Circuits and Lab
CPE/ENGR 305-Digital Logic Design and Lab
CPE/ENGR 433-Microprocessor System Design and Lab
CPE 489-Engineering Capstone Project I
CPE 490-Engineering Capstone Project II
CPE/CIS 386-Computer Organization
CPE/ENGR 221,222-Intro. Electrical Engineering and Lab
CPE 234-Introduction to Networking
CPE/ENGR /MATH 490-Engineering Capstone Project II
DATA 418-Big Data Analytics
CIS/ENGR/MATH 100-Freshman Seminar
ENGR 243-Engineering Mechanics of Materials
ENGR 300-Introduction to Robotics
MATH 310/ENGR 242-Applied Fluid Mechanics
ENGR 326-Linear Systems (Digital Signal Processing)
ENGR 101-Introduction to Engineering ................................................................. 222
ENGR 102-Computer Engineering ................................................................. 228
CPE 221/ENGR 221-Introduction to Electrical Engineering ......................... 232
ENGR 241-Engineering Mechanics ............................................................. 237
ENGR 242-Engineering Mechanics Dynamics ............................................. 243
ENGR 301-Engineering Thermodynamics .................................................... 249
ENVS 201-Foundations in Environmental Science I ..................................... 255
ENVS 201L-Foundations in Environmental Science I Laboratory ................ 261
ENVS 202-Foundations in Environmental Science II .................................... 265
ENVS 202L-Foundations in Environmental Science II Laboratory ............ 272
ENVS 341-Sustainable Energy and Lab ....................................................... 278
ENVS 441-Hydrology and Lab ................................................................. 283
ENVS 390 -Geographic Information Systems and Lab ................................ 289
MATH 207-Calculus I .................................................................................. 293
MATH 208-Calculus II ............................................................................. 296
MATH 254-Discrete Mathematics .............................................................. 297
MATH 309-Calculus III ............................................................................ 298
MATH 310-Differential Equations ............................................................. 299
MATH 321-Probability and Statistics .......................................................... 301
MATH 307-Linear Algebra ......................................................................... 303
MATH 314-Statistics ................................................................................ 307
MATH 329-Mathematical Modeling ............................................................ 313
MATH 354-Operations Research ............................................................... 315
PHYS 221-General Physics I ................................................................. 319
PHYS 221L-General Physics I Laboratory ............................................... 327
PHYS 222-General Physics II ................................................................. 335
PHYS 301-Physics of Energy ................................................................. 342

Appendix D: Faculty vitae ............................................................................. 349
Summary
Shepherd University is submitting a new program proposal (WV-HEPC Series 11) for a Bachelor of Science, Engineering Science (B.S., ES). The proposed, 120-credit comprehensive major is interdisciplinary in nature, and, is designed to provide students with exposure to rudimentary and advanced knowledge in engineering and the applied sciences. These highly desired areas include: applied mathematics, electronics, thermodynamics, linear systems, hydrodynamics, as well as computer engineering and computer sciences topics. The intent-to-plan proposal was approved by the Shepherd University Board of Governors on September 27, 2016 and by the Chancellor on October 19, 2016. Following approval of the implementation plan by the West Virginia Higher Education Policy Commission (WV-HEPC), the University would be poised to begin offering this comprehensive major in fall 2017.

6.2. Program Description
As stated in 6.2.a. under “educational objectives,” the proposed Engineering Science major is a 120-credit hour program designed to provide students with mastery in subjects that form the rudiments of engineering and the applied sciences. Please refer to this section for a more detailed description of the program. The program features two concentrations: Systems Engineering and Environmental Engineering. In addition to the required 42 credits of core curriculum courses, of which each concentration has some prescribed coursework, students in these concentrations take courses in mathematics, engineering, environmental science, computer information systems, and data analytics.

6.2.a. Program Objectives
The proposed Engineering Science major is a 120-credit hour program designed to provide students with mastery in subjects that form the rudiments of engineering and the applied sciences. This interdisciplinary degree program includes subject areas in applied mathematics including differential equations linear algebra, operations research, math modeling and numerical analysis. An integral part of the program includes core topics in engineering and physics: digital and analog electronics, thermodynamics, linear systems, electromagnetic fields, statics and dynamics, all of which are built on advanced mathematical concepts. The proposed comprehensive undergraduate major also encompasses computer engineering and computer sciences topics to provide students with the necessary knowledge and skills in embedded and control systems. These essential skills are highly desired and utilized in the field of robotics, both in hardware and software. Basic topics in management such as Economics and Principles of Management and courses in Computer Networking, as well as the liberal arts focus of Shepherd’s core curriculum are also included to provide a well-rounded experience for Shepherd’s undergraduate students.
High-impact educational practices identified by AAC& U (American Association of Colleges and Universities) are expected to play a prominent role in this program, specifically, entry-level and capstone courses, experiential learning, undergraduate research, and collaborative assignments. As with all courses at Shepherd, syllabi identify core competencies such as critical thinking, scientific inquiry, oral and written communication, life-long and integrative learning (See Appendix C-Course Syllabi).

These best practices include and will be augmented by the following:

- Lab experiences to expose students to connections between abstract concepts and real-world applications via design-oriented projects;
- In the capstone course, students are given an opportunity to specialize in a particular area in engineering and applied sciences. Faculty will mentor students on their projects, with the possibility of presentations/publications at professional conferences.
- With an emphasis on undergraduate research, we believe the proposed program in Engineering Science will serve as an excellent avenue for this high-impact practice.

The proposed Engineering Science program will have two concentrations, which are described in the following paragraphs:

**Environmental Engineering**

The environmental engineering concentration prepares students for careers in applying engineering technology to environmental issues and problems. The need for trained environmental engineers is clearly illustrated through the numerous employment opportunities available for individuals trained in this field, in industry or at state and federal agencies, and with environmental consulting firms. According to https://collegegrad.com/, prospects for employment should be favorable due to anticipated population growth, as well as a wave of retirements in that field. Moreover, the introduction of this program will serve to fulfill the recent call to attention by various civic and private groups like the Chamber of Commerce to increase the number of highly skilled workers in the Eastern Panhandle of West Virginia and the quad-state region.

There has been a great emphasis in recent years by state and local governments regarding environmental assessment, planning and design--in particular, concerns about water safety and its resource management. This has led to efforts to increase the efficiency of water use and monitoring its quality, demonstrating an example of the need for environmental engineers. Current and future employment growth is projected to be in professional, scientific, and technical services, as municipalities draw on the expertise of environmental engineers to address these issues. The result is that job growth in this area is expected to increase more than 10% over the next decade.
The program curriculum provides students with skills to achieve success in this challenging field that includes project and research based sequence of courses enhancing the degree program. Instructional emphasis also prepares students with the knowledge and high-level skills necessary for graduate study in environmental engineering.

*Systems Engineering*

Systems engineering prepares students, through an interdisciplinary approach, to have a working understanding of the technical aspects in engineering process and design. Systems engineering is a key component in systems implementation and management, as well as enabling the realization of successful engineering and technical systems. Improving business strategies of integrated systems requires a solid foundation of knowledge and skills in engineering, mathematics, computer modeling and networking, and operation research. According to the U. S. Department of Labor in the *Occupational Outlook Handbook, 2016-17 Edition*, employment of systems administrators is projected to grow around the average rate for all occupations from 2014-2021. Demand for information technology workers continues to be high and is expected to continue to increase as companies invest in newer, faster networks. Those students who complete a degree in systems analyst or systems engineering would enter a field where the job outlook is projected to grow more quickly than the average, at over 21% during the same period.

As West Virginia strives to diversify its economy, the need for qualified employees in these disciplines represents a potential area of employment growth for the state. The U.S. Department of Labor notes in its demographic data that West Virginia ranks below the median rate in the number of engineers for the location.

The B. S. in Engineering Science is intended to be a 120-credit comprehensive major with clearly defined program objectives:

- Provide students with an exposure to Engineering and Applied sciences through its curriculum, building a strong foundation in Mathematics and Engineering, along with an emphasis on applications of these disciplines.
- Prepare students for industrial jobs either in manufacturing or research through research-oriented projects during the Senior Capstone.
- Reveal to students the connections and interactions between concepts in Computer Science, Mathematics, Engineering, Environmental Science, Business and Management.
- Prepare students with a comprehensive background in Engineering and Applied Sciences, giving students the flexibility to be trained for current and future industrial careers.
• Prepare students for graduate school by providing opportunities for undergraduate research and the presentation of their research results at professional conferences.
• Develop students’ abilities to apply mathematics, science and engineering knowledge.
• Apply systems design, conduct experiments, analyze and interpret data.
• Utilize the techniques, skills, and modern engineering tools necessary for engineering practice.
• Identify, formulate, and solve real-world engineering problems.
• Promote an ability to engage in life-long learning.

6.2.b. Program Identification
The Engineering Science program is identified as Engineering Science as defined in CIP (Classification of Instructional Programs) developed and published by the U.S. Department of Education Center for Education Statistics’ code 14.1301 as follows:

“Engineering Science. A program with a general focuses on the general application of various combinations of mathematical and scientific principles to the analysis and evaluation of engineering problems, including applied research in human behavior, statistics, biology, chemistry, the earth and planetary sciences, atmospherics and meteorology, and computer applications.”

6.2.c. Program Features
The Bachelor of Science in Engineering Science at Shepherd University is proposed as a comprehensive, multidisciplinary and interdisciplinary baccalaureate program utilizing courses in Computer Information Systems (CIS), Computer Information Technology (CIT), Computer Engineering (CPE), Engineering (ENGR), Environmental Studies (ENVS), Mathematics (MATH) and Physics (PHYS). The program includes Core Curriculum requirements (with some courses specific to the program), environmental and physical science requirements, mathematics and engineering requirements and for the systems engineering concentration, computer science requirements. Students may also choose from a menu or elective courses in the systems engineering concentration.

The program requirements are summarized in the curriculum overview below; the full curriculum is provided in section 6.2.c.2 of this implementation plan, with catalog descriptions in Appendix A (systems Engineering Concentration), Appendix B (Environmental Engineering concentration) and course syllabi in Appendix C.

The proposed comprehensive major in Engineering Science requires a minimum of 120 credits, of which 42 credits must be earned in courses above the sophomore level. Students in this
major will take fundamental as well as specialized courses in mathematics and engineering. In the first two years, the focus will be on building a strong foundation in those disciplines, along with the core curriculum courses required of all students. This is followed by specialized courses in mathematics and engineering in the junior and senior year. The proposed degree program will culminate with a capstone project in the senior year, which includes individual efforts along the guidelines of undergraduate research mentored by faculty members. The resulting outcome is expected to be a publication and/or presentation at a professional conference.

To graduate with a B.S. degree in Engineering Science, a cumulative GPA of 2.5 and a minimum grade of “C” in all core and elective courses are required.

**Curriculum for Engineering Science – Environmental Engineering Concentration**

Total hours required (including technical electives) ........................................................................................................120 hours
Core Curriculum Requirements.............................................................................................................................................42 hours
Specific Core Curriculum Requirements (included in the 42 hours of core curriculum)..........................16 Hours
  • ENGR 100 Freshman Seminar (1)
  • ECON 205 Principle of Macroeconomics (3)
  • MATH 207 Calculus I (4)
  • ENVS 201 Foundations of Environmental Science I (3)
  • ENVS 201L Foundations of Environmental Science I-LAB (1)
  • ENVS 202 Foundations of Environmental Science II (3)
  • ENVS 202L Foundations of Environmental Science II-LAB (1)

Environmental and Physical Science Requirements........................................................................................................36 hours
Mathematics and Engineering Requirements..................................................................................................................42 hours

**Curriculum for Engineering Science – Systems Engineering Concentration**

Total hours required (including technical electives) ........................................................................................................120 hours
Core Curriculum Requirements.............................................................................................................................................42 hours
Specific Core Curriculum Requirements (included in the 42 hours of core curriculum)..........................22 Hours
  • ENGR 100 Freshman Seminar (1)
  • ECON 205 Principle of Macroeconomics (3)
  • ECON 207 Principle of Microeconomics (3)
  • MATH 207 Calculus I (4)
  • PHYS 221 General Physics I (3)
  • PHYS 221L General Physics I Laboratory (1)
  • PHYS 222 General Physics II (3)
  • PHYS 222L General Physics II Laboratory (1)
  • CHEM 207 General Chemistry (3)
Mathematics Requirements..................................................................................................................................................30 hours
Engineering Requirements........................................................................................................................................20 hours
CIS Requirements..........................................................................................................................................................21 hours
Elective Courses...........................................................................................................................................................7 hours

6.2.c.1. Admissions and Performance Standards
The B.S. in Engineering Science program will adhere to the admissions standards as outlined in the Shepherd University Board of Governors’ policy 7. Initial admission to the university follows the standard admissions requirements detailed here:
http://catalog.shepherd.edu/content.php?catoid=9&navoid=1114

Admissions standards and procedures are outlined for international students at:
http://www.shepherd.edu/admissions/international-students

General Freshman Admission: A student applying for general freshman admission may submit an application any time after the completion of six semesters of high school.
Required documents:
• Official secondary school records documenting completion of the minimum high school academic unit requirements.
• Results of the American College Test (ACT) or the Scholastic Aptitude Test (SAT), including the writing portion.
• Required Grade Averages and Test Scores.
  - Minimum 2.0 academic grade point average (on a 4-point scale).
  - Minimum composite ACT score of 19 and/or SAT score of 910. (Writing portion is required.)
  *Applicants who graduated from high school more than five years prior to the time of application for admissions do not need ACT or SAT scores unless specified.
• Required Units: (Years) 4 English (including courses in grammar, composition, and literature). 3 social studies (including U.S. history). 3 mathematics (algebra I, and at least 2 higher units). 3 science (2 of 3 units must be laboratory science. At least 2 units from coordinated and thematic science 10, biology, chemistry, physics and other courses with a strong laboratory science orientation). It is strongly recommended, but not required, that the student complete a minimum of two consecutive units of a foreign language.
• Elective Units: It is recommended that the remaining elective units be chosen from the academic core (English/language arts, mathematics, science, social studies) or subjects such as computer science, fine arts, humanities, and keyboarding.
Specific requirements for the Engineering Science program:
In addition to the general requirements for admission to Shepherd University, potential students must also meet the following specific requirements for admission into the Engineering Science program:

1. Have a cumulative high school GPA of 3.00 or better.
2. Have grades of “B” or better in the following high school courses: Chemistry, Physics, Algebra I and II, Plane Geometry and Trigonometry.
3. Have completed four years of English.
4. Have minimum Mathematical scores of 24 on ACT or 510 on SAT.

Students not meeting the requirements listed above may be admitted to the program after satisfactory completion of similar college-level courses.

6.2.c.2. Program Requirements
The proposed comprehensive major in Engineering Science requires a minimum of 120 credits, among which 42 credits must be earned in upper division courses, designated at the 300 or 400 level. Students in this major will take fundamental as well as specialized courses in Mathematics and Engineering. In the first two years, the focus will be on building a solid foundation on Mathematics, Engineering and general studies followed by specialized courses in Mathematics and Engineering in the junior and senior. The proposed degree program will culminate with a Senior Capstone project in the final year. The Senior Capstone will be an individual project that conforms to departmental guidelines for faculty-mentored undergraduate research and will be expected to result in a publication and/or presentation at a professional conference.

To graduate with a B.S. degree in Engineering Science, an overall GPA of 2.5 and a minimum grade of “C” in all program core and elective courses are required.

6.2.d. Program Outcomes
The B. S. in Engineering Science is intended to be a 120-credit comprehensive major with clearly defined program outcomes:

- Graduates will be well rounded, with exposure to courses in both mathematics and engineering, coupled with their application to Engineering Sciences and infused with a strong liberal arts core.
- Graduates of the program will possess critical thinking skills and will be problem solvers in their respective careers as engineers and/or applied scientists.
• Through their experience in research projects, graduates will possess the knowledge and skills that will prepare them for success in graduate school.
• Students will possess sound theoretical backgrounds and practice in the relevant applications and practices that arise in engineering and applied sciences.

6.2.e  Program Content
The proposed program is consistent with the Shepherd University mission and vision statements, core values, as well as the university’s strategic plan and institutional compact. Details are provided in section 6.3.a.

6.2.e.1. Program Content and Length
The proposed comprehensive major in Engineering Science requires a minimum of 120 credits, among which 42 credits must be earned in upper division courses, designated at the 300 or 400 level. Students in this major will take fundamental as well as specialized courses in Mathematics and Engineering. In the first two years, the focus will be on building a solid foundation on Mathematics, Engineering and general studies followed by specialized courses in Mathematics and Engineering in the junior and senior. The proposed degree program will culminate with a Senior Capstone project in the final year. The Senior Capstone will be an individual project that conforms to departmental guidelines for faculty-mentored undergraduate research and will be expected to result in a publication and/or presentation at a professional conference.

As noted in 6.2.e.2, there are specific requirements for each concentration in relation to the core curriculum or general studies requirements.

To graduate with a B.S. degree in Engineering Science, an overall GPA of 2.5 and a minimum grade of “C” in all core and elective courses are required. The expectation is that a student will enroll in 15 credits per semester and complete the program in eight semesters.

6.2.e.2. General Education Content
Background to Shepherd’s current common core curriculum program: In December 2011, Shepherd University approved a new core curriculum framework based on program goals and intended student outcomes from LEAP (Liberal Education and America’s Promise), developed by the Association of American Colleges and Universities (AAC&U). The framework of courses may be found here: http://www.shepherd.edu/core-curriculum/core-curriculum-checklists

The following four goals constitute the framework of Shepherd University’s core curriculum:
**Goal No. 1: Knowledge of Human Cultures and the Physical and Natural World**

a) Acquire knowledge in the sciences and mathematics, social sciences, humanities, histories, languages, and the arts through progressively more challenging problems, projects, and standards for performance

b) Engage in both contemporary and enduring questions

**Goal No. 2: Intellectual and Practical Skills throughout the Curriculum**

a) Engage in inquiry and analysis

b) Demonstrate abilities in critical and creative thinking

c) Effectively communicate, in both oral and written English

d) Acquire quantitative and information literacy

e) Demonstrate a capacity for collaboration/teamwork and problem solving

f) Integrate the foundations and the skills for lifelong learning and wellness

**Goal No. 3: Personal and Social Responsibility**

a) Develop civic knowledge and civic engagement

b) Develop global understanding and respect for cultures and societies outside of the United States

c) Demonstrate understanding of multiculturalism and sensitivity to issues of diversity

d) Practice professional ethics and ethical reasoning

**Goal No. 4: Integrative Learning**

a) Demonstrate a synthesis of, and advanced accomplishment across, general and specialized studies through a capstone experience in the chosen discipline.

**The Basic Framework (At a Glance)**

This section lists the various parts of the Core Curriculum framework and their credits. Core competencies from the Goals and ISOs document have been underlined.

**The First Tier (Initial Inquiry) – 21 credits.** Students may take first-tier courses at any time, but are strongly encouraged to take them in the first two years of their college career. First-tier courses should generally not have prerequisites, except as necessary given the student’s previous academic background or because of course sequencing.
WRITTEN ENGLISH – 6 credits
MATHEMATICS – 3 credits.
WRITTEN ENGLISH – 6 credits.
MATHEMATICS – 3 credits.
FIRST-YEAR EXPERIENCE – Minimum of 1 credit (may be in the major)

The Second Tier (Expressions of Knowledge) – 21 credits. Students are expected to take second-tier courses in the first three years, and these courses may have prerequisites.
ARTS – 3 credits.
HUMANITIES – 6 credits.
SOCIAL SCIENCES – 9 credits.
WELLNESS – 3 credits.
WRITING IN THE MAJOR – 3 credits. (This major course does not count toward the 21 credits of the Second Tier or the 42-credit minimum.)

The Third Tier (Integrative Learning) Students must have senior standing to take this course.
CAPSTONE IN THE MAJOR – 1 to 12 credits. (This course in the major does not count toward the 42-credit minimum.)

The B.S. in Engineering Science also specifies the following specific core curriculum requirements for each of the two concentrations:

Curriculum for Engineering Science – Environmental Engineering Concentration
Core Curriculum
Requirements........................................................................................................................................42 hours
Specific Core Curriculum Requirements (included in the 42 hours of core curriculum)....16 Hours
• ENGR 100 Freshman Seminar (1)
• ECON 205 Principle of Macroeconomics (3)
• MATH 207 Calculus I (4)
• ENVS 201 Foundations of Environmental Science I (3)
• ENVS 201L Foundations of Environmental Science I-LAB (1)
• ENVS 202 Foundations of Environmental Science II (3)
• ENVS 202L Foundations of Environmental Science II-LAB (1)

Curriculum for Engineering Science – Systems Engineering Concentration
Core Curriculum Requirements......................................................................................................................42 hours
Specific Core Curriculum Requirements (included in the 42 hours of core curriculum)....22 Hours
• ENGR 100 Freshman Seminar (1)
• ECON 205 Principle of Macroeconomics (3)
• ECON 207 Principle of Microeconomics (3)
• MATH 207 Calculus I (4)
• PHYS 221 General Physics I (3)
• PHYS 221L General Physics I Laboratory (1)
• PHYS 222 General Physics II (3)
• PHYS 222L General Physics II Laboratory (1)
• CHEM 207 General Chemistry (3)

6.2.e.3. Minimum General Education Requirement
According to West Virginia state code and WV-HEPC policy, the minimum general education requirement for undergraduate programs is as follows:
• 15 credit hours for a technical associate’s degree
• 24 hours for transfer associate’s degree
• 30 hours for a bachelor’s degree

The Bachelor of Science in Engineering Science is a baccalaureate degree (comprehensive major) and must have at least 30 credit hours of general education to meet state code and regional accreditor requirements. The program meets this requirement by utilizing Shepherd University’s common core curriculum of 42 credit hours [Reference link: http://catalog.shepherd.edu/preview_program.php?catoid=10&poid=828]

6.3.a. Relationship to Institutional Goals and Objectives
“Shepherd University, a West Virginia public liberal arts university, is a diverse community of learners and a gateway to the world of opportunities and ideas. We are the regional center for academic, cultural, and economic opportunity. Our mission of service succeeds because we are dedicated to our core values: learning, engagement, integrity, accessibility, and community.”

The Engineering Science program will support the University mission as follows:
• **Fulfill our duty to serve the community:** Generate graduates with a well-rounded background in Engineering and Applied Sciences, thereby serving the workforce and the economy in West Virginia’s Eastern Panhandle and surrounding communities. There is a documented need for employees with a well-rounded exposure in Engineering and Applied Sciences.
• **Promote Core Values:** Because of the interdisciplinary nature of the program, students will have a diverse approach to their education, will be engaged through research, publishing and internship opportunities, and have access to this program enhanced by lower rates of tuition in West Virginia.

• **Enhance research and publishing capabilities:** Maintain resources and tools necessary to support research projects for faculty members and also involve undergraduate students. The results of this research will lead to publications in peer-reviewed journals and presentations at professional conferences. These professional scholarship outcomes also fulfill target metric areas in the WV-HEPC master plan for higher education, *Leading the Way.*

The Department of Computer Science, Mathematics and Engineering (CME) at Shepherd University currently offers an Industrial Mathematics Degree program that targets students with an aptitude towards research in Applied Mathematics and its connections to solving industrial problems. CME also offers degrees in both Computer Science and Computer Engineering. The proposed Engineering Science program will engage potential students who are more inclined towards Engineering, Sciences and the connections therein. This distinction is realized through the capstone course and/or co-op/internship opportunities where research projects will focus more on the application of intended student outcomes to solving problems that arise in the field of Engineering and Applied Sciences.

A degree in engineering science will also support Shepherd’s vision statement: “Shepherd – a premier liberal arts university. *We will be a nationally respected community of learners where passion, purpose, and experience unite to inspire individuals to shape the world.*”

The proposed degree in Engineering Science will serve the regional workforce by providing a broad-based liberal arts education, hands-on course work through group and individual laboratory projects, and various experiential, collaborative arrangements with government, business, and industry where students apply knowledge and skills in a real world environment. As the program grows, it will support ever-increasing numbers of research projects, faculty development opportunities, academic exchanges, and scholarly/creative presentations by both faculty and students.

**Special Features that Make the Institution a Desirable Place to Initiate a Program**

The location of Shepherd University is central to a variety of Federal agencies and private industries that require employees with critical thinking, data analysis, and advanced problem-solving skills that are associated with a background in Engineering Sciences.
These critical skills are associated with the strong foundation provided by the University’s core curriculum, as well as advanced, specialized programs of study in the Schools of Arts and Humanities, Business and Social Sciences, Education and Professional Studies, and Natural Sciences and Mathematics. This is a solid foundation on which to build an integrative, interdisciplinary program in the area of engineering science [Reference link: http://www.shepherd.edu/core-curriculum]

CME has integrated multiple disciplines to include faculty in the areas of Computer Science, Mathematics and Engineering, making it easier to coordinate course offerings. The department’s long history of emphasizing undergraduate research has resulted in numerous presentations and publications by students and faculty in existing programs as well as those with interdisciplinary features. We are confident students in the quad-state area with the desire and motivation to pursue engineering and/or mathematics, coupled with an aptitude towards research and making interdisciplinary connections, will benefit from Shepherd’s proposed program in Engineering Science.

6.3.b. Existing Programs

Currently there are no engineering science programs within a seventy-five mile radius of Shepherd University. Engineering Science is not a common program in major universities due to its interdisciplinary nature, and the lack of cohesiveness across the disciplines of computer science, mathematics and engineering. Because of our academic organization and structure, Shepherd University has a unique opportunity to provide a quality engineering program to potential students, as all three disciplines are housed in the same department (Reference link: http://www.shepherd.edu/cmeweb/).

Marshall University offers a B.S. in Engineering (BSE) housed in its College of Engineering and Information Technology. The BSE program at Marshall University has its focus on civil or mechanical engineering. As stated above, the three disciplines (Computer Science, Mathematics and Engineering) encountered in the Engineering Science degree program are not separate disciplines but are housed within a single department. Shepherd’s proposed Engineering Science degree program offers two concentrations: Systems Engineering and Environmental Engineering.

West Virginia University does offer a variety of engineering opportunities; however, it does not have a stand-alone environmental engineering program. Their engineering concentration is civil and environmental. Shepherd’s program would be the only stand-alone environmental engineering program in the state.
In the Washington-Baltimore area and beyond, there are a number of prestigious institutions that offer these concentrations at a much higher rate of tuition:

- Systems Engineering: Penn State University, Johns Hopkins University, Georgetown University, George Washington University, and George Mason University.
- Environmental Engineering: Johns Hopkins University, Morgan State University, University of Maryland, and Virginia Polytechnic Institute (VPI).

Shepherd’s unique location in the Eastern Panhandle offers an outstanding opportunity for not only students from West Virginia, but also from the quad-state region (MD, PA, VA, DC) to be a part of this proposed new degree program in Engineering Science, offered at an affordable rate of tuition [Reference Link: http://www.shepherd.edu/tuition-and-fees/].

6.3.c. Program Planning and Development
The CME program has taken deliberate and targeted steps to prepare for the future implementation of an undergraduate degree program in Engineering Science. The need for a four-year degree in Engineering Science has been an on-going discussion among Dean of the School of Natural Sciences and Mathematics, the chair of the Department of Computer and Information Sciences, Mathematics and Engineering departments and the departmental faculty for over 10 years. These discussions resulted in the creation of the Computer Science, Mathematics and Engineering department by merging the existing Mathematics, Engineering and Computer Information Science departments in 2005.

The merger was followed by recruitment of mathematics faculty with professional and academic qualifications in the areas of applied mathematics and engineering. The proposed Engineering Science program is part of an interdisciplinary field of study that draws upon courses from the curriculum in Mathematics, Engineering and Computer Information Sciences, Chemistry and, the Institute of Environmental and Physical Sciences. Faculty qualifications, research and scholarship outcomes are demonstrated in Appendix D-Faculty vitae

6.3.d. Clientele and Need
The proposed Engineering Science program provides opportunities to recruit and retain students who wish to remain at Shepherd University and pursue a career in Applied Sciences and Engineering. These students may desire to remain in the area due to financial, familial or other preferences such as local internships opportunities. This program would allow students to complete a degree in Engineering Science directly related to the workforce needs of the Eastern Panhandle. The program will also utilize existing faculty expertise in engineering and
the applied sciences across multiple disciplines in Shepherd’s School of Natural Sciences and Mathematics.

The applicant pools that will be specifically targeted by recruitment efforts for this program include, but are not limited to the following groups:

- Current Shepherd University students pursuing the engineering minor and core engineering requirements in the mathematics major would be the primary target population. Without this degree program, these students would need to transfer to other institutions to pursue a four-year degree in engineering. The proposed program would aid in retaining these students both at Shepherd and within the state.
- New students recruited to Shepherd University as mathematics majors with an interest in the engineering and applied sciences would also be a target audience. The program will be actively advertised to high schools to show prospective students that a variety of degree programs are available at Shepherd, which would allow them to remain in the region to complete the undergraduate degree.
- Students at local two-year institutions such as Hagerstown Community College and Blue Ridge Community and Technical College who wish to continue their studies to achieve a four-year degree also represent a potential pool of students. Working with the Office of Enrollment Management, faculty and administrators will develop articulation agreements (i.e., 2+2 programs) to coordinate curricula, allowing graduates of two-year institutions to easily transition into a four-year program at Shepherd.
- The Environmental Engineering concentration was eliminated in fall 2015 from the Institute of Environmental and Physical Sciences at Shepherd University. Currently there are over 20 students in that concentration (not reflected in enrollment projection-Form 1. Offering this degree program with a concentration in Environmental Engineering provides a relevant baccalaureate degree from their academic area of interest.

6.3.e. Employment Opportunities

Given the affordable tuition at Shepherd University, growth and expansion in the government and industrial sector in the quad-state area and the increasing student interest in the applied sciences and engineering, we anticipate a high demand for this program. As noted, Shepherd University is accessible to potential students both in the Eastern Panhandle of West Virginia and the surrounding region.

Shepherd University’s location is ideal for initiating an Engineering Science program. According to a recent study by the West Virginia Bureau of Business and Economic Research (Reference
link: [http://be.wvu.edu/bber/pdfs/BBER-2014-04.pdf](http://be.wvu.edu/bber/pdfs/BBER-2014-04.pdf), the counties surrounding Shepherd University (Jefferson and Berkeley) are expected to sustain continued growth in the future, continuing progress that has taken place over the last two decades. This has led to an increasing number of educational and employment opportunities for West Virginia residents. Many of these jobs are in the field of engineering and applied sciences, and there has been a strong demand for engineers, engineering management personnel, as well as for applied scientists in the area of manufacture and information technology. Employment opportunities remain strong for this discipline, with specializations like environmental and systems engineering having potential job rates higher than the national average for the next decade (Source: The U. S. Bureau of Labor Statistics, 2012).

The continued integration of computer technology in a variety of manufacturing settings will require current and future employees to have a strong foundation in the scientific and engineering principles behind the applications. The introduction and implementation of this program will fulfill the recent call by various civic and private groups like the Chamber of Commerce and Gateway New Economic Council to increase the number of highly-skilled workers in the Eastern Panhandle of West Virginia and the region Shepherd University serves.

According to the U. S. Department of Labor in the *Occupational Outlook Handbook, 2016-17 Edition*, employment of systems administrators is projected to grow 8% from 2014-2021. Demand for information technology workers is high and should continue to increase as companies invest in newer, faster networks. For those students who move towards the area of systems analyst or systems engineering, the job outlook is expected to grow at over 21% during the same period.

The need for trained environmental engineers is illustrated through the numerous employment opportunities available for individuals trained in this field, in industry or at state and federal agencies, and with environmental consulting firms. According to [https://collegegrad.com/](https://collegegrad.com/), prospects for employment should be favorable due to anticipated population growth, as well as a wave of retirements in that field with job growth in this area expected to increase 12% over the next decade.

Shepherd University has the third highest economic impact among West Virginia’s four- and two-year colleges according to a study commissioned by the West Virginia Higher Education Policy Commission. The study, titled “The Economic Impact of Public Institutions of Higher Education in West Virginia,” shows that Shepherd’s economic impact on Berkeley and Jefferson counties is $91.1 million. Part of this study, which was conducted by the West Virginia University Bureau of Business and Economic Research, examined the economic impact of direct
university expenditures like supplies and utilities, university payroll, and out-of-state student expenditures. The study showed that in fiscal year 2014, Shepherd had a total budget of $60.8 million and spent about $32.6 million on salaries and benefits for its 647 employees.

(Reference Link: http://wvutoday.wvu.edu/n/2016/08/04/west-virginia-s-public-higher-education-institutions-have-2-7-billion-impact-on-state)

6.3.f. Program Impact
The Engineering Science program will have minimal impact on the programs at Shepherd University outside of those in the School of Natural Sciences and Mathematics. Courses needed for the program currently exist in other degree programs and concentration areas, and several Economics and Management courses have been designated as required for the Systems Engineering concentration; however, they are currently part of Shepherd University’s Core Curriculum.

Current and future students in Mathematics and Computer Science could move to this degree option if it is perceived as better meeting their needs, academic background, and will provide enhanced job opportunities.

6.3.g. Cooperative Arrangements
Cooperative arrangements will be a major component in Shepherd’s Engineering Science program. Currently, the CME department places student interns in many facilities in the region such as the Coast Guard, Veterans Administration, KRM Associates Inc., Volvo Power Train, Mountain View Solar and the Internal Revenue Service. There is also an extensive network of cooperative arrangements with local business organizations. It is anticipated that the arrangements mentioned above will grow with time and supplement the Engineering Science program in terms of internship and job placement. Students will also have the opportunity to take CPE 492, Co-operative Work Arrangement in Computer Science and Engineering (See Appendix B for course descriptions). Information on co-operative education may be found here: http://www.shepherd.edu/cooperative-education
6.3.h. Alternatives to Program Development
As noted earlier in this document, the CME department has taken specific and targeted steps to prepare for an undergraduate graduate program in Engineering Science. These include recruitment of faculty with the academic credentials and professional experience to teach in the program, the merging of several departments into a cohesive whole, and ongoing discussions with internal and external stakeholder groups.

The proposed program provides the best opportunity for students in the Eastern Panhandle to pursue the undergraduate degree in engineering science at a reasonable cost.

6.4.a. Program Administration
The B.S. in Engineering Science program will be housed within Shepherd University’s Department of Computer Science, Mathematics and Engineering (CME), which in turn is one of four departments within the School of Natural Sciences and Mathematics. Several departments and programs in the school will offer courses listed in the proposed B. S. in Engineering Science.

The organizational reporting structure is shown below:

**Engineering Science Program Reporting Structure**

- Provost
  - Dean, Natural Sciences and Mathematics
    - Department Chair, Computer Science, Mathematics and Engineering
      - Program Faculty

6.4.b. Program Projections
The first-year enrollment for the Engineering Science program should be at least 12 students, as there are currently 20 students enrolled in the Environmental Engineering concentration, currently housed in the Institute of Environmental and Physical Sciences. It is expected that these current students will make an academic change to the new degree program. As new students are attracted to the program, the enrollment is projected to reach 15 in the second year and reach 20 in the third year. The goal is to eventually sustain an annual enrollment of 30 Engineering Science majors. Each FTE major is expected to take a total of 30 credit hours per
academic year in order to graduate in four years. This value was used to calculate the *number of credit hours generated by majors in the program* on FORM 1.

**WV-HEPC FORM 1: FIVE-YEAR PROJECTION OF PROGRAM SIZE**

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of students served</strong> through course offerings of the Program:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headcount</td>
<td>12</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>FTE</td>
<td>.8</td>
<td>1.0</td>
<td>1.33</td>
<td>1.67</td>
<td>2</td>
</tr>
<tr>
<td><strong>Student credit hours generated by courses in the program (for the full academic year):</strong></td>
<td>128</td>
<td>160</td>
<td>240</td>
<td>360</td>
<td>400</td>
</tr>
<tr>
<td><strong>Number of Majors:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Headcount</td>
<td>12</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>FTE Majors (headcount)</td>
<td>12</td>
<td>15</td>
<td>20</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td><strong>Number of student credit hours generated by majors in the program for the full academic year:</strong></td>
<td>360</td>
<td>450</td>
<td>600</td>
<td>750</td>
<td>900</td>
</tr>
<tr>
<td><strong>Number of degrees to be granted (annual total):</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>10</td>
</tr>
</tbody>
</table>

Shepherd University, B.S. Engineering Science • Series 11-6, New Program Proposal
6.4.c. Faculty Instructional Requirements
There will not be additional faculty lines required to implement the B. S. in Engineering Science. As the program grows, the faculty, chair and school dean will work through the institutional budget process to request an additional faculty line.

Working with President Hendrix, the Provost, Deans’ Council and Executive Leadership, the institution is currently exploring the implementation of new programs at the undergraduate and graduate levels to meet the needs of the communities it serves. In the process, a specific pro forma is being developed to address resources needed to implement and sustain new programs as it relates to new income streams and reallocation of current fiscal and human resources. The pro forma process has also been used in the past to address new hires required for these innovative academic programs.

The Faculty vitae in Appendix D clearly demonstrate the qualifications of Shepherd’s faculty regarding academic and professional qualifications, research initiatives and scholarship outcomes.

6.4.d. Library Resources and Instructional Materials
Shepherd University has the classrooms and laboratories, library resources, and instructional materials required for the proposed Engineering Science program.

All classrooms and other teaching spaces on campus are equipped with a standard set of information technologies: a computer, overhead projector, web access, and white boards. Classroom and lab technology upgrades were a top priority in the previous institutional strategic plan (2009-2013). Some classrooms have additional technology capabilities, such as “smart” boards, or a high-end sound system, and specialized technologies for areas such as graphic design and computer science. Classroom and laboratory computers and software are replenished on an established rotation cycle, ranging from five years for computers to seven years for projectors.

The Shepherd University library currently subscribes to select IEEE (Institute of Electrical and Electronics Engineers) and ACM (Association for Computing Machinery) periodicals along with the MAA (Mathematical Association of America) and AMS (American Mathematical Society) monthlies. There is no charge to the campus community for the use of these journals and also for online article searches. Public access computers in the library can be used to browse the Internet or for literature searches. In addition, the library provides for interlibrary loan on articles that are not available online or through journals in the library holdings.
Library staff includes the following, many of whom hold specialized credentials:

- Dean (Faculty Librarian);
- Four additional Faculty Librarians;
- One Staff Librarian (Archives);
- One part-time Staff Reference Librarian;
- One professionally credentialed Librarian in a paraprofessional position;
- One other FT paraprofessional;
- Two part-time PT paraprofessionals;
- One IT Assistant;
- Approximately 3.5 FTE of work-study student employees.

The online digital library is licensed for group membership so students and faculty have easy access to relevant publications while in the library, as well as remotely. Users have access to thousands of full-text journals from over 50 databases, including subscription databases such as LexisNexis and JSTOR. The library assesses no fees for online searches or for its interlibrary loan services. Librarians also teach a one-credit course titled “Research Methods and Information Retrieval” (LBSC 100).

Professional librarians are available to assist faculty and students for a total of about 56 hours a week. In addition to LBSC 100, there are regularly scheduled tours, workshops, and orientation sessions for those who need assistance in utilizing the library’s materials. Librarians offer tailored information literacy skills class sessions that focus on using the library’s databases for research assignments. These sessions are held in the library’s instruction lab enabling students to develop their online searching skills with the assistance of a librarian. The library is normally open 86 hours per week during the fall and spring semesters and has a computer-equipped workroom open 24 hours a day. The reference section of the library is typically open 56 hours weekly during the regular academic year. At present there are 33 reference lab computers and 8 public computers on the main floor of the library. The 24-hour room has 8 computers; the instruction lab 24, the third floor 10, and 38 are available for checkout.

Below is a statistical snapshot of the Scarborough Library as of January 2016.

**Collection Holdings:**

1. Audio CDs 2,517
2. Books & Bound Serials 136,729
3. E-Books 6,727
4. Electronic Journals & Databases* 302*
5. Government Documents (Federal & WV) 14,017
6. Maps 638
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7. Microforms</td>
<td>16,292</td>
</tr>
<tr>
<td>8. DVDs, Videos</td>
<td>2,162</td>
</tr>
</tbody>
</table>

*Note: 145 online periodical subscriptions and 157 electronic resources/databases. These do not include full-text journals available in the databases.

### 6.4.e. Support Service Requirements

The institution’s academic and student support services are adequate to address the needs of students in the Engineering Science program. As noted in 6.4.f., the program will be housed in the Snyder and Stutzman-Slonaker Halls. Please see this section for specific resources found in these instructional spaces.

Shepherd’s Academic Support Center, which features tutorial services, IT User Support, and the Center for Teaching and Learning, is housed in the nearby Scarborough Library. Disability Support Services are also available on the campus. The Academic Support Center provides students with a variety of services aimed at supporting student success.

These include:
- placement testing;
- student advising by professional advisors;
- campus tutoring program;
- assistance with writing and editing essays;
- directing of stretch-model classes in writing and mathematics;
- TRiO Student Support Services: This program provides additional support and services to 160 students who are either first-generation college students, have a disability, and/or are low-income [http://www.shepherd.edu/trio](http://www.shepherd.edu/trio).
- Disability Support Services facilitates student success by providing accommodations that allow students with diverse needs to achieve their academic and social potential. Disability Support Services collaborates with students, faculty, staff, and administration to maintain safe learning and living environments based on mutual respect and acceptance of differences [http://www.shepherd.edu/disability](http://www.shepherd.edu/disability).

### 6.4.f. Facilities Requirements

Courses for the proposed Engineering Science major will be taught in facilities available to the School of Natural Sciences and Mathematics and the Department of Computer Science, Mathematics and Engineering. These facilities are adequate for the academic and laboratory requirements for the proposed Engineering Science program. This includes both instructional
and laboratory space in Snyder and Stutzman-Slonaker Halls. Classrooms vary in capacity and all are technologically outfitted with computer projection systems and web access. The CME department recently acquired a 3-D printer and a PNC machine that would further support the proposed Engineering Science program. The March 2016 report for the Higher Learning Commission notes that there are 28 teaching and research labs for the natural and physical sciences housed within the facilities listed above.

The department has two engineering labs and one mathematics lab with access to MATLAB (engineering software) and MAPLE (technical computing software for engineers). The engineering laboratories are also used for the Analog and Digital Electronics course. The department also has three laboratories used for computer programming, computer organization, and networking and security. In addition, students are able to use two labs for experimenting with robotics-centric design and programming. The facilities feature state-of-the-art equipment and are easily adapted to teaching all the courses necessary for the proposed Engineering Science program.

6.4.g. Operating Resource Requirements

**WV-HEPC FORM 2: FIVE-YEAR PROJECTION OF TOTAL OPERATING RESOURCES REQUIREMENTS**

<table>
<thead>
<tr>
<th align="left">A. FTE POSITIONS (by semester)</th>
<th>First Year</th>
<th>Second Year</th>
<th>Third Year</th>
<th>Fourth Year</th>
<th>Fifth Year</th>
</tr>
</thead>
<tbody>
<tr>
<td align="left">1. Administrators</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td align="left">2. Full-time Faculty</td>
<td>.25</td>
<td>.25</td>
<td>.50</td>
<td>.75</td>
<td>1.0</td>
</tr>
<tr>
<td align="left">3. Adjunct Faculty</td>
<td>.33</td>
<td>.50</td>
<td>.66</td>
<td>.66</td>
<td>.75</td>
</tr>
<tr>
<td align="left">4. Graduate Assistants</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td align="left">5. Other Personnel:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td align="left">a. Clerical Workers</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td align="left">b. Professionals</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Note: Current clerical and instructional staffing is built into the budget; costs represent new hires.

B. OPERATING COSTS (by semester)

1. Personnel Services:
   a. Administrators 0 0 0 0 0 0
   b. Full-time Faculty 0 0 62,500 65,000 65,000
   c. Adjunct Faculty 2,800 5,600 7,000 7,000 8,400
   d. Graduate Assistants 0 0 0 0 0
   e. Non-Academic Personnel:
      Clerical Workers 0 0 0 0 0
      Professionals 0 0 0 0 0

Total Salaries 2,800 5,600 69,500 72,000 73,400

WV-HEPC FORM 2, page 2

FIVE-YEAR PROJECTION OF TOTAL OPERATING RESOURCES REQUIREMENTS*

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Current Expenses*</td>
<td>15,900</td>
<td>16,750</td>
<td>17,500</td>
<td>17,850</td>
<td>18,000</td>
</tr>
<tr>
<td>3. Repairs and Alterations</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4. Equipment:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educational Equipment</td>
<td>14,300</td>
<td>15,000</td>
<td>15,700</td>
<td>16,000</td>
<td>16,200</td>
</tr>
<tr>
<td>5. Nonrecurring Expense</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total Costs</td>
<td>30,200</td>
<td>31,750</td>
<td>33,200</td>
<td>33,850</td>
<td>34,200</td>
</tr>
</tbody>
</table>
C. SOURCES

1. Gen. Fund Appropriations  0  0  0  0  0  0
   (Appropriated Funds Only)
   __ Reallocation  __ New funds

2. Federal Government
   (Non-appropriated Funds Only)

3. Private and Other Revenue
   (Lab fees)  45,400  46,000  47,500  49,000  50,000

   Total All Sources  45,400  46,000  47,500  49,000  50,000

*NOTE: The instructional costs and educational expenses for the proposed Engineering Science program major are built into the current institutional budget. The program will be housed in the Department of Computer Science Mathematics and Engineering, on whose budgets these projections are based. The expenses include supplies, maintenance contracts for equipment, printing, student activities, vehicle rental, copy costs, etc.

6.4.h. Source of Operating Resources

Shepherd University is not seeking new financial support for implementing the Engineering Sciences program. The program will be supported mainly by tuition revenue, lab fees and the institutional budget. All funding is subject to approval through the institution’s normal budget review and allocation process. Resource needs are not expected to extend beyond the usual operating costs for any similarly sized educational program. As the program develops, and as noted in 6.4.c., the program will work through the institutional process to develop a request for an additional faculty line.

6.5. Program Evaluation

Shepherd University has established procedures for program evaluation and has cultivated a culture of assessment over the past decades. Assessment occurs at multiple levels across the institution, in both academic and administrative units, and embraces a full-circle approaches that leads to programmatic improvements. The University, school, and departmental mission statements align and the assessment process is connected to strategic planning at each level.
6.5a. Evaluation Procedures
The CME department is required by the Center for Teaching and Learning at Shepherd University to perform assessments in all areas of degree programs, including the proposed new Engineering Science degree program. Technical electives found in the program curriculum, along with electives in the Humanities and Social Sciences will ensure that students are well prepared with the essential skills and knowledge for a variety of career paths.

The B.S. in Engineering Science will undergo regularly scheduled evaluation using the established program review process and guidelines. These include maintaining an accurate assessment record and continual monitoring of the program by the Center for Teaching and Learning, as well as by the department. These measures will address the viability, necessity, and quality of the program to ensure that objectives and goals are met. With the aim of continuous quality improvement, the proposed program will also meet all requirements as established by the University’s accrediting body, the Higher Learning Commission (HLC).

Assessment Procedures:
The Department of Computer Science, Mathematics and Engineering is committed to the institutional assessment process, as it measures our effectiveness in preparing students for the field of engineering. Capstone courses have been designed for the engineering majors, an integral component in assessing student learning outcomes prior to graduation. In addition, the department plans to assess this new degree program using guidelines established for engineering programs by ABET (Accreditation Board for Engineering and Technology).

In the assessment plan for engineering programs, three constituent groups are identified for assessment: students, employers and faculty. This process also sets up identifiable objectives with skills necessary for successful engineering practice, and outcomes for engineering programs to ensure the objectives can be achieved.

The department is also aware of the importance of ABET accreditation. Working collaboratively, faculty have conducted an extensive overhaul of the curriculum for our existing engineering and computing programs. The mathematics standards and requirements have been strengthened and undergraduate research has been introduced. Faculty have participated in an ABET Accreditation Workshop and are planning to attend the ABET Symposium in Baltimore in April 2017. The CME department has no reservations in preparing our current engineering and computing programs and the proposed Engineering Science program for ABET accreditation in the next few years.
Program Outcomes: The Engineering Science program will provide students with skills necessary for successful engineering practice. These skills include critical thinking, problem solving, design and implementation, data interpretation, computer and information literacy, teamwork and communication, modern engineering software and tools, and ethics. The Engineering Capstone courses will be the main component in assessing program outcomes prior to students’ graduation.

Course Evaluation: Each course in the Engineering Science program offered by the department has a set of course objectives that follow ABET format and guidelines. The program curriculum was developed by the departmental faculty with guidance from the department chair. This collaborative process ensures a thorough coverage of engineering program objectives as identified by ABET. At the close of each semester, students have the opportunity to evaluate the classes and provide their feedback regarding the course, classroom environment and instructor. The department makes adjustments based on the course evaluation results to guarantee the quality of each course offering and the degree program as a whole.

Examples of Feedback for Continuous Improvement:

1. Students in Engineering Capstone classes will present their capstone project to the departmental faculty. Through their presentations, students will demonstrate and will be asked about their experience as engineering students at Shepherd University, with a focus on engineering program learning outcomes.

2. The department maintains close relationships with local employers such as the U.S. Coast Guard Operations Systems Center, Volvo Powertrains, etc. Through a survey, these employers will be asked to make comments regarding the preparation of our graduates and suggestions for program improvement.

3. Engineering alumni regularly visit Shepherd University during university or departmental events such as annual Shepherd University Robotics Festival. This stakeholder group provides valuable feedback on how well our engineering programs have prepared them for their career.

Feedback will be examined and evaluated by the department to generate appropriate plans for program improvement.

University Process: A major strength of the University assessment program is that all departments and administrative units across campus have assessment facilitators and produce assessment plans and reports on an annual basis. Each academic program is required to submit an assessment plan and report annually to the Center for Teaching and Learning (CTL). The CTL
requests that assessment facilitators from all departments and administrative units identify at least two to three intended student-learning outcomes. Within these outcomes, faculty and assessment facilitators provide two means of assessment (direct and indirect – academic departments are encouraged to provide as many direct measures as possible). Each assessment strategy must include criteria or benchmarks for success. Following the completion of these assessments, the data are analyzed and assessment facilitators (with their respective faculties) decide how the assessment data will be used to improve student learning. In other words, all departments and units establish two to three learning goals, direct and indirect means of measuring these goals, benchmarks for success, and a detailed plan for improvement. After each plan and report are reviewed by the Assessment Task Force, department and unit assessment facilitators receive a letter from the Dean of Teaching, Learning, and Instructional Resources recognizing accomplishments and offering suggestions for areas of improvement. Assessment plans and reports are transparent and posted on the CTL website [http://www.shepherd.edu/ctl/assess_learning.html].

Reports are uploaded into the WEAVE assessment program to generate departmental, programmatic, and/or unit reports. Such reports are generated as evidence for institutional and programmatic accreditation site visits. Additionally, each semester the CTL hosts assessment, advisement, and Focus on Student Learning (FOSL) workshops. Faculty members are encouraged to attend these workshops as professional enhancement, e.g., in innovative pedagogy, and to contribute to campus discussions on these topics. A campus goal is to integrate the Global Learning Inventory, or a comparable instrument, into the summative assessment.

Program Review Procedures: Shepherd University ensures the ongoing quality of its academic programs, its faculty, and curricula through regular assessment in cyclical program reviews. These reviews occur at the undergraduate and graduate levels. Information regarding the cycle and guidelines are found in Appendix G of the faculty handbook located here: http://www.shepherd.edu/employees/senate/documents/handbook.pdf

The Shepherd University Program Review Committee utilizes an evaluation procedure and established criteria for on-campus program reviews consistent with policy. Crucial components of the review are the unit self-study, which must state accomplishments achieved since the last review, and the use of an external reviewer who evaluates the self-study, completes a site visit, and issues a report with commendations and recommendations. The use of external experts in the field helps to ensure continuous quality improvement of a program. Changes made as a result of the program review process are an important component in closing the loop on assessment as it relates to the mission and strategic priorities of the University. The review of
academic programs is listed as a power and duty of the Board of Governors by legislative policy. Committee findings and recommendations are reported to the Board during its April meeting.

6.5.b. Accreditation Status

With the development of the undergraduate program in Engineering Science, Shepherd would pursue initial accreditation with the Accreditation Board for Engineering and Technology. In anticipation of seeking accreditation, the curriculum for the B.S. in Engineering Science, as well as course syllabi and student outcomes have been developed to address ABET standards. It should be noted that many of the items and information required for initial accreditation are similar to those required for the WV-HEPC Series 11 documents.

The Engineering Science program would also be covered by the institution’s regional accreditor, the Higher Learning Commission (HLC).
Appendix A: Course Descriptions

Systems Engineering Concentration

The following course descriptions are found in Shepherd University’s online catalog:

catalog.shepherd.edu.
Curriculum for Engineering Science – Systems Engineering Concentration

Specific Core Curriculum Requirements, 22 Hours

ENGR 100 - Freshman Seminar
(1 cr) This course provides beginning freshman students with information and tools to prepare them for a successful life as a student. This course is aimed at developing the cognitive skills required in computer, mathematics, and engineering courses. The activities in this course are designed to introduce the student to an academic support system through which freshman students can explore various concentrations in computer science, mathematics, and engineering and learn academic success strategies including developing a support network. This course also helps students develop good wellness habits that have lifelong benefits. One pass/fail credit.  

CORE CODE: FY

ECON 205 - Principles of Macroeconomics
(3 cr) Introduction to fundamental economic concepts including production possibilities and economic growth, market supply and demand analysis, money, banking, and government fiscal and monetary policies. Emphasis is placed upon fluctuations in national income, employment, and the price level. Prerequisites: Qualifying Mathematics placement scores of ACT 19 or SAT 460; or MATH 101 or higher.  

CORE CODES: SO  CK  GL

MATH 207 - Calculus I
(4 cr) Fundamental concepts of calculus, using analytic geometry. After preliminaries about the real number system, intervals, and functions, properties of limits are carefully stated. These are used to develop standard differentiation formulas. Applications of the derivative (as a rate of change) are stressed in a wide variety of problems. Introduction to integration via antidifferentiation and area and the fundamental theorem. Applications of the integral (volumes, arc length, surface area, etc.) Prerequisites: MATH 108 or satisfactory math placement score.  

CORE CODES: MA

PHYS 221 - General Physics I
(3 cr) A calculus-based treatment of fundamentals of selected classical physics topics including motion, force, Newton’s laws, energy, momentum, gravitation, rotation, acoustics, fluid dynamics, and thermodynamics. PHYS 221L must be taken concurrently with PHYS 221.  

Prerequisite/corequisite: MATH 207.

PHYS 221L - General Physics I Laboratory
(1 cr) A two hour per week laboratory course focusing on selected classical physics topics including motion, force, Newton’s laws, energy, momentum, gravitation, rotation, acoustics,
fluid dynamics, and thermodynamics. Corequisite: Must be taken concurrently with PHYS 221.

**PHYS 222 - General Physics II**
*(3 cr)* A calculus-based treatment of the fundamentals of selected classical and modern physics topics including acoustics, fluid dynamics, thermodynamics, electromagnetism, optics, relativity, and quantum mechanics. Prerequisites: PHYS 221. Corequisite: PHYS 222L must be taken concurrently with PHYS 222. **CORE CODES: LS**

**PHYS 221L - General Physics I Laboratory**
*(1 cr)* A two hour per week laboratory course focusing on selected classical physics topics including motion, force, Newton’s laws, energy, momentum, gravitation, rotation, acoustics, fluid dynamics, and thermodynamics. Corequisite: Must be taken concurrently with PHYS 221.

**CHEM 207 - General Chemistry I**
*(3 cr)* CHEM 207 and its companion lab, CHEM 207L, are the first part of a two-semester sequence that serves as an introduction to modern chemistry for students majoring in the sciences. The course provides a basis for, and is a prerequisite for, advanced courses in chemistry, biochemistry and molecular biology. Science majors, premedical and other pre-professional students should take this course. The topics covered include measurements and units, atomic and molecular structure, periodic properties of the elements, chemical bonding, stoichiometry, chemical reactivity, thermochemistry, and the structure and properties of gases, liquids and solids. This course, along with CHEM 207L, CHEM 209, and CHEM 209L, fulfills the Core Curriculum Laboratory Sciences requirement. Prerequisites: Background in high school chemistry and algebra. Corequisite: It is recommended, but not required, that CHEM 207L be taken concurrently. **CORE CODES: LS**

**Mathematics Requirements, 30 Hours**

**MATH 208 - Calculus II**
*(4 cr)* Continuation of MATH 207. Calculus of exponential, logarithmic, and trigonometric functions; techniques of integration. Review of conic sections in standard form and in rotation. Polar coordinates, l’Hôpital’s rule, improper integrals, infinite series, and Taylor series. Prerequisites: MATH 207.

**MATH 254 - Discrete Mathematics**
*(3 cr)* Topics from modern mathematics with particular emphasis on those with applications to computer science. Logic, sets, number systems and number theory, enumeration, graphs and trees, matrices, finite algebraic systems, and analysis of algorithms are examined. Prerequisites: MATH 154 or MATH 155; or MATH 205 or MATH 207.
MATH 307 - Introduction to Linear Algebra
(3 cr) The course begins with a study of linear systems, using matrices and determinants to solve them. Vector spaces are treated axiomatically and discussed geometrically. Linear transformation of vector spaces and their matrix representations are considered. Finally eigenvectors and eigenvalues are considered with applications. Prerequisites: MATH 155 or MATH 254, and MATH 207 or MATH 205.

MATH 309 - Calculus III
(4 cr) Continuation of MATH 208. Vectors in the plane and in space, parametric equations, solid analytic geometry. Calculus of functions of several variables including partial derivatives, multiple integrals, and their applications. Prerequisites: MATH 208.

MATH 310 - Differential Equations
(4 cr) Examines first order ordinary differential equations (e.g., exact, separable, Bernoulli, homogeneous), direction field, numerical solution; higher order equations including the methods of Lagrange and undetermined coefficients; Laplace transforms; systems of first order equations; introduction to Fourier series; and applications in the physical and biological sciences. Prerequisites: MATH 208, and MATH 307.

MATH 318 - Numerical Analysis
(3 cr) A study of the mathematics of numerical approximation. Topics include initial value problems, iterative techniques for linear systems, approximation theory, finding eigen values, boundary value problems, and numerical solutions to partial differential equations. Prerequisites: ENGR 102, MATH 307, and MATH 310.

MATH 321 - Probability and Statistics
(3 cr) Topics include axioms for probability; random variables, discrete and continuous probability distributions; expected value; functions of random variables; covariance; conditional probability; independence; confidence intervals; tests of hypotheses: normal, t, signed-rank, chi-square tests; linear regression and correlation. Prerequisites: MATH 309.

MATH 329 - Mathematical Modeling
(3 cr) A study of how to model the world around us using mathematics, how to solve the resulting equations, and how to apply the results. Includes a thorough study of how to use both quantitative and qualitative solution behavior in the modeling process. Prerequisites: MATH 318, MATH 321, and MATH 310.
MATH 354 - Operations Research
(3 cr) An introduction to main topics of operations research: linear programming, network optimization, dynamic programming, and queueing theory. The simplex algorithm will be studied in detail, including duality theory and sensitivity analysis. In network optimization the OSPF algorithm, PERT, and CPM will be considered. Examples of applications from industry, notably some queueing algorithms. Additional topics may be chosen from Markov chains, integer programming, nonlinear programming, game theory and decision analysis, and simulation. Prerequisites: MATH 155 and MATH 207 or MATH 254.

Engineering Requirements, 20 Hours

ENGR 101 - Engineering I
(3 cr) Topics include developing engineering design and problem-solving techniques including group projects and team work, basic engineering design concepts; spreadsheet programming; MathLab, dimensional analysis, use of computer, data, analysis, design, design process, visualization, material science, vector analysis, technical report writings and engineering ethics, professional and ethical responsibilities; and technical library and internet research. Prerequisites: MATH 108.

ENGR 102 - Engineering II
(3 cr) Topics include an introduction to computing environments for solving engineering problems including computer-aided engineering (CAE), mathematical packages, and structured programming processes including algorithms, pseudo code, and editing and debugging with the C++ programming language. Applications include topics from numerical analysis and graphical representations. Corequisite: MATH 207.

ENGR 221 - Introduction to Electrical Engineering
(3 cr) Topics include electrical engineering units, circuit elements, circuit laws, measurement principles, mesh and node equations, network theorems, energy storage elements, RC and RL circuits, unit step response, and second order circuits. Prerequisites: ENGR 102 and MATH 207.

ENGR 222 - Electrical Engineering Laboratory
(1 cr) A laboratory course in electrical engineering, 3 hours per week, to be taken simultaneously with ENGR 221.

ENGR 224 - Electrical Circuits
(3 cr) Introduction to network analysis including sinusoidal (AC) steady state, average and RMS values, phasors, polyphase systems, complex frequency, network frequency response, two port networks and transformers, Fourier methods, and Laplace Transforms. Prerequisites: ENGR
ENGR 225 - Electrical Circuits Laboratory
(1 cr) A laboratory course in electrical circuits, 3 hours per week, to be taken simultaneously with ENGR 224.

ENGR 300 - Introduction to Robotics
(3 cr) The course uses a hands-on approach to introduce the basics of modeling, design, programming and control of mobile robot systems. The course introduces fundamental concepts in robotics, including controllers, drive systems, motion, sensors and vision systems, and robotics programming. The format of this course includes lectures, research and reading assignments, and numerous hands-on team experiments using interactive robots that can communicate with humans and other objects using sensors and actuators controlled by developed software apps running inside a microcontroller. Prerequisites: Permission of instructor.

ENGR 489 - Engineering Capstone Project I
(1 cr) Students learn methods and skills for the engineering design process, demonstrate the ability to explore principles of engineering experimentation and design, identity real world projects in multidisciplinary engineering areas, and develop a practical plan to complete the projects (individual and/or group). Approved written project proposals and oral presentations are required at the end of the semester. The written proposal should include problem descriptions, objectives, selected approach, design alternatives, equipment requirements, and time line, as well as ethical, legal, and environmental issues. Pass/fail grade. Prerequisites: Junior or senior standing and permission of instructor.

ENGR 490 - Engineering Capstone Project II
(2 cr) Students develop and complete the proposed projects by utilizing the knowledge and experience gained from previous courses and by demonstrating the analyses and experiments. Student are required to present work in a professional manner which consists of three parts: comprehensive written reports including research and analysis, oral presentations, and operating working models. Previously offered as 3 credits. Prerequisites: ENGR 489.

CIS Requirements, 21 Hours
CIS 104 - Introduction to Computer and Information Sciences
(3 cr) Provides an overview of the wide range of topics in computer and information sciences. Topics include computer number systems and theory of computation, computer hardware and organization, computer languages, programming, compilation, systems analysis and design,
decision support, artificial intelligence, as well as ethical, global, and social issues. Prerequisite/corequisite: **MATH 105**, or math placement.

**CIS 211 - Computer Language Concepts**  
**(3 cr)** A first course in the fundamentals of computer programming using an object-oriented programming. Includes basic data types, problem solving and algorithm design methods, program design, coding, testing, and debugging. Students learn the programming characteristics of subprograms, parameter passing, and modularity. Includes formal laboratory session. *Previously 4 credits.* Prerequisites: **CIS 104**, and **MATH 155** or **MATH 154** or **MATH 108**.

**CIS 287 - System Analysis and Design**  
**(3 cr)** The system life cycle, starting with the requirements statement and ending with system extinction/replacement. Primary emphasis on the logical design phase of an information system. Includes explanations of both the traditional design approach and prototyping. Advantages and disadvantages of both approaches are examined. Prerequisites: **CIS 211**.

**CIS 314 - Advanced Computer Language Concepts**  
**(3 cr)** This course examines object-oriented programming and its use in software development. Topics include object-oriented design, classes and objects, code reusability, data hiding, polymorphism and inheritance. *Previously 4 credits.* Prerequisites: **CIS 211**.

**CIS 321 - Data and File Structures**  
**(4 cr)** The topics in this course include definitions and implementations of basic data structures including linked lists, stacks, queues, trees, and graphs and their applications; recursion as a algorithm design tool; and file organization and access techniques. Prerequisites: **CIS 314**; **MATH 254**; and **MATH 205** or **207**; or permission of instructor.

**CIS 418 - Management Information Systems**  
**(3 cr)** An integration of the material covered in previous programming and systems courses. An examination of modern management information systems in a business setting. Topics include structured decision systems, decision support systems, information systems acquisition and management, database management systems, and the role of information processing systems in business decisions. Prerequisites: **CIS 287**.

**CIS 486 - Network Security**  
**(4 cr)** Students will learn how to protect computer networks from internal and external digital threats by studying security concepts and techniques. Topics include fundamental concepts of cryptography, cryptographic key distribution and management, authentication protocols, digital
signatures, security policy, virtual private networks (VPNs) and their implications to security, and protection of Internet and Web-based systems and services. Weekly hands-on laboratories will investigate computer network security techniques. Prerequisites: CIS 423 or permission of instructor.

**Elective Courses, 7 Hours**

**ENGR 241 - Engineering Statics**

(3 cr) Examines engineering applications of equilibrium of forces, vector operations, couple and moment of force, resultants (2 and 3 dimensions), center of gravity and center of pressure, static friction, freebody diagrams, equilibrium trusses and frames. Prerequisites: ENGR 101. Corequisite: MATH 207.

**ENGR 242 - Engineering Dynamics**

(3 cr) A course examining Newtonian dynamics of particles and rigid bodies: engineering applications of equations of motion, work and energy, conservative forces, impulse and momentum, impulsive forces, acceleration in several coordinate systems, and relative motion. Prerequisites: ENGR 241, MATH 207, and PHYS 221.

**ENGR 305 - Digital Logic Design and Lab**

(4 cr) Topics include the logic gates and integrated circuits, design of Boolean logic and finite state machines, simplifications methods, combinational circuits and networks, programmable logic and devices (PLDs), registers and counters, memory elements, Mealy and Moore machines, and analysis and design of sequential circuits. Laboratory projects include combinatorial and sequential logic design using logic gates and PLDs, and simulation and implementation using hardware description language (HDL). Prerequisites: ENGR 102 or MATH 254 or permission of instructor.

**ENGR 326 - Linear Systems**

(3 cr) Signal types, linearity, causality, linear differential and difference equations, zero state response, zero input response, discrete time, continuous time, convolution, correlation, Laplace transforms, transfer functions, pole-zero placement, initial value theorem, final value theorem, Z-transforms, sampling, frequency domain analysis. Prerequisites: ENGR 224, MATH 310.

**CIS 310 - Information Security**

(3 cr) Students will be introduced to fundamental concepts of information security including the establishment and implementation of an organization-wide security policy which is designed to protect the information assets of an organization. This course provides the student with the skills necessary to enforce an organization security policy and lays the foundation for continued
study in the areas of information security. Prerequisites: **CIS 234**.

**CIS 388 - Database Management Systems**

*(4 cr)* The design and maintenance of a computerized database management system. Includes all operations such as design, creation, searching, sorting, and editing that must be performed on both sequential and direct access files and sets of files. Examines advantages and disadvantages of tree, network, and relational data structures. Coverage of query languages, data dictionaries, and security and privacy considerations. Prerequisites: **CIS 211**.

**CIS 390 - Operating Systems**

*(3 cr)* An introduction to the fundamentals of operating systems across computing platforms. Topics include process and storage management, protection and security, and distributed systems. Format principles are complemented with surveys of contemporary operating systems (including UNIX). Prerequisites: **CIS 386**.

**CPE 234 - Introduction to Networking**

*(3 cr)* Students will learn the fundamental concepts of networking. Case studies and hands-on projects will consider networking topics including hardware, protocols, architecture, media, design, implementation, and troubleshooting, maintaining, and upgrading computer networks. Prerequisites: **CIS 104**.

**CPE 386 - Computer Organization**

*(4 cr)* Students will learn the principles of computer organization. Topics include the functional components of a computer, memory organization, auxiliary storage, system interconnection, digital logic, assembly language programming, and evolution and future trends of computer organization. Weekly laboratories will illustrate computer organization concepts and techniques. Prerequisites: **CIS 211** and **CPE 234**.

**CPE 433 - Microprocessor System Design and Lab**

*(4 cr)* This course is a basic introduction to microprocessor/microcontroller programming using the INTEL 80xxx series of microprocessor/microcontrollers. The course has a strong lab component where students will be exposed to programming the INTEL 80xxx series microprocessors in addition to learning their basic architecture. Topics include Assembly language programming, instruction time cycles, memory interfacing, input-output interfacing, data converters A/D and D/A, interrupts, general purpose programmable peripherals, etc. If time permits, students will be asked to do a lab project in which the microprocessor/microcontroller is used in a real-life application, e.g., a digital thermometer.
Prerequisites: **ENGR 305** and **CPE 386**.

**CPE 482 - Real Time and Embedded System Design**

*(3 cr)* A general introduction to real-time operating systems and embedded system design.
Prerequisites: **CPE 421**.

**DATA 418 - Big Data Analytics**

*(3 cr)* This course introduces students to concepts, methods and tools used in the analysis and management of massive data sets. Topics will include the map-reduce programming paradigm, cluster analysis, algorithms and libraries for working with large graphs, disk-based and memory-based distributed computing, stream processing, large-scale machine learning, and analysis of distributed algorithms. The course will explore the historical context, current relevance, and future growth of data analytics.
Prerequisites: One from **CIS 234, CIS 324, or CIS 388**; AND one from **MATH 318, MATH 329, or MATH 354**.
Appendix B: Course Descriptions

Environmental Engineering Concentration

The following course descriptions are found in Shepherd University’s online catalog: catalog.shepherd.edu.
**Curriculum for Engineering Science – Environmental Engineering Concentration**

**Specific Core Curriculum Requirements, 16 Hours**

**ENGR 100 - Freshman Seminar**

(1 cr) This course provides beginning freshman students with information and tools to prepare them for a successful life as a student. This course is aimed at developing the cognitive skills required in computer, mathematics, and engineering courses. The activities in this course are designed to introduce the student to an academic support system through which freshman students can explore various concentrations in computer science, mathematics, and engineering and learn academic success strategies including developing a support network. This course also helps students develop good wellness habits that have lifelong benefits. One pass/fail credit. **CORE CODE: FY**

**ECON 205 - Principles of Macroeconomics**

(3 cr) Introduction to fundamental economic concepts including production possibilities and economic growth, market supply and demand analysis, money, banking, and government fiscal and monetary policies. Emphasis is placed upon fluctuations in national income, employment, and the price level. Prerequisites: Qualifying Mathematics placement scores of ACT 19 or SAT 460; or MATH 101 or higher. **CORE CODES: SO CK GL**

**MATH 207 - Calculus I**

(4 cr) Fundamental concepts of calculus, using analytic geometry. After preliminaries about the real number system, intervals, and functions, properties of limits are carefully stated. These are used to develop standard differentiation formulas. Applications of the derivative (as a rate of change) are stressed in a wide variety of problems. Introduction to integration via anti-differentiation and area and the fundamental theorem. Applications of the integral (volumes, arc length, surface area, etc.) Prerequisites: **MATH 108** or satisfactory math placement score. **CORE CODES: MA**

**ENVS 201 - Foundations In Environmental Science I**

(3cr) This course introduces fundamental concepts in environmental studies, with specific focus on human impacts on ecosystem function and biotic interactions. Students explore interactions between humans and earth’s biotic resources, examining topics such as ecosystem conservation, population growth and regulation, food production and pest control. Anthropogenic environmental issues such as biodiversity decline, soil degradation and environmental toxicology and related governmental policies are explored within a social framework that considers both the different environmental impacts and experiences of humans
based on geographical region and culture. Corequisite: ENVS 201L, or permission of Department Chair. **CORE CODES: LS**

**ENVS 201 - Foundations In Environmental Science I Lab**

(1cr) A two hour per week laboratory course focusing on field techniques, equipment and scientific methodologies used in environmental studies, including such topics as microscopy, organism classification, experimental design and interpretation, ecological footprints, biodiversity and food web analysis. Corequisite: ENVS 201, or permission of Department Chair. **CORE CODES: LS**

**ENVS 202 - Foundations In Environmental Science II**

(3cr) This course introduces fundamental concepts in environmental studies, with specific focus on energy, earth systems and human resource utilization. Students explore interactions between humans and earth’s abiotic resources, examining topics such as natural resource extraction, renewable and non-renewable energy production, hydrologic resource use and associated global environmental impacts. Human-induced environmental issues such as global climate change, non-renewable resource consumption and toxic and solid waste production are discussed, as well as key governmental policies around these issues. Concepts are framed within a social context that reveals how humans of different cultures and geographical regions both contribute to and experience various environmental problems differentially. Previously titled *Dimensions of Environmental Science II (4cr)*. Corequisite: ENVS 202L, or permission of Department Chair. **CORE CODES: LS**

**ENVS 202L - Foundations In Environmental Science II Lab**

(1cr) A two hour per week laboratory course focusing on field techniques, equipment and scientific methodologies used in environmental studies, including topics such as scientific measurements, energy conversions and calculations, use of topographic maps, compass, and multimeter, water quality analysis, electrical generators, solar and wind power. Corequisite: ENVS 202, or permission of Department Chair. **CORE CODES: LS**

**Environmental and Physical Science Requirements, 36 Hours**

**ENVS 341 - Sustainable Energy and Lab**

(4 cr) This course introduces concepts of energy conservation and management and explores different renewable energy sources that are considered environmentally sustainable. Problems associated with nonrenewable energy use will be examined, and the range of sustainable alternatives will be explored. The fundamentals of passive solar collection, photovoltaics, wind, hydro, geothermal, and biomass will be covered. Economic and social implications for adopting each technology also will be considered. Prerequisites: ENVS 201 and 202 (including labs).
ENVS 390 - Geographic Information Systems
(4 cr) An introductory course into the many varieties of remote sensing employed within the environmental sciences and applications of these techniques to field analysis. The course will focus on application of Geographic Information Systems (GIS) to the environmental sciences. These systems employ computers to store, retrieve, transform, and display spatial environmentally oriented data and have a myriad of applications in environmental studies. Remote sensing is typically employed in environmental analyses, ranging from land use to wetlands characterization, requiring the environmental studies student’s awareness of these frequently applied techniques. Prerequisites: ENVS 201 and ENVS 202 (including labs), or BIOL 208 and BIOL 209.

ENVS 441 - Hydrology and Lab
(4 cr) This course will focus on the dynamic nature of earth’s surface and subsurface waters and the impact of human exploitation of these water resources. Techniques for monitoring and analyzing both surface and subsurface waters will be presented and practically applied as part of the laboratory component. Water quality standards and the criteria on which these standards are based will also be addressed in this course. Coursework assumes knowledge of basic algebra. Prerequisites: ENVS 201 and ENVS 202 (including labs), or BIOL 208 and BIOL 209.

PHYS 221 - General Physics I
(3 cr) A calculus-based treatment of fundamentals of selected classical physics topics including motion, force, Newton’s laws, energy, momentum, gravitation, rotation, acoustics, fluid dynamics, and thermodynamics. PHYS 221L must be taken concurrently with PHYS 221. Prerequisite/corequisite: MATH 207.

PHYS 221L - General Physics I Laboratory
(1 cr) A two hour per week laboratory course focusing on selected classical physics topics including motion, force, Newton’s laws, energy, momentum, gravitation, rotation, acoustics, fluid dynamics, and thermodynamics. Corequisite: Must be taken concurrently with PHYS 221.

PHYS 222 - General Physics II
(3 cr) A calculus-based treatment of the fundamentals of selected classical and modern physics topics including acoustics, fluid dynamics, thermodynamics, electromagnetism, optics, relativity, and quantum mechanics. Prerequisites: PHYS 221. Corequisite: PHYS 222L must be taken concurrently with PHYS 222. CORE CODES: LS

PHYS 221L - General Physics I Laboratory
(1 cr) A two hour per week laboratory course focusing on selected classical physics topics
including motion, force, Newton’s laws, energy, momentum, gravitation, rotation, acoustics, fluid dynamics, and thermodynamics. Corequisite: Must be taken concurrently with PHYS 221.

PHYS 301 - Energy
(4cr) In this course students will learn fundamentals of how energy is converted from one form to another and utilized to do useful work. These fundamentals are essential to our energy-intensive civilization and important for understanding humankind’s impact on the environment and utilization of natural resources. Topics will include thermodynamics processes, heat engines, heat transfer, electromagnetic induction, nuclear physics, and the photoelectric effect. Previously titled Physics of Energy (3cr). Prerequisites: Any 4-credit Core Curriculum science class, or Permission of Instructor.

CHEM 207 - General Chemistry I
(3 cr) CHEM 207 and its companion lab, CHEM 207L, are the first part of a two-semester sequence that serves as an introduction to modern chemistry for students majoring in the sciences. The course provides a basis for, and is a prerequisite for, advanced courses in chemistry, biochemistry and molecular biology. Science majors, premedical and other pre-professional students should take this course. The topics covered include measurements and units, atomic and molecular structure, periodic properties of the elements, chemical bonding, stoichiometry, chemical reactivity, thermochemistry, and the structure and properties of gases, liquids and solids. This course, along with CHEM 207L, CHEM 209, and CHEM 209L, fulfills the Core Curriculum Laboratory Sciences requirement. Prerequisites: Background in high school chemistry and algebra. Corequisite: It is recommended, but not required, that CHEM 207L be taken concurrently. CORE CODES: LS

CHEM 207L - General Chemistry I Laboratory
(1 cr) CHEM 207L is a laboratory course that is designed to accompany CHEM 207. The course provides a basis for, and is a prerequisite for, advanced courses in chemistry, biochemistry and molecular biology. Science majors, premedical and other pre-professional students should take this course. The topics covered include measurements and units, basic laboratory techniques, quantitative analysis, qualitative analysis, spectrophotometric analysis, gravimetric analysis, stoichiometry, thermochemistry and chromatography. This course, along with CHEM 207, CHEM 209, and CHEM 209L, fulfills the Core Curriculum Laboratory Sciences requirement. Prerequisites: Background in high school chemistry and algebra. Corequisite: It is recommended, but not required, that CHEM 207 be taken concurrently.

CHEM 209 - General Chemistry II
(3 cr) CHEM 209 and its associated lab, CHEM 209L, are the second part of a two-semester sequence that serves as an introduction to modern chemistry for students majoring in the
sciences. The course provides a basis for, and is a prerequisite for, advanced courses in chemistry, biochemistry and molecular biology. Science majors, premedical and other pre-professional students should take this course. The topics covered include equilibrium, acid-base chemistry, solutions and solubility, electrochemistry, chemical kinetics, nuclear chemistry and an introduction to organic chemistry. This course, along with CHEM 207, CHEM 207L, and CHEM 209L, fulfills the Core Curriculum Laboratory Sciences requirement.

Prerequisites: CHEM 207. Corequisite: It is recommended, but not required, that CHEM 209L be taken concurrently. **CORE CODES:** LS

**CHEM 209L - General Chemistry II Laboratory**

(1 cr) CHEM 209L is a laboratory course that is designed to accompany CHEM 209. The course provides a basis for, and is a prerequisite for, advanced courses in chemistry, biochemistry and molecular biology. Science majors, premedical and other pre-professional students should take this course. The topics covered include volumetric analysis, chromatography, spectroscopy, acid-base chemistry, electrochemistry, colligative properties and organic and inorganic synthesis. This course, along with CHEM 207, CHEM 207L, and CHEM 209, fulfills the Core Curriculum Laboratory Sciences requirement. Prerequisites: CHEM 207 and CHEM 207L. Corequisite: It is recommended, but not required, that CHEM 209 be taken concurrently.

**CHEM 333 - Environmental Chemistry**

(3 cr) CHEM 333 is a course for students interested in the chemical aspects of the environment. This course is intended for chemistry, environmental science and biology majors. Environmental Chemistry is a one-semester survey course that includes many topics. These include studies of the chemistry of the upper and lower atmosphere, the greenhouse effect, the chemistry of ground and surface water, energy use and its consequences, important organic and inorganic environmental toxins, and waste management. Prerequisites: CHEM 209. Corequisite: It is recommended, but not required, that CHEM 333L be taken concurrently.

**CHEM 333L - Environmental Chemistry Lab**

(1 cr) CHEM 333L is a one-credit laboratory course covering analytical techniques important to environmental testing. Particular emphasis is placed on methods for water and soil analysis. Volumetric, electrochemical, chromatographic and spectroscopic techniques are covered. Students learn how to prepare samples and how to make accurate and precise measurements. Particular attention is given to data analysis and evaluation of data. Prerequisites: CHEM 209L. Corequisite: It is recommended, but not required, that CHEM 333 be taken concurrently.
Mathematics and Engineering Requirements, 42 Hours

ENGR 101 - Engineering I
(3 cr) Topics include developing engineering design and problem-solving techniques including group projects and team work, basic engineering design concepts; spreadsheet programming; MathLab, dimensional analysis, use of computer, data, analysis, design, design process, visualization, material science, vector analysis, technical report writings and engineering ethics, professional and ethical responsibilities; and technical library and internet research. Prerequisites: MATH 108.

ENGR 102 - Engineering II
(3 cr) Topics include an introduction to computing environments for solving engineering problems including computer-aided engineering (CAE), mathematical packages, and structured programming processes including algorithms, pseudo code, and editing and debugging with the C++ programming language. Applications include topics from numerical analysis and graphical representations. Corequisite: MATH 207.

ENGR 221 - Introduction to Electrical Engineering
(3 cr) Topics include electrical engineering units, circuit elements, circuit laws, measurement principles, mesh and node equations, network theorems, energy storage elements, RC and RL circuits, unit step response, and second order circuits. Prerequisites: ENGR 102 and MATH 207.

ENGR 222 - Electrical Engineering Laboratory
(1 cr) A laboratory course in electrical engineering, 3 hours per week, to be taken simultaneously with ENGR 221.

ENGR 241 - Engineering Statics
(3 cr) Examines engineering applications of equilibrium of forces, vector operations, couple and moment of force, resultants (2 and 3 dimensions), center of gravity and center of pressure, static friction, freebody diagrams, equilibrium trusses and frames. Prerequisites: ENGR 101. Corequisite: MATH 207.

ENGR 242 - Engineering Dynamics
(3 cr) A course examining Newtonian dynamics of particles and rigid bodies: engineering applications of equations of motion, work and energy, conservative forces, impulse and momentum, impulsive forces, acceleration in several coordinate systems, and relative motion. Prerequisites: ENGR 241, MATH 207, and PHYS 221.
ENGR 243 - Engineering Mechanics of Materials
(3 cr) Analysis of stress, deformation, and failure of solid bodies under the action of forces including internal force resultants, stress, strain, Mohr’s Circle, mechanical properties of engineering materials, generalized Hooke’s Law, analysis of axial, bending and buckling loads, and combinations. Prerequisites: ENGR 241 and MATH 207.

ENGR 301 - Engineering Thermodynamics
(3 cr) Basic thermodynamic concepts, properties of pure substances, First and Second Law analysis of systems and control volumes are examined. Prerequisites: MATH 207 and PHYS 221.

ENGR 351 - Introduction to Fluid Mechanics
(3 cr) This course will examine fluid statics, laminar and turbulent flow of compressible and incompressible fluids, flow measurements, open channel flow, and kinetics of fluids. Prerequisites: MATH 310 and ENGR 242.

MATH 208 - Calculus II
(4 cr) Continuation of MATH 207. Calculus of exponential, logarithmic, and trigonometric functions; techniques of integration. Review of conic sections in standard form and in rotation. Polar coordinates, l’Hôpital’s rule, improper integrals, infinite series, and Taylor series. Prerequisites: MATH 207.

MATH 307 - Introduction to Linear Algebra
(3 cr) The course begins with a study of linear systems, using matrices and determinants to solve them. Vector spaces are treated axiomatically and discussed geometrically. Linear transformation of vector spaces and their matrix representations are considered. Finally eigenvectors and eigenvalues are considered with applications. Prerequisites: MATH 155 or MATH 254, and MATH 207 or MATH 205.

MATH 310 - Differential Equations
(4 cr) Examines first order ordinary differential equations (e.g., exact, separable, Bernoulli, homogeneous), direction field, numerical solution; higher order equations including the methods of Lagrange and undetermined coefficients; Laplace transforms; systems of first order equations; introduction to Fourier series; and applications in the physical and biological sciences. Prerequisites: MATH 208, and MATH 307.

MATH 314 – Statistics
(3 cr) This is a first course in statistics, primarily for those needing knowledge of statistical methods and the interpretation of statistical data. It discusses basic probability ideas, then
deals with frequency distributions, measures of central tendency and dispersion; hypothesis testing using z, t, and chi-square tests; correlation, linear regression, and one-way ANOVA. For reinforcement, students must complete several laboratory assignments using statistical software. Students may not receive credit for both this course and BADM 224. Prerequisites: MATH 105 or permission of chair.

**MATH 329 - Mathematical Modeling**

*(3 cr)* A study of how to model the world around us using mathematics, how to solve the resulting equations, and how to apply the results. Includes a thorough study of how to use both quantitative and qualitative solution behavior in the modeling process.

Prerequisites: MATH 318, MATH 321, and MATH 310.

**CPE 492 - Cooperative Work Experience in Computer Science and Engineering**

*(1-3 cr)* A supervised work experience in which the student is employed in an approved professional position with an industry, firm, or government agency. A final written report and a presentation are required. May be repeated to a maximum of 3 credits. Pass/fail grading only.

Prerequisites: CIS 392/CPE 392 with a pass grade and positive comments from both the faculty and on-site advisors; 3.0 GPA in the major; 2.3 GPA overall; and the recommendation of the student’s advisor.

**ENGR 489 - Engineering Capstone Project I**

*(1 cr)* Students learn methods and skills for the engineering design process, demonstrate the ability to explore principles of engineering experimentation and design, identify real world projects in multidisciplinary engineering areas, and develop a practical plan to complete the projects (individual and/or group). Approved written project proposals and oral presentations are required at the end of the semester. The written proposal should include problem descriptions, objectives, selected approach, design alternatives, equipment requirements, and time line, as well as ethical, legal, and environmental issues. Pass/fail grade. Prerequisites: Junior or senior standing and permission of instructor.

**ENGR 490 - Engineering Capstone Project II**

*(2 cr)* Students develop and complete the proposed projects by utilizing the knowledge and experience gained from previous courses and by demonstrating the analyses and experiments. Students are required to present work in a professional manner which consists of three parts: comprehensive written reports including research and analysis, oral presentations, and operating working models. *Previously offered as 3 credits.* Prerequisites: ENGR 489.
**CORE CODES**

CORE CODES appear throughout the Catalog and the semester Schedule of Classes (both print and online) to identify courses that have been approved to satisfy requirements within the Core Curriculum of the university. Consult with your advisor as to specific Core Curriculum requirements that may be designated within your academic program.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Tier/Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR</td>
<td>Arts</td>
<td>Tier Two (3 credits)</td>
</tr>
<tr>
<td>CK</td>
<td>Civic Knowledge and Engagement</td>
<td>Tier Two (courses must include one with this code)</td>
</tr>
<tr>
<td>CP</td>
<td>Capstone</td>
<td>Tier Three (required in major)</td>
</tr>
<tr>
<td>FY</td>
<td>First-Year Experience</td>
<td>Tier One (minimum 1 credit)</td>
</tr>
<tr>
<td>GL</td>
<td>Global Awareness</td>
<td>Tier Two (courses must include one with this code)</td>
</tr>
<tr>
<td>HM</td>
<td>Humanities</td>
<td>Tier Two (6 credits)</td>
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<tr>
<td>LS</td>
<td>Lab Science</td>
<td>Tier One (complete a full 8-credit sequence of the same science)</td>
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<td>MA</td>
<td>Mathematics</td>
<td>Tier One (3-4 credits)</td>
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<tr>
<td>MD</td>
<td>Multiculturalism and Diversity</td>
<td>Tier Two (courses must include one with this code)</td>
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<td>SO</td>
<td>Social Sciences</td>
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<tr>
<td>WE</td>
<td>Wellness</td>
<td>Tier Two (3 credits)</td>
</tr>
<tr>
<td>WM</td>
<td>Writing in the Major</td>
<td>Tier Two (required in major)</td>
</tr>
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Appendix C:
Course Syllabi
Appendix D: Faculty Vitae