Instructor: Samer Gozem
Office: 504 Science Annex
E-mail: sgozem@gsu.edu
Office Hours: ________________________________

Lecture time and place: ________________________________

Course Prerequisites: Math 2212 or Math 2202
Phys 2212K or Phys 1112K
Chem 2400
All with a grade of C or higher.


E-Text: Redshelf offers a 180 day online / downloadable version of the Turro textbook for $51.00.

Course Description: Photon Sciences is a 3-credit semester course that discusses events occurring in molecular systems following the absorption of light. The first few lectures will introduce some important background concepts. Next, we will discuss how light absorption is accompanied by changes in the molecular electronic and nuclear structures (photophysics). We will then discuss how such photophysical processes can sometimes lead to molecular transformations (photochemistry). Finally, we will discuss photochemistry that occurs in biological systems such as proteins and DNA (photobiology).

Learning Outcomes: In this course, students will:
- gain a comprehensive understanding of light-induced processes in molecular and biological systems, not only at the molecular level but also at the electronic level.
- learn how molecules employ energy from light to drive radiative, non-radiative, and chemical processes.
- learn about common photochemical reactions in organic molecules.
- learn how light is utilized in biology through photoreceptors and photosynthetic systems.
- learn about some of the harmful effects of light, and the mechanism of DNA photodamage.

Grading:

<table>
<thead>
<tr>
<th>Contribution</th>
<th>% (4470)</th>
<th>% (6470)</th>
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</thead>
<tbody>
<tr>
<td>Quizzes</td>
<td>30</td>
<td>25</td>
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<tr>
<td>Midterm</td>
<td>30</td>
<td>25</td>
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<tr>
<td>Final</td>
<td>30</td>
<td>25</td>
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<tr>
<td>Project Report</td>
<td>10</td>
<td>25</td>
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Quizzes & Exams: There will be five unannounced quizzes throughout the semester. They will be short quizzes (5 mins) given at the end of the week to probe the student understanding of the material covered the prior week. There will also be one midterm exam and one final exam. For Chem 4470 students, quizzes are worth 6% of the grade each, and exams worth 30% each. For Chem 6470 students, quizzes will be worth 5% of the grade each, and exams worth 25%.
Project: Towards the middle of the semester, students will each be assigned an individual project. Students have the opportunity to discuss their projects with the instructor beforehand and suggest something relevant to their academic/research interests. Otherwise, students will be assigned a random project. The project will require students to discuss the photophysics/photochemistry of a system that was not used as an example in class using concepts and terms they learned during the class. Reports need to be concise, clearly written, and referenced. The report is due 1 week before the end of classes, on __________.

Chem 4470 reports are worth 10% of the course grade and should be at most 5 pages long (ACS style, double spaced, 12-sized font, 1-inch margins, including figures and references). Reports will be assessed based on the student’s ability to discuss the photophysics or photochemistry of a system using at least one concept learned in this class and referencing appropriate chemical literature.

Chem 6470 reports will be worth 25% of the course grade and should be at most 12 pages long (double spaced, 12-sized font, 1-inch margins, including figures and references). The report should introduce a problem and discuss its photophysics or photochemistry using several concepts learned in this class, based on what is reported in literature. The report will be assessed based on the student’s ability to produce a coherent description of the photophysics or photochemistry of a system using reports from literature in a well written and correctly referenced ACS-style report.

Last day to withdraw: ______________________________________

The University requires faculty, on a date set by the Provost after the mid-point of the course, 1. to give a WF to all those students who are on their rolls but no longer taking the class, and 2. to report the last day the student attended or turned in an assignment.

Student Integrity Policy: All assignments, exams and tests taken must represent the student’s individual, unaided efforts. Receiving unauthorized outside information or offering unauthorized information to another student during an examination is cheating. Any suspected offenses may be referred to the Department of Chemistry and the College of Arts and Sciences for appropriate action.

Tentative Course Schedule:

<table>
<thead>
<tr>
<th>Dates</th>
<th>Subject</th>
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<tbody>
<tr>
<td>Part I: Background (Total: ~8 days)</td>
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<tr>
<td>~1 day</td>
<td>Electromagnetic radiation, energy scales, time scales of physical/chemical processes</td>
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<tr>
<td>~3 days</td>
<td>What is an excited state? (Electronic, vibrational, and spin configurations of states)</td>
</tr>
<tr>
<td>~3 days</td>
<td>Potential energy surfaces (Beyond the Jablonski diagram, Born-Oppenheimer approximation, understanding the Franck-Condon principle)</td>
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<tr>
<td>~1 day</td>
<td>Transitioning between states with light (single and multiphoton absorption, stimulated and spontaneous emission)</td>
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Part II: Photophysics (Total: ~13 days)

~6 days Radiative processes: fluorescence and phosphorescence (Stokes shift, Kasha’s rule, Mirror-image rule and exceptions, effect of solvent/environment, time-resolved fluorescence spectroscopy, fluorescence lifetimes/quantum yields, quenching, Stern-Volmer equation, fluorescence polarization/anisotropy, FRET, sensing applications)
~3 days Nonradiative photophysical processes: Internal conversion and intersystem crossing
~4 days Energy/Electron transfer (Dexter vs Forster, Marcus theory, triplet-triplet annihilation, singlet fission)

Part III: Photochemistry (Total: ~13 days)

~2 days Molecular orbitals
~1 day photochemical σ bond breaking
~1 day photochemical π bond breaking
~1 day Conical intersections
~2 days Woodward-Hoffman rules, correlation diagrams.
~6 days Common photochemical reactions

Part IV: Photobiology (Total: ~8 days)

~3 days Natural fluorophores (Trp, Tyr, Phe, NAD, flavins), extrinsic fluorophores (non-covalent proteins probes, membrane probes, NIR probes, DNA probes), fluorescent proteins (GFP, bilin-binding FPs, flavin-binding FPs)
~1 day Bioluminescence
~2 days Different classes of photoreceptors and their photochemistry
~2 days Photophysical and photochemical processes in DNA bases.