HONS 3035 3D Imaging, Spring 2008
Lecture Place and Time: 210 French House; Tu/Th 1:40pm-3:00pm
Lab Place and Time: 101 Frey Computing Services Building; Tu/Th 1:40pm-3:00pm

Instructors:
Dr. Leslie G. Butler (Chemistry) <lbutler@lsu.edu>
Dr. Dominique G. Homberger (Biological Sciences) zodhomb@lsu.edu (drop an e-mail for an appointment)
Imtiaz Hossain (Visualization Services Center, ITS) <imtiaz@lsu.edu>
Dr. Kenneth L. Matthews II (Physics & Astronomy) <kipmatth@lsu.edu>
Dr. Gestur Olafsson (Mathematics) <olafsson@math.lsu.edu>
Dr. Karsten Thompson (Chemical Engineering) <karsten@lsu.edu>

1. **Course Mission Statement:** When students complete this course, they will have learned:
   - The principles of X-ray tomography, both in theory (lectures) and in practice (lab projects);
   - A sampling of the on-going research in mathematics for image acquisition, reconstruction and analysis;
   - Some computer workstation expertise with image visualization software;
   - A survey of applications of 3D imaging to problems and questions in medicine, engineering, materials science, and more.

2. **Class website:** This class is an early adopter of the new LSU course management system, Moodle.
   a) Go to <http://moodle.test.lsu.edu>
   b) Use your PAWS ID name and password to logon
   c) Select HNRS 3035

3. **The lectures do not parallel the laboratory exercises.** As the course progresses, however, you will be able to see how all the materials are interconnected. The lectures, required readings, and laboratory exercises will supplement or reinforce one another. Relevant materials will be posted on the Moodle web site for the course in folders for each instructor.

4. **3D Imaging is a work-intensive course.** Plan to spend every day learning and reviewing the materials. Because of the large amount of material to be learned, you will not be able to "cram" for a few days before the exam. Get together in study groups to review the materials. Keep in mind that the final exam is comprehensive. Therefore, you will have to learn the materials for the long term. In order to do well on the quizzes, you need to keep up with the materials.

5. **Your instructors** are more than willing to help you if you encounter any difficulty with the course materials. Please make sure to contact them any time.

6. **Videotaping of the lectures** will be executed for private podcasting to the faculty.

7. **Attendance** will be taken in lectures and labs through sign-in sheets.

8. **Field trips** will be organized for after hours (leave 4:30pm; return 6:30pm). At least one of the field trips must be attended; a separate research report may be substituted for the second field trip.
   A. Field Trip to Mary Bird Perkins Cancer Center (MBPCC) <http://www.marybird.org/>
   B. Field trip to Center for Advanced Microstructures and Devices (CAMD) < http://www.camd.lsu.edu/>

9. **Schedule of exams:**
   Mid-term exam: Tuesday, March 4, 2008
   Final exam: Tuesday, May 6, 2008; 12:30pm- 2:30pm

10. The **exams** will be essay and short-answer exams. Blank writing paper will be provided. Bring your own pencil or pen and sheets of ruled paper, if you do not like writing on blank paper. **Spelling errors** in your answers will be marked, and 0.5 point will be deducted for each.

11. **Homework:**
    For each lecture and lab period, each student is required to generate one or more questions and the answers to these questions, to demonstrate a grasp of the course material. Questions and answers are submitted electronically through their personal access on the Moodle website. Depending on the originality, complexity, and completeness of the questions and answers, 1-3 points can be earned per homework assignment.

12. The **final grade** will be based on the following items:
    Homework: 25 %; Mid-term exam (one hour): 25 %; Final comprehensive exam (two hours): 40 %; Lab project: 10%

13. The **final letter grade** for the course will be determined according to the following scale: 90-100% = A; 80-89% = B; 70-79% = C; 60-69% = D; below 60% = F

Schedule of lectures and labs

Week 1:

- **Tu, Jan 15:** Matthews (**Lecture:** Intro to radiation physics)
- **Th, Jan 17:** Matthews (**Lecture:** Physical basis for imaging with x-rays)

Week 2:

- **Tu, Jan 22:** Matthews (**Lecture:** X-ray images as 2D projections of 3D objects)
- **Th, Jan 24:** Hossain (**Lab**: Introduction to tomography and viewing 3D datasets)

Week 3:

- **Tu, Jan 29:** Olafsson (**Lecture:** Introduction to discrete tomography)
- **Th, Jan 31:** Olafsson (**Lecture:** Introduction to discrete tomography)

Week 4:

- **Tu, Feb 5:** ***Mardi Gras***
- **Th, Feb7:** Matthews (**Lecture:** X-ray production and detection)

Week 5:

- **Tu, Feb 12:** Matthews (**Lecture:** Computed tomography systems)
- **Th, Feb 14:** Matthews (**Lab:** SkyScan image acquisition)

Week 6:

- **Tu, Feb 19:** Homberger (**Lecture:** Biological basis of 2D and 3D vision; history of 3D visualization)
- **Th, Feb 21:** Homberger (**Lecture:** History of 3D visualization of biological specimens; images as models)

Week 7:

- **Tu, Feb 26:** Homberger (**Lecture:** 3D imaging as applied to novel questions in biology)
- **Th, Feb 28:** Hossain (**Lab**: Histograms, segmentation; introduction to visualization tools)

Week 8:

- **Tu, Mar 4:** ***Mid-term exam***
- **Th, Mar 6:** Olafsson (**Lecture:** The mathematics of tomography)

Week 9:

- **Tu, Mar 11:** Hossain (**Lab**: Common image file formats; creating fly-throughs)
- **Th, 13 Mar:** Olafsson (**Lecture:** The mathematics of tomography)

Spring Break: March 17-21

Week 10:

- **Tu, Mar 25:** Butler (**Lecture:** Multi-spectra X-ray imaging, concentration gradients)
- **Th, Mar 27:** Butler (**Lecture:** Image simulation and error analysis, diffusion measurement)

Week 11:

- **Tu, Apr 1:** Hossain (**Lab**: Vector field visualization; large datasets and distributed visualization)
- **Th, Apr 3:** Hossain (**Lab**: Demonstration of stereo- imaging; tour of Imaginarium)

Week 12:

- **Tu, Apr 8:** Thompson (**Lecture:** Grayscale to binary conversions; noise reduction)
- **Th, Apr 10:** Hossain (**Lab**: Analyzing datasets from the Visible Human Project)

Week 13:

- **Tu, Apr 15:** Hossain (**Lab**)

- **Th, Apr 17:** Thompson (**Lecture:** Segmentation and object identification)

Week 14:

- **Tu, Apr 22:** Thompson (**Lecture:** Visualization and computations involving surfaces)
- **Th, Apr 24:** Thompson (**Lecture:** Techniques for quantifying structure)

Week 15:

- **Tu, Apr 29:** Hossain (**Lab:** TBA)
- **Th, May 1:** Hossain (**Lab**: Skyscan student presentations)