Course Title
Quantitative Physiology I

Course Abstract
A course (lectures and supervised laboratory sections) designed to elaborate the physiological background necessary for advanced work in biomedical engineering. A quantitative model-oriented approach to physiological systems is stressed. Topics include biological signals and systems; sensory systems; nerve action potentials; skeletal muscle and electromyography; and movement mechanics.

Goals
• To integrate previous math, physical science, biology and engineering studies into a rigorous investigation of the quantitative foundations of physiology.
• To build the analytic and numerical skills to evaluate existing models of biology and to develop new models based upon experimental and computational experiment.

Prerequisites
• BME 140: Introduction to Biomedical Engineering
• One of the following programming courses
  o CSE 131: Computer Science I
  o CSE 200: Engineering and Scientific Computing
• ESE 230: Introduction to Electrical Networks
• ESE 317: Engineering Mathematics
• Biol 3058: Physiological Control Systems

Corequisite
• EP 310: Technical Writing

Meeting Times
• Lectures: Tuesdays, Thursdays, 1:00 to 2:30 PM
• Laboratory Sections
  o Lab Section A: Thursdays, 2:30 to 6:30 PM
  o Lab Section B: Fridays 9:00 AM to 1:00 PM

Meeting Locations
• Lectures: Whitaker 100
• Computational Labs: Whitaker 130 & Whitaker 135
• Physical Labs: Whitaker 135 & Brauer 2011

Coursemaster
• Kurt Thoroughman, thoroughman@wustl.edu [all administrative issues]

Course staff
• Professors: Dennis Barbour, Kurt Thoroughman
• TAs: Kyle Oetjen, Lindsey Moses, Gina Hyun, Liz Phillips, Kelly Hill, Amy Daitch, Haoxin Sun, Ruiye Ni, Chao Li
• Email to TAs: bme301a@seas.wustl.edu
  o **Note:** If sending email to any course staff, please put “BME 301A” in the subject line.

**Course Materials**
• Required texts:
• Other Readings (required and supplementary)
  o Will be distributed in class and posted online on Blackboard (bb.wustl.edu)
• Discussions to take place online

**Office Hours**
• Dr. Thoroughman: Tuesdays, 10 – noon and by appointment, Whitaker 200F
• Dr. Barbour: Tuesdays, 2:30 – 4:30 and by appointment, Whitaker 200E
• TAs: To Be Announced

**Grading**
• Point distribution
  o 10% Participation (in class, in lab, online)
  o 15% Homework
  o 15% Computational
    ▪ Lab writeups (50%)
    ▪ Computational lab practicum (50%)
  o 30% Physical laboratory writeups
  o 30% Exams (midterm and final exams weighted equally)
• Regrading policy:
  o Students can request regrades on any *entire* document (not just chosen subsections); grade may go up or down. Regrades will occur at end of semester only if overall grades could depend on outcome.

**Curving**
• Total points for class summed at course end
• Mean of top two scores adjusted to 100%; top two scores assigned A+
• Remainder of grades determined from this ceiling, rounded to nearest tenth:

  93 – 100%: A
  90 – 92.9%: A-
  87 – 89.9%: B+
  83 – 86.9%: B
  80 – 82.9%: B-
  77 – 79.9%: C+
  73 – 76.9%: C
  70 – 72.9%: C-
  67 – 69.9%: D+
  63 – 66.9%: D
  60 – 62.9%: D-
  < 60%: F
# Lecture Schedule

<table>
<thead>
<tr>
<th>Class</th>
<th>Date</th>
<th>Day</th>
<th>Topic</th>
<th>Lab Sections (Thurs &amp; Fri)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aug 30</td>
<td>Tues</td>
<td>Introduction</td>
<td>--</td>
</tr>
<tr>
<td>2</td>
<td>Sep 1</td>
<td>Thurs</td>
<td>Systems 1</td>
<td>Computational Lab 1: Intro to Software</td>
</tr>
<tr>
<td>3</td>
<td>Sep 6</td>
<td>Tues</td>
<td>Systems 2</td>
<td>--</td>
</tr>
<tr>
<td>4</td>
<td>Sep 8</td>
<td>Thurs</td>
<td>Systems 3</td>
<td>Physical Lab 1: Instrumentation</td>
</tr>
<tr>
<td>5</td>
<td>Sep 13</td>
<td>Tues</td>
<td>Systems 4</td>
<td>--</td>
</tr>
<tr>
<td>6</td>
<td>Sep 15</td>
<td>Thurs</td>
<td>Systems 5</td>
<td>Computational Lab 2: Signals &amp; Systems</td>
</tr>
<tr>
<td>7</td>
<td>Sep 20</td>
<td>Tues</td>
<td>Systems 6</td>
<td>--</td>
</tr>
<tr>
<td>8</td>
<td>Sep 22</td>
<td>Thurs</td>
<td>Sensory 1</td>
<td>Physical Lab 2: Signals</td>
</tr>
<tr>
<td>9</td>
<td>Sep 27</td>
<td>Tues</td>
<td>Sensory 2</td>
<td>--</td>
</tr>
<tr>
<td>10</td>
<td>Sep 29</td>
<td>Thurs</td>
<td>Sensory 3</td>
<td>Computational Lab 3: Sensory</td>
</tr>
<tr>
<td>11</td>
<td>Oct 4</td>
<td>Tues</td>
<td>Sensory 4</td>
<td>--</td>
</tr>
<tr>
<td>12</td>
<td>Oct 6</td>
<td>Thurs</td>
<td>Sensory 5</td>
<td>Physical Lab 3: Evoked Potentials</td>
</tr>
<tr>
<td>13</td>
<td>Oct 11</td>
<td>Tues</td>
<td>Review 1</td>
<td>--</td>
</tr>
<tr>
<td>14</td>
<td>Oct 13</td>
<td>Thurs</td>
<td>Midterm Exam</td>
<td>No Lab - Fall Break</td>
</tr>
<tr>
<td>15</td>
<td>Oct 18</td>
<td>Tues</td>
<td>Nerve 1</td>
<td>--</td>
</tr>
<tr>
<td>16</td>
<td>Oct 20</td>
<td>Thurs</td>
<td>Nerve 2</td>
<td>Computational Lab 4: RC Neuron Model</td>
</tr>
<tr>
<td>17</td>
<td>Oct 25</td>
<td>Tues</td>
<td>Nerve 3</td>
<td>--</td>
</tr>
<tr>
<td>18</td>
<td>Oct 27</td>
<td>Thurs</td>
<td>Nerve 4</td>
<td>* Physical Lab 4: Frog Nerve</td>
</tr>
<tr>
<td>19</td>
<td>Nov 1</td>
<td>Tues</td>
<td>Nerve 5</td>
<td>--</td>
</tr>
<tr>
<td>20</td>
<td>Nov 3</td>
<td>Thurs</td>
<td>Muscle 1</td>
<td>Computational Lab 5: Hodgkin-Huxley</td>
</tr>
<tr>
<td>21</td>
<td>Nov 8</td>
<td>Tues</td>
<td>Muscle 2</td>
<td>--</td>
</tr>
<tr>
<td>22</td>
<td>Nov 10</td>
<td>Thurs</td>
<td>Muscle 3</td>
<td>* Physical Lab 5: Frog Muscle</td>
</tr>
<tr>
<td>23</td>
<td>Nov 15</td>
<td>Tues</td>
<td>Muscle 4</td>
<td>--</td>
</tr>
<tr>
<td>24</td>
<td>Nov 17</td>
<td>Thurs</td>
<td>Muscle 5</td>
<td>Computational Lab 6: Hill Muscle Model</td>
</tr>
<tr>
<td>25</td>
<td>Nov 22</td>
<td>Tues</td>
<td>Neural Prosth. 1</td>
<td>--</td>
</tr>
<tr>
<td>26</td>
<td>Nov 29</td>
<td>Tues</td>
<td>Neural Prosth. 2</td>
<td>--</td>
</tr>
<tr>
<td>27</td>
<td>Dec 1</td>
<td>Thurs</td>
<td>Neural Prosth. 3</td>
<td>Physical Lab 6: EMG &amp; Movement</td>
</tr>
<tr>
<td>28</td>
<td>Dec 6</td>
<td>Tues</td>
<td>Neural Prosth. 4</td>
<td>--</td>
</tr>
<tr>
<td>29</td>
<td>Dec 8</td>
<td>Thurs</td>
<td>Review 2</td>
<td>Computational Lab Practicum</td>
</tr>
<tr>
<td></td>
<td>Dec 13</td>
<td>Tues</td>
<td>Reading Day</td>
<td>--</td>
</tr>
<tr>
<td>30</td>
<td>Dec 20</td>
<td>Tues</td>
<td>Final Exam 1-3PM Whitaker 100</td>
<td>--</td>
</tr>
</tbody>
</table>

**Note:** Frog labs (marked *) take five hours to complete; please plan accordingly
Homeworks
One homework will be assigned on the first lecture day of each module and will be due on the fourth or fifth lecture day of the module at the BEGINNING of class (1:07 PM). Homeworks are late if turned in after this time. You are not to miss lab or lecture to finish a homework. No homework will be accepted late without penalty, which is 1/24th of the total points deducted for each of the first 3 hours late and 1/8th of the total points deducted per day late. Homework will not be accepted (score of 0) if submitted after solutions are available.

Physical Lab Reports
Physical labs constitute a major, unique learning opportunity for this course. Written physical lab materials will be distributed one week prior to the lab, and reports will be due at 11:59 PM on the second Wednesday following the lab. Lab reports are late if turned in after this time. You are not to miss lab or lecture to finish a lab report. No lab report will be accepted late without penalty, which is 1/24th of the total points deducted for each of the first 3 hours late and 1/8th of the total points deducted per day late.

Computational Lab Reports
The Simulink/Matlab laboratory sessions are designed to be self-contained. Preparatory reading will often be distributed, but the labs and short write-ups can be completed within the four-hour session, and you are strongly encouraged to do so. Write-ups will be formally due at 11:59 PM on the Monday evening following the lab. No lab report will be accepted late without penalty, which is 1/24th of the total points deducted for each of the first 3 hours late and 1/8th of the total points deducted per day late. The Computational Lab Practicum will require individual design, implementation, and analysis of a quantitative model of physiology, and will determine 50% of the overall Computational lab portion of the grade.

Participation
Everyone begins with a 50% participation grade. Scores can increase or decrease throughout the semester. Absences and lack of engagement in labs are the most common causes of score decreases. Evidence of creating an active learning environment for your classmates, such as addressing their questions online, is the most common contribution to score increases.

Online Course Material
A major means of communication for this course will be electronically through Blackboard. We will utilize this resource several ways throughout the semester, so plan to check it regularly.

Academic Integrity and Fairness
In the spirit of academic openness, students are encouraged to share learning experiences with one another. Discussion of (NOT collaboration on) homework and labs is strongly encouraged. Write the names of your discussants on each assignment. All written work must be generated solely by yourself. Exam work should be your own with no discussion, even for take-home exams. Violations of academic integrity by any student will be handled according to the guidelines laid out for all Washington University students:

http://www.wustl.edu/policies/undergraduate-academic-integrity.html

Exceptions to any of the policies outlined in this syllabus for an individual student (e.g., due dates and times) will be handled on a case-by-case basis and possibly put to the remainder of the class for evaluation. No non-emergency deadline extension of any sort will be granted without the submission of a partially completed assignment.