# PGY630: Quantitative methods for biomedical research

Wednesday mornings, 9-11 am, via synchronous Zoom, <https://uky.zoom.us/j/86064607238>

## Faculty

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| --- | --- | --- | --- | --- |
| Kenneth S. Campbell, PhD | Course Director | MN510 UKMC | 859-323-8157 | [k.s.campbell@uky.edu](mailto:k.s.campbell@uky.edu) |

## Office Hours

Dr. Campbell is available for questions or concerns as needed. The best first step is to speak to him during class-time. Follow-up by email as required.

## Canvas

Information will be provided via the PGY630 site on Canvas (<https://uk.instructure.com/courses/2002208>). The Canvas system will also be used to send emails to the class. Please make sure that your contact details on Canvas are up to date.

To resolve technical difficulties with Canvas, please contact UK Information Technology (<http://www.uky.edu/ukit>, 859-218-HELP, or [helpdesk@uky.edu](mailto:helpdesk@uky.edu)).

## Course description

“*Quantitative methods for biomedical research*” is a 2 credit graduate-level class designed for PhD students and others who wish to develop skills relating to data analysis and interpretation. The course will include sections on data handling, plotting, statistics, and image analysis. Students will be shown how to automate routine analysis tasks and encouraged to develop quantitative skills that will help them to solve future problems by themselves. The course will use MATLAB software but the techniques and content are relevant to all types of scientific programming. Students will also be introduced to GitHub and shown how to organize code and data to improve rigor and reproducibility.

Classes will typically consist of one-hour of didactic instruction and/or tutorials followed by a second hour of hands-on practical experience. Videos may be posted before some classes to allow for a ‘flipped-classroom’ style of teaching.

## Additional resources

All lecture material will be published at <https://campbell-muscle-lab.github.io/teaching_PGY630_QM/>

## Student learning outcomes

At the end of this course, a student should be able to use MATLAB or similar software to:

* Import experimental data from text files, spread-sheets, images, and movies
* Plot data in appropriate formats (including bar charts, scatter plots, surface plots)
* Fit models to data (including straight lines, polynomials, and exponentials)
* Perform and interpret hypothesis tests (including t-tests and ANOVA)
* Segment images to detect features
* Extract statistics about image features (including areas, colors, and eccentricities)
* Analyze gels and immunoblots

## Course pre-requisites and materials

Students will be accepted at the discretion of the Course Director.

Customized lecture notes and videos will provided via Canvas.

Students will need access to MATLAB software throughout the semester. Most students will find it helpful to have MATLAB installed on a laptop that they bring to class.

Information on installing the University of Kentucky’s MATLAB instance is at  
<http://www.uky.edu/its/sites/www.uky.edu.its/files/TAH_quickstart_guide.pdf>

## Additional points

* Install MATLAB on your laptop before you come to the first class.
* Individuals who have not previously used MATLAB software should complete the MATLAB Onramp (available at <https://matlabacademy.mathworks.com/>) before the first class.  
  **NOTE THAT THERE ABOUT 3 HOURS OF VIDEOS. DEPENDING ON YOUR EXPERIENCE, IT MAY TAKE YOU LONGER THAN THIS TO COMPLETE THE TRAINING.**

## Course activities

The course will use a mixture of didactic approaches, in-person tutorials, and self-paced learning activities. Students will be asked to submit brief assignments each week.

## Grading

Students will be able to accumulate a maximum of 100 points as follows:

|  |  |  |
| --- | --- | --- |
| Component | Points | Grading criteria |
| Mid-term project | 20 | Student:   * attempts an appropriate problem * demonstrates problem-solving skills * documents limitations of approach |
| Final project | 20 | Student:   * attempts an appropriate problem * demonstrates problem-solving skills * documents limitations of approach |
| Weekly assignments | 28 (2 per assignment) | Student:   * makes a significant attempt to complete the task |
| Class discussion | 32 (2 per class) | Student:   * is engaged throughout the class period * asks questions and participates in discussions |

Grades will allocated as follows:

* A: 90 to 100 points
* B: 80 to 89 points
* C: 70 to 79 points
* D: 60-69 points
* E: 59 points or lower

Midterm grades will be assigned to each student.

## Submission details and deadlines

All assignments should be uploaded to Canvas as a single PDF file. You may wish to make this file using PowerPoint but you can also publish code from MATLAB (<https://www.mathworks.com/help/matlab/matlab_prog/publishing-matlab-code.html>).

* Weekly assignments, noon on Tuesdays
* Mid-term projects, noon on Wednesday, 10 March
* Final projects, noon on Wednesday, 5 May

## Attendance policies

* Attendance is mandatory. Students who miss 20% or more of classes may be asked to withdraw from the class.
* Students without excused absences will be given zero points for class discussion / presentation
* Students without excused absences who do not submit weekly assignments on time will be given zero points for their assignments
* Students with excused absences will be given make-up opportunities

## Verification of Absences

Students may be asked to verify their absences in order for them to be considered excused. Senate Rule 5.2.4.2 states that faculty have the right to request “appropriate verification” when students claim an excused absence because of illness or death in the family. Appropriate notification of absences due to university-related trips is required prior to the absence.

For an excused absence for illness, a Tier 2 or Tier 3 document provided to the student by UHS is appropriate verification.

## Disabilities and Medical Conditions

A student with a documented disability that requires academic accommodations for this course must make a request to the University Disability Resource Center. When accommodations are approved, the Center will provide the course director with a Letter of Accommodation that details the recommended accommodations from the Disability Resource Center. In order to receive the recommended accommodations, the student must provide the Course Director with an official letter from the Disability Resource Center at least 10 days before the assessment is due.

More information about the Disability Resource Center is available at <https://www.uky.edu/DisabilityResourceCenter/>

## Class Behavior, Decorum and Civility

Students are expected to maintain a level of dignity and respect towards faculty, staff, and fellow students. Students are expected to value differences among all members of our academic community. Conversely, all students have the right to take reasoned exception and voice opinions contrary to those offered by the instructor and/or other students according to University Senate Rules. Equally, a faculty member has the right and the responsibility to ensure that all academic discourse occurs in a context characterized by respect and civility. Acceptable decorum and civility does not include attacks of a personal nature or statements denigrating another on the basis of race, sex, religion, sexual orientation, age, or national/regional origin.

## Academic Integrity

Per university policy, students shall not plagiarize, cheat, falsify, or misuse academic records. Students are expected to adhere to University policy on cheating and plagiarism in all courses. The minimum penalty for a first offense is a zero on the assignment on which the offense occurred. If the offense is considered severe or the student has other academic offenses on their record, more serious penalties, up to suspension from the university may be imposed. Plagiarism and cheating are serious breaches of academic conduct. Each student is advised to become familiar with the various forms of academic dishonesty as explained in the Code of Student Rights and Responsibilities. Complete information can be found at the following website: [http://www.uky.edu/Ombud.](http://www.uky.edu/Ombud) A plea of ignorance is not acceptable as a defense against the charge of academic dishonesty. It is important that you review this information as all ideas borrowed from others need to be properly credited.

Part II of *Student Rights and Responsibilities* [(http://www.uky.edu/StudentAffairs/Code/part2.html](http://www.uky.edu/StudentAffairs/Code/part2.html)) states that all academic work, written or otherwise, submitted by students to their instructors or other academic supervisors, is expected to be the result of their own thought, research, or self-expression. In cases where students feel unsure about the question of plagiarism involving their own work, they are obliged to consult their instructors on the matter before submission. When students submit work purporting to be their own, but which in any way borrows ideas, organization, wording or anything else from another source without appropriate acknowledgement of the fact, the students are guilty of plagiarism. Plagiarism includes reproducing someone else’s work, whether it be a published article, chapter of a book, a paper from a friend or some file, or something similar to this. Plagiarism also includes the practice of employing or allowing another person to alter or revise the work that a student submits as his/her own, whoever that other person may be. Students may discuss assignments among themselves or with an instructor or tutor, but when the actual work is done, it must be done by the student and the student alone. When a student’s assignment involves research in outside sources of information, the student must carefully acknowledge exactly what, where and how he/she employed them. If the words of someone else are used, the student must put quotation marks around the passage in question and add an appropriate indication of its origin. Making simple changes while leaving the organization, content and phraseology intact is plagiaristic. However, nothing in these Rules shall apply to those ideas which are so generally and freely circulated as to be a part of the public domain (Senate Rule 6.3.1).

## Lesson plan

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| --- | --- | --- | --- | --- |
| ***General area*** | ***Week*** | ***Date*** | ***Topic*** | ***Additional details*** |
| Getting started | 1 | 27 Jan, 2021 | Introduction to the class | Setting goals for the class, introduction to GitHub |
| Basics | 2 | 3 Feb, 2021 | Data | Reading and writing data files, tables, filtering and sorting |
|  | 3 | 10 Feb, 2021 | Files | Organizing projects, batch processing |
|  | 4 | 17 Feb, 2021 | Plotting | Bar charts, scatter plots, jitter plots |
| Curve fitting | 5 | 24 Feb, 2021 | Linear regression | Fitting a straight line to data, Interpretation of p value and r |
|  | 6 | 3 Mar, 2021 | Non-linear regression | Fitting curves to data |
| Statistics | 7 | 10 Mar, 2021 | Statistics 1 | t-tests |
|  | 8 | 17 Mar, 2021 | Statistics 2 | ANOVA |
|  | 9 | 24 Mar, 2021 | Review of mid-term project |  |
| Image processing | 10 | 31 Mar, 2021 | Image basics | Bit resolution, color spaces, image formats |
|  | 11 | 7 April, 2021 | Image handling | Resizing, cropping, brightness and contrast |
|  | 12 | 14 Apr, 2021 | Segmentation | Thresholding |
|  | 13 | 21 Apr, 2021 | Binary image analysis | Shape statistics |
|  | 14 | 28 Apr, 2021 | Gels and immunoblots | Densitometry profiles, background correction |
|  | 15 | 5 May, 2021 | Movies | Reviewing of image formats, tracking objects |
|  | 16 | 12 May, 2021 | Review | Discussion of final projects |