If this new plan is not listed in the current NAU academic program inventory, then you must first complete the academic planning framework.

If this new certificate will be eligible for federal financial aid, then please submit the gainful employment application.

All Plans with NCATE/CAEP designation, or plans seeking NCATE/CAEP designation, must include an NCATE/CAEP Accreditation Memo of Approval from the NAU NCATE/CAEP administrator prior to submission.

UCC proposals must include an 8-term plan (if applicable).  UGC proposals must include a program of study.

1. College: College of Engineering, Forestry, and Natural Sciences
2. Academic Unit: Biological Sciences, Mechanical Engineering
3. Academic Plan Name: DOCTORAL PROGRAM in Bioengineering
4. Emphasis:

6. Justification for the new plan or certificate, including how the need for the plan was determined. Please also address how it is designed to meet local market, professional requirements, employment opportunities, or other needs.

Justification: A comprehensive, interdisciplinary Ph.D. Program in Bioengineering will prepare graduates who are ready to enter one of the fastest growing and highest paid local, state, and national job markets, as well as provide highly trained students to accelerate research productivity and increase extramural funding of NAU faculty.

Determination of Need: The need for the plan was determined using data from the U.S. Bureau of Labor Statistics, NAU’s Strategic Plan, the Arizona Board of Regents’ 2020 Vision, data on similar programs in the State of Arizona and the Southwestern U.S., as well as discussions with stakeholders including participating NAU departments and representatives of a dozen local and regional bioengineering businesses (see attached letters of support).

Local Market Needs, Professional Requirements, and Employment Opportunities: Multidisciplinary research collaborations between Biological Sciences and Mechanical Engineering have been fostered by the new Center for Bioengineering Innovation and the new Informatics and Computing Program at NAU. A new doctoral program in Bioengineering will facilitate the development of partnerships with local and state industries including W. L. Gore & Associates, Protein Genomics Inc., Barrow Neurological Institute, NACET, the Arizona Commerce Authority, and others to achieve mutual research and educational goals. A Bioengineering program would also expand NAU’s intellectual...
property portfolio, promoting NAU Technology Transfer spin-offs, increasing collaborations with the Northern Arizona Center for Entrepreneurship and Technology (NACET), and creating new business startups in the region. Increasing technology transfer spin-offs is a nationwide trend that many top universities and institutions have leveraged to increase revenue. While technology transfer is increasing in all disciplines, the life sciences are a major driving force.

The program will significantly expand NAU’s research strengths in the areas of biomaterials and biomechanics research while building capacity for basic research in the life sciences to be translated into engineering solutions in the biotechnology sector. New hires in the areas of biomaterials, biomechanics, drug delivery, and transcriptomics will significantly enhance the ability of NAU’s existing life sciences researchers to participate in technology transfer of their work.

There is a growing and unmet demand from undergraduate and graduate students for courses and training in Bioengineering in Arizona which is only partially addressed by the current Biomedical Engineering offerings from Arizona State University and the University of Arizona (see below). NAU is poised to provide students with a new program option while also fulfilling a greater state need for broader Bioengineering expertise beyond Biomedical engineering. Bioengineering is a quickly growing job market in Arizona, where demand will continue to be strong because of an aging population and an increased need for medical care. Additionally, increased public awareness of bioengineering and biomedical advances is driving more students to these fields of study (U.S. Bureau of Labor Statistics, 2015).

Arizona State University offers a Ph.D. in Biomedical Engineering that, while providing a broad-based education in both engineering and the life and natural sciences, is focused on improving the overall quality of global health care, particularly in the areas of adaptive neural systems, assistive technologies, advanced diagnostics, monitoring and treatment of disease, and individualized medicine. The University of Arizona also offers a Ph.D. in Biomedical Engineering with research emphases in the areas of bioimaging, bioprocessing, cardiovascular nanomedicine, and sensors & implementation.

We plan to create a unique Ph.D. program within the state that would support iconic research projects in the areas of biomaterials and biomechanics at NAU, not limited to biomedical applications. These projects will range beyond biomedical engineering per se, including such areas as energy efficient remote sensing, engineering of artificial “plants,” muscle-like actuation, and others. Additionally, we have targeted our program primarily for training of leaders in industrial research and development, although we do expect that some of our trainees may elect to stay in academia. Unique program features that support this goal include mentoring by professors of practice who are active entrepreneur scientists, industrial internships arranged by students’ advisory committees and supported by program administrators, and an optional certificate in business foundations.

California leads the southwestern United States in number of Biomedical (4) and Bioengineering (6) Ph.D. programs. California universities with doctoral programs in Bioengineering include Caltech, Stanford, University of California at San Diego, San Diego State University, and a joint Bioengineering program co-sponsored by UC Berkeley and UC San Francisco, where one mechanical engineering graduate from NAU recently matriculated.

The remainder of the southwestern U.S. is sparsely populated with Bioengineering and Biomedical Engineering programs. Idaho offers no such programs, whereas New Mexico offers a single Ph.D. program in Biomedical Engineering at the University of New Mexico. Nevada offers a single Ph.D. program in Biomedical Engineering at the University of Nevada at Reno, Colorado offers a single Ph.D. program in Biomedical Engineering at Colorado State University, and Utah offers doctoral programs in both Bioengineering and Biomedical Engineering at the University of Utah and a doctoral program in Biological Engineering at Utah State University.

The lack of sustainability of Ph.D. programs in Biology and Biomedicine is widely touted. There are already more trainees with Ph.D.s than the workforce can support. This trend does not extend to Bioengineering, where there is a current workforce need for bioengineers, primarily in the private sector. Biomedical engineering is expected to be the fastest-growing job market in the United States during the next seven years, according to the U.S. Bureau of Labor Statistics. Between 2014 and 2022, the number of biomedical engineers is projected to rise much faster than the average for all
occupations. A combination of necessity and opportunity will result in the majority of trainees entering careers in industry rather than remaining in academia as teachers and researchers.

We propose a curriculum that is broadly similar to many other doctoral programs in Bioengineering. Interdisciplinary doctoral work requires breadth of disciplinary knowledge as well as highly specialized knowledge and skills in the area of research focus. Coursework in Interdisciplinary programs is thus typically broad in scope, and each student's program of study is highly individualized. Our program is modeled after one of the largest and highly ranked: the joint UCSF UC Berkeley Bioengineering Ph.D. Program (http://bioegrad.berkeley.edu). Most Bioengineering Ph.D. programs require students to take courses in biology, engineering, and quantitative disciplines (mathematics, statistics, computing). To fulfill the breadth of knowledge in bioengineering, students typically select from a list of 400- and 500-level courses that are often co-convened with undergraduate and graduate students.

We will work closely with the Graduate College to develop a marketing plan for this new doctoral program. Our recruitment efforts will target students with a M.S. in biology, engineering, or a related field, and broadly trained undergraduate students with previous research experience. We believe that, first and foremost, students will apply to our program because they are interested in participating in the transformative bioengineering research opportunities that the Graduate Faculty in Bioengineering at NAU can provide. Doctoral programs were historically targeted toward students interested in academic careers. It is evident that there is now significant interest in doctoral-level research undertaken at universities with industrial partners; such programs act as pathways to a variety of additional professional careers. We think that the first students to matriculate in our program will accept our offers of admission due to familiarity with and interest in specific faculty research projects and the career opportunities that they can provide. In the longer term, we aim to attract an increasingly large applicant pool on the basis of the reputation of the program’s outstanding research achievements and the placement of our graduates into both industrial and academic research positions.

The Provost and President plan to include this new Doctoral Program in Bioengineering in the Academic Strategic Plan in February 2016. Although a select few interested students may enter the program as early as Fall 2016 through the Ph.D. Program in Biology, marketing and recruitment is targeted for Fall 2016 for a full cohort of students who would be admitted in Fall 2017. Admission of a few students for Fall 2016 will help to meet NAU and ABOR goals for increasing the number of doctoral degrees completed by 2020. Although we do not plan to request approval of new courses for the program at this time, we anticipate that a number of new courses will be developed within the next 18 months. New courses that we plan to develop include: Internship in Bioengineering, Nanomaterials, Instrumentation, Microelectrical Mechanical Systems (MEMS), Bioengineering Product Development, Bioengineering Research Methods, Biorobotics, and specialty courses taught by new faculty hires.

7. Student learning outcomes of the plan. If structured as plan/emphasis, include for both core and emphasis. (Resources, Examples & Tools for Developing Effective Program Student Learning Outcomes)

**Student Learning Outcomes:** Students will build skills and knowledge through formal coursework and an original dissertation project. The goal is to foster students’ abilities to identify and synthesize fundamental principles of bioengineering and apply them to complex problems. NAU graduates with a Ph.D. in Bioengineering will have achieved the following learning outcomes:

**LO1** Identify major theories, research methods, and technical approaches that support the development of bioengineered devices or systems for the benefit of society at large.

**LO2** Investigate biological systems’ morphology and behavior, and transfer their features in novel bio-engineered systems through deployment of mechanical engineering tools such as mechanism analysis, structural analysis, continuum mechanics, kinematics, and dynamics.

**LO3** Identify, explain, integrate, and apply **interdisciplinary** knowledge (information, data, techniques, tools, perspectives, concepts, and/or theories) associated with the research area of interest to advance fundamental
understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice.

LO4 Identify, survey, analyze, organize, and critically distill information from the scientific literature within the bioengineering research area and formulate open research questions.

LO5 Independently apply appropriate expertise, methods, and tools to the creative design, execution, and assessment of an investigation that addresses original bioengineering research questions.

LO6 Compose and engage in highly effective written and oral communication in bioengineering areas; demonstrate clear argumentation and logical cohesion in a variety of written and oral communications, including scholarly dissemination, funding requests, industry, and lay-communication.

Assessment of Student Performance: Our assessment plan is outlined in Table 2, which refers to the learning outcomes described above and to core and emphasis courses and milestones described in Section 8 (below). Progress will be assessed yearly by each student’s Advisory Committee, which will consist of the major advisor and at least four additional committee members from the Bioengineering Graduate Faculty, with at least one faculty member from both Biology and Mechanical Engineering on each graduate student’s committee.

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>Preparation</th>
<th>Method of Assessment</th>
</tr>
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<tbody>
<tr>
<td>LO1</td>
<td>ME563; ME573; and emphasis courses</td>
<td>Coursework, GPA, Annual Assessment of Research Progress</td>
</tr>
<tr>
<td>LO2</td>
<td>ME563; ME573; BIO/ME698; BIO/ME799, and emphasis courses</td>
<td>Course projects, Prospectus (Graduate Research Proposal), Research Design, Dissertation</td>
</tr>
<tr>
<td>LO3</td>
<td>BIO698; BIO699; core and emphasis courses</td>
<td>Prospectus, Internship, Annual Assessment of Research Progress, Dissertation</td>
</tr>
<tr>
<td>LO4</td>
<td>BIO699; BIO/ME799</td>
<td>Advancement to Candidacy Exam, Professional Presentations, Dissertation Defense</td>
</tr>
<tr>
<td>LO5</td>
<td>BIO698; BIO/ME799; core and emphasis courses</td>
<td>Prospectus, Dissertation</td>
</tr>
</tbody>
</table>

8. Academic Catalog text and requirements:

8a. Text to be displayed in the Academic Description field in the academic catalog (max 3 paragraphs):

The Doctor of Philosophy in Bioengineering allows advanced students to pursue their academic interests and to develop their research skills while studying with faculty specialists in the broad field of bioengineering. Bioengineering research is highly interdisciplinary and facilitates collaborations among faculty and students from several departments across campus including Biology, Mechanical Engineering, Electrical Engineering, Physics, and Physical Therapy. Students from a wide range of science backgrounds can enter this program. The goal of the program is to educate future leaders in industry and academia in the field of Bioengineering.

This doctoral degree provides advanced training in research and technology development through focused coursework, extensive research experience, and industry collaboration. In this program, students will join a new generation of industry leaders, scientists, and engineers who will be uniquely trained to embrace opportunities in the Bioengineering field. The goal of this degree is to foster interdisciplinary, collaborative, and transformative research that lies between traditional science and engineering sub-disciplines. The program promotes professional development by
emphasizing excellence in research and effective communication of ideas and findings.

The program focuses on biomaterials and biomechanics with emphases in informatics and computing and biophysics. Advanced research facilities available to doctoral students in the program include the Center for Bioengineering Innovation (CBI) and the Imaging & Histology Core Facility (IHCF), as well as industrial collaborations in Flagstaff, the state of Arizona, and nationwide.

8b. Text (including the marketing description) to be displayed on the Career tab in the academic catalog (max 3 paragraphs):

**What Can I Do with a Doctor of Philosophy in Bioengineering?**

The Doctor of Philosophy in Bioengineering provides advanced training in research through focused coursework and extensive research experience using an integrative and interdisciplinary approach. Students will develop expertise in collecting, analyzing, interpreting, and presenting data at a level appropriate for positions in industrial research and development or academia. After completing this degree, students will be ready to undertake careers in private companies, government organizations, nonprofits, and universities. Graduates will be prepared to direct a research laboratory and decide which questions to investigate, lead a team that solves problems related to bioengineering, coordinate large research and development projects, teach others about bioengineering including how to conduct research, and translate research discoveries into inventions, products, and businesses.

8c. Text to be displayed on the Overview tab in the academic catalog (max 3 paragraphs):

To receive a Doctor of Philosophy Degree (Ph.D.) at Northern Arizona University, you must complete a planned group of courses from one or more disciplines, satisfied by 60-109 units of graduate-level courses. Most plans require research, a dissertation, and comprehensive exams. All plans have residency requirements regarding time spent on the Flagstaff campus engaged in full-time study.

<table>
<thead>
<tr>
<th>Minimum Units for Completion</th>
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<tbody>
<tr>
<td>Additional Admission Requirements</td>
<td>Required</td>
</tr>
<tr>
<td>Dissertation</td>
<td>Dissertation is required.</td>
</tr>
<tr>
<td>Comprehensive Exam</td>
<td>Comprehensive Exam is required.</td>
</tr>
<tr>
<td>Oral Defense</td>
<td>Oral Defense is required.</td>
</tr>
<tr>
<td>Foreign Language</td>
<td>Optional</td>
</tr>
<tr>
<td>Research</td>
<td>Individualized research is required.</td>
</tr>
</tbody>
</table>

8d. Plan requirements to be displayed on the “Details” tab in the academic catalog. If the plan requires an emphasis, include summary text for each emphasis:

**ADDITIONAL ADMISSION REQUIREMENTS**

Admission to many graduate programs is on a competitive basis, and programs may have higher standards than those established by the Graduate College. For details on graduate admission policies, please visit the Graduate Admissions Policy. International applicants have additional admission requirements. Please see the International Graduate Admissions Policy.

Admission requirements over and above admission to NAU are required and include the following items:

- An NAU Graduate Online application is required for all programs. Details on admission requirements are included in the online application.
- Undergraduate degree in biology, engineering, or other science discipline from a regionally accredited institution. Typically this includes a two-year college mathematics sequence, a one-year sequence in each of physics, chemistry, and computer science, and extensive upper-division work in engineering and biology.

**Effective Fall 2015**
Admission requirements over and above admission to NAU are required and include the following items:
- An NAU Graduate Online application is required for all programs. Details on admission requirements are included in the online application.
- Undergraduate degree from a regionally accredited institution.
- Grade Point Average (GPA) of ≥3.00 (scale is 4.00 = "A"), or the equivalent.
- Undergraduate and graduate coursework transcripts
- GRE® revised General Test
- 3 letters of recommendation
- Personal statement or essay
- All applicants are expected to make contact (i.e. email communication or lab visit) with potential faculty members in the department BEFORE APPLYING. Applicants should only apply if a mentor agrees to support the applicant.
- An earned thesis-based MS degree in a bioengineering, biology, mechanical engineering, or appropriately related science. Direct entry into the PhD Program from a BS degree will be considered on a case-by-case basis for exemplary applicants.
- Demonstrated research ability by being a responsible author on a scientific, peer-reviewed publication (journal article).
- Have equivalent credentials to above, which may include considerable relevant research experience, average GRE scores above the 70th national percentile in Verbal, Quantitative and Writing Ability, experience presenting scientific papers as an author at regional, national or international scientific meetings, with reference letters attesting to the student's performance and responsibility for the science reported at such venues.

DOCTORAL REQUIREMENTS

For the doctoral program in bioengineering, you must complete at least 60 credit hours of coursework, including required foundation and elective courses. Given the breadth of Bioengineering as a discipline, to best prepare you for your dissertation research, your Advisory Committee will approve our individualized Plan of Study at the end of your first year. You must obtain an overall grade point average of at least 3.0 to remain in the program in good standing.

Bioengineering Foundation (11 credits)
- ME 563 (3 credits): Biomechanical Engineering
- ME 573 (3 credits): Biostatistics
- BIO 540 (3 credits): Comparative Animal Physiology
- BIO 698 (1 credit): Scientific Writing
- BIO/ME 698 (1 credit): Graduate Seminar (Challenges of Interdisciplinarity)

Biology Electives
- BIO 514, BIO 535, BIO 541, BIO 542, BIO 545, BIO 587, BIO 682, BIO 685, BIO 799
- BIO 599-Immunology
- BIO 599-Pathology
- BIO 599-Human Gross Anatomy
- BIO 599-Human Physiology
- BIO 599-Human Tissue Biology
- BIO 698-Professional Grant Writing
  BIO 501 (3 credits): Immunobiology
  BIO 514 (3 credits): Advanced Exercise Physiology
  BIO 515 (6 credits): Human Gross Anatomy
  BIO 520 (3 credits): Pathology
  BIO 535 (3 credits): Neurobiology and Behavior
  BIO 541 (3 credits): Cardiorespiratory Physiology
  BIO 542 (3 credits): Biomechanics
  BIO 545 (3 credits): Endocrinology

Effective Fall 2015
Mechanical Engineering Electives
- EGR 502
- ME 520, ME 554, ME 560, ME 561, ME 575, ME 580, ME 599, ME 685, ME 799
ME 502 (3): Advanced Engineering Design
ME 520 (3): Advanced Fluid Dynamics
ME 554 (3): Finite-Element Analysis
ME 560 (3): Advanced Solid Mechanics
ME 561 (3): Engineering Plasticity
ME 575 (3): Adaptive Materials and Systems
ME 580 (3): Mechanics of Composite Materials
ME 599 (3): Contemporary Developments
ME 685 (1-9): Graduate Research
ME 799 (1-9): Dissertation Research

Interdisciplinary Emphases (minimum of 12 units)
- Bioengineering Informatics: courses offered by the Informatics and Computing Program
- Bioengineering & Biophysics: courses offered by the Department of Physics & Astronomy

Other Electives:
As a doctoral student in the Bioengineering program, you are encouraged to pursue coursework related to business foundations and entrepreneurship in the Franke College of Business. You will also be encouraged to obtain an internship with a local or regional industrial partner as part of your graduate training.

Required Milestones: The focus of this program is to develop and execute an original research project in Bioengineering, along with excellent oral and written communication skills necessary for leadership in industry and academia.

Prospectus (beginning of 3rd semester): You will be expected to complete a dissertation prospectus by the beginning of your third semester. Writing of the prospectus will commence in the first semester in BIO 698 Scientific Writing, a required course for all incoming students. The prospectus will include a literature review of your proposed topic area, motivation and rationale for your proposed studies, detailed methods including hypotheses to be tested, expected results and interpretation, and expected impact on the field.

Advancement to Candidacy (end of 4th semester): After completion of your prospectus, you will form an Advisory Committee in consultation with your major advisor. Advancement to candidacy will be conferred based on evaluation of your written prospectus and an oral presentation to your Advisory Committee, based on the prospectus, which must be completed before the end of your second year.

Dissertation Defense (end of final year): You will submit a written doctoral dissertation to your Advisory Committee, and present a public seminar based on your research. An oral examination will be administered by your advisory committee after completion of your public seminar.

8e. Attributes to be displayed on the Overview tab in the academic catalog:

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<th>Required</th>
<th>Not Required</th>
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<th>Recommended</th>
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Effective Fall 2015
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9. Will this proposal impact other plans, sub plans, or course offerings, etc.? Yes □ No □

If yes, list and include evidence of notification to and/or response from each impacted academic unit as necessary.

The Bioengineering Program at NAU will be led primarily by two of the largest and fastest growing departments on campus, the Department of Biological Sciences and the Department of Mechanical Engineering, as well as the new Center for Bioengineering Innovation. The Biology Department has quadrupled in size during the past 10 years to over 2,500 undergraduates and 100 graduate students, including ~35 Ph.D. students, making it the largest department on campus. Mechanical Engineering (ME) is one of the fastest-growing departments on campus and is now the second largest department in the College of Engineering, Forestry, and Natural Sciences (CEFNS), with ~825 undergraduate and ~20 M.S. students. With such large student enrollments in Biology and Mechanical Engineering, growing numbers of these students have the background and interest to pursue the field of Bioengineering, and in fact an undergraduate Bioengineering Club was established recently on the NAU campus. Of even greater importance is the number of new students who will be attracted to NAU from other parts of the state and nation to participate in the new Bioengineering doctoral program at NAU.

In addition to the Ph.D. Program in Sustainability, this new Ph.D. Program in Bioengineering will be the second interdepartmental doctoral program on the NAU campus. We envision that the program will be administered by an interdisciplinary Graduate Faculty in Bioengineering, which will be headed by two new Directors of Graduate Study in Bioengineering, one each in the departments of Mechanical Engineering (Dr. Timothy Becker) and Biological Sciences (Dr. Robert Kellar). We also envision that the new Bioengineering Graduate Faculty will include members from several other departments across the college and university whose research interests fall with the areas of biomaterials and biomechanics, including the Informatics and Computing Program (Dr. Kyle Winfree and others), the Department of Physics (Drs. Christopher Mann and John Gibbs), and the Department of Physical Therapy and Athletic Training in the College of Health and Human Services (Dr. Tarang Jain and others). We aim for inclusiveness to build research capacity across disciplines and colleges at NAU.

Our proposed curriculum includes existing graduate courses in the Departments of Biological Sciences and Mechanical Engineering. Our program requires 6 hours of Statistics or other quantitative discipline (mathematics, computer science) Additional courses from the Department of Physics and Astronomy and the Informatics and Computing Program can be used to fulfill 12-credit hour requirements for interdisciplinary emphases in Informatics and Computing or Biophysics. We also recommend graduate certificate programs in Business Foundations and Applied Effective Fall 2015
Statistics for our students. Letters of support from impacted programs are attached.

10. Check all campuses where the plan will be offered:
- Flagstaff ☑
- Online ☐
- Statewide ☐

List the Statewide Campuses where the plan will be offered:

Answer 11-14 for UCC/ECCC only:
11. A major is differentiated from another major by required course commonality: 24 units of the required coursework to complete the major must be unique, (i.e. not common or not dual use as a required element in another major), to that major. Does this plan have 24 units of unique required credit? Yes ☐ No ☑

12. An emphasis is differentiated from another emphasis by required course commonality: 15 units of the required coursework to complete the emphasis must be unique, (i.e. not common or not dual use as a required element in another emphasis), to that emphasis. Do the emphases each have 15 units of unique required credit? Yes ☐ No ☑

13. An undergraduate certificate is differentiated from another certificate by required course commonality: 12 units of the required coursework to complete the certificate must be unique (i.e. not common or not dual use as a required element in another certificate), to that certificate. Does this certificate have 12 units of unique required credit? Yes ☐ No ☑

14. A minor is differentiated from another minor by required course commonality: 12 units of the required coursework to complete the minor must be unique, (i.e. not common or not dual use as a required element in another minor), to that minor. Does this minor have 12 units of unique required credit? Yes ☐ No ☑

Answer 15-18 for UGC only:
15. Master’s degrees are differentiated from one another by required curriculum and course commonality: at least 12 units of required coursework to complete the degree must be unique (i.e. not common or for dual use as a required element in another degree). Does this degree contain at least 12 unique units of required credit? Yes ☑ No ☐

16. Emphases within a Master’s degree are differentiated by required curriculum and course commonality: at least 9 units of required coursework to complete the emphasis must be unique (i.e. not common or not dual use as a required element in another emphasis). Do emphases contain at least 9 unique units of required credit? Yes ☑ No ☐

17. If this is a non-thesis plan, does it require a minimum of 24 units of formal graded coursework? If no, explain why this proposal should be approved. Yes ☑ No ☐

18. If this is a thesis plan, does it require a minimum of 18 units of formal graded coursework? If no, explain why this proposal should be approved. Yes ☑ No ☐

FLAGSTAFF MOUNTAIN CAMPUS

Effective Fall 2015
EXTENDED CAMPUS

Reviewed by Curriculum Process Associate Date

Approvals:

Academic Unit Head Date

Division Curriculum Committee (Yuma, Yavapai, or Personalized Learning) Date

Division Administrator in Extended Campuses (Yuma, Yavapai, or Personalized Learning) Date

Faculty Chair of Extended Campuses Curriculum Committee (Yuma, Yavapai, or Personalized Learning) Date

UGC Approval (Graduate-Level Plans Only) Date

Chief Academic Officer; Extended Campuses (or Designee) Date
To: Kiisa Nishikawa  
   Director, Center for Bioengineering Innovation (CBI)

From: Jason Wilder  
   Associate Professor and Chair, Department of Biological Sciences

Date: September 5, 2015

Subject: Letter of Support for Bioengineering, PhD

The Department of Biological Sciences at NAU is pleased to offer its unqualified support for the new PhD program in Bioengineering, which will be housed jointly between the Departments of Biological Sciences and Mechanical Engineering, with support from the Center for Bioengineering Innovation.

The proposed PhD program will create outstanding opportunities for graduate student training and increased research activity in areas closely aligned with existing faculty interests within the Department of Biological Sciences. Moreover, the program will enhance opportunities for interdisciplinary research and forge novel connections between biologists and faculty in fields from across campus, including Mechanical Engineering, Physics, and Chemistry. Our faculty in diverse areas including physiology, exercise science, cell & molecular biology, and genetics all have potential to find common interest with research related to the new Bioengineering degree program.

The Department of Biological Sciences welcomes growth of its graduate program to include students seeking the newly offered doctoral degree in Bioengineering. We anticipate accommodating these students within our graduate program alongside our other existing graduate degree tracks. We expect the Director of Graduate Study in Bioengineering – Biology (Dr. Rob Kellar) to work closely with the Department of Biological Science’s Associate Chair for Graduate Studies (currently Dr. Steven Hempleman) to establish graduate assistantships appropriate for students in the new graduate program and to help monitor and assist with student progress. The Department of Biological Sciences will also provide administrative assistance associated with these students, supported by a small FTE request in the budget of the Bioengineering Degree Proposal.

Beyond adding new graduate students, the Department of Biological Sciences is enthusiastic about the opportunities for faculty expansion to support the Bioengineering degree. We are particularly excited by the prospect of a new hire with expertise in a translational research area, such as drug delivery or tissue engineering. This will grow our department in an exciting new direction, with the potential to generate additional research activity and enhanced training opportunities for students at every level.
Appendix I: Supporting Letters

A. Jason Wilder, Department of Biological Sciences, NAU
B. Ernesto Penado, Department of Mechanical Engineering, NAU
C. John Georgas, Informatics and Computing Program, NAU
D. Stephen Tegler, Department of Physics and Astronomy, NAU
E. Patricia Pohl, Department of Physical Therapy & Athletic Training, NAU
F. Michael Falk, Department of Mathematics and Statistics, NAU
G. Kathryn Savage, Franke College of Business, NAU
H. Paul Begovac, W. L. Gore & Associates, Flagstaff, AZ
I. Brent Vernon, Aneuvas Technologies, Inc., San Tan Valley, AZ
J. Annette Zinky, NACET, Flagstaff, AZ
K. Burt Ensley, Protein Genomics, Flagstaff, AZ
L. Mark Preul, Barrow Neurological Institute, Phoenix, AZ
M. Cameron McDougall, Barrow Neurological Institute, Phoenix, AZ
N. Sergio Gazic, Arizona Commerce Authority
O. Ron Wilson, Medtronic Inc, Tempe, AZ
P. Daniel Kasprzyk, Symple Surgical, Flagstaff, AZ
Q. Robert Kellar, Development Engineering Sciences, Flagstaff, AZ
R. Brian Strini, Machine Solutions, Flagstaff, AZ
S. Jeff Saville, Center for Entrepreneurial Innovation, Maricopa Community Colleges
In sum, we are excited to partner with CBI and the Department of Mechanical Engineering in the development of the PhD program in Bioengineering. We view this as an outstanding opportunity to enhance our research activity and educational opportunities in an exciting field of biosciences, while also greatly increasing opportunities for interdisciplinary collaboration.

Please do not hesitate to contact me if I can be of further assistance.

Sincerely,

[Signature]

Jason Wilder
Chair, Department of Biological Sciences
Director, Biomedical Science Program
Northern Arizona University
Flagstaff, AZ 86011-5640
928-523-5286
TO: Kiisa Nishikawa, Ph.D.
Director, Center for Bioengineering Innovation

FROM: F. Ernesto Penado, Ph.D.

DATE: September 9, 2015

SUBJECT: Support for Bioengineering Ph.D.

On behalf of the Department of Mechanical Engineering, I would like to offer my enthusiastic support of the development and launch of the Ph.D. degree in Bioengineering supported by the Center for Bioengineering Innovation (CBI).

The proposed new Ph.D. Program in Bioengineering, with areas of emphasis including biomaterials and biomechanics, is directly aligned with research interests of several of our faculty in the department. In particular, research in Biomechanics and Biomaterials has a natural synergy with research projects and faculty in the Department of Mechanical Engineering, especially with Drs. Tim Becker, John Tester, Cornel Ciocanel, Brent Nelson, Heidi Feigenbaum, Michael Shafer, and myself, who are eager to participate as members of the Graduate Faculty in Bioengineering. Indeed, Mechanical Engineering and CBI faculty are already engaged in collaborative work on National Science Foundation pending and existing awards.

We look forward to working closely with CBI and collaborators to integrate our related faculty, as well as the relevant graduate courses that are currently taught by our department, into your new doctoral program in the areas of Biomechanics and Biomaterials. This interdisciplinary doctoral program will provide a concrete mechanism for collaborative Mechanical Engineering/CBI research projects and graduate student education.

We look forward to working with you on the development, implementation, and coordination of these exciting new opportunities at NAU.

Sincerely,

______________________________
F. Ernesto Penado, Ph.D.
Professor and Chair
Department of Mechanical Engineering
Northern Arizona University
TO:   Center for Bioengineering Innovation  
      Department of Biological Sciences  
      Department of Mechanical Engineering

FROM: John C. Georgas  
      Associate Director, Informatics and Computing Program

DATE: August 11, 2015

SUBJECT: Statement of Collaboration/Support for Bioengineering Ph.D.

The Informatics and Computing Program (ICP) offers its full support for the development  
and launch of the Ph.D. degree in Bioengineering, supported through the College of  
Engineering, Forestry and Natural Sciences, the Center for Bioengineering Innovation  
(CBI), the Department of Biological Sciences, and the Department of Mechanical  
Engineering.

ICP is engaged in interdisciplinary research that applies computational science to a  
variety of domains, such as genetic and genomic analysis, population health, remote  
sensing, ecological modeling, and cyber- and software-centric systems. These areas of  
research have a natural synergy with the research focus of the Ph.D. in Bioengineering,  
and ICP faculty are already engaged in collaborative work with CBI to address the data  
analysis needs of complex prosthetics.

We also plan to strongly integrate the development of our own Ph.D. in Informatics and  
Computing with the Ph.D. in Bioengineering through the creation of a collaborative  
Bioengineering Informatics emphasis supported through both degree programs. Students in  
the Ph.D. in Informatics and Computing will be able to focus in this emphasis by taking 18  
units of coursework from the Bioengineering program, while students in the Ph.D. in  
Bioengineering will focus on the emphasis by taking at least 12 units of coursework from  
Informatics and Computing coursework. This collaborative emphasis will provide a concrete  
focal point for joint ICP/CBI research projects and graduate student training.

We see exciting collaborative and grant-seeking potential in the development of the Ph.D.  
in Bioengineering and offer our wholehearted support.
TO: Kiisa Nishikawa, Ph.D.  
Director, Center for Bioengineering Innovation

FROM: Stephen Tegler, Ph.D.  
Chair, Department of Physics & Astronomy

DATE: August 28, 2015

SUBJECT: Statement of Collaboration/Support for Bioengineering Ph.D.

The Department of Physics and Astronomy at NAU offers its enthusiastic support for the development and launch of the Ph.D. degree in Bioengineering.

In particular, biomaterials research has a natural synergy with research projects and faculty members in the Department of Physics and Astronomy, in particular with Drs. Christopher Mann and John Gibbs who are eager to participate in the Bioengineering program by supervising PhD students. Indeed, Physics and CBI faculty are already engaged in collaborative work on a recent award from the W. M. Keck Foundation to image protein interactions in muscle. In addition, we would also be happy to have Bioengineering PhD students enrolled in graduate physics classes relevant to biophysics. We look forward to working with you on the development and coordination of these exciting new opportunities at NAU.
TO: Kiisa Nishikawa, Ph.D.
Director, Center for Bioengineering Innovation

FROM: Patricia S. Pohl, Ph.D.
Professor and Chair, Department of Physical Therapy & Athletic Training

DATE: August 31, 2015

SUBJECT: Statement of Collaboration/Support for Bioengineering Ph.D.

The Department of Physical Therapy and Athletic Training at NAU offers its enthusiastic support for the development and launch of the Ph.D. degree in Bioengineering supported by the Center for Bioengineering Innovation (CBI).

The proposed new Ph.D. Program in Bioengineering, with areas of emphasis including biomaterials and biomechanics in the broadest sense, is aligned with research interests of faculty in my department.

In particular, biomechanics research has a natural synergy with research projects and faculty in the Physical Therapy and Athletic Training Department, in particular with Drs. Tarang Jain and Petra Williams, who are eager to participate as members of the Graduate Faculty in Bioengineering. Indeed, Physical Therapy and CBI faculty are already engaged in collaborative work on recent grant proposals to the National Science Foundation and NAU’s Research Development Grants Program.

We look forward to working closely with your Center and collaborators to integrate these Physical Therapy faculty, as well as selected graduate courses that are currently taught by our department, into your new doctoral program in the area of Biomechanics. This interdisciplinary doctoral program will provide a concrete mechanism for collaborative Physical Therapy/CBI research projects and graduate student training.

We look forward to working with you on the development and coordination of these exciting new opportunities at NAU.

Patricia S. Pohl
MEMORANDUM

To: Kiisa Nishikawa, Director, Center for Bioengineering Innovation
From: Michael Falk, Chair, Dept. of Mathematics and Statistics
Re: support for Bioengineering Ph.D. proposal

This memorandum is to confirm that the Department of Mathematics and Statistics strongly supports the development of an interdisciplinary Ph.D. program in Bioengineering, as proposed by the Center for Biological Innovation. With fewer than a half-dozen students in the proposed program, and no specified statistics courses besides STA 570, we believe the program is small enough and the statistics component of the curriculum flexible enough that there should be no significant impact on our department instructional resources. At the same time, the prospect that some of students in the program may decide to work toward a graduate certificate in Applied Statistics in the course of their Ph.D. study will provide an important benefit to our department, helping to ensure that our graduate statistics courses besides STA 570 remain well-populated. More broadly, we believe the proposed degree will help NAU to enhance its reputation in the frontiers of science, and to produce graduates who can make important contributions for the betterment of society in the future.
TO: Center for Bioengineering Innovation, 
Department of Biological Sciences 
Department of Mechanical Engineering

FROM: Kathryn Savage, Graduate Coordinator, The W.A. Franke College of Business

DATE: October 14, 2015

SUBJECT: Support for Bioengineering Ph.D.

The W.A. Franke College of Business supports the inclusion of its Business Foundations 
Graduate Certificate as a recommended elective option in the proposed Ph.D. degree in 
Bioengineering, supported through the College of Engineering, Forestry and Natural Sciences, 
the Center for Bioengineering Innovation (CBI), the Department of Biological Sciences, and 
the Department of Mechanical Engineering.
September 9, 2015

Kiisa Nishikawa, Ph.D.
Director, Center for Bioengineering Innovation
Northern Arizona University
Flagstaff, AZ 85023

Dear Dr. Nishikawa,

We write to offer our support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphases that include Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

W. L. Gore & Associates is a technology and science based Enterprise with the goals of improving people's lives through our advanced materials. As you are well aware, our Flagstaff operations are focused on implantable medical devices and we have a long clinical history with our products since our vascular graft was first launched in 1975. We have had a long and productive relationship over these years supporting Northern Arizona University through many avenues, perhaps most significantly by hiring the talented students from NAU in all areas of our operations, especially engineering and sciences. The network of Associates from NAU and the symbiotic relationship of Northern Arizona University and W. L Gore & Associates has grown over the decades and we look forward to continued networking and collaboration together.

With the development of this new Ph.D. program at Northern Arizona University, we see exciting novel opportunities for collaboration and partnerships with NAU faculty and students. We are also happy to participate in program development and refinement through participation in the program's advisory committee if needed. We look forward to the progress of this new program.

With best wishes for success,

[Signature]

Paul C. Begovac, Ph.D
Business-Technology Leader
September 9, 2015

Kiisa Nishikawa, Ph.D.
Director, Center for Bioengineering Innovation
Northern Arizona University

Dear Dr. Nishikawa,

We write to offer our support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphases that include Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

Aneuvas Technologies, Inc. (ATI) was formed with a mission to develop a line of advanced embolics to treat blood vessel lesions of the brain. ATI has licensed a patent, originating from university-funded research efforts, for a novel liquid embolic material that utilizes the latest minimally invasive delivery techniques for treatment of aneurysms. Further development is supported by a growing network of experienced scientists, engineers, and clinicians collaborating with ATI. ATI and NAU have also collaborated on an STTR grant submission in hopes of propelling this research effort forward.

With the development of this new Ph.D. program at Northern Arizona University, we see exciting potential opportunities for further collaboration and partnerships with NAU faculty and students. In addition to collaborative research opportunities, we are willing to participate in program development and refinement through participation in the program's advisory committee. We are also excited to offer a variety of opportunities for students to become involved in cutting edge research and development.

Best regards,

Brent Vernon, Ph.D.
Founder, Aneuvas Technologies, Inc.

Timothy A. Becker, Ph.D.
CTO, Aneuvas Technologies, Inc.
September 9, 2015

Robert S. Kellar, Ph.D.
Associate Professor of Practice
Center for Bioengineering Innovation (CBI)
Northern Arizona University

Dear Dr. Kellar:

NACET gladly extends our support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphases that include Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

NACET is an entrepreneurial support organization based in northern Arizona, operating incubators, accelerators and training programs across the state. We shorten the learning curve for entrepreneurs and startups, and we save growing businesses time, money, effort and frustration as they scale their companies up.

We recognize and emphasize that best-in-field scientists, engineers, entrepreneurs, executives, and creative people—who could live anywhere in the world—choose to live in northern Arizona for the high quality of life. As a community, we have begun connecting these people to one another, and to companies and initiatives that will leverage the intelligence, networks, and resources we have at our fingertips. We have the necessary ingredients for a booming startup culture, and the NACET team is proud to be part of driving this culture of innovation.

With the development of this Bioengineering Ph.D. program at NAU, we see enormous potential for collaboration and partnership with NAU faculty and students.

We would be honored to assist in program development and outreach as you need us to, including assisting in research and commercialization efforts. We are willing to participate in the program's advisory committee. We are also committed to offering a variety of opportunities for students to become involved in cutting edge research and development.

Kind regards,

Annette Zinky
President/CEO
Northern Arizona Center for Entrepreneurship and Technology
September 2\textsuperscript{nd}, 2015

Robert S. Kellar, Ph.D.
Associate Professor of Practice
Center for Bioengineering Innovation (CBI)
Northern Arizona University

Dear Dr. Kellar,

We write to offer our enthusiastic support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphases that include Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

Protein Genomics, Inc (PGen) designs and manufactures biomaterials for regenerative tissue applications. The Company maintains a laboratory at NACET and owns a proprietary library of human matrix proteins. PGen produces commercial quantities of human tropoelastin (TE), the soluble precursor to human elastin. Monomer versions of these proteins are being used in topical and research products that are currently sold direct to the consumer through a subsidiary via the internet and a variety of distribution channels.

PGen also collaborates with American Cryostem, Inc. to incorporate their Adipose Derived Stem Cells into PGen extracellular matrices to produce wound healing products using live human cells. These “living bandages” are currently being evaluated for their efficacy in rapidly closing and healing wounds.

With the development of this new Ph.D. program at Northern Arizona University, we see exciting potential opportunities for collaboration and partnerships with NAU faculty and Students, and potential employment opportunities for Program graduates.

In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program's advisory committee. We are also excited to offer a variety of opportunities for students to become involved in cutting edge research and development.

With best wishes for success,

\[ \text{\textit{Signature}} \]

Burt D. Ensley, PhD
CEO
Protein Genomics
September 8, 2015

Kiisa Nishikawa, Ph.D.
Director, Center for Bioengineering Innovation
Northern Arizona University

Dear Dr. Nishikawa,

I am pleased and eager to support you for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphasis in Medical Devices, Biomaterials, Biomechanics, Informatics and Computing, and Biophysics. We have first-rate facilities here in the Neurosurgery Research Laboratory with a dedicated endovascular laboratory, angiographic equipment, surgical preparation for large animal models, and endovascular surgical procedures. Included is the broad experience of my expert staff in conducting these surgical and endovascular procedures. Barrow has a long and extensive record of working with academia on PhD-related research efforts and publications, as well as industry development and training.

The new Bioengineering PhD program has my support and the support of the Neurosurgery Research Department. We are also excited to offer a variety of opportunities for students to become involved in cutting edge research and development.

Sincerely,

Mark C. Preul, MD
Newsome Family Endowed Chair of Neurosurgery Research
Director, Neurosurgery Research Laboratory
Professor of Neuroscience
Barrow Neurological Institute
St. Joseph's Hospital and Medical Center
350 W. Thomas Rd.
Phoenix, AZ 85013 USA
tel 602-406-5025
mpreul@dignityhealth.org
September 8, 2015

Kiisa Nishikawa, Ph.D.
Director, Center for Bioengineering Innovation
Northern Arizona University

Dear Dr. Nishikawa,

This letter is to confirm my support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphases that include Medical Devices, Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

It would be my pleasure to provide endovascular and neurosurgical expertise on new Bioengineering research efforts, as well as provide perspective on medical device product development and implementation. With the creation of this new Ph.D. program at Northern Arizona University, I see exciting potential opportunities for collaboration and partnerships with NAU faculty and students.

Sincerely,

Cameron McDougall, M.D., FRCSC
Director, Endovascular Neurosurgery
Barrow Neurological Institute
September 9, 2015

Kiisa Nishikawa, Ph.D.
Director, Center for Bioengineering Innovation
Northern Arizona University

Dear Dr. Nishikawa,

I write to offer my support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphases that include Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

Arizona Commerce Authority (ACA) is the State’s leading economic development organization with a streamlined mission to grow and strengthen Arizona’s economy. The ACA uses a three-pronged approach to advance the overall economy: recruit, grow, create – recruit out-of-state companies to expand their operations in Arizona; work with existing companies to grow their business in Arizona and beyond; and partner with entrepreneurs and companies large and small to create new jobs and businesses in targeted industries. The Arizona Commerce Authority is committed to long-term strategies that will further enhance a solid foundation for Arizona business growth and development. As the Bioscience Portfolio Manager at the ACA, I work closely with and provide assistance and support of AZ’s growing bioscience ecosystem.

With the development of this new Ph.D. program at Northern Arizona University, I see exciting potential opportunities for collaboration and partnerships among biotechnology businesses in Arizona and NAU faculty and students. I also know that many of our bioscience companies are looking forward to the high caliber of local workforce which will become available.

I would be pleased to help you find interested businesses who might be interested in participating in the development of your program, participating on the program’s advisory committee, serving on student advisory committees, or employing graduates.

With best wishes for success,

Sergio Gazic
Bioscience Portfolio Manager
Arizona Commerce Agency
September 9, 2015

Kiiro Nishikawa, Ph.D.
Director, Center for Bioengineering Innovation
Northern Arizona University

Dear Dr. Nishikawa:

We write to offer our support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphases that include Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

As an Arizona-based division of the world’s leading medical device company, Medtronic Tempe is dedicated to the design, development and manufacturing of micro-electronic solutions that ‘alleviate pain, restore health and extend life,’ per the Medtronic mission written over 60 years ago. Our goal is to understand and develop solutions to unmet medical needs in the Cardiovascular, Neurological, Diabetes, Spinal and Surgical space.

We cannot fulfill our mission without a foundation and pipeline of engineers who are ready and capable to build a career in medical device engineering and given our regional needs we prefer to have those engineers come from Arizona universities. Engineering disciplines that we look for include Electrical, Mechanical, Computer Science, Materials Science and Biomedical Engineering. Ideally the BME students would have a strong foundation in one or more of the core engineering disciplines as well.

With the development of this new Ph.D. program at Northern Arizona University, we see exciting potential opportunities for collaboration and partnerships with NAU faculty and students to further our mission as a company and to build a strong base of engineering talent for the State of Arizona.

We are open to participate in program development and refinement through participation in the program’s advisory committee and will look forward to opportunities to work with NAU on development opportunities that are mutually beneficial to the university, students, and our industry.

With best wishes for success,

Ron Wilson
Vice President and General Manager

Larry Tyler
Distinguished Engineer & Bakken Fellow
September 1st, 2015

Robert S. Kellar, Ph.D.
Associate Professor of Practice
Center for Bioengineering Innovation (CBI)
Northern Arizona University

Dear Dr. Kellar,

We are writing to offer our support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphases that include Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

Symple Surgical (www.symlesurgical.com) is an early stage medical device startup company headquarter in Flagstaff, Arizona. With the development of this new Ph. D. program at Northern Arizona University it will provide enormous value to startup’s as well as established bioscience companies as we explore the utilization of interns, provide thesis opportunities, and generally assemble a talent pool in the bioengineering field that fosters the creativity required to launch cutting edge medical device products.

In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program's advisory committee. We are also excited to offer a variety of opportunities for students to become involved in cutting edge research and development.

With best wishes for success,

Daniel J. Kasprzyk
President & CEO
September 10, 2015

Kiisa Nishikawa, Ph.D.
Director
Center for Bioengineering Innovation (CBI)
Northern Arizona University

Dear Dr. Nishikawa

I’m writing to offer our support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University (NAU), with emphases that include Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

Development Engineering Sciences (www.des-company.com) is a bioengineering firm with expertise in research, product development, business, marketing, and sales. We are headquartered in Flagstaff, AZ and located in the NACET facilities. Historically, we have offered direct, independent research project experiences for NAU undergraduate and graduate students. With the development of this new Ph.D. program at NAU it will provide enormous value to industrial startup’s as well as established bioscience companies as we continue to support the utilization of interns, provide thesis opportunities, and generally assemble a talent pool in the bioengineering field that fosters the creativity required to launch cutting edge medical device products.

In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program’s advisory committee. We are also excited to offer a variety of opportunities for students to become involved in cutting edge research and development.

With best wishes for success,

Robert Kellar, Ph.D.
President
Development Engineering Sciences
2225 N. Gemini Dr.
Suite W8, Box #2
Flagstaff, AZ  86004
rskellar@des-company.com
928-600-6608
September 14, 2015

Kiisa Nishikawa, Ph.D.
Director, Center for Bioengineering Innovation
Northern Arizona University

Dear Dr. Nishikawa,

We write to offer our support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphases that include Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

Machine Solutions, Inc. has the honor of being the leading global supplier of automated equipment used for testing and manufacturing catheter and stent devices. We take pride in our innovative solutions which aid in advancing the lives of the device’s end users, this initiative is supported by our commitment to advance the lives of our team members by providing a safe, fulfilling and prosperous work environment. Our focus on quality and creativity will maintain our position at the forefront of the industry.

With the development of this new Ph.D. program at Northern Arizona University, we see exciting potential opportunities for collaboration and partnerships with NAU faculty and Students.

In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program's advisory committee. We are excited to offer a variety of opportunities for students to become involved in cutting edge research and development.

With best wishes for success,

[Signature]

Brian Strini
President, Machine Solutions Inc.
09-13-2015

Robert S. Kellar, Ph.D.
Associate Professor of Practice
Center for Bioengineering Innovation (CBI)
Northern Arizona University

Dear Dr. Kellar,

We write to offer our support for the development and launch of a new Ph.D. program in Bioengineering at Northern Arizona University, with emphases that include Biomaterials, Biomechanics, Informatics and Computing, and Biophysics.

Here at the Center for Entrepreneurial Innovation in Phoenix, AZ, we support programs like Dr. Kellar’s because we have an intense focus in Medical Device and Bio-Tech start-ups. Our clients of the incubator are always looking for great talent and there never seems to be enough educated people in the Bio-Science area. Supporting these types of Ph.D programs really continues to put the state of Arizona on the map. CEI’s focus on job creation and leveraging the student and faculty talent from Northern Arizona University really help our startups continue to gain traction.

With the development of this new Ph.D. program at Northern Arizona University, we see exciting potential opportunities for collaboration and partnerships with NAU faculty and students.

In addition to collaborative research opportunities, we are also happy to participate in program development and refinement through participation in the program's advisory committee. We are also excited to offer a variety of opportunities for students to become involved in cutting edge research and development.

With best wishes for success,

Jeff Sayville
Executive Director
Center for Entrepreneurial Innovation
Maricopa Community Colleges