CSU Degree Program Proposal

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Bachelor of Science

Biomedical Physics

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Department of Physics
California State University, Fresno
September 2006 v. 1.0
March 2007 v. 1.1
August 2007 v. 1.2
October 2007 v. 1.3

1. Program Type (Please specify any from the list below that apply—delete the others)

New Program

Fast Track

2. Program Identification

a. Campus: California State University, Fresno

b. Full and exact degree designation and title (e.g. Master of Science in Genetic Counseling, Bachelor of Arts with a Major in History):
Bachelor of Science in Biomedical Physics

c. Date the Board of Trustees approved adding this program projection to the campus Academic Plan: Fast Track

d. Term and academic year of intended implementation (e.g. Fall 2007): Spring 2008

e. Name of the department(s), division, or other unit of the campus that would offer the proposed degree major program. Please identify the unit that will have primary responsibility:
Department of Physics

f. Name, title, and rank of the individual(s) primarily responsible for drafting the proposed degree major program:

Dr. Amir Huda, Ph.D., CHP
Director, Biomedical Physics
Associate Professor, Department of Physics

Dr. Gerardo Muñoz, Ph.D.
Chair and Professor, Department of Physics

Dr. Charles R. Tenney, Ph.D.
Assistant Professor, Department of Physics

g. Statement from the appropriate campus administrative authority that the addition of this program supports the campus mission and will not impede the successful operation and growth of existing academic programs. **(CPEC "Appropriateness to Institutional and Segmental Mission")**

h. Any other campus approval documents that may apply (e.g. curriculum committee approvals): Attached

i. Please specify whether this proposed program is subject to WASC Substantive Change review.
Not subject to WASC Substantive Review.

j. Optional: Proposed Classification of Instructional Programs **(CIP) Code** and CSU Degree **Program Code**
Campuses are invited to suggest one CSU degree program code and one corresponding CIP code. If an appropriate CSU code does not appear on the systemwide list at: http://www.calstate.edu/app/documents/HEGIS-CIP2000_102406.xls , you can search CIP 2000 at http://nces.ed.gov/pubs2002/cip2000/ to identify the code that best matches the proposed degree program. The Classification of Instructional Programs (CIP) is a National Center for Education Statistics (NCES) publication that provides a numerical classification and standard terminology for secondary and postsecondary instructional programs. The CSU degree program code (based on old HEGIS codes) and CIP code will be assigned when the program is approved by the Chancellor.

3. Program Overview and Rationale

a. Rationale, including a brief description of the program, its purpose and strengths, fit with institutional mission, and a justification for offering the program at this time. The rationale may explain the relationship among the program philosophy, design, target population, and any distinctive pedagogical methods. **(CPEC "Appropriateness to Institutional and Segmental Mission")**

The proposed program reflects an innovative vision to attract and motivate students to pursue careers in quantitative medicine. The program will help students overcome two currently held barriers in the pursuit of such studies: (i) the broad and interdisciplinary nature of the subject makes a graduate program in quantitative medicine such as biomedical physics, computational neurosciences, or molecular imaging quite intensive, and (ii) the lack of a strong mathematics and physics foundation makes innovation and understanding challenging at higher levels. The proposed program fills this niche by building a proper foundation for such careers.

b. Proposed catalog description, including program description, degree requirements, and admission requirements. For master's degrees, please also include catalog copy describing the culminating experience requirement(s).

The University proposes to offer a new undergraduate curriculum in Biomedical Physics. The program provides fundamental groundwork in biology, physics, and mathematics, with specialized courses such as magnetic resonance imaging and spectroscopy, nuclear medicine, radiation measurement systems, radiation oncology, and others. The classroom instruction is enhanced by actual hands-on training at local area medical centers, summer internships at prospective graduate schools with state-of-the-art laboratories in research institutions, and structured seminars with one-

to-one interaction with the best researchers in the country. The B.S. program will require a minimum of 120 units of study. A minimum of 25 units for the degree must be from the Campus College of Science and Mathematics.

Catalog Description: Bachelor of Science (B.S.) in Biomedical Physics

Bachelor of Science in Biomedical Physics Requirements

Those seeking admission to the B.S. in Biomedical Physics major must adhere to university admissions requirements, including submission of applications, official transcripts, and appropriate standardized test scores.

Biomedical Physics Major	*Units*
Biomedical Physics Requirements……...46	
(see note1)	
Physics core……(14)	
PHYS 4A, 4AL, 4B, 4BL, 4C, 102	
Biology core……(9)	
PHYAN 65, 130	
Upper division courses……(23)	
PHYS 135, 136, 137, 155, 156, 157, 158	
Additional Requirements……..33	
MATH 75, 76, 77, 81; CHEM 1A, 1B; CSCI 40; BioSc 1A	
General Education Requirements……51*	
Total units……..……...120	

* There are 51 units required for General Education. Of these 51 required units, 10 units will be satisfied by the following two courses in additional requirements. 3 units of CHEM 1 A in G.E. Breadth B1, 3 units of MATH 75 in G.E. Foundation B4, and 4 units of BIOSC 1A in G.E. Breadth B2.

Advising Notes

1. CR/NC grading is not permitted in the biomedical physics major. Additional requirements, however, may be taken CR/NC (see Credit/No Credit Grading).

2. Students should be sure to take sufficient upper-division units in their General Education courses and electives to satisfy the university requirement of 40 upper-division units. It is important to fulfill the upper-division writing skills requirement by exam or W class after completing 60 units for which a student may request 1 unit of credit.

4. 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 specific goals of this program are three-fold:

- The program will ensure that the undergraduates receive a solid background in biology, physics, and mathematics to tackle the involved challenges of an interdisciplinary program of graduate instruction in the field. It aims to serve as a feeder program to graduate schools within the state of California and other states in the nation. As such, it is an unusual program and would give a strong advantage to its graduates.
- It will also focus strongly on exposing the students to what is currently happening in the field; not only through class room instruction only but by "hands-on" instruction on the scanners at the local area medical centers, and by inviting researchers from well known programs to come and talk about their research in an informal and personal way so that the students not only learn about the research but observe also the passion of the researchers and the interest that motivates the people in their chosen profession. Students often identify with the passion or lack thereof within the instructor. Thus a personal approach with the ability of the students to interact one-on-one with the researchers will hopefully inculcate interest and inspire the students to learn more about the field.
- Another objective is to give the students an opportunity to learn first-hand the nature of research or clinical work in the field by exposing them to exciting, state-of-the art technology and having them test out the research life in the field through summer laboratory experiences to make their transition to graduate school as seamless as possible. The laboratory experiences are staged as critical transition points into graduate school. A summer internship program with nearby institutions such as UCLA, UCSD, Stanford, and UCSF will serve as an ideal ground to develop practical skills and will create awareness of more opportunities in the field.

Student Learning Outcomes:

Upon successful completion of the program, the student will have a unique and strong foundation involving physics, mathematics, and biology, which will serve as a preparation for an interdisciplinary career in any branch of medicine and/or neurosciences. Furthermore, the program with the summer internship and seminar series will make the transition to graduate school easier. The students will have an understanding of the basis and practice of all imaging modalities such as PET, SPECT, MRI, MRS, fMRI, CT, Ultrasound, and x-rays, used currently for diagnoses of diseases as well as understanding of the neurological basis of many neurodegenerative diseases and the basic neurology of the human brain. Students will also learn about IMRT, IGRT, radioisotope therapy, etc. used for treatment of cancer.

b. Plans for assessing program goals and student learning outcomes. Some planners find it helpful to develop matrices in which student learning outcomes and required courses are mapped, indicating where content related to the learning outcomes is introduced, reinforced,

and practiced at an advanced level in required courses. **(CPEC "Maintenance and Improvement of Quality")**

There are several courses designed to meet the program goals and student learning outcomes. The assessment within the courses such as Nuclear Medicine Physics, Diagnostic Imaging X-ray Physics, Radiation Oncology Physics, Radiation Physics, Radiation Measurements Laboratory, Human Anatomy and Physiology, Neuroanatomy, and Seminars in Biomedical Physics/Neurosciences will provide adequate assessment to ensure that the goals and learning outcomes are easily met. In addition, every two years an advisory committee to monitor course content, student progress, and assess the program will conduct a review. The membership of this committee would include faculty from the department as well as adjunct faculty, medical physicists from local area medical centers, and external faculty from another university.

c. Total number of units required for the major. 120

d. Include a justification for any baccalaureate program that requires more than 120-semester units or 180-quarter units. Not Applicable

e. If any formal options, concentrations, or special emphases are planned under the proposed major, identify and explain fully. Optional: You may propose a CSU degree program code and CIP code for each concentration that you would like to report separately from the major program, if the option is approximately equivalent to a degree currently listed on the CSU application-booklet degree program table. If you do not find an appropriate CSU degree program code at: http://www.calstate.edu/app/documents/HEGIS-CIP2000_102406.xls , you can search CIP 2000 at http://nces.ed.gov/pubs2002/cip2000/ to help identify the code that best matches the proposed curriculum.

Not Applicable

f. A list of all courses *required* for the major, 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).

Freshman Year:

First Semester	*Second Semester*
General Chemistry 1A* (5)	General Chemistry 1B (5)
Math 75* Math Analysis I (4)	Math 76 Math Analysis II (4)
GE Requirements (3)	Phys 4A, 4AL Mech and Wave Motion (4)
English 1* (3)	[Prereq: Math 75]
	GE Requirements (3)
	Phys 155 Sem in Biomed/Neurosci (1)
15 units	17 units

Sophomore Year:

First Semester	*Second Semester*
Phys 4B, 4BL Elec, Mag and Heat (4)	Phys 4C Light and Modern Phys (3)
[Prereq: Math 76]	[Prereq: Math 77]
Math 77 Math Analysis III (4)	Math 81 Applied Analysis (3)
BioSc 1 A* Intro Biol (4)	GE Requirements (8)
CSI 40 Intro to Progmg (4)	
16 units	14 units

Junior Year:

First Semester	*Second Semester*
PHYAN 65: Human Phys (5)	PHYAN 130: Neuroanatomy (4)
Phys 136: Radiation Physics (3)	Phys 137: Rad Msmts Lab (3)
[Prereq: Phys 4A, 4B, 4C]	[Prereq: Phys 136]
GE Requirements (6)	Phys 155: Sem in Biomed/Neurosci (1)
Phys 102: Modern Physics (3)	GE Requirements (6)
[Prereq: Phys 4A, 4B, 4C]	
17 units	14 units

Senior Year:

First Semester	*Second Semester*
Phys 135: MRI/MRS of the brain (4)	Phys 157: Nuc Med Phys (4)
[Prereq: Phys 4A,4B, 4C]	[Prereq: Phys 136]
Phys 156: Diag. Img X-ray Phys (4)	Phys 190:Und Rsch in Neuroimg (3) OR
[Prereq: Phys 136]	Phys 158: Rad Onc Phys [Prereq:Phys 136]
GE Requirements (6)	GE Requirements (6)
14 units	13 units

* NOTE: Courses with asterisks [Chem 1A, Math 75, English 1, and BioSc1 A] will fulfill GE Requirements for B1, B4, A2, and B2 respectively.

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

Note: With regard to Sections 4f and 4g, a proposed program should take advantage of courses already offered in other departments when subject matter would have considerable overlapping content.

No new elective courses are proposed. The only elective that is offered is between Physics 158: Radiation Oncology Physics course and Physics 190: Undergraduate Research in Neuroimaging.

h. 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.

All new courses needed to initiate the program have already been developed and are being offered.

i. Attach a proposed course-offering plan for the first three years of program implementation, indicating, where possible, likely faculty teaching assignments.

For the course-offering plan, see response to section 4f. There are no new courses to be added to the list. Likely faculty teaching assignments for specific biomedical physics courses are as follows:

Phys 135, 136, 137, 155:	Dr. Amir Huda
Phys 156, 157:	Dr. Charles Tenney
Phys 158:	Dr. Richard Dunia

j. For master's degree proposals, include evidence that program requirements conform to the minimum requirements for the culminating experience, as specified in Section 40510 of Title 5 of the California Code of Regulations.

Not Applicable

k. Admission criteria, including prerequisite coursework.

University Admission requirements.

l. Criteria for student continuation in the program.

University criteria.

m. For undergraduate programs, planned provisions for articulation of the proposed major with community college programs.

None for biomedical physics courses.

n. If there is a Lower-Division Transfer Pattern (LDTP) for this major, indicate the relationship between the LDTP and the requirements presented in this proposal. Information on LDTP is available at: http://www.calstate.edu/AcadAff/ldtp.shtml

Not Applicable

o. Advising "roadmaps" that have been developed for the major.

See response to section 4f.

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

Not Applicable.

5. Need for the Proposed Degree Major Program

(CPEC "Societal Need," "Number of Existing Programs in the Field," and "Advancement of the Field")

a. List of other California State University campuses currently offering or projecting the proposed degree major program; list of neighboring institutions, public and private, currently offering the proposed degree major program.

The need for this program can perhaps be best described in the words of a reviewer of the grant received from the National Institute of Mental Health (NIMH) and the National Institute of Biomedical Imaging and Bioengineering. The review states:

"The program is well conceived. It addresses a critical need for the training of experts in the multidisciplinary field of neuroscience with a special emphasis on neuroimaging…In its full implementation, the program will begin with outreach activities during high school to a large area of California that has a high representation of minorities. The vigorous and well-developed recruitment plans to reach these students are exemplary. The undergraduate curriculum is rigorous and includes fundamental and advanced undergraduate mathematics, physics, biology, chemistry, anatomy, and physiology... The proposed curriculum will provide a rich source of applicants to the growing number of graduate programs in the area of basic and clinical neuroscience that have a focus on neuroimaging."

Program at Other Campuses:
Only one CSU campus, California State University, Northridge (CSUN) offers a similar degree with a similar name: B.A. in Biomedical Physics. However, as noted below, there are substantial differences

b. Differences between the proposed program and programs listed in Section 5a above.

The proposed program will educate students in the areas in which Medical Physics is practiced in a clinical setting, including diagnostic imaging, nuclear medicine, and radiation therapy. In contrast, the degree offered by CSUN, although having a similar name, is concerned instead with Biophysics, including the application of physics to studies of anatomy, physiology, and cellular and molecular biology, while including only a single course on diagnostic imaging. The CSUN program and the proposed program fulfill different roles, so there is no duplication of effort implicit in the proposed program.

c. List of other curricula currently offered by the campus that are closely related to the proposed program.

There are no official on-campus programs that are currently offered. However, the Department of Physics under a grant from the National Institutes of Mental Health has recruited students for a B.S. Special Major in Biomedical Physics since fall 2005. The original goal was to enroll six students. We currently have 20 students in the program.

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

This is "hands-on" curriculum and the students will be participating in laboratory activities at community medical centers and cancer treatment facilities, As such, their interaction with personnel in the hospital may facilitate career opportunities in the very hospitals they are trained in.

e. Applicable workforce demand projections and other relevant data.

Since B.S. level education in Biomedical Physics is rare within the US, it is difficult to give an accurate measure of the demand at that level. However, this particular field of physics has a huge demand as demonstrated by the annual survey by the American Association of Physicists in Medicine. The survey states: "The job market for medical physicists continued to be very strong in 2005. Members who were full-time employed in both 2004 and 2005 reported that their primary salaries increased by 10.2% on average. Whereas the inflation rate during this time was still low at 3.4%, as measured by the Consumer Price Index for all Urban consumers (CPI-U). The average primary salary for calendar year 2004 was $144,100 and the total income including consulting fees averaged $152,100." The median salary for a member with a master's degree in biomedical physics and 0-2 years experience was $90,000.

Another example of the demand is demonstrated by the webpage of the medical physics program (http://medicalphysics.duke.edu/), which offers ***graduate*** programs in the field. It states, "There is currently a national shortage of trained medical physicists. There are about 3000 medical physicists in the U.S. The current need is for approximately 250-300 new medical physicists per year, but only 50-60 are being produced by the current training programs. In addition, about 50% of current medical physicists are over the age of 50, meaning that there will be an increasing shortage in the coming years due to retirement. Thus, the job market for medical physics graduates is quite strong."

A critical shortage also exists in the supply of qualified radiation safety professionals throughout a broad spectrum of activities within the Unites States, including medical practice and research, regulatory oversight, academic research, environmental protection, occupational safety, and the research application of nuclear technologies. A recent survey conducted by the Health Physics Society indicates that present demand for radiation safety professionals is approximately 130% of supply. Demand during the next five years, which appears to be related solely to attrition, is expected to exceed supply by nearly 160%."

Our graduates at Fresno State will be easily able to enter both of the above-mentioned specialties.

f. 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.

See response to 5e above.

6. Student Demand (CPEC "Student Demand")

a. Compelling evidence of student interest in enrolling in the proposed program. Types of evidence vary and may include national, statewide, and professional employment forecasts and surveys; petitions; lists of related associate degree programs at feeder community colleges; reports from community college transfer centers; and enrollments from feeder baccalaureate programs, for example.

As reflected by the enrollment numbers (see 5c), there has been considerable interest in the program despite it being a special major for now which considerably limits students. For example, students are unable to declare themselves as a special major when they enter the university and have to go through additional processes of advisement and paperwork. Furthermore, they are unable to have a dual major under the special major proviso. The faculty of this program and the outreach officer of the college have made considerable efforts in reaching out to local area high schools and community colleges giving presentations and brochures.

b. Issues of access considered when planning this program.

Any student that meets University's admission requirements is admitted to the program.

c. For master's degree proposals, the number of declared undergraduate majors and the degree production over the preceding three years for the corresponding baccalaureate program, if there is one.

Not Applicable.

d. Professional uses of the proposed degree program.

A number of opportunities will be available to graduates of the program. The program's primary purpose is to prepare students for graduate work and future employment in Biomedical Physics, and to ease the transition for the students into graduate school. However, the broad, interdisciplinary base of scientific knowledge presented in the program will also prepare students for further study or immediate employment in fields such as biomedical physics, biomedical engineering, imaging science, neurosciences, bioengineering, molecular biology, health physics, and nano-sciences. Potential employers include hospitals, government and university laboratories, and the nuclear and medical industries. In addition, supplementing the major with an additional two semesters in organic chemistry would result in a very strong pre-med curriculum for those interested in medical school.

e. The expected number of majors 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.

At this time, there are 20 students in the Special Major program, all of whom would transition into the proposed Biomedical Physics major. This would increase to 25-30 students after three years, and 30-40 students after five years. The anticipated number of students graduating from the program in its first year is 6-7, increasing to 8-9 graduates in the third year, and 10-12 graduates in the fifth year. This is based on projection of data from the current special major that is offered in biomedical physics. Our goal has been modest considering it is a challenging curriculum. Indeed, while the number of Biomedical Physics majors is estimated to be roughly 35% of the total number of Physics majors, the number of students graduating from the Biomedical Physics Major program is expected to equal or exceed the number of students graduating with a BS in Physics (the 2001-2005 average for the latter stands at 4.5 – see the California State University, Fresno 2005-2006 Data Book).

7. Existing Support Resources for the Proposed Degree Major Program
(CPEC "Total Costs of the Program")

Note: Sections 7 and 8 should be prepared in consultation with the campus administrators responsible for faculty staffing and instructional facilities allocation and planning. A statement from the responsible administrator(s) should be attached to the proposal assuring that such consultation has taken place.

a. Faculty who would teach in the program, indicating rank, appointment status, highest degree earned, date and field of highest degree, professional experience, and affiliations with other campus programs. For master's degrees, include faculty publications or curriculum vitae.

Note: For all proposed graduate degree programs, a minimum of five full-time faculty members with the appropriate terminal degree should be on the program staff. (Code Memo EP&R 85-20)

Faculty Members (See Appendix A for CVs)

- Dr. Amir Huda, Ph.D., CHP
  UCLA, 1998, Biomedical Physics
  Director, Biomedical Physics Program
  Associate Professor, Department of Physics
  Adjunct Assistant Professor, Department of Radiological Sciences, UCLA

- Dr. Charles R. Tenney, Ph.D.
  University of North Carolina at Chapel Hill, 1997, Biomedical Engineering
  Assistant Professor, Department of Physics

- Dr. Christopher Njeh, Ph.D.
  Sheffield Hallam University, Sheffield, UK, 1995, Medical Physics
  Adjunct Assistant Professor, Department of Physics

- Dr. Douglas Singleton, Ph.D.
  University of Virginia, 1994, Physics
  Associate Professor, Department of Physics

- Dr. Richard Dunia, Ph.D.
  UCLA, 1988, Neurosciences
  Adjunct Assistant Professor, Department of Physics

- Dr. Hossein Haghighi, D.Sc.
  University of Texas at Arlington, 1991, Physics
  Adjunct Assistant Professor, Department of Physics (apt. pending)

- Dr. Jason Bush, Ph.D.
  University of British Columbia, Vancouver, Canada, 2002, Cancer Biology

Assistant Professor, Department of Biology

- Dr. Gerardo Munoz, Ph.D.
  Johns Hopkins University, 1989, Physics
  Chair and Professor, Department of Physics

b. Space and facilities that would be used in support of the proposed program.

- Science II Room 310: This room is used as the primary room for biomedical physics lectures and seminars.

- Science II Room 311: This room is used as a computer lab for data processing. In addition, phantoms and chemicals used in scanning are housed here. This lab is solely for radiation-producing machine but no radioactive material is used here.

- Science I Room 16: This basement laboratory is used for radioactive material research and teaching for Physics 137.

- Imaging Division at the VACCHCS: The imaging facilities at the VA are used for laboratories in Physics 135, 156, and 157. These include nuclear medicine scanners and gamma camera, MR scanner, x-ray equipment, fluoroscopy machines and CT scanner.

c. A report provided by the campus Library, detailing resources available to support the program (discussion of subject areas, volume counts, periodical holdings, etc. are appropriate).

The requested report is attached herewith. No additional library resources are needed. Currently the library subscribes to the International Nuclear Information System (INIS) in Vienna and the Oak Ridge database called ETDEWEB. In addition, the library also subscribes to the publications of the National Council on Radiation Protection (NCRP) and the International Commission on Radiological Protection (ICRP).

d. Existing academic technology, equipment, and other specialized materials currently available.

Majority of the equipment needed for teaching and research is already purchased. Some minor items are being purchased.

8. Additional Support Resources Required
(CPEC "Total Costs of the Program")

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 special characteristics of the additional faculty or staff support positions needed to implement the proposed program.

   No additional faculty or staff support positions are required to implement the program.

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.

   No additional lecture/laboratory space is required.

c. A report written in consultation with the campus librarian, indicating any additional library resources needed. Indicate the commitment of the campus either to purchase or borrow through interlibrary loan these additional resources.

   See response to 7c.

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.

   Some resources such as speakers' fund for seminars, travel fund, etc. will be provided by the current programs in the College of Science and Mathematics. No additional resources are required.