

**Final Exam**  
**Ph 135, Fall 2019**

Instructions:

- This exam must be taken in one sitting over the period of 5 hours from start to end. Please note on the top of your solution the starting and finishing time.
- The exam contains four problems. To obtain a perfect score you need to answer only three out of the four problems. If you tackled more than 3 problems, indicate in the beginning of your exam which problems we should grade.
- you may use any personal notes, course hand-outs, and *two* books of your choice during the exam. Note the textbooks you are using in your solution. A computer math program is not necessary, but if you feel the need to use one (mathematica, matlab, maple, etc.), it is allowed.
- If you need to make any assumptions due to lack of information in the text, specify clearly your assumptions.
- Your solution is due by email to Swati jschaudha@caltech.edu, cc'd to Gil, refael@caltech.edu, by monday, Dec. 16th, 5pm.
- Do not discuss the exam with your colleagues before your solution and theirs is handed in.