**DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING**

*AISE 4025 – Introduction to Computer Assisted Surgeries: Theory and Practice*

**COURSE DESCRIPTION:** Modern surgical theatres are equipped with advanced computing and mechatronic resources to assist surgeons in performing surgical interventions. In this course, mathematical foundations and practical implementation of computer-assisted surgical techniques, such as medical imaging processing, registration, and surgical navigation using virtual and augmented reality environments, are explored at an intermediate level.

**ACADEMIC CALENDAR:**
https://www.westerncalendar.uwo.ca/Courses.cfm?CourseAcadCalendarID=MAIN_031456_1&SelectedCalendar=Live&ArchiveID=

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**PRE OR COREQUISITES:** (Engineering Science 1036A/B or Computer Science 1025A/B or Computer Science 1026A/B) and (NMM 2276A/B or NMM 2277A/B) and ECE 4445A/B.

**ANTIREQUISITES:** none

**CEAB ACADEMIC UNITS:**

**CONTACT HOURS:** Timetable information is available at https://draftmyschedule.uwo.ca/.

Three lecture hours occur weekly. Two hour laboratory sessions occur bi-weekly

**RECOMMENDED/REQUIRED TEXT:** lecture notes and Github

**RECOMMENDED/ REQUIRED SOFTWARE:** Python, Jupyter Notebook, Matlab

**RECOMMENDED RESOURCES/REFERENCES:**

https://github.com/cheneuwo/UWO_AISE_4025.git

**GENERAL LEARNING OBJECTIVES (CEAB GRADUATE ATTRIBUTES)**

| Knowledge Base | A | Engineering Tools | A | Impact on Society | **I** |
|---|---|---|---|---|---|
| Problem Analysis | A | Individual & Teamwork | | Ethics and Equity | |
| Investigation | A | Communication | D | Economics and Project Mgmt. | |
| Design | D | Professionalism | | Life-Long Learning | **D** |

Notation: x represents the content level code as defined by the CEAB. blank = not applicable; I = introduced (introductory); D = developed (intermediate) and A = applied (advanced).

Rating: I – The instructor will introduce the topic at the level required. It is not necessary for the student to have seen the material before. D – There may be a reminder or review, but the student is expected to have seen and been tested on the material before taking the course. A – It is expected that the student can apply the knowledge without prompting (e. g. no review).

**COURSE MATERIALS:** Weekly content and guides for the laboratories will be available on the course OWL site. The material for this course will be taught in both lectures and labs; therefore, it is imperative that you attend each lecture and lab.

**UNITS:** SI

**COURSE TOPICS AND SPECIFIC LEARNING OUTCOMES:**

**The following table summarizes the course learning outcomes along with CEAB GAIs where the GAIs in bold indicate ones to be measured and reported annually.**

| Course Topics and Specific Learning Outcomes | CEAB Graduate Attribute Indicators |
|---|---|
| **Surgical Metrology**<br><br>At the end of this section, student will be able to:<br>　a) Understand the competing principles between spatial measurement devices, including mechanical, optical, magnetic, and vision-based tracking systems<br>　b) Understand the mathematical principles of spatial calibrations for surgical instruments and sensing equipment<br>　c) Understand camera models and camera calibration | KB3,PA2,IN3,LL |

| | |
|---|---|
| d) Understand how to quantify errors and uncertainties in spatial measurements and calibration | |
| **Image Processing and Registration**<br><br>At the end of this section, students will be able to:<br>a) Extract image features using both the procedural and machine-learning based techniques<br>b) Perform rigid and deformable, multi-model, image registrations<br>c) Understand how to quantify registration errors | KB3,PA2,ET2,D3 |
| **Detailed design**<br><br>At the end of this section, students will be able to:<br>a) Use open-source library (SciKit-Surgery) to implement a basic surgical navigation system<br>b) Produce detailed design documentation to acceptable engineering standards<br>c) Implement and integrate software toolkits into their software with consideration for human-computer interface (HCI) | D4,ET2,CS3 |

**EVALUATION:**

| Name | % Worth | CEAB GAs ASSESSED |
|---|---|---|
| Labs (Total = 4) | 20% | KB3,PA2,ET2 |
| Project | 30% | CS3,ET2,KB3,LL2 |
| Mid-Term Examination | 20% | KB3,PA2 |
| Final Examination | 30% | KB3,PA2 |

Note that the dates listed above are **tentative** and may be adjusted if needed. Marks will be assigned on the basis of method of analysis and presentation, correctness of solution, clarity and neatness.

**Laboratory**: The schedule for laboratory exercises will be posted on the course online portal. All lab exercises are to be completed in person during the allocated laboratory time. It is mandatory for the students to complete all lab exercises.

**Project**: A group project will be completed in which students will perform a complete sensor and actual selection process. The details of the project will be distributed in class. Project requirements will be posted on the OWL site and the due dates for specific

components will be posted on the OWL calendar.

**Mid-term Examination**: The mid-term examination will take place during the regular lecture hour period. The mid-term exam will be one (1) hour long, *partially* open-book, covering all topics presented in the lecture (upon and prior to the mid-term examination). Necessary equations are provided. Non-programmable calculators are allowed.

**Final Examination**: The final examination will take place during the regular examination period. The final exam will be three (3) hours long, *partially* open-book, covering all topics in the course outline. Necessary equations are provided. Non-programmable calculators are allowed.

**COURSE POLICIES:**
All work submitted must be of professional quality in the requested format. Material that is handed in dirty, illegible, disorganized, or in an unapproved format will be returned to the student for resubmission and the late submission penalty will take effect. An additional penalty of 10% may be deducted for poor grammar, incoherence, or lack of flow in the written reports.

**Final Examination: To obtain a passing grade in the course, a mark of 60% or more must be achieved on the final examination. A final examination mark < 60% will result in a final course grade of 48% or less.**

**LABORATORIES:** Labs will run 4 times per semester at an interval of every 2 weeks. Attendance at all laboratory sessions is mandatory. Absence from any session, or a portion of a session, without permission will result in a zero assigned to the corresponding laboratory report. The teaching assistants will sign your lab report as testimony to your attendance. Students who arrive 20 min after the scheduled lab time without a legitimate reason, leave the lab early without permission from the teaching assistant, or miss the lab without a legitimate reason will receive a zero for the corresponding laboratory assignment. Students who miss a lab with academic consideration are required to contact the course instructor within x days for further instructions. Failure to do so will result in a zero mark for that lab.

Except where indicated, the laboratory exercises are to be completed individually. The lab deliverables will be assessed as a combination of in-lab demonstrations and materials submitted online. In-lab demonstrations must take place by the end of the designated lab period. Related materials submitted online are due by midnight of the same day.

A minimum average of 60% across all laboratory exercises is required to pass the course

**LATE SUBMISSION POLICY:**
Advise the instructor if you are having problems completing the assignment on time prior to the due date of the assignment and be prepared to submit an Academic Consideration Request and provide documentation if requested by the instructor at:
https://www.eng.uwo.ca/undergraduate/academic-consideration-for-absences.html

If you are granted an extension, establish a due date with the instructor. The approval of the Chair of your Department is not required if assignments are completed prior to the last day of classes. Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies.
Documentation is mandatory.

This course employs flexible deadlines for assignments. The assignment deadlines can be found above in the course outline. For each assignment, students are expected to submit the assignment by the deadline listed. Should illness or extenuating circumstances arise, students are permitted to submit their assignment up to 72 hours past the deadline without academic penalty. Should students submit their assessment beyond 72 hours past the deadline, a late penalty of 10% per day will be subtracted from the assessed grade. **As flexible deadlines are used in this course, requests for academic consideration will not be granted.** If you have a long-term academic consideration or an accommodation for disability that allows greater flexibility than provided here, please reach out to your instructor at least one week prior to the posted deadline.

**ATTENDANCE:** Attendance is mandatory for all lectures and labs.