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| **Numerical Methods in Biomedical EngineeringBMEG 230**  |
| Credit Hours: 3, LectureSpring 2019 |
| **Instructor Information:** | Robin Hissamrobin.hissam@mail.wvu.edu 304-293-9339ESB 513 |
| **Office Hours:** | W 2:00-3:00pm; R 2:30-3:30pm; by appointment preferred |
| **Lecture Information:** | 9:00 – 10:15 MW ESB G11 |
| **Prerequisites:** | BMEG 201, MATH 251 (co-requisite) |
| **Course Description:**  | Introduce the integrative set of computational problem solving tools important to biomedical engineers. Through the use of comprehensive homework exercises, relevant examples and extensive case studies, this course will integrate principles and techniques of numerical analysis into biomedical engineering concepts from cellular and molecular systems, to physiological and biomechanical phenomena and tissue systems.  |
| **Required Textbooks:** | M. R. King, N. A. Mody; *Numerical and Statistical Methods for Bioengineering: Applications in MATLAB*, Cambridge University Press, 2010  |
| **Reference Textbooks:** | S. C. Chapra; *Applied Numerical Methods with MATLAB for Engineers and Scientists*, 3rd (or 4th) edition, McGraw Hill, 2008B. Hahn and D. T. Valentine; *Essential MATLAB for Engineers and Scientists*, 5th edition, Elsevier Ltd, 2013 |
| **Course Objectives:**  | Upon completing this course, students will be able to: 1. Explain why modeling biosystems is required to advance the profession of a biomedical engineer. (*ABET Outcome 1*)
2. Use MATLAB and Excel to solve problems related to applications of engineering in biological systems. (*ABET Outcome 1)*
3. Apply basic concepts of numerical analysis to biosystems. (*ABET Outcome 1)*
4. Solve linear and nonlinear algebraic equations as applied to biological systems (e.g., force balance in biomechanics, biomedical image processing, enzyme kinetics, receptor-ligand dynamics, etc.). (*ABET Outcome 1)*
5. Evaluate the dynamic behavior of biological systems (e.g., dynamics of stem cell differentiation, enzyme catalysis reactions, cell migration, etc.). (*ABET Outcome 1)*
6. Apply ordinary and partial differential equations in dynamic systems to evaluate biomedical engineering relevant problems (e.g., pharmacokinetics of a drug, tissue growth and differentiation, diffusion across membranes, and cell migration). (*ABET Outcome 1)*
7. Apply basic fundamentals of statistics to biomedical engineering problems. (*ABET Outcome 1)*
8. Demonstrate proficiency in oral and written communication. (*ABET Outcome 3)*
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| **Grading:** | Problem Sets 75 pointsExam 1 75 points Exam 2 75 pointsExam 3 75 pointsSemester Project 100 points Final Exam 100 points |
| **Grading Scale:**  | 450 - 500 A 400 - 449 B 350 - 399 C 300 - 349 DBelow 300 F |
|  | No make-up exams except by prior arrangement with instructor. Late assignments will not be accepted for credit, but can be checked for correctness. Exam grading appeals must be received in writing within one week of the exam being returned. |
| **Assignment Descriptions:** | *Problem Sets:* Assignments will be weighted equally in determining the final homework grade, unless otherwise stated. Students are encouraged to work together to understand the concepts in the homework; however, students should work out their own solutions. Submitted homework should reflect their own work. Assignments that are obviously copied will receive no credit.*Exams:* Exams will be in-class examinations and will be closed to textbook and notebooks. They will be based primarily on material covered since the last exam. There are no make-up exams unless discussed with the professor at least three days prior to the scheduled exam day. *Project:*All students will be required to participate in a group project as part of this course. The project will consist of an open-ended “design” or “development” problem related to the course material, where students will be expected to research information not provided, and use both general engineering problem-solving techniques and the skills learned in this course to arrive at a solution. The project will be a written report and a rubric will be supplied with the project statement on Wednesday, March 20.  |

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| **Course Schedule:**  |

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| **Week** | **Topic** | **Due** |
| 1 | Introduction |  |
| Mathematical modeling for Biosystems |
| MATLAB Fundamentals |
| 2 | MATLAB Programming | *HW 1* |
| Sources of Error |
| 3 | *No Class Monday, January 21* | *HW 2* |
| Probability and Statistics |
| 4 | **Exam 1: Monday, January 28** |  |
| Linear models of biological systems and examples |
| 5 | Linear models of biological systems and examples | *HW 3* |
| Nonlinear equations in biomedical engineering and examples |
| 6 | Nonlinear equations in biomedical engineering and examples | *HW 4* |
| 7 | **Exam 2: Monday, February 18** |  |
| Curve Fitting |
| Least-Squares Regression |
| 8 | Finite Difference | *HW 5* |
| Interpolation |
| 9 | Integration | *HW 6* |
| Differentiation |
| 10 | *Spring Break* | *HW 7* |
| 11 | **Exam 3: Monday, March 18** |  |
| Dynamic Systems: Ordinary Differential Equations and Examples |
| 12 | Stability and Stiff Equations | *HW 8* |
| MATLAB ODE Solvers |
| 13 | ODE Solvers - Project |  |
| 14 | ODE Solvers - Project  | *Project* |
| 15 | Machine Learning  |  |
| 16 | Machine Learning | *HW 9* |
| 17 | **Final Exam – Tuesday, April 30, 2pm** |  |

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| **Attendance Policy:** | This class incorporates a great deal of problem solving time into the lectures and since that will often include programming strategies, students who regularly attend lectures will be more successful in the course. Students are responsible for obtaining material covered in the course, keeping track of assignments and examination dates.  |
| **Policies and Statements** | Academic Policies and Syllabus Statements found at [https://tlcommons.wvu.edu/quality matters/syllabus-policies-and-statements](https://tlcommons.wvu.edu/quality%20matters/syllabus-policies-and-statements) will be implemented and followed for this course. Please review this webpage for more information and feel free to ask any questions regarding these statements and policies. |