BME 130 BIOMEDICAL SIGNALS AND SYSTEMS

Catalog Data: **BME130 Biomedical Signals and Systems (Credit units: 4) F.** Analysis of analog and digital biomedical signals; Fourier series expansions; difference and differential equations; convolution. System models: discrete-time and continuous-time linear time-invariant systems; Laplace and Fourier transforms. Analysis of signals and systems using computer programs. Prerequisites: Mathematics 2J and 3D; Statistics 8 recommended. (Design units: 1) Biomedical Engineering and Biomedical Engineering: Premedical majors have first consideration for enrollment.

Required Textbook: None

Recommended Textbook: Robert B. Northrop, Signals and Systems Analysis In Biomedical Engineering, 2nd Edition, CRC Press, 2010, ISBN-13: 978-1439812518.

References: http://www.mathworks.com/products/matlab/

Coordinator: Zoran Nenadic

Relationship to Student Outcomes

This course relates to Student Outcomes: EAC a, EAC k

Course Learning Outcomes. Students will:

1. Understand the nature of common biomedical signals (EAC a, EAC k)
2. Apply the essential techniques for analyzing analog and digital biomedical signals (EAC a, EAC k)
3. Analyze linear time-invariant systems (EAC a, EAC k)
4. Develop computing skills by using MATLAB for signals analysis and system modeling (EAC k)

Prerequisites by Topic

Solving ordinary linear differential and difference equations, complex numbers, basic linear algebra (matrices, vectors and vector spaces, determinants), elementary calculus (integration, limits, functions of real and complex variables, understanding of infinite series).

Lecture Topics:

- Definition of Systems, Signals and Variables. Mathematical Models. (week 1)
- Input-output and state-space models. Physiological variables and signals. (week 2)
- Time domain signal characteristics. Linear systems. (week 3)
- Time-invariance. Review of ordinary differential equations. (week 4)
- Time domain response of linear time invariant (LTI) systems. Convolution. Causality. (week 5)
- Comparative review of continuous and discrete LTI systems. Laplace transform. (week 6)
- Transfer function. Equilibrium. Stability. (week 7)
- Frequency response. Bode plot (week 8)
- Fourier transform. Fast Fourier transform and power spectrum. (week 9)
- Time-frequency analysis. The sampling theorem. Random signals and denoising. (week 10)

Class Schedule: Meets for 3 hours of lecture and 1 hour of discussion each week for 10 weeks.

Computer Usage: Basic knowledge of MATLAB.

Laboratory Projects: None

Professional Component

Contributes toward the Biomedical Engineering and Biomedical Engineering: Premedical topics courses and major design experience.

Design Content Description

Approach: The design skills are developed and tested through a number of homework problems such as:

- design of signal samplers so that the periodicity of a signal is preserved after discretization
- determining personalized drug injection rate that guarantees given steady-state drug concentration
- determining hormone's loss rate constant given concentrations at different points in time
- design a pendulum clock so that its oscillation period matches the specifications
- design a strategy for glucose intake that will prevent pre-diabetic response
- design a feedback controller to stabilize an open-loop unstable system
- determining parameters of the transfer function given its Bode plot
- design a low-pass filter that attenuates particular high-frequencies from a signal with a specific attenuation factor

Homework: 100%
Lectures: 0%
Laboratory: NA

Grading Criteria:

• Homework:	20%
• Midterm #1:	25%
• Midterm #2:	25%
• Final Exam:	30%
• Total:	100%

Estimated ABET Category Content:

Mathematics and Basic Science:	0.0 credit units
Engineering Science:	3.0 credit units
Engineering Design:	1.0 credit units

Prepared by: Zoran Nenadic, DSc; **Date**: April 9, 2012

Senate Approved: June 2012

Approved Effective: 2012 Fall Qtr