Proposal Form For Addition And Revision Of Courses

1. Proposing College / School: Samuel Ginn College of Engineering
   Department: Polymer and Fiber Engineering

2. Course Prefix and Number: PFEN 5700/6700/6706
   3. Effective Term: Fall 2014

4. Course Title: Biomedical Applications of Polymeric Materials
   Abbreviated Title (30 characters or less): BIOMED APPS OF POLYMERS

5. Requested Action:
   - [ ] Renumber a Course
   - [ ] Add a Course
   - [ ] Revise a Course
   Current Course Number:
   Proposed Course Number:
   Type of Revision:

6. Course Credit:
<table>
<thead>
<tr>
<th>Contact/Group Hours</th>
<th>Scheduled Type</th>
<th>Weekly or Per Term?</th>
<th>Credit Hours</th>
<th>Anticipated Enrollment</th>
</tr>
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<tbody>
<tr>
<td>Maximum Hours</td>
<td>Lecture</td>
<td>Weekly</td>
<td>3</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td>Lab</td>
<td>Term</td>
<td>0</td>
<td>25</td>
</tr>
</tbody>
</table>
   Total Credit Hours: 3

7. Grading Type:
   - [ ] Regular (ABCDF)
   - [ ] Satisfactory/Unsatisfactory (S/U)
   - [ ] Audit

8. Prerequisites/Corequisites:
   Use "P:" to indicate a prerequisite, "C:" to indicate a corequisite, and "P/C:" to indicate a prerequisite with concurrency.
   See Attached - Requirements will not fit in this box.

9. Restrictions: List specific restriction in space above.
   - [ ] College
   - [ ] Major
   - [ ] Standing
   - [ ] Degree

10. Course Description:
    (20 Words or Less; exactly as it should appear in the Bulletin)
    Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function.

11. May Count Either:
   - 5700
   - 6700
   (Indicate if this particular course cannot be counted for credit in addition to another)
   Program Type
   (e.g.: minor, major, etc.)
   Program Title
   (e.g.: MS in Chemistry, Performance Option, Minor in Art)
   Requirement or Elective?
   (required or optional?)

12. Affected Program(s):
    (Respond "N/A" if not included in any program; attach memorandum if more space is required)
    Major: Bachelor of Polymer and Fiber Engineering
    Elective

13. Overlapping or Duplication of Other Units' Offerings:
    (If course is included in any other degree program, is used as an elective frequently by other unit(s), or is in an area similar to that covered by another college/school, attach correspondence with relevant unit)
    - [ ] Applicable
    - [ ] Not Applicable
14. Justification: Over the last 60 years there has been a proliferation of the use of polymeric materials in medicine. Most devices developed and used in medicine currently utilize polymers in whole or in part. Sutures, catheters, artificial heart valves, and artificial joints are a few of the many medical applications that utilize the unique property set available from polymers. Design of health care devices requires and understanding both the fundamental behavior of the materials used and the effect of the unique environment to which the materials will be subjected. As the population ages, life span increases, and efforts are made to improve the availability and reduce the cost of health care the need for the rational development of medical devices and materials grows. The proposed course is intended to introduce key concepts relating to the development and use of polymeric materials in medical applications to students that may someday be responsible for the development, production, evaluation, and use of medical devices.

15. Resources: Existing resources are adequate to support the proposed course.

16. Student Learning Outcomes: All students will be expected to:
1. Identify the key developments, people, and dates
2. Describe methodologies used in the early development of biomaterials
3. Summarize issues faced during the early development of biomaterials and corrective action taken to address them
4. Name the primary polymers used in medical applications
5. Match polymer type to potential medical applications
6. Explain the limitations of polymer types in various medical applications
7. Recognize key features of the wound healing process
8. Explain the interaction between the extracellular matrix and implanted materials
9. Identify the general requirements for hard and soft tissue replacement
10. Summarize the material properties that influence thrombogenicity
11. Describe the material requirements for tissue engineering

In addition, Graduate students will be expected to:
1. Predict the degradation behavior of polymer sutures based on chemical composition
2. Compare and contrast test methods for degradation behavior of biodegradable polymer materials
3. Critically assess current literature in the field of biomaterials
4. Recommend research focuses for the development of polymers for biomedical applications

17. Course Content Outline:
Week 1
i) Introduction
   (1) History of Biomaterials
   (2) Why biomaterial science is a multidisciplinary endeavor

Week 2 – Agreement on Research Topic
ii) Materials used in biomedical applications
   (1) Metals
   (2) Ceramics
   (3) Polymers
      (a) Types
      (b) Manufacturing Methods
      (c) Properties
Week 3
(4) Hydrogels
(5) “Smart Polymers”
(6) Biopolymers
(7) Composites
(8) Surface Characterization
Week 4
iii) Biology, Biochemistry, and Medicine
   (1) General concepts
   (2) Host Reactions to Biomaterials
      (a) Adsorbed Proteins
      (b) Extracellular Matrix
      (c) Cells and Cell Injury
Week 5 – Lab one, Test one
   (3) Biological Testing
Week 6 – Lab one report due
iv) Response of Polymers to the Biological Environment
   (1) General concepts
   (2) Degradation
      (a) Surface vs. bulk
      (b) Mechanisms
      (c) Rational of design
   (3) Calcification of Biomaterials
   (4) Surface attachment of biomolecules
Week 7 – First Presentation
v) Application of Polymeric Materials in Medicine
   (1) Implants
      (a) Soft Tissue Replacement
         (i) Sutures, Skin, Adhesives
Week 8
   (ii) Blood Interfacing (catheters, grafts, heart valves, etc.)
      (iii) Intraocular Lens Implants
      (iv) Ligaments - tendons
      (v) Other organs
Week 9 – Lab 2
   (b) Hard Tissue Replacement
      (i) Wires, Pins, Screws
      (ii) Fracture Plates
      (iii) Joint replacement - Spinal Implants
      (iv) Dental restoration
      (v) Bone Cement
      (c) Whole and Partial Organ Replacement
Week 10 – Lab 2 report due
   (2) Medical Devices
      (a) Heart Bypass machines
      (b) Catheters
      (c) Contacts
      (d) Dental applications
Week 11 – Second Test
   (3) Tissue Engineering
      (a) Introduction
      (b) Applications
      (c) Material considerations
Week 12 – Lab 3
   vi) Practical Aspects of implants
      (1) Sterilization
      (2) Implant Failure
Week 13 – Lab 3 Report due
   vii) Standards and regulatory issues in materials development for biomedical applications
Week 14 – Final Presentations, Final Report, Final during Finial Exam time.
18. Assignments / Projects:

A. Presentations
Each student (or undergraduate student group depending on class size, all graduate students will be required to make individual presentations) will make two in-class presentations. The primary subject of the presentations will be a medical condition and the treatment thereof. The conditions will be selected based on student interest and the extent of use of polymer devices used in the treatment and will be selected by the students with the advice and consent of the instructor. The first presentation will introduce the condition including levels of severity, typical outcomes, extent of effect to the population, etc. The second presentation will focus on the use of polymeric materials in the treatment of the condition, including types of polymers used, specific requirements, current limitation of the materials used, and new materials or techniques under development. These presentations contribute to the overall learning experience of the students by allowing them to explore in greater detail a specific application of polymers in medicine. Undergraduate presentations will be ~10 min. while those of graduate students will be ~20 min. in length to allow them to elaborate further on the subject and display the increased knowledge and understanding commensurate with their level of education.

B. Final Report
Each student (or undergraduate student group depending on class size, all graduate students will be required to make individual presentations) will prepare a report on the subject selected for the presentations. This report is expected to further elaborate on the topic selected and presented. These reports contribute to the overall learning experience of the students by allowing them to further explore and summarize a specific application of polymers in medicine. Undergraduate reports are expected to be in the 15 to 20 page range, while those of graduate students are expected to be in the 25 to 30 page range to allow them to elaborate further on the subject and display the increased knowledge and understanding commensurate with their level of education. In addition, graduate students are expected to utilize more references (15-20 vs. 5-10 for undergraduates), elaborate more on limitation of the current treatment options (citations to peer-reviewed publication will be required of graduate students while alternate sources will be satisfactory for undergraduates), and elaborate more on the development of new treatment options.

C. Lab Reports
During the semester there will be 2-3 in-lab activities conducted in the instructor’s lab that focus on particular properties of polymers used in medicine. These labs will occur during regular class times and the length and scope do not require additional laboratory resources or a separate meeting time. The lab activities range from a study of the degradation rates of bioabsorbable sutures to the preparation of bone cement. At the conclusion of each lab students will be asked to write up their observations or findings and provide a written reflection on what they learned during the lab and how it relates to the material covered during lectures. In addition, graduate students will be expected to prepare more detailed reports which include comparison of the data generated to literature data, with appropriate references, and making recommendations for improvement of the lab activities.

D. Tests – typically 2
In-class exams will be given to students over the course of the semester. These tests will allow evaluation of retention of key ideas presented in the course materials. Multiple choice questions, computational questions, and other question types will be used to test students retention of the material covered. In addition, various short answer questions, some based on case studies, will be used to evaluate students understanding of the interrelationships of the material. Graduate students will be expected to provide more thorough answers to the short answer questions. Questions will include material based on lectures, supplemental material, and the
presentations made by students.

E. Final Exam

A final exam will be given with a similar format to that of the tests described above. This exam will be used to further evaluate the students understanding of the course material.

(List all quizzes, projects, reports, activities and other components of the course grade -- including a brief description of each assignment that clarifies its contribution to the course's learning objectives)

19. Rubric and Grading Scale:

Components of the final grade will be:
1. Tests – 20%
2. Project Presentations – 20%
3. Lab Reports – 10%
4. Final Report – 20%
5. Final – 30%

The Grading scale used will be:
A = Substantial mastery of subject matter (Superior)
   Overall average > 90%
   - Mistakes in concept or application are rare.
   - Ability to deal at the highest conceptual level in both the cognitive and affective realm of technical and non-technical fields.
   - Ability to formulate, translate and express ideas in both technical and non-technical language and thought patterns.
B = Moderate mastery of subject matter (Good)
   90% > Overall average > 80%
   - Mistakes in concept or application are not common.
   - Ability to deal at a high conceptual level in both the cognitive and affective realm of technical and non-technical fields with at least modest competence.
C = Competent grasp of subject matter (Acceptable)
   80% > Overall average > 70%
   - Mistakes in concept or application are not serious or frequent enough to endanger life or property.
   - Usually can be relied on to produce sound, competent work under supervision, and to express the results in technical language.
   - Exhibits the minimum level of performance acceptable in professional practice.
D = Some grasp of subject matter (Marginal… not Acceptable)
   70% > Overall average > 60%
   - Mistakes in concepts or applications are serious or frequent enough to endanger life or property.
   - Should work in the subject area only under close supervision.
F = Inadequate grasp of the subject matter (Failure)
   60% > Overall average
   - Serious mistakes in concepts or applications.
   - Sufficiently incompetent that an attempt to do engineering work or to use knowledge in the subject area would constitute a hazard to the public.

(List all components of the course grade -- including attendance and/or participation if relevant -- with point totals for each; indicate point totals and ranges or percentages for grading scale; for S/U grading, detail performance expectations for a passing grade)

20. Justification for Graduate Credit:

Graduate students enrolled will be expected to obtain and display a significantly deeper and broader level of understanding of the subject matter than undergraduate students; see Student Learning Outcomes for course listed in section 16 above. A higher level performance on assignments is also expected of graduate students; see Assignments / Projects for course listed in section 18 above. Critical thinking skills will be developed and evaluated in graduate students in relation to their ability to envision the next generation of polymers for medical applications and / or the next generation of treatment options that will be made possible by
advancements in polymer science. Analytical skills will be enhanced by requiring more calculation of properties and or performance than required of undergraduate students.

(Include a brief statement explaining how the course meets graduate educational standards (i.e.: rigorous standards for evaluation, development of critical thinking and analytical skills, etc.))

(Included below are standard statements regarding course policies. If necessary, a statement may be altered to reflect the academic policies of individual faculty members and/or the academic unit or department, provided that there is no conflict with the Student Policy eHandbook, Faculty Handbook, or any existing university policy.)

POLICY STATEMENTS

Attendance: Although attendance is not required, students are expected to attend all classes, and will be held responsible for any content covered in the event of an absence.

Excused Absences: Students are granted excused absences from class for the following reasons: illness of the student or serious illness of a member of the student's immediate family, the death of a member of the student's immediate family, trips for student organizations sponsored by an academic unit, trips for university classes, trips for participation in intercollegiate athletic events, subpoena for a court appearance, and religious holidays. Students who wish to have an excused absence from class for any other reason must contact the instructor in advance of the absence to request permission. The instructor will weigh the merits of the request, and render a decision. When feasible, the student must notify the instructor prior to the occurrence of any excused absences, but in no case shall such notification occur more than one week after the absence. Appropriate documentation for all excused absences is required. Please consult the Student Policy eHandbook for more information on excused absences.

Make-Up Policy: Arrangement to make up a missed major examination (e.g.: hour exams, mid-term exams) due to properly authorized excused absences must be initiated by the student within one week of the end of the period of the excused absence(s). Except in unusual circumstances, such as the continued absence of the student or the advent of university holidays, a make-up exam will take place within two weeks of the date that the student initiates arrangements for it. Except in extraordinary circumstances, no make-up exams will be arranged during the last three days before the final exam period begins.

Academic Honesty Policy: All portions of the Auburn University student academic honesty code (Title XII) found in the Student Policy eHandbook will apply to university courses. All academic honesty violations or alleged violations of the SGA Code of Laws will be reported to the Office of the Provost, which will then refer the case to the Academic Honesty Committee.

Disability Accommodations: Students who need accommodations are asked to electronically submit their approved accommodations through AU Access and to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by e-mail. If you have not established accommodations through the Office of Accessibility, but need accommodations, make an appointment with the Office of Accessibility, 1228 Haley Center, 844-2096 (V/TT).
PFEN 5700/6700/6706 - Biomedical Applications of Polymeric Materials

1. **Proposed by:**
   Polymer and Fiber Engineering Department of the Samuel Ginn College of Engineering

2. **Course Prefix and Number:**
   PFEN 5700 / PFEN 6700 / PFEN 6706

3. **Effective Term:**
   Spring 2014

4. **Course Title:**
   Biomedical Applications of Polymeric Materials (Short Title – BIOMED APPS of POLYMERS)

5. **Requested Action:**
   Add a Course

6. **Course Credit:**

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<tr>
<td>3</td>
<td>Lecture</td>
<td>Weekly</td>
<td>3</td>
<td>25</td>
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   Total Credit Hours: 3

   Maximum Hours: 3

   **Note:** Lab activities are described in section 18.C below. Only two – three lab sessions will occur per semester. They will take place in the instructor’s lab during normal course times. As such additional credit hours for a lab section is not required or requested.

7. **Grading Types:**
   Regular (ABCDF)

8. **Prerequisites/Corequisites:**
   1. Standing: Junior, Senior, or Graduate level
   2. For Graduate Students: None
   3. For Engineering, Veterinary Medicine, and Nursing undergraduate students: None
   4. For other undergraduate students the Pre or Corequisites are at least one of the following:
      a. BIOL 1030 – Organismal Biology
      b. CHEM 2070 – Organic Chemistry I
      c. Instructor approval
9. **Restrictions:**
   Standing (see above)

10. **Course Description:**
    Study of polymers used in the body for the purposes of aiding healing, correcting abnormalities, and restoring lost function.

11. **May Count Either:**
    N/A

12. **Affected Programs:**
    N/A

13. **Overlapping or Duplication of Other Units’ Offerings:**
    N/A

14. **Justification:**
    Over the last 60 years there has been a proliferation of the use of polymeric materials in medicine. Most devices developed and used in medicine currently utilize polymers in whole or in part. Sutures, catheters, artificial heart valves, and artificial joints are a few of the many medical applications that utilize the unique property set available from polymers. Design of health care devices requires and understanding both the fundamental behavior of the materials used and the effect of the unique environment to which the materials will be subjected. As the population ages, life span increases, and efforts are made to improve the availability and reduce the cost of health care the need for the rational development of medical devices and materials grows. The proposed course is intended to introduce key concepts relating to the development and use of polymeric materials in medical applications to students that may someday be responsible for the development, production, evaluation, and use of medical devices.

15. **Resources:**
    N/A

16. **Student Learning Outcomes:**

    All students will be expected to:
    1. Identify the key developments, people, and dates
    2. Describe methodologies used in the early development of biomaterials
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    4. Name the primary polymers used in medical applications
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    7. Recognize key features of the wound healing process
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In addition, Graduate students will be expected to:
1. Predict the degradation behavior of polymer sutures based on chemical composition
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4. Recommend research focuses for the development of polymers for biomedical applications

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**Week 1**

i) Introduction
   (1) History of Biomaterials
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**Week 2 – Agreement on Research Topic**

ii) Materials used in biomedical applications
   (1) Metals
   (2) Ceramics
   (3) Polymers
      (a) Types
      (b) Manufacturing Methods
      (c) Properties

**Week 3**

(4) Hydrogels
(5) “Smart Polymers”
(6) Biopolymers
(7) Composites
(8) Surface Characterization

**Week 4**

iii) Biology, Biochemistry, and Medicine
   (1) General concepts
   (2) Host Reactions to Biomaterials
      (a) Adsorbed Proteins
      (b) Extracellular Matrix
      (c) Cells and Cell Injury

**Week 5 – Lab one, Test one**

(3) Biological Testing

**Week 6 – Lab one report due**

iv) Response of Polymers to the Biological Environment
   (1) General concepts
   (2) Degradation
(a) Surface vs. bulk
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(c) Rational of design
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Week 7 – First Presentation
v) Application of Polymeric Materials in Medicine
   (1) Implants
      (a) Soft Tissue Replacement
          (i) Sutures, Skin, Adhesives

Week 8
   (ii) Blood Interfacing (catheters, grafts, heart valves, etc.)
   (iii) Intraocular Lens Implants
   (iv) Ligaments - tendons
   (v) Other organs

Week 9 – Lab 2
   (b) Hard Tissue Replacement
      (i) Wires, Pins, Screws
      (ii) Fracture Plates
      (iii) Joint replacement - Spinal Implants
      (iv) Dental restoration
      (v) Bone Cement
   (c) Whole and Partial Organ Replacement

Week 10 – Lab 2 report due
   (2) Medical Devices
      (a) Heart Bypass machines
      (b) Catheters
      (c) Contacts
      (d) Dental applications

Week 11 – Second Test
   (3) Tissue Engineering
      (a) Introduction
      (b) Applications
      (c) Material considerations

Week 12 – Lab 3
vi) Practical Aspects of implants
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B = Moderate mastery of subject matter (Good) - 90% > Overall average > 80%
   • Mistakes in concept or application are not common.
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C = Competent grasp of subject matter (Acceptable) - 80% > Overall average > 70%
   • Mistakes in concept or application are not serious or frequent enough to endanger life or property.
   • Usually can be relied on to produce sound, competent work under supervision, and to express the results in technical language.
   • Exhibits the minimum level of performance acceptable in professional practice.
D = Some grasp of subject matter (Marginal... not Acceptable) - 70% > Overall average > 60%
- Mistakes in concepts or applications are serious or frequent enough to endanger life or property.
- Should work in the subject area only under close supervision.

F = Inadequate grasp of the subject matter (Failure) - 60% > Overall average
- Serious mistakes in concepts or applications.
- Sufficiently incompetent that an attempt to do engineering work or to use knowledge in the subject area would constitute a hazard to the public.

20. Justification for Graduate Credit:
Graduate students enrolled will be expected to obtain and display a significantly deeper and broader level of understanding of the subject matter than undergraduate students; see Student Learning Outcomes for course listed in section 16 above. A higher level performance on assignments is also expected of graduate students; see Assignments / Projects for course listed in section 18 above. Critical thinking skills will be developed and evaluated in graduate students in relation to their ability to envision the next generation of polymers for medical applications and/or the next generation of treatment options that will be made possible by advancements in polymer science. Analytical skills will be enhanced by requiring more calculation of properties and or performance than required of undergraduate students.