1. **Course Number: BME 420**
2. **Course Title: Advanced Biomaterial Science**
3. **Instructor name:** Rajarshi Chattaraj, Ph.D.
4. **Textbooks and Materials:**
   Required – Biomaterials Science – An Introduction to Materials in Medicine, Ratner, Hoffman, Schoen, Lemons (Elsevier).
   Reference as needed - MtSE 301 textbook, Foundations of Materials Science and Engineering (FMSE); William F. Smith, McGraw-Hill
   Supplementary material (papers for class discussion) posted on Moodle
5. Specific course information:

Course Description:

The goal of this course is to learn about material selection, important properties of materials for use in the body and how the body interacts/ reacts with these materials. The first part of the course will cover the structure and properties of materials used as biomaterials including metals,ceramics, synthetic polymers, and biopolymers. The structure of these materials will be reviewed and how structure defines the behavior of a material. The bulk behavior of materials will be reviewed, including the generalized Hooke's Law, and new concepts will be introduced (including thermal strain, surface properties, and viscoelasticity). Students will be presented with problems of property characterization, failure analysis and performance testing. The second part of the class will cover the definition and criteria for a biocompatible material with emphasis on clinical relevance. The process of material selection for biocompatibility will be introduced in regard to body responses including immunological, cell and tissue interaction, toxicity and safety. Failure analysis and performance testing will be discussed. Students will work in teams to analyze a marketed implant or device using biomaterial(s) using the tools and concepts learned in the course.

Prerequisites BME 302, BME 303, BME 304, MtSE 301

6. Specific goals for course:

Course Learning Outcomes (CLOs):

1. Understand the multidisciplinary nature of biomaterials as a field of study and define design criteria for a material with relationship to their clinical application. This is in addition to how it is related to the relationship between material selection and performance *in vivo*.
2. Identify the major types of materials that are used in the body and their major modes of failure and apply material property fundamentals to analyze the performance of a material *in vivo* and translate material properties from test data to material performance.
3. Understand how to analyze the interaction of materials with the human body and what biocompatibility is in relation to specific materials.
4. Analyze issues relevant to property retention for materials when implanted in the human body and be capable of reading, comprehending and communicating the content of technical articles on biomaterials research and applications.
5. Ability to present data analysis and effectively communicate interpretation of design, test results, and data interpretation. Ability to discuss clinical relevance.
6. Develop an appreciation for scientific methods, citations (Endnote), and clinicaltranslation, including market analysis and FDA regulatory pathways/ burden.

7. Work in a group of your randomly selected peers to identify a project, develop a niche market and identifiable innovation over the standard of care, and pitch your product.

Student Outcomes:

Student outcome 1 - an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

Related CLO – 1, 2, 3, 5, 6, 7

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

Related CLO – 1, 2, 3, 4, 5, 6, 7

Student outcome 3 - an ability to communicate effectively with a **range of audiences.**

Related CLO – 4, 5, 6, 7

Student outcome 4 - an ability to function effectively on a team whose members together provide leadership, create collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

Related CLO – 5, 6, 7

Student outcome 5 - an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Related CLO – 5, 6, 7

7. List of topics to be covered | Syllabus schedule

Class	Part A	Part B	Assignment
Class 1	Review of Biomaterials	Review literature (read a paper, Endnote, write a summary), make teams	
Class 2	Chemical bonds; mechanical and surface characterization of biomaterials Choose a Biomaterial and characterize it		**HW 1 (due Fri Feb 8th)**
Class 3	Polymers and materials used in medicine & **Review session**		
Class 4	**In-class presentation of the chem, mech and bio characteristics of your material**	**Exam 1**	**Exam 1**
Class 5	Biological responses to biomaterials	What is the immune response?	
Class 6	Biological response and testing of materials		**HW 2**
Class 7	Biological testing and degradation of materials	What is the application and path for your biomaterial + **Review**	
Class 8	**Discussion of design matrix for biological characterization**	**Exam 2**	**Exam 2**
Class 9	Applications of Biomaterials Hearth Valves Intro		
Class 10	Applications of Biomaterials CVD	Renal, Hip implants	**HW 3**
Class 11	Applications of Biomaterials Orthopedic / Dental	Intellectual property	
Class 12	Applications of Biomaterials in functional TE II	What is the route to clinic, target product profile	**HW 4**
Class 13	Translating Biomaterial	Practice Pitch, **Exam review**	
Class 14	**Exam 3 (May 7th)**	**Pitchfest and Prizes & Final report (10 page) (May 7th)**	**Exam 3**