**BIEN 235 Applied Biomaterials: Team Project 1 2019S**

**Improving an Orthopedic Device**

This is your opportunity to test drive your future profession in biomedical engineering. You will be assigned to small teams with other future biomedical engineers.

You and your teammates will write a report that addresses each of the requirements and questions posed below. You will be given time during several class periods to gather information, choose an implant and a replacement material, and make decisions about what to write in your project report. Please also communicate via e-mail or an online team app outside of class. At least 1 or 2 teammates should bring computers to class each day to find implants, materials and material properties online. The course PPT slides and the textbook will also be useful for finding the information that you will need.

As you look for information, please keep in mind that you must “***cite***” the source(s) for each piece of information you got from books, internet, etc., AND the figures in your report. Please keep a record of the following information for your works cited (references) section of your report: 1. Website: URL/date accessed/title or other identifying information; 2. Book: title/authors/pages/publisher/date published; 3. Journal article: authors/title/journal name/volume/pages). We will cover how to format your references section in one of the class lectures before your report is due. Also, the report must have page numbers and section headings.

It is important that *each of you contribute equally* to this effort. I suggest you divide the research tasks and assign them to individuals. Also, plan what to write as a group but assign sections to individuals. This way, you will help each other learn. You will be learning as you gather and discuss information, which is like what you will be doing in your future careers as engineers, unlike sitting in a class listening to lectures.

The following information contains your section headings (Implant Description, Composition and Material Properties, …), expected content, and the suggested number of paragraphs (¶) for each section. Your team’s **typed** final report will be due by ***6 PM*** on Friday, May 3, 2019. It must be submitted as a Word document via the ***Turn-it-in link on Moodle*** (only one team member will submit the team’s report). In addition to your written report, your team will create a short PowerPoint presentation to give to the class during our lab period on Thursday, May 2, 2019. A sample Project 1 PPT is posted on Moodle for you to use as a guide.

**1. Implant Description**

Each team will select a joint implant that is currently on the market. The device must have at least three parts, one of which must be non-metallic. For example, you could select a hip implant with a titanium alloy stem, cobalt chrome femoral head, and an ultra-high molecular weight polyethylene (UHMWPE) acetabular cup. Alternatively, you could select a 2-part device that is cemented in place (cement would be the third component), or that has a cup that is held in place by a polymer screw. (\* If you wish to select an all-metallic device, see the last paragraph of these instructions.) Describe your device and show at least one image (e.g., a photo, radiograph, or drawing). This section of your report should be about one paragraph (1 ¶) in length.

**2. Composition and Material Properties**

Describe the composition of each material. If your device has 4 or more different materials in the device, report on three of them. If a material is a metal alloy, a block polymer, or a composite then list the percentage of each material component (list these or make a table). If the % values for components are not published, then estimate each value using a similar material. If available, you can also state the phase of any metal material(s). In addition, describe the components of bone, including biological components (the types of cells and proteins) and the types of minerals.

Next, you will find the material properties of the three implant components. If material properties are not publicly available, find similar materials and use those properties. Also, find the properties of the type of bone that is in contact with the implant. Create a ***table*** showing the elastic modulus, yield strength (for polymers this may be nonexistent, simply put a dash or NA in the table), ultimate tensile strength and elongation to failure (which may be ~zero) of the three implant materials and bone. You may add other properties that you find if you believe they are important to the performance of the device. The book has tables of some of these values; other values may be found online depending on the material(s) that you select. Write the specific name for each material and for the type of bone on your table. In addition, write a statement that compares these material properties to the properties of bone.

Also, show hypothetical or actual stress strain curves for each of these materials, including bone, in a tensile test. ***Plot*** these on the ***same*** axis (find actual values or estimate them) and use different colored and/or patterned lines to denote the line for each material. Include a key to match each material with the color and/or pattern of its line. Additionally, compare the areas under the curves and state which material you believe is the toughest and which is the most brittle. Also, state which material is the strongest (highest ultimate tensile strength). A single material could be the strongest in tension and the most brittle, but not always.

Additionally, write a brief (~1 ¶) comparison of the material properties of the components and comment on which ones are most important relative to a component’s function in the implant. (Total 2¶, 1 table and 2 plots)

Finally, describe a test that can estimate the relative longevity of the device over years of use. Also, show a hypothetical or actual ***plot*** of the output of this type of test. If you copy one from a class PPT slide, please cite the PPT and instructor.

**3. Biocompatibility**

Write a description of what will happen to some of the bone next to the implant over time. Be specific about which part(s) of a specific bone is/are affected and what may happen over years of use. Describe the physical/mechanical and cellular mechanisms that are responsible. (1 ¶)

**4. Sterilization**

Implant components are generally made in factories and must be sterilized before they can be implanted. Select the two best methods for sterilizing the implant parts and include your reasons for selecting them. Given an example of a method that you would not use and state why it is not appropriate to use that method. Also, in this section of your report, provide information that answers the following questions. What types of biological hazards does sterilization inactivate? Also, describe why accidental infections that occur due to contaminated implants are such a big problem (i.e. explain why these types of infections so difficult to successfully treat). (1 ¶)­­­­­

**5. Design Improvements**

Recommend replacing one of the materials with a different material that will make the implant last longer, reducing the need for revision surgeries, and/or that will eliminate or mitigate another problem with the hip implant. (\*If your original device had all metallic components, then you must change one of the components to a non-metallic material.) Justify your choices in terms of the new material’s properties, demonstrating that one or more of these properties are better suited for the implant. Show a table with important material properties or a plot showing an important improvement in performance. Also discuss how/why the changes would likely affect, or not affect, the implant’s biocompatibility; be specific in describing at least one potential effect. (2 ¶)