CALIFORNIA STATE UNIVERSITY, BAKERSFIELD

ACADEMIC SENATE

Proposal for Energy and Power Engineering Emphasis within the B.S. degree in Electrical Engineering

RES 192012

AAC & BPC

RESOLVED: that the Academic Senate recommends the approval of the Energy and Power Engineering Emphasis, offered within the B.S. degree in Electrical Engineering.

RATIONALE: the Academic Affairs Committee and the Budget and Planning Committee have both reviewed the proposal. They have found that this emphasis has the resources required to deliver the program effectively and efficiently and fulfills a need for both students and industry.

PROPOSAL FOR A NEW MINOR, CONCENTRATION or EMPHASIS

Proposals to add a new minor, concentration or emphasis must receive appropriate campus approval prior to implementation. In addition, the Chancellor's Office must be notified of the campus approval prior to implementation. All attachments are to be added to this cover sheet and remain with the proposal through the required steps of evaluation. Please consult with the Associate Vice President of Academic Programs for questions or assistance.

This new proposal is a (check one):

☐ Minor - Is this minor available to all undergraduate students? ☐ Yes ☐ No, only in _____

☐ Concentration ☑ Emphasis within the degree of B.S. in Electrical Engineering

Title Energy and Power Engineering effective (term): Fall 2020

☐ Use the following degree code _____ instead of the major degree code for reporting (note the necessary criteria and degree codes)

Originating Department or Individual: CEE/CS Dr. Melissa Danforth

If a department formally approved the attached proposal, attach the appropriate memorandum and approval date.

Signature: _____ date: 4/12/2019

Curriculum Committee(s): Interschool programs should attach comments or approval from relevant school or department curriculum committees before being submitted to the Academic Affairs Committee, acting as the University Curriculum Committee. A memorandum and approval date from the curriculum committee must be attached. If any revisions were required or agreed to, a revised copy of the proposal must be attached.

Chair Signature: _____ date: 12th April 2019

School Dean(s): I have reviewed this proposal and send it forward for university-wide review with my comments attached. These comments include my analysis of the resource commitments that must be made to support the program and the origin(s) of those resources.

Dean Signature: _____ date: 4/13/2019

AVP of Academic Programs: I have reviewed this proposal and send it forward to the Provost.

AVP Signature: _____ date: 10/23/19

Date of Senate Approval: _____ **Date of President Approval:** _____

Please attach the final Academic Senate Resolution, as signed by the President and return to the Office of Academic Programs, which will notify the Chancellor's Office and the appropriate campus departments. A copy of this form and final electronic catalog copy must be sent to the Director of Academic Operations and Support.

COPY

Curriculum Committee
School of Natural Sciences, Mathematics and Engineering
California State University, Bakersfield
9001 Stockdale Highway
Bakersfield, CA 93311-1022

Date: 26th of April, 2019

To: Kathleen Madden, Dean, NSM&E
cc: Melissa Danforth, Chair, CEECS

From: F. Javier Trigos-Arrieta, Chair, Curriculum Committee NSM&E

Subject: Proposal for Energy and Power Engineering Emphasis

At its meeting of the 26th of April, 2019, the Curriculum Committee approved the emphasis in "Energy and Power Engineering" within the Bachelor of Science in Electrical Engineering.

CSU Bakersfield

School of Natural Sciences, Mathematics, and Engineering

Department of Computer and Electrical
Engineering and Computer Science

Mail Stop: 63 SCI
9001 Stockdale Highway
Bakersfield, California 93311-1022

(661) 654-3082
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www.cs.csub.edu

April 12, 2019

To: NSME Curriculum Committee
Re: Proposal for Electrical Engineering Emphasis in Energy and Power Engineering

1. Approval
The proposed emphasis was approved by the CEE/CS Department at the department meeting on February 14, 2019.

2. Proposed Changes
See attached proposal.

3. Resource Implications
See attached proposal.

4. Curriculum Impacts
See attached proposal.

5. Rationale
As part of the new Title V grant activities, curriculum is being developed in the area of energy and power. A subcommittee of faculty from both departments are developing the curriculum. This curriculum is designed to be accessible to both Electrical Engineering and Engineering Science students, so students interested in energy and power can take the same set of courses in both departments. The attached proposal represents the Electrical Engineering component of the grant activities.

Sincerely,

Dr. Melissa Danforth
Chair of CEE/CS

CSU Bakersfield
School of Natural Sciences, Mathematics, and Engineering
Department of Computer and Electrical Engineering and Computer Science

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To: Dr. Javier Trigos, Chair, NSME Curriculum Committee

From: Melissa Danforth, Department Chair

Date: January 9, 2019

Re: Proposal for a new Energy and Power Engineering Emphasis within the B. S. in Electrical Engineering

The department of Computer and Electrical Engineering and Computer Science has approved the attached proposal for a new Emphasis in Energy and Power Engineering. The emphasis is optional within the B. S. in Electrical Engineering.

The new emphasis requires three upper-division ENGR courses. We have consulted with the Department of Physics and Engineering, and secured their support. A memo from Dr. Alexander Dzyubenko, Chair of that Department is attached here as evidence of such support.

We are requesting the institutional review and approval of this proposal. Thanks for considering our request.

Proposal for a new emphasis in Energy and Power Engineering within the B. S. in Electrical Engineering

Table of Contents

Summary. The Department of Computer and Electrical Engineering and Computer Science (CEE/CS) has three programs, namely Computer Science, Computer Engineering and Electrical Engineering. The department has overseen the B.S in Electrical Engineering program since the Fall 2012. The Electrical Engineering core courses are designed following the state-wide and national established programs in Electrical Engineering. The program started to reflect regional industry needs and local student interest. Some of those local industries are in the area of Energy and Power. We are now proposing a new Emphasis in Energy and Power Engineering within the B.S. in Electrical Engineering program. We have already developed a similar emphasis in the Department of Physics and Engineering (P&E).

The development of the Electrical and Computer Engineering programs in the CEE/CS department and the associated facilities was funded initially by a $3.8M five-year grant from the US Department of Education that ran out in 2015. After the start of the Electrical Engineering program, the faculty of the CEE/CS department have been active in seeking external funding and secured external funding from several agencies for research, instruction, and equipment. Finally, in collaboration with the P&E department, we presently have a $3.6M Title V Department of Education grant to offer an Energy and Power Engineering track to our students. The grant is presently in its fourth year and ends September 30, 2020. The grant was also recently used to establish an emphasis similar to the one being proposed in this document in the P&E department.

We are not requesting any new resources from the university. The equipment required for the courses in this proposal has been (or will be) purchased fully using funds from the Title V grant. The courses which comprise the new emphasis are all from the P&E and CEE/CS departments, have been approved by the university, and students have started taking some of them. These courses already count towards the engineering electives requirement for the B.S. in Electrical Engineering. The existing faculty have the required expertise, and no new faculty are necessary to teach these courses. This emphasis is a cost-effective program in the sense that its comprising courses (and the associated resources) are already in place. In part because the proposed emphasis with similar courses already exists in the P&E department. We are just packaging them into an emphasis to give our students additional leverage in the work place.

This new program will generate and support new synergies with CSUB's Center for Research Excellence in Science and Technology (CREST) and California Energy Research Center (CERC). Indeed, some of our faculty (in both CEE/CS and P&E) are already involved in both centers.

Energy production and power distribution play a central role in the economy. This will always be true, whether the energy sources are conventional (such as gas and petroleum) or renewable (such as wind, hydro, geothermal and solar). The new emphasis will allow our

students to be more marketable in this sector, and will allow our department to more effectively perform outreach and recruit students, as well as serve the needs of the community.

Our proposed new emphasis requires three courses from the P&E department. We have consulted with our colleagues in that department and we include a letter of support in Appendix C. The catalog descriptions for those three courses are included in Appendix D.

Proposal

1) **Program Identification**

a) *Full and exact degree designation and title:* Bachelor of Science with a Major in Electrical Engineering with Emphasis in Energy and Power Engineering.

b) *Term and academic year of intended implementation:* Fall 2020.

c) *Total number of units required for graduation*: 120 units.

d) *How this emphasis will support the campus mission and will not impede the successful operation and growth of existing academic programs.*

The emphasis is being proposed in response to high demand in the region for engineers with expertise in the energy production and power distribution sectors. Thus, the new emphasis will support the economic development of the region, as well as advancing the opportunities available to students interested in this field. The emphasis will involve structuring existing elective courses within the Electrical Engineering, and Engineering Sciences programs. No new courses or laboratories will be required. The electives will be taught by full time faculty already in the two departments. This emphasis will be self-supporting, and will not adversely affect existing academic programs by diverting resources needed elsewhere. At the same time, the emphasis will provide our students access to a robust engineering education in fields that are especially marketable in the Southern San Joaquin Valley. Nevertheless, the skills provided by our curricula will enable our graduates to find engineering employment anywhere.

e) If students must apply directly to the concentration or emphasis (rather than the major), propose the Classification of Instructional Programs (CIP) Code and CSU Degree Program Code to be used.

Same as current Electrical Engineering program: 14.1001

2) **Program Overview and Rationale**

a) Rationale, including a brief description of the emphasis, its purpose and strengths, fit with institutional mission, and a justification for offering the emphasis at this time. The rationale may explain the relationship among the emphasis philosophy, design, target population, and any distinctive pedagogical methods.

There are a variety of reasons why it makes perfect sense to offer a formal emphasis in energy and power within our Electrical Engineering program at this time.

The proposed emphasis focuses on the engineering aspects of energy production and power distribution. It complements our existing engineering programs, and similarly builds on background already provided by the curriculum for the B.S. in Electriclal Engineering. Furthermore, the new emphasis avails of existing engineering expertise in the P&E department. The emphasis utilizes only existing courses.

Clearly, oil production is and will continue to be a very important part of our area's economy. However, our students would be well served by understanding how one takes this energy source, as well as others (such as natural gas, biomass, wind, solar, hydro, geothermal, etc.), and extract the energy to transform it to electricity, and how we go about distributing it for its consumption. California produces and consumes enormous amounts of energy, and it is of course one of the leading states in the field. Energy availability, especially from environmentally-friendly sources and processes will always be important.

All the courses which will be required for the emphasis are already offered as part of the similar emphasis in the P&E department. Many of the students in the CEE/CS department have expressed an interest in Energy and Power Engineering.

The California Energy Research Center (CERC) will offer many opportunities for research and collaboration with industry. Our students will be well-positioned to take advantage of opportunities for synergies arising from the center. Research activities will be structured to complement the curricular activities and contribute to ABET's (the engineering accreditation agency) Student Outcomes in the non-traditional areas, such as contemporary issues, economics, societal impact, health and safety, professional, global issues, multidisciplinary team work, manufacturability, sustainability, environmental, ethical, political, and life-long learning. Furthermore, collaboration with CERC will help attainment of the Electrical Engineering Program Educational Objectives.

We have a Department of Education Title V $3.6M five-year grant that has allowed us to set up the infrastructure required to establish this program. The Physics and Engineering department has already used the resources from that grant to start an Energy and Power Engineering emphasis (We are presently in grant year four). The expenses supported by the grant include acquisition of sophisticated equipment, as well as outreach to Bakersfield College and local High Schools. Having a formal emphasis in energy and power engineering within our Electrical Engineering program will allow us to advertise and do outreach to the community and continue to make the case that we are addressing its needs.

The proposed Emphasis in Energy and Power Engineering would offer students an opportunity to pursue a formal program that is relevant to our community and the state. It can also offer to local industry a source of well-educated engineers who are ready for the field, and who are also native to the Bakersfield area.

b) Complete catalog description, including program description, units required for degree, degree requirements, and admission requirements.

The complete catalog copy is included below. Additions to the present 2020 catalog are indicated by red text and deletions by red strike-trough text. There are no special admission requirements for the program beyond the normal requirements for admission to the university.

Department of Computer and Electrical Engineering and Computer Science
School of Natural Sciences, Mathematics, and Engineering
Department Chair: Melissa Danforth
Program Office: Science Building III, 317
Telephone: (661) 654-3082
email: ceecs@cs.csubak.edu
Website: www.cs.csubak.edu
Faculty: A. Bianchi, A. Cardenas, A. Cruz, M. Danforth, S. Garcia, G. Griesel, S. Jafarzadeh, C. Lei, W. Li, V. On, E. Reihani, N. Toothman
Emeriti Faculty: T. Meyer, D. Meyers, M. Thomas, H. Wang

Program Description
Electrical Engineering is a large and expanding field which is concerned with the following fundamental areas: digital signal processing, semiconductor electronics, microprocessors and embedded systems, VSLI design, cyber-physical systems, data communications, energy systems and power electronics, transmission and distribution, RF and microwave, robotics and control system design, electromechanics and mechatronics, computer networks, digital design, image processing and computer vision. If computer science can be regarded to be on the information processing side of computer engineering, then electrical engineering can be regarded to be on the side which builds upon the fundamental physical properties of electricity and magnetism. Electrical engineers often work with other engineers, physical scientists, and computer scientists.

The Computer and Electrical Engineering and Computer Science Department moved into a new building in Fall 2008. The department administers its own local area network which includes multiple Unix/Linux servers, two software programming labs, a walk-in lab/tutoring center, one advanced workstation lab, an isolated network lab, an AI/visualization lab, a DSP/communications lab, one digital electronics hardware lab, a power systems/electronics lab, and a robotics/control systems lab. There is also a department library/major study room with computers available to students.

An important goal of the department is to enable students to work much more closely with faculty than they would be able to at larger universities. A detailed description of student learning goals and objectives can be found at https://www.cs.csub.edu/abet/.

Requirements for the Bachelor of Science Degree in Electrical Engineering, accredited by the Engineering Accreditation Commission of ABET, www.abet.org

Total Units Required to Graduate	**120 units**
Major Requirements	**90-~~92~~ 94 units**
CMPS/ECE Courses	56-58
Cognate Courses	34-36
Minor Requirement	**0 units**

General Education Requirements	**24 units**
First-Year Seminar	0*
LD Area A Foundational Skills	6*
LD Area B Natural Sciences	0*
LD Area C Arts and Humanities	6
LD Area D Social and Behavioral Sciences	3*
American Institutions	6
SELF	0**
Junior Year Diversity Requirement	3
UD Thematic Areas C and D	0*
Capstone	0*
GWAR (Exam) or Class	0**
Additional Units	**42-6 units*** **

*The following required major courses also meet general education requirements: ECE/ENGR 1618 and 1628 meet First-year Seminar, MATH 2310 or 2510 meets Foundational Skill A4, PHYS 2210 meets LD Area B1, PHIL 3318 meets UD Thematic Area C, and CMPS 4928 meets Capstone. Engineering majors have the following GE modifications: Foundational Skill A3, LD Area B2, 3 units of LD Area D, and UD Thematic Area D.

**The SELF requirement can be met by selecting another General Education course with a SELF overlay or by taking a stand-alone course. The GWAR may be satisfied by taking the GWAR exam, by taking another General Education course with a GWAR overlay, or by taking a stand-alone course. If a student opts to take a stand-alone course for either or both of these requirements, the course(s) will add additional units to that student's general education pathway.

***Additional Units are required to meet the 120-unit requirement for graduation. Any accepted university units may be used to meet this requirement, including stand-alone courses for SELF and GWAR.

SB1440 units required — 58-60 units*

*Units required for graduation after completion of the Engineering (Electrical Engineering focus) model curriculum and lower-division general education at a California community college.

Note: One (1) semester unit of credit normally represents one hour of in-class work and 2-3 hours of outside study per week.

Requirements for the Major in Electrical Engineering

1. **Lower Division** (12 units)
   ECE/ENGR 1618, 1628, ENGR/ECE/PHYS 2070, CMPS 2010
2. **Upper Division** (32 units)
   ECE 3040, 3070, 3200, 3230, 3320, 3370, 3340, 4910, 4928
3. **Upper Division Elective courses** (12 units) **OR Emphasis courses** (14 units)
   Students with a declared emphasis must complete the upper division elective courses required for the emphasis (see below).
   Students without a declared emphasis (Traditional students) must ~~Select~~ select 12 units of upper division elective courses from the following. At least one course must be at the 4000-level:

   Digital Design and Embedded Systems
   ECE 3220, 3250, 4240

   Digital Communication and Digital Signal Processing
   ECE 4220, 4250, 4260

   Control Systems and Robotics
   ECE 3280, 3610, 4570, CMPS/ECE 4550

   Power Systems and Power Electronics
   ECE 3380, 4330, 4370, 4380+4381*

**Students must take both ECE 4380 and 4381 to receive elective credit for the Electrical Engineering degree.*

Image Processing and Computer Vision

ECE 4460, 4470

Special Topics and Independent Study

ECE 3770, 3771, 4770, 4771, 4800, 4860, 4870, 4890

Only a combined total of 4 units of ECE 377x, 477x, 48xx may be used for elective credit.

4. **Required Cognate courses** (34-36 units)
   MATH 2510 or 2310, MATH 2520 or 2320, MATH 2530 or 2533 or 2330 or both MATH 2531 and 2532, MATH 2610, 3200, CHEM 1000, PHYS 2210, 2220, PHIL 3318
5. **General Education Courses and Notes**
   Some of the courses required for the Electrical Engineering major also satisfy General Education requirements. Students who complete each of these courses with the appropriate grade will also satisfy the GE requirement, even if they were to change majors:
   - ECE/ENGR 1618 and 1628 satisfy the First-Year Seminar requirement.
   - ECE 4928 satisfies the Capstone requirement.
   - PHIL 3318 satisfies UD Thematic Area C and the Electrical Engineering Ethics requirement.
   - PHYS 2210 satisfies LD Area B1.
   - MATH 2510 or 2310 with a grade of C- or better satisfies Foundational Skill A4.

   Engineering majors have the following General Education Modifications (GEMs), which means they do not have to take courses to satisfy these GE requirements. These GEMs are specific to the three engineering majors (Computer Engineering, Electrical Engineering and Engineering Sciences). Students who change to another major will not keep the modifications:
   - Foundational Skill A3 is embedded in PHYS 2210, 2220 and ECE/ENGR/PHYS 2070.
   - LD Area B2 is embedded throughout the curriculum.
   - 3 units of LD Area D is met through EAC/ABET outcomes 2 and 4.
   - UD Thematic Area D is met through EAC/ABET outcomes 2 and 4.

Requirements for the Major in Electrical Engineering with Energy and Power Engineering Emphasis

The Energy and Power Emphasis is obtained by taking the courses required above for the BS degree in Electrical Engineering but choosing the following 14 units of Upper Division electives: ENGR 3110, ENGR 4610, ENGR 4620, ECE 4380, and ECE 4381. In addition, students pursuing this emphasis are encouraged to undertake a design project related to energy and power engineering, when available, in ECE 4910 and 4928.

Lower Division

ECE/ENGR 1618 Introduction to Engineering I (2)

This course will provide an introduction to the practice of engineering and the various areas within the engineering disciplines. Students will be informed of engineering curricula and career opportunities within the various engineering disciplines. This course will also introduce students to important topics for academic success, both at the major level and at the university level. Each week meets for 50 minutes of lecture and 100 minutes of activity.

ECE/ENGR 1628 Introduction to Engineering II (2)

This course builds on the foundational skills in engineering design and practices developed in ENGR/ECE 1618. Students will design, build, test, and present engineering projects designed to solve specified problems within given constraints. Additionally, the impact of engineering from a global, social, economic, and environmental perspective is presented through case studies. Each week meets for 50 minutes of lecture and 100 minutes of activity. Prerequisite: ENGR/ECE 1618. Completion of ECE/ENGR 1618 and 1628 satisfies general education requirement First-Year Seminar.

ECE/ENGR/PHYS 2070 Electric Circuits (4)
An introduction to the analysis of electrical circuits. Use of analytical techniques based on the application of circuit laws and network theorems. Analysis of DC and AC circuits containing resistors, capacitors, inductors, dependent sources and/or switches. Natural and forced responses of first and second order RLC circuits; the use of phasors; AC power calculations; power transfer; and energy concepts. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: PHYS 2220 with a grade of C- or better, or permission of the instructor.

ECE 2600 High-speed Rail (4)
The course gives an overview of the high-speed rail (HSR) technology crossing electrical transmission and traction drive control systems, power supply technology, signal and communication systems, mechanical and civil engineering, and transportation scheduling, and provides an opportunity to learn a variety of software packages regarding the aerodynamics impact on a high-speed train, operating the high speed train and designing the train interior layout, and the passage service system. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 1030 or 1040 or 1060 and basic computer skills.

ECE 2770 Special Topics in Engineering (1-3)
This course will be used to supplement regularly scheduled courses with additional material at the beginning level.

ECE 2771 Special Topics Laboratory (1)
Optional laboratory for the study of topics at the beginning level. Corequisite: ECE 2770.

Upper Division

ECE 3040 Signals and Systems (4)
Time and frequency domain techniques for signal and system analysis. Fourier series and transforms, and Laplace transforms. Topics in differential equations and probability. Use of a numerical computing environment such as MATLAB. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520 with a grade of C- or better and ENGR/ECE/PHYS 2070 with a grade of C- or better.

ECE 3070 Analog Circuits (4)
Design, construction, and debugging of analog electronic circuits. Diodes, filters, oscillators, transistors, JFETs, op-amps, and basic analog circuit design. Broadband applications in networking and communications. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520 with a grade of C- or better, MATH 2610, and ENGR/ECE/PHYS 2070 with a grade of C- or better.

ECE 3200 Digital Circuits (4)
Introduce combinational logic and sequential logic designs, and microprocessors. Cover digital concepts, number systems, operations, and codes, logic gates, Boolean algebra and logic simplification, combinational logic and its functions, flip-flops and related devices, counters, shift registers, memory and storage, concepts of microprocessors, assembly language, computers, and buses. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ENGR/ECE/PHYS 2070 with a grade of C- or better.

ECE 3220 Digital Design with VHDL (4)
Introduces logic system design using a hardware description language (VHDL). Covers the VHDL language in depth and explains how to use it to describe complex combinational and sequential logic circuits. Include a weekly lab where students will get hands-on experience implementing digital systems on Field Programmable Gate Arrays. Each week

lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ENGR/ECE/PHYS 2070 with a grade of C- or better and ECE 3200.

ECE 3230 Digital Communications (4)
This course focuses on the representation of signals and noise, Gaussian processes, correlation functions and power spectra, linear systems and random processes, performance analysis and design of coherent and non-coherent communication systems, phase-shift-keying, frequency-shift-keying, and M-ary communication systems, optimum receivers and signal space concepts, information and its measure, source encoding, channel capacity, and error correcting coding. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520 with a grade of C- or better, ENGR/ECE/PHYS 2070 with a grade of C- or better, ECE 3040 with a grade of C- or better.

ECE 3250 Embedded Systems (4)
Introduce embedded systems. Cover embedded concepts, NI sbRIO embedded system devices, LabVIEW RT and FPGA modules, combinational and sequential logic circuits design, finite state machines, memory and storage, sensor and motor interface. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ECE 3070 and 3200.

ECE 3280 Instrumentation, Control, and Data Acquisition (4)
Introduction to LabVIEW and NI Elvis board. Students learn how to use NI virtual instruments, such as function generators, oscilloscopes, etc., design a variety of projects on analog and digital inputs, outputs, and signal generations, and use both simulation and hardware test-beds to verify their projects and performance. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ECE 3200 or consent of the instructor.

ECE 3320 Fields and Waves (4)
This course focuses on the fundamentals of electromagnetics. Students are expected to acquire expertise in vector analysis, electrostatic and magnetic fields, Maxwell's equations, plane waves, reflection, attenuation, and impedance. Knowledge of circuit theory, Matlab, differential equations, and calculus are required to successfully complete the course. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520 with a grade of C- or better and ENGR/ECE/PHYS 2070 with a grade of C- or better.

ECE 3340 Control Systems (4)
Introduce control system analysis and design. Cover control system modeling, time response, reduction of multiple systems, stability analysis, steady-state errors, root locus technique, PID controller, and fuzzy controller. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: ECE 3040 with a grade of C- or better.

ECE 3370 Power Systems Fundamentals (4)
This course is an introductory subject in the field of electric power systems. Electric power systems have become increasingly important as a way of transmitting and transforming energy in industrial, military and transportation uses. The course covers basic elements of power system, three-phase circuit analysis, transformers, transmission line configuration, the per unit system and power flow. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ECE/ENGR/PHYS 2070 or ENGR/PHYS 207 with a grade of C- or better.

ECE 3380 Power Electronics and Electrical Drives (4)
The course is an introduction to switched-mode power converters, electromechanical energy conversion systems, and electric drives. It provides a basic knowledge of circuitry for the control and conversion of electrical power with high efficiency. These converters can change and regulate the voltage, current, or power; dc-dc converters, ac-dc rectifiers,

dc-ac inverters, and ac-ac cycloconverters are in common use. Applications include electronic power supplies, aerospace and vehicular hybrid power systems, and renewable energy systems. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: ECE 3070, 3320, 3370.

ECE 3610 Intermediate High-Speed Rail (4)
High Speed Rail (HSR) is an interdisciplinary subject crossing electrical engineering, including electrical transmission and traction drive control systems, power supply technology, and mechanical and civil engineering, including train structures and track construction. The class provides an opportunity to learn a variety of software packages regarding aerodynamic impact on a high-speed train, operating a high-speed train, and designing the interior layout. Students will use a physical HSR simulator for lab projects. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: ECE 3040 and 3070.

ECE 3770 Special Topics in Engineering (1-3)
This course will be used to supplement regularly scheduled courses with additional material at the intermediate level. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements.

ECE 3771 Special Topics Laboratory (1)
Optional laboratory for the study of topics at the intermediate level. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Corequisite: ECE 3770.

ECE 4220 Digital Signal Processing (4)
This course provides an introduction to principles of Digital Signal Processing (DSP) including sampling theory, aliasing effects, frequency response, Finite Impulse Response filters, Infinite Impulse Response filters, spectrum analysis, Z transforms, Discrete Fourier Transform and Fast Fourier Transform. Overviews of modern DSP applications such as modems, speech processing, audio and video compression and expansion, and cellular protocols. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520 with a grade of C- or better, ENGR/ECE/PHYS 2070 with a grade of C- or better, ECE 3040 with a grade of C- or better.

ECE 4240 Microprocessor System Design (4)
Introduce microprocessor architecture and organization. Cover bus architectures, types and buffering techniques, Memory and I/O subsystems, organization, timing and interfacing, Peripheral controllers and programming. Design a microprocessor system. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: ENGR/ECE/PHYS 2070 with a grade of C- or better and ECE 3200.

ECE 4250 Wireless Communications (4)
In this course analytical characterizations of mobile communications channels are developed. The main techniques for mitigating the mobile communication channel effects such as Equalization, Diversity, etc. are examined. Multiple access techniques used in wireless communications, such as FDMA as well as digital TDMA and CDMA techniques are presented. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: MATH 2320 or 2520 with a grade of C- or better, ENGR/ECE/PHYS 2070 with a grade of C- or better, ECE 3040 with a grade of C- or better.

ECE 4260 Wireless Networks (4)
This course focuses on wireless data communications including wireless internet. The students acquire knowledge into the current and future state-of-the-art of technology in the field of wireless communications. Another goal of the

course is to ensure student(s) can explain the impact of commercial, political, and regulatory factors on the design of wireless systems. The course will treat current relevant technologies, and the exact content may change from year to year. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: MATH 2320 or 2520 with a grade of C- or better.

ECE 4330 Mechatronics (4)
Intelligent electro-mechanical systems. Topics include electronics (A/D, D/A converters, op-amps, filters, power devices), software program design (event-driven programming, state machine-based design), DC and stepper motors, basic sensing and basic mechanical design. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: CMPS 2020 with a grade of C- or better, ECE 3070, and 3200.

ECE 4370 Power Systems Analysis (4)
This course follows the discussions from the first course in power systems. This course focuses on power flow, symmetrical components, faulted system analysis, and protection schemes. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: ECE 3370.

ECE 4380 Power System Operation with Renewable Energy Resources (3)
Renewable energy, distributed generation, impacts of renewable energy-based generation on power system operation, electrical energy markets, deregulated power system, hybrid power generation. Each week meets for 150 minutes of lecture. Prerequisite: ECE 3370.

ECE 4381 Power System Operation with Renewable Energy Resources Laboratory (1)
Laboratory in power system operations with renewable energy-based generation. Completion of the laboratory component is required for Electrical Engineering majors to get elective credit for this course. Each week meets for 150 minutes of laboratory. Prerequisite or corequisite: ECE 4380.

ECE 4460 Image Processing (4)
This course covers the following: digital image acquisition, image enhancement and restoration, image compression, spatial and frequency-based image filtering, color processing, low level image segmentation and feature extraction. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: ECE 3040 with a grade of C- or better.

ECE/CMPS 4470 Computer Vision (4)
This course covers the following: Image formation, early vision, image morphology, image segmentation, object/feature representation and an introduction to supervised and unsupervised learning with an emphasis on image understanding. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: MATH 2320 or 2520 with a grade of C- or better and (CMPS 3120 with a grade of C- or better or ECE 3040 with a grade of C- or better).

CMPS/ECE 4550 Applied Machine Learning (4)
Students will learn the basics of machine learning including: supervised vs. unsupervised learning, regression, dimensionality reduction and reinforcement learning. Focus will be given to experimental setup including normalization, evaluation criteria and outlier detection. Experiments will be carried out with contemporary and classical methods on real world data sets in a wide range of applications. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisite: MATH 3200.

ECE 4570 Robotics (4)
Introduce robotic systems. Cover Mindstorms NXT, motion control, target steering and trajectory planning, obstacle avoidance, line tracking, and multiple sensor fusion. Each week lecture meets for 150 minutes and lab meets for 150 minutes. Prerequisites: ENGR/ECE/PHYS 2070 with a grade of C- or better and ECE 3040 with a grade of C- or better.

ECE 4770 Special Topics in Engineering (1-3)
This course will often be used to supplement other courses with additional work at a more advanced level. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

ECE 4771 Special Topics Laboratory (1)
Optional laboratory for the study of topics at a more advanced level. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Corequisite: ECE 4770. Prerequisite: Permission of the instructor.

ECE 4800 Undergraduate Research (1-4)
Independent study into a research topic under the supervision of a faculty member. Students will establish the research goals and objectives with their faculty supervisor. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

ECE 4860 Internship (1-4)
Internships may be arranged by the department with various agencies, businesses, or industries. The assignments and coordination of work projects with conferences and reading, as well as course credits, evaluation, and grading are the responsibility of the faculty liaison (or course instructor), working with the field supervisor. Offered on a credit, no-credit basis only. The department will determine the number of credit units offered. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

ECE 4870 Cooperative Education (1-4)
The Cooperative Education program offers a sponsored learning experience in a work setting, integrated with a field analysis seminar. The field experience is contracted by the Cooperative Education office on an individual basis, subject to approval by the department. The field experience, including the seminar and reading assignments, is supervised by the cooperative education coordinator and the faculty liaison (or course instructor), working with the field supervisor. Students are expected to enroll in the course for at least two semesters. Offered on a credit, no-credit basis only. The department will determine the number of credit units offered. Course is repeatable, but only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: Permission of the instructor.

ECE 4890 Experiential Prior Learning (1-4)
Majors in Computer and Electrical Engineering with significant prior experience in computers and/or electronics may have some of their experience count for academic credit toward their degree. In order to be considered for experiential learning credit the student must have completed CMPS 2010 and have the approval of the department. Only a combined total of 4 units of ECE 377x, 477x, and 48xx may be used for elective credit towards the major requirements. Prerequisite: CMPS 2010 with a grade of C- or better and permission of the instructor

ECE 4910 Senior Project I (2)
After consultation with the faculty supervisor and investigation of relevant literature, the student(s) shall prepare a substantial project with significance in the designated area. The timeline, teamwork responsibilities, milestones, and presentation(s) will be scheduled. Prerequisite: At least 12 units of 3000- or 4000- level ECE and CMPS courses.

ECE 4928 Senior Project II (2)
This is the completion phase of the project. Students will present a project report to the entire class, explaining the nature of the work, the finished product, and its relationship to the field. Students will demonstrate proficiency in critical thinking, information literacy, written communication, and quantitative reasoning in their written project report. Additionally, students will demonstrate an understanding of their academic pursuits by reflecting on their studies of the arts, humanities, natural sciences, behavioral sciences, and social sciences. Prerequisite: ECE 4910 and completion of at least 90 units. Prerequisite or Corequisite: Completion of or concurrent enrollment in all GE course requirements for engineering majors. Satisfies general education requirement Capstone.

ECE 4960 Leadership in Engineering (1-2)
Leadership in computer and electrical engineering related activities that meet campus and/or community needs. Offered on a credit, no-credit basis only. Course is repeatable. Course credits cannot be used as elective credit towards the major requirements but can be used as additional university units. Prerequisite: Permission of the instructor.

ECE 4970 Service Learning in Engineering (1-2)
Service learning in computer and electrical engineering related activities that meet campus and/or community needs. Students will design and/or implement a service learning project in consultation with their faculty supervisor and, if applicable, community partners. Offered on a credit, no-credit basis only. Course is repeatable. Course credits cannot be used as elective credit towards the major requirements but can be used as additional university units. Prerequisite: Permission of the instructor.

ECE 4980 Teaching in Engineering (1-2)
Experience supporting teaching activities in department courses, providing tutoring in the department tutoring center, leading problem-solving sessions, and/or supporting other instructional activities in the department. Offered on a credit, no-credit basis only. Course is repeatable. Course credits cannot be used as elective credit towards the major requirements but can be used as additional university units. Prerequisite: Permission of the instructor.

3) Curriculum

a) Goals for the (1) program and (2) student learning outcomes. Program goals are very broad statements about what the program is intended to achieve, including what kinds of graduates will be produced. Student learning outcomes are more specific statements that are related to the program goals but that more narrowly identify what students will know and be able to do upon successful completion of the program.

The Energy and Power Engineering Emphasis will be integrated with the B.S. in Electrical Engineering program, and so will share the same goals (Program Educational Objectives) and will support the program Student Learning Outcomes.

The Program Educational Objectives are to produce graduates who will, after 3-5 years after graduation:

- Engage in the productive practice of electrical engineering to identify and solve significant real-world problems across a broad range of application areas.
- Ethically apply their electrical engineering knowledge and skills with an understanding of realistic constraints for the overall benefit of a diverse society.
- Enhance the economic well-being of both Kern County and the State of California through a combination of technical expertise, social responsibility, leadership, and entrepreneurship.
- Effectively define, lead, and manage electrical engineering projects to deliver timely results.

Student Outcomes for the Electrical Engineering program are the following. Upon finishing the B.S. degree, a graduate in Electrical Engineering should demonstrate:

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- An ability to communicate effectively with a range of audiences.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

b) Plans for assessing program goals and student learning outcomes.

The new emphasis will be assessed as a part of the assessment of the Electrical Engineering program. The current assessment plan is in Appendix A. Additional assessment will involve surveys of graduating students, alumni, and their employers.

c) Other concentrations or emphases and how their curriculum overlaps that proposed.

The B.S. in Electrical Engineering program has no other concentrations or emphases. However, the proposed emphasis is coordinated with the P&E department and will be similar to the Energy and Power Engineering emphasis already developed in that department.

d) *A list of all courses required for the program, specifying catalog number, title, units of credit, and prerequisites or co-requisites (ensuring that there are no "hidden" prerequisites that would drive the total units required to graduate beyond the total reported in 4c above). Include proposed catalog descriptions of all new courses.*

The Energy and Power Engineering Emphasis is obtained by choosing the electives listed below. All listed prerequisites are required for the Electrical Engineering program, i.e. there are no additional, hidden, prerequisites. All courses listed have been approved and are already in the 2018-2020 University Catalog.

- ENGR 3110 Thermodynamics (4). Prerequisites: PHYS 2210, CHEM 1000.
- ENGR 4610 Conventional Energy Production (3). Prerequisite: ENGR 3110 Thermodynamics.
- ENGR 4620 Renewable Energy Production (3). Prerequisite: ENGR 3110 Thermodynamics.
- ECE 4380 Power System Operation with Renewable Energy Resources (3). Prerequisite: ECE 3370.
- ECE 4381 Power Systems with Renewable Energy Laboratory (1). Prerequisite: ECE 3370.

e) *List of elective courses that can be used to satisfy requirements for the program, specifying catalog number, title, units of credit, and prerequisites or co-requisites. Include proposed catalog descriptions and course approval sheets for all new courses. For graduate program proposals, identify whether each course is a graduate or undergraduate offering.*

None

f) *List of any new courses that are: (1) needed to initiate the program and (2) needed during the first two years after implementation. Only include proposed catalog descriptions for new courses. For graduate program proposals, identify whether each course is a graduate-level or undergraduate-level offering.*

N/A

g) *For undergraduate programs, planned provisions for articulation of the proposed program with community college programs. In particular, designate the proposed program as similar or dissimilar to any transfer model curricula developed for compliance with SB 1440 (the STAR Act).*

N/A

h) *Advising "roadmaps" that have been developed.*

A student intending to fulfill the requirements for the emphasis will need to start taking the relevant elective courses in the fall semester of her/his junior year. The representative roadmap we have developed is included in Appendix B.

i) *Provision for meeting accreditation requirements, if applicable, and anticipated date of accreditation request (including the WASC Substantive Change process)*.

The relevant accrediting agency is ABET (formerly known as Accreditation Board for Engineering and Technology). The Electrical Engineering program has recently received the accreditation. The relevant ABET requirement is that the program contain a minimum of 45 units of engineering topics. The core Electrical Engineering courses add up well above this limit. As a result, this condition is met with the proposed elective courses. Thus, the ABET requirement is satisfied.

4) ***Need for the Proposed Program***

a) *List of other California State University campuses currently offering similar programs; list of neighboring institutions, public and private, currently offering similar programs.*

Electrical Engineering is a traditional degree within engineering disciplines. Most CSU campuses offer a degree in Electrical Engineering. However, no CSU campus offer a BS in Energy Engineering. Also none offers an emphasis or concentration in Power Engineering. UC Berkeley offers a BS in Energy Engineering. Stanford University offers a BS in Energy Resources Engineering.

b) *List of any other curricula currently offered by the campus that are closely related to the proposed program.*

The only program similar to the proposed emphasis is the Energy and Power Engineering emphasis developed in the P&E department. In fact, the proposed emphasis in this document is the continuation of the emphasis in the P&E department offered to the students majored in the Electrical Engineering program.

c) *Community participation, if any, in the planning process. This may include prospective employers of graduates.*

We have consulted with the CSUB Engineering Industry Advisory Board, which has representatives from the major industries in the area, as well as government and alumni. They were very supportive of the new emphasis and contributed valuable suggestions during the planning stages.

d) *Applicable workforce demand projections and other relevant data.*

Specific employment projections data for such specific field as Energy and Power Engineering are not available from the usual sources (e.g. U. S. Bureau of Labor Statistics, State of California Employment Development Department, California Energy Commission, etc.) However, one can get a reasonably good picture of workforce demands by looking at energy production and consumption in the state and in the nation.

According to the U. S. Energy Information Administration (US EIA), California's total energy demand is second only to Texas. There are 2,179 power plants, of all types, in our state (according to the California Energy Commission). We consumed 290,567 GWh in 2016 (29% from renewable sources), of which we import 92,341 GWh from other states. California is the country's top producer of hydroelectric power (US EIA, California Profile Data, Reserves and Supply, updated September 8, 2016). Indeed, it became the first state in the nation to get more than 5% of its utility scale electricity generation from

its solar resource (US EIA, "California first state to generate more than 5% of electricity from utility-scale solar," Today in Energy, March 24, 2015). California's official goal is to obtain 50% of its electricity from renewable sources by 2030. A proposal being considered by the legislature would increase this goal to 60% by 2030 and phase out fossil fuels by 2045 (LA Times "California's goal: an electricity grid moving only clean energy" August 31, 2017).

The production and distribution of these enormous amounts of energy require thousands of engineers. Most of them are Mechanical and Electrical Engineers, although some have engineering degrees in Energy, Renewable Energy, or other related disciplines. The electives in the proposed emphasis will further prepare the student to pursue careers in the energy production and power distribution sectors.

In 2010, NSM&E hired an outside firm (Jacquelyn S. Jans Marketing & Corporate Image Consultant) to conduct a needs assessment study in connection with energy engineering (and also computer engineering). They found that over half of the potential employers surveyed believe that graduates of the proposed program will actually be "more employable than traditional engineering programs".

As the energy landscape in California and the United States continues to develop there will be new opportunities for employment in a variety of energy-related fields. These areas include: oil and gas, energy storage (batteries), solar, wind, hydroelectric, hydrogen, and perhaps even nuclear.

e) *If the program was proposed to meet society's need for the advancement of knowledge, please specify the need and explain how the program meets that need.*

N/A

5) ***Student Demand*** *It may be helpful to address the following areas:*

a) *Evidence of student interest in enrolling in the proposed program.*

Our students are eager to pursue programs which are interesting and will prepare them for jobs in industry, especially those located in the California. The recent implementation of the proposed emphasis in the P&E department has been successful. The number of students choosing the Energy and Power Engineering emphasis in the P&E department is increasing. This demonstrates the interest among CSUB engineering students.

b) *Issues of diversity and access to the university considered when planning this program.*

Our engineering program has 52% Hispanic students, 23% Caucasian, 7% Asian, and 3% Black/African American, 15% Other. This is comparable to CSUB's demographics (52%

Hispanic, 23% Caucasian, 7% Black/African American, 7% Asian, 11% Other). Furthermore, we have around 25% female students. This is significantly less than the female representation across campus, which is around 62%. We did not specifically address diversity issues when planning this program, although we are trying to recruit and retain more female students by supporting the local student chapter of the Society of Women Engineers (SWE) and by assertively pursuing female applicants when any faculty positions open up.

c) *For master's degree proposals, the number of declared undergraduate majors in closely allied disciplines and the degree production over the preceding three years for the corresponding baccalaureate program(s), if they exist.*

N/A

d) *Professional uses of the proposed program.*

Our graduates will perform technical and managerial engineering tasks. Our new emphasis focuses on technical needs of the energy production and power distribution industries. However, these students will still take the Electrical Engineering core courses, so they will have access to other engineering positions.

e) *The expected number students in the program in the year of initiation and three years and five years thereafter. The expected number of graduates in the year of initiation, and three years and five years thereafter.*

We use the rather conservative assumptions that we will get 8 freshmen and 8 transfer students from the community college for each of the next five years. (We are already doing grant-funded outreach to Bakersfield College and local high schools.) In addition, we assume 50% attrition rate over four years. This yields the estimates below.

	2019-2020	2021-2022	2023-2024
E & P Engineering Emphasis students	16	33	37
E & P Engineering Emphasis graduates	0	6	10

6) ***Existing Support Resources for the Proposed Program***

a) *Faculty who would teach in the program, indicating rank, appointment status, and highest degree earned. For master's degrees, include faculty publications or curriculum vitae.*

No new faculty will be hired specifically to teach in this new emphasis. The proposed

emphasis contains courses offered in the Electrical Engineering (ECE) and Engineering Sciences (ENGR) programs. The necessary ECE courses can be taught by Dr. Saeed Jafarzadeh (Associate Professor), or Dr. Ehsan Reihani (Assistant Professor). The necessary ENGR courses can be taught by Dr. Karim Salehpoor (Full Time Lecturer), Dr. Travis Moore (Assistant Professor), or Dr. Tathagata Acharya (Assistant Professor).

The new emphasis electives will be offered on a two-year rotation basis. ECE 3370 is a core course required for the BS in Electrical Engineering and is offered once a year. ENGR 3110 is a core course required for the BS in Engineering Sciences program and is offered once a year by the P&E department. The schedule for the necessary electives is as follows:

	F-19	S-20	F-20	S-21	F-21	S-22
ENGR 3110	X		X		X	
ENGR 4610				X		
ENGR 4620		X				X
ECE 3370		X		X		X
ECE 4380	X		X		X	
ECE 4381	X		X		X	

We will not need to cancel any other courses in order to offer these classes. We have sufficient faculty to staff them. These are existing courses that are already being offered as part of the Energy and Power Engineering emphasis in the P&E department.

b) *Describe special space, facilities, library resources, equipment, academic technology, or special materials that would be used in support of the proposed program.*

These are mostly lecture courses. The only exception is ECE 3370, which has a lab component, and is taught in Engineering Complex 201. Any additional sections of that lab (due to either growth in Electrical Engineering or the E&P Emphasis) will be held there as well. As to the lecture component of these courses, we do not anticipate them being larger than about 24 so we do not foresee any space problems (beyond those we already have).

The equipment required for the ECE 3370 laboratory has been purchased already with grant funds. We use modules called Electromechanical Training Systems to perform power systems experiments. Any additional modules will also be purchased from grant funds.

The only library resources needed for the emphasis is the IEEE journals subscription that we already have in connection with the Electrical Engineering program.

7) ***Additional Support Resources Required*** *Note: If additional support resources will be needed to implement and maintain the program, a statement by the responsible administrator(s) should be attached to the proposal assuring that such resources will be provided.*

a) *Any additional faculty or staff support positions needed to implement the proposed program.*

N/A

b) *The amount of additional lecture and/or laboratory space required to initiate and to sustain the program over the next five years. Indicate any additional special facilities that will be required. If the space is under construction, what is the projected occupancy date? If the space is planned, indicate campus-wide priority of the facility, capital outlay program priority, and projected date of occupancy.*

N/A

c) *Any additional library resources needed. Indicate the commitment of the campus either to purchase or borrow through interlibrary loan these additional resources.*

No additional library resources beyond the existing resources will be needed.

d) *Additional academic technology, equipment, or specialized materials that will be (1) needed to implement the program and (2) needed during the first two years after initiation. Indicate the source of funds and priority to secure these resource needs.*

We have purchased the Training Systems mentioned above. Any more modules or equipment to support the emphasis will be purchased using funds from the Title V grant. The grant has a total of $626,708 allocated to equipment and $185,123 for supplies. We are presently in the fourth year of this five-year grant. These funds will be more than sufficient for the proposed program's needs.

Appendix A

Bachelor of Science in Electrical Engineering
Assessment Plan

Electrical Engineering Performance Indicators

(1) an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

1a) Apply and perform the correct mathematical analysis.
2a) Prepare and solve the appropriate physical model of the problem.
3a) Utilize appropriate engineering principles for computer and electrical engineering.

(2) an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

2a) Follow systematic and logical design procedures and define specifications to meet project requirements.
2b) Adhere to realistic constraints such as environmental, social, political, ethical, health and safety, and sustainability.
2c) Consider alternative designs and choose the optimal solution.
2d) Consider a variety of available options in engineering design and make a proper choice based on their impact.

(3) an ability to communicate effectively with a range of audiences

3a) Write technical reports.
3b) Prepare and deliver oral presentations.

(4) an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts

4a) Recognize ethical issues involved in a professional setting.
4b) Recognize and cope with professional and ethical issues related to safety and sustainability in engineering problems.
4c) Understand the impact of engineering solutions on society and the environment in a global economic context.
4d) Understand and explain non-technical issues related to global, economic, environmental, and societal contexts.

(5) an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

5a) Fulfill team duties and share in the work of the team.
5b) Listen and communicate with other team members.

5c) Meet deadlines and achieve project goals.

(6) an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

6a) Design and set up experiments.
6b) Conduct experiments and perform measurements.
6c) Analyze data and interpret results.
6d) Use appropriate tools, simulation software, or hardware design tools to solve engineering problems.

(7) an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

7a) Carry out research on engineering topics by reading and reporting on papers in the technical literature.
7b) Involve oneself in professional activities (e.g. meeting, presentations, workshops).
7c) Identify and discuss emerging technologies related to computer and electrical engineering.
7d) Understand the relation of classical topics in engineering with their implementation in modern technologies.

Electrical Engineering Proposed (Semester Conversion affected 3040 and 4910+4928)

E = Even Years (2016/17, 2018/19, etc) O = Odd Years (2017/18, 2019/20, etc) A = All Years

		3040	3070	3200	3230	3320	3340	3370	4910	4928	Summary
1. Eng/Sci/Math											**1**
1a	Math	O	E					E			A
1b	Science		O								O
1c	Engineering					E					E
2. Design											**2**
2a	Design								A		A
2b	Constraints								A		A
2c	Alternatives								A		A
2d	Choose Solution								A		A
3. Communicate											**3**
3a	Written Comm.									A	A
3b	Oral Comm.									A	A
4. Eth. & Prof. Resp.											**4**
4a	Ethical Issues								A		A
4b	Professional								A		A
4c	Solution Impact								A		A
4d	Non-technical								A		A
5. Teamwork											**5**
5a	Team Duties									A	A
5b	Communicate									A	A
5c	Deadlines									A	A
6. Experimentation											**6**
6a	Design			O							O
6b	Conduct			O							O
6c	Analyze						O				O
6d	Use Tools				E						E
7. New Knowledge											**7**
7a	Research								A		A
7b	Prof. Activities								A		A
7c	Emerging Tech.								A		A
7d	Modern Tech.								A		A

Appendix B

Sample roadmap for
BS in Electrical Engineering with Emphasis in Energy and Power Engineering

Semester	Fall	Spring
Freshman	ECE/ENGR 1618 - Intro to Engineering I (2) MATH 2310 or 2510 - Calculus I (4) GE A1 - Oral Communication (3) CMPS 2010 - Programming I (4) GE A2 - Written Communication (3)	ECE/ENGR 1628 - Intro to Engineering II (2) MATH 2320 or 2520 - Calculus II (4) PHYS 2210 - Physics I (4) CHEM 1000 - General Chemistry (3) GE C1 - Art/Music (3)
32 units	**16 units**	**16 units**
Sophomore	MATH 2530 - Vector Calculus (4) MATH 2610 - Linear Algebra (4) PHYS 2220 - Physics II (4) GE Area D (3)	ECE/ENGR 2070 - Electric Circuits (4) MATH 3200 - Probability Theory (4) GE US History (3) GE C2 – Humanities (3)
29 units	**15 units**	**14 units**
Junior	ECE 3040 - Signals and Systems (4) ECE 3200 - Digital Circuits (4) ENGR 3110 - Thermodynamics (4) GE JYDR (3)	ECE 3070 - Analog Circuits (4) ECE 3230 - Digital Commun. (4) ECE 3370 - Power Systems (4) ENGR 4610 - Conventional Energy Production (3) GE SELF (0)
30 units	**15 units**	**15 units**
Senior	ECE 3320 - Fields and Waves (4) ECE 4910 - Senior Project I (2) ECE 4380 - Power Sys. Op. w/Ren. Energy Resources (3) ECE 4381 - Power Sys. Op. w/Ren. Energy Resources Laboratory (1). PHIL 3318 - Professional Ethics (3) GE GWAR class (3)	ECE 3340 - Control Theory (4) ECE 4928 - Senior Project II (2) ENGR 4620 - Renewable Energy Production (3) GE American Government (3)
28 units	**16 units**	**12 units**

Appendix C

Letter of Support – Physics and Engineering Department Chair

CSU Bakersfield
School of Natural Sciences, Mathematics, and Engineering
Department of Physics and Engineering

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(661) 654-2693 FAX
www.csub.edu/nsme

March 29, 2019

Re: Letter of Support for Energy and Power emphasis in Electrical Engineering

The Physics and Engineering (P&E) Department supports the proposed Energy and Power Emphasis in Electrical Engineering. The proposed curriculum was developed in consultation with faculty in the P&E Department and multiple faculty members from the department have been involved with the Title V Energy and Power grant. This emphasis provides many opportunities for interdisciplinary collaborations between the P&E and Computer and Electrical Engineering and Computer Science departments in the areas of energy and power, along with opportunities to collaborate with the California Energy Research Center (CERC) and community partners.

The proposed emphasis will require three ENGR courses in the areas of Thermodynamics and Energy Production. The department has designed the three required ENGR courses to be accessible to Electrical Engineering students who are following this emphasis. The courses are also part of our own department's Energy and Power Emphasis, so we are committed to offering them on a regular basis. Additionally, existing faculty have the expertise to teach these courses.

The P&E Department has committed to offering the three required ENGR courses in the following rotation:

- ENGR 3110 Thermodynamics will be offered every Fall semester. This course is also a core course for Engineering Sciences students.
- ENGR 4610 Conventional Energy Production is currently offered every other Spring semester. This course is also an elective course for Engineering Sciences students.
- ENGR 4620 Renewable Energy Production is currently offered every other Spring semester. This course is also an elective course for Engineering Sciences students.

Sincerely,

Alexander Dzyubenko
Department Chair

Appendix D

Catalog descriptions of ENGR courses required for the emphasis

ENGR 3110 Thermodynamics (4)
Study of the first law of thermodynamics, properties of pure substances, entropy, the second law of thermodynamics, reversible and irreversible processes, availability (exergy), ideal vapor power cycles, ideal gas power cycles, and refrigeration and heat pump cycles. 150 minutes lecture/discussion and 150 minutes laboratory per week. Prerequisites: PHYS 2220, and CHEM 1000 both with a C- or better.

ENGR 4610 Conventional Energy Production (3)
Study of combustion of fossil fuels, thermal power plant and cogeneration, gas turbine power plant and cogeneration, combined gas turbine-thermal power plant, integrated gasification combined cycle (IGCC) power plants, nuclear power plants, and environmental impacts associated with conventional energy production methods. 150 minutes lecture/discussion. Prerequisite: ENGR 3110.

ENGR 4620 Renewable Energy Production (3)
Study of hydro energy systems, geothermal energy systems, wind energy systems, solar energy systems, fuel cells, thermoelectric power generator, biomass, carbon capturing and sequestration, energy storage, economic analysis of energy generating systems, and environmental impacts associated with renewable energy production methods. 150 minutes lecture/discussion. Prerequisite: ENGR 3110.