Bioengineering Signals and Systems (BENG320) Syllabus

Term: Spring 2016
Instructor: Dr. James Diaz-Gonzalez

Time: Th 07:20PM-10:00PM
Room: Enterprise Hall 275

Office: BENG 3707
Phone: (703)-993-5383

Credit Hours: 3
E-mail: jdiazgon@gmu.edu

Office Hour: Th 6:30 PM - 7:20 PM, or by appointment.

Teaching Assistant: Devaraj Dhakshinamurthy, Email: ddhakshi@gmu.edu


Description: The course builds on concepts introduced in BENG 101 and BENG 220. Concepts include (1) signal analysis and (2) system analysis, design and implementation. In this course analytical tools and methods in the time and the frequency domain will be introduced to analysis continuous-time (CT) and discrete-time (DT) physiological signals and systems. Major topics include properties of linear time-invariant signals and systems, Filtering, Fourier series, Fourier transforms, Laplace Transforms, and applications to biomedical problems. This course will make use of Matlab/Simulink in homework assignments and projects. Applications to biological and physiological signals and systems will be emphasized throughout the class.

Prerequisite(s):
1. Grade C or better in Calculus including Differential Equations (MATH 214 or equivalent)
2. Introduction to Bioengineering (BENG 101 or equivalent)

General Objectives: The student will demonstrate an understanding of the topics of the course. Upon competition of this course, the student should be able to:

- Use mathematical tools such as differential equations, statistic, computational techniques, cellular and integrative physiology to describe and address bioengineering problems.
- Identify basic continuous time and discrete signals and manipulate them using filtering and transform techniques and apply engineering judgment to evaluate answers.
- Identify basic continuous time and discrete time signals (e.g. unit step functions, ramps, and impulses) and manipulate them with basic operations (e.g. shift, fold). Students will be able to apply an appropriate combination of mathematical, scientific and engineering techniques to solve bioengineering problems.
- Characterize systems based on basic system properties (e.g. linearity, time invariant, causality, stability).
- Use computational tools, such as signal analysis, modeling and pattern recognition, to understand bioengineering systems.
- Compute energy and power of CT and DT signals.
- Use the proper frequency domain or time domain to interpret or analyze bioengineering systems
- Collaborate with others towards the completion of a project with the presentation of reports that are clear and addressed to the appropriate audience (Team-Work)
- The course will encourage the student in seeking complementary information from multiple sources to solve unfamiliar problems in homeworks and projects.

Specific Objectives: Upon the completion of the course the student will be able to:

*This course syllabus provides a general plan for the course; deviations may be necessary.
• Model bioengineering linear systems using differential equations formulation
• Use time and frequency domain to represent continuous and discret signals with their main characteristics
• Use Laplace and Fourier transformations methods to manipulate bioengineering signals
• Use frequency domain representation to evaluate the magnitude and phase of a signal, and analyze the signal energy distribution
• Use the LTI system definition to evaluate if a specific bioengineering system can be modeled as a LTI system
• Use the transfer function concept to get a proper representation LTI bioengineering systems
• Deduct the proper transfer function from the bode plots
• Design appropriate linear filters using Laplace and Z transforms methods
• Use differential equations to analyze electric circuits

**Course Outcome:** Course addresses ABET Student Outcome(s): A,G,I,K

**Class Layout:** This class will meet once per week, Thursday from 7:20PM to 10:00PM. The class will be divided into two sessions with a break of 10 min in between. The first session will run from 7:20PM-8:30PM and the second session will run from 8:40PM-10:00PM.

**Attendance:** Students are expected to attend class every time and arrive in a timely fashion for both sessions. Attendance will be taken. There will often be graded in-class activities, and you will get a 0 grade for any that you do not show up to. Students who arrive late may be barred from class, denied participation points, prevented from submitting homework, and/or given participation demerits.

**Homework (120pts):** Homework, consisting of ten problems will be assigned on the dates indicated in the Outline. In total you may earn 120 points towards your final grade through homework. Homework must be submitted when called for at the start of class. Specific homework may have additional requirements (e.g., It should be typeset and printed). Students should be ready to present their homework in class when called upon to do so. Students who refuse to or cannot present their homework in class will not be given full credit for the homework in question.

**Project (160 pts):** There will be one Bioengineering application project. The final submission due date is May 05, 2016 at 07:20PM-10:00PM. The project will consist of three reviews, of 20 points each, and the final document with 100 points.

**In-Class Exams:** There will be two 100 points in-class exams. The exams are scheduled for February 25, and March 31.

**Make-Up Policy:** There will be no makeup on homework, project, and in-class work. To allow for excused absences, I will drop your lowest homework score. Makeup on an exam will be given at the discretion of the instructor. A legitimate and verifiable excuse is required. If the excuse is approved, the makeup will be given within one week of the missed test.

**Final Exam:** There is a comprehensive 100 points final exam. The final exam will be held on Monday, May 05 from 7:20 PM - 10:00 PM in the regularly scheduled lecture room. The University’s final exam regulations will be strictly followed.

**Important Deadlines:** Registration and add/drop ends January 26. The last day to withdraw from the course is February 19.

**Grades:** The total number of points available in the course is 600. Grades will be no lower than those set forth in the following table.
Course Outline: We will be covering selected topics from chapters 1-12 of the textbook and Supplemental Material Posted (SMP) on Blackboard.

<table>
<thead>
<tr>
<th>No</th>
<th>Date</th>
<th>Lecture Topics</th>
<th>Chapters</th>
<th>Assignments</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>01/21/16</td>
<td>Introduction to CT and DT Signals. Basic properties</td>
<td>Ch. 1.0</td>
<td>HW#1 Assigned</td>
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<td>Project Out</td>
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<td>2</td>
<td>01/28/16</td>
<td>Concept in signals Processing: Basic Signals, Signals Comparison and Transformation</td>
<td>Ch. 2.0</td>
<td>HW#1 Due</td>
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<td>HW#2 Assigned</td>
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<td>3</td>
<td>02/04/16</td>
<td>Introduction to Fourier Serie and Transform</td>
<td>Ch. 3.0</td>
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<td>4</td>
<td>02/11/16</td>
<td>Applications of the Fourier Transform</td>
<td>Ch. 4</td>
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<td>5</td>
<td>02/18/16</td>
<td>1. Linear Systems and Superposition</td>
<td>Ch. 5.1-5.3</td>
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<td>2. Transfer Function Concept</td>
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<td>Review Review</td>
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<td>3. Review Exercises for Exam No. 1</td>
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<td>6</td>
<td>02/25/16</td>
<td>Exam No. 1</td>
<td>Ch. 1.0-4.0</td>
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<td>03/03/16</td>
<td>Introduction to Bode Plots</td>
<td>Ch. 5.4</td>
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<td>8</td>
<td>03/10/16</td>
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<td>9</td>
<td>03/17/16</td>
<td>Introduction to the Laplace transform</td>
<td>Ch. 6.1-6.2</td>
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<td>10</td>
<td>03/24/16</td>
<td>1. Laplace transform applied in Transfer Functions</td>
<td>Ch. 6.3-6.5</td>
<td>Project Methods Section</td>
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<td>2. Review Exercises for Exam No. 2</td>
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<td>Review Review</td>
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<td>03/31/16</td>
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<td>Ch. 5.4-6.0</td>
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<td>HW#7 Assigned</td>
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<td>04/07/16</td>
<td>1. LTI Systems: Convolution</td>
<td>Ch. 7.1-7.6</td>
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<td>2. System Simulation with Simulink</td>
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<td>13</td>
<td>04/14/16</td>
<td>1. Linear Filters: Design and Implantation</td>
<td>Ch. 8.1-8.5</td>
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<td>14</td>
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<td>Introduction to Z transform</td>
<td>Ch. 8.6</td>
<td>Project Results Section</td>
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<td>Review Review</td>
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<td>15</td>
<td>04/28/16</td>
<td>Sampling</td>
<td>SMP-8</td>
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<td>16</td>
<td>05/05/16</td>
<td>Final Exam</td>
<td>Ch. 1-8</td>
<td>Project Due</td>
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Policy on Academic Honesty: All students are expected to abide by George Mason University policy on academic honesty of George Mason University Catalog. The integrity of the University community is affected by the individual choices made by each of us. GMU has an Honor Code with clear guidelines regarding academic integrity. Three fundamental and rather simple principles to follow at all times are that: (1) all work submitted be your own; (2) when using the work or ideas of others, including fellow students, give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment, ask for clarification. No grade is important enough to justify academic misconduct. With collaborative work, names of all the participants should appear on the work. Homework problems are designed to be undertaken independently. You may discuss
your ideas with others and conference with peers; however, it is not appropriate to give your work to someone else to review. You are responsible for making certain that there is no question that the work you hand in is your own. If only your name appears on an assignment, your professor has the right to expect that you have done the work yourself, fully and independently. Plagiarism means using the exact words, opinions, or factual information from another person without giving the person credit. Writers give credit through accepted documentation styles, such as parenthetical citation, footnotes, or endnotes. Paraphrased material must also be properly cited. A simple listing of books or articles is not sufficient. Plagiarism is the equivalent of intellectual robbery and cannot be tolerated in the academic setting.

There will be a zero tolerance policy in this course for plagiarism in the exams, written project report and in homework submissions. Every instance of plagiarism will be reported to the GMU Honor Committee. No excuses. No exceptions. If you have any doubts about what constitutes plagiarism, please see the instructor.

Extra Help: Get to know each other; you will be each other’s resources. Also, do not hesitate to come to my office during office hours or by appointment to discuss a homework problem, a proof, a concept, or any aspect of the course.

Student Disabilities Policy: If you have now or develop during this semester a physical or learning disability and you want your professor to make reasonable accommodations for that, you must contact the Office of Disability Resources at (703) 993-2474. Once the Office of Disability Resources has received appropriate documentation, they will inform your instructors.

Email policy: You must use your Mason email account for all email correspondence having anything to do with your work at Mason. Federal laws protecting your privacy rights require that we only communicate student information directly to students – and use of the university email system is the only way to validate your identity. You may forward your campus email elsewhere, but we can respond only to a Mason email account.

Microsoft downloads: This course uses Microsoft software available at no charge through the Microsoft DreamSpark program. You should have received notification of your access to this program when you first registered for a course in the Volgenau School of Engineering. If you can’t find that notification email, please read the DreamSpark FAQ on http://labs.vse.gmu.edu for instructions on activating your account or resetting your password.

VSE Labs: All software required for this course is installed on computers in the open student lab in ENGR 1506. Lab hours can be found on the Labs web site, http://labs.vse.gmu.edu. Please remember to save your work to an external drive as any data stored on those computers will not persist after a reboot.

Virtual Computing Lab: Software for this course has been installed on the Mason Virtual Computing Lab (VCL), run by Mason’s ITS. The VCL allows you to run remote sessions through your own computer. You can initiate a VCL session through http://vcl.gmu.edu and that site also has a link for instructions on its use. Please remember to save all of your work on a drive separate from the virtual machine as the entire virtual machine disappears after you exit.

VSE Computing Web Site Resources: Volgenau School Computing Resources has answers to many questions about school systems on their web site: http://labs.vse.gmu.edu and will try to help you if have problems connecting to school computing systems. However, they will not provide assistance with general computing questions or course assignments. Please contact your instructor or GTA if you have any questions about how to use software to complete your assignments.

WAVES: Wellness, Alcohol and Violence Education and Services WAVES promotes wellness within the Mason community through health education, alcohol/drug assessment and education, and violence awareness, prevention and sexual assault response. We help students make healthy, safe choices and encourage lifelong, thoughtful healthy decision-making through individualized support, creative programming, and evidence-based education and outreach.
WAVES office 703-993-9999

SUB I, Suite 3200

24-Hour Sexual and Intimate Partner Violence Crisis Line 703-380-1434

wave.gmu.edu

- 703-360-7273 (Fairfax County Office for Women and Domestic and Sexual Violence Services 25 hotline)
- 703-228-4848 (Arlington County Domestic Violence Services Hotline)
- 703-368-4141 (Prince William County Sexual Assault Victims Advocacy Services (SAVAS) hotline)
- 1-800-838-8238 (Virginia Family Violence and Sexual Assault Hotline)
- 1-800-656-HOPE (Rape, Abuse and Incest National Network) https://ohl.rainn.org/online/

CAPS: Counseling and Psychological Services Counseling and Psychological Services (CAPS) provides a wide range of free confidential services to students, faculty, and staff. Services are provided by a staff of professional clinical psychologists, social workers, counselors, learning specialists, and psychiatric providers. CAPS individual and group counseling, workshops, and outreach programs are designed to enhance students’ personal experience and academic performance. Visit us at caps.gmu.edu for additional resources.

- For consultation or emergency assistance during office hours call 703-993-2380.
- For assistance during non-office hours, call University Police at 703-993-4357.
- 703-527-4077 (CrisisLink) o 1-800-273-8255 (National Suicide Prevention Lifeline)
- 1-877-838-2838 (Veterans’ Crisis Hotline)

Student Health Services (SHS) — Provides confidential health care to enrolled students in emergency and non-emergency circumstances on the Fairfax, Arlington and Prince William campuses. If there is a medical emergency and Student Health Services (SHS) is closed, please contact the free after-hours nurse ((703) 993-2831), a hospital emergency room, an urgent care facility, or call 911.

SUB 1, Suite 2300

703-993-2831

University Police:
Emergency: 911
Non-Emergency: (703) 993-2810
Reporting a Crime (Crime Solvers Anonymous Tip Hot-Line): (703) 993-4111
Mason Police Website: http://police.gmu.edu/
Eric Heath, Chief of Police Phone: (703) 993-3840 E-mail: eheath2@gmu.edu