

NatSci 499 E/F: Integrative Scientific Research (iCons 4; 6 credits)

Faculty Contact: Prof. Scott M. Auerbach (iCons Program Director; auerbach@chem.umass.edu) or designee.

Prerequisites: Completion of iCons 3 with a grade of “C” or better.

Course Catalog Description: Students in iCons 4 will engage in authentic scientific research in UMass Amherst faculty research laboratories. UMass Amherst offers a rich portfolio of world-class research opportunities in the fields of Renewable Energy and Biomedicine, the two available concentration areas in the iCons Program. Each iCons 4 student will join a laboratory and develop a capstone research project that identifies and fills a scientific knowledge gap in their chosen theme area.* The project must be interdisciplinary and integrative—crossing disciplinary boundaries, and building upon previous learning in Gen Eds and major courses at UMass Amherst—to create new knowledge in the theme area. iCons 4 students will deepen the integrative nature of their learning through reflective portfolio development. iCons 4 concludes with the Senior Expo, a research symposium open to all members of the University and the general public. This course fulfills the requirements of the Commonwealth Honors College Capstone project.

University of Massachusetts Amherst Integrative Experience Criteria:[†]

1. **IE1** = Providing a structured, credited context for students to reflect on and to integrate their learning and experience from the broad exposure in their General Education courses and the focus in their major.
2. **IE2** = Providing students with the opportunity to practice General Education learning objectives such as oral communication, collaboration, critical thinking, and interdisciplinary perspective-taking, at a more advanced level.
3. **IE3** = Offering students a shared learning experience for applying their prior learning to new situations, challenging questions, and real-world problems.

Student Learning Goals: Students completing iCons 4 will become skilled at the following:

- Thrive in a research laboratory with a faculty advisor and research group members (addresses IE3).
- Identify holes and gaps in scientific knowledge related to the chosen theme area (IE2).
- Ask and refine good scientific questions related to real-world problems and contexts (IE2).
- Design scientific experiments that may yield valid insights (IE2).
- Carry out rigorous scientific studies with careful collection/analyses of data (IE2).
- Quantitatively interpret data to arrive at new insights related to the theme area (IE2).
- Integrate learning from present and previous study (i.e., from General Education and major courses) to promote scholarship in a given theme area (IE1).
- Collaborate in student teams to support research and promote the integrative experience (IE3).
- Communicate research results orally and in writing to experts, other scientists, and non-scientists (IE2).
- Engage in self-reflection as learners, providing and utilizing constructive criticism (IE1).

Course Components: Students in iCons 4 will engage in the following activities:

- Joining a research laboratory/group at UMass Amherst.
- Joining a peer support team composed of other iCons 4 students.

*In this document we use “theme” and “concentration” interchangeably.

[†]From <http://www.umass.edu/gened/teachingAdvising/integrativeExperience/ieCriteria.html>.

- Writing a research proposal.
- Performing cutting-edge, scientific research.
- Reporting research findings through a written thesis.
- Reporting research findings through an oral presentation at the iCons Senior Expo.
- Self-reflection and knowledge integration through portfolio development and dissemination.

Course Timeline and Mechanics: The language we use below is based on the iCons case study structure, involving the following components: Inception / Engagement / Research / Create / Reflect.[‡]

Step 1: Pre-proposal – Each iCons 4 student submits the following to the iCons Director or their designee by the end of the Spring semester of their Junior year:

- *Suggested faculty research advisor* including their name, department, office location, laboratory location, phone number, and email address. The faculty advisor is the student’s thesis committee chairperson, while the iCons Director or their designee is the thesis committee co-chairperson.
- *Suggested research topic* expressed as a very brief abstract including Objectives, Approaches, and Impacts of the planned capstone research.
- *Explanation of the fit between the faculty advisor and the research topic.*
- *Signature of faculty advisor indicating their willingness to serve as research advisor and their approval of the proposed research topic.*

The pre-proposal may be rejected and returned for revision if any or all are true:

- The suggested faculty research advisor is unwilling and/or unable to fulfill this role.[§]
- The suggested research topic is a poor fit with the suggested faculty advisor’s expertise.
- The suggested research topic does not overlap sufficiently with the student’s iCons concentration area. iCons 4 students may appeal this by written statement.

Step 2: Proposal – Each iCons 4 student submits a Research Proposal (~3 pages plus figures and references) to their thesis committee *on or before October 1st*. The Research Proposal and its preparation involve the following:

- *Background Research* on the accepted research topic, identifying the “*known knowns*” of the field. The faculty research advisor may support this background research through giving advice and/or suggesting relevant literature.
- *Specific Aims/Questions:* Identify critical gaps in knowledge (the “*known unknowns*”) relevant to their iCons concentration area, proposing to answer certain questions or accomplish specific aims to fill these gaps in knowledge. This constitutes the Objectives of the proposal.
- *Approaches:* Identify the appropriate and effective means of reaching their objectives, including determining the specific systems to study, properties to vary, controls to establish baseline behaviors, specific measurement techniques, and the appropriate data analyses. Students should anticipate how their iCons 4 work will likely integrate learning from their major courses, General Education courses, and other disciplines. Also include a regular schedule for meetings between student and faculty research advisor.
- *Impacts:* Provide a statement of anticipated impact of their work: (i) in their field of science, (ii) in neighboring fields of study, (iii) in society in the context of the concentration area, and (iv) on themselves as life-long learners.

N.B. Research may commence only after acceptance of the Research Proposal by iCons 4 faculty.

[‡]<http://www.cns.umass.edu/iicons-program/format-of-an-iicons-case-study>.

[§]We strongly recommend that iCons students contact prospective faculty research advisors asking to join laboratories *well before* students become seniors, at the latest in their Junior Spring semester.

Step 3: Research – Each iCons 4 student will engage in research, involving the following:

- Time spent in laboratory setting as appropriate to the project.
- Periodic meetings with research advisor and research group as appropriate.
- Periodic meetings with peer-support team (see below).
- Periodic meetings with entire cohort to provide structured opportunities to synthesize the various aspects of their college education (see below).

Step 4: Create – The work of each iCons 4 student will culminate in the following communication products, to be archived, *completed around the beginning of May*:

- **Written Thesis** – with the following broad structure (no defined page limit; usually ~25 pp):
 1. *Introduction*: Background and significance of research.
 2. *Specific Aims*: List of questions to be addressed.
 3. *Methods*: Description of approaches used in research, with emphasis on interdisciplinarity and integration.
 4. *Results and Discussion*: Description of the data (tables, figures) and what they mean.
 5. *Summary and Conclusions*: What you did, what you found, what it means in the big picture of your concentration area, and what are the next steps.
 6. *Bibliography*: A listing of all the literature that informed your work.
- **Research Poster** – for the iCons Senior Expo finale, using effective graphics to portray the Objectives, Approaches, Findings, and Impacts of the research.

Step 5: Reflect – Each iCons 4 student will construct and disseminate their own digital portfolio, *completed around the first week of May*. This is up to each student to craft, and should reveal each student's individuality. Common components of the Portfolio include:

1. Reflections on course objectives in light of a student's personal/professional objectives. This includes a prioritization of the importance of course objectives for a given student.
2. Reflections on particularly insightful moments or events (i.e., "aha moments").
3. Reflections on important new attitudes, knowledge, and/or skills gained during the course.
4. Examples of outstanding work, with reflection on what makes each piece of work outstanding; this item will be archived.
5. End-of-course (summative) reflections on:
 - *Personal Journey*: Formative moments/events during each student's academic path through the university and the iCons program.
 - *Academic Development*: Each student's own strengths and weaknesses, including a self-assessment on the extent to which she/he has met the iCons 4 course objectives prioritized in light of their own personal/professional goals (see reflection 1 above).
 - *Integrative Experience*: Each student's particular integration of attitudes, knowledge, and skills from previous General Education and major courses taken at UMass Amherst (or elsewhere as appropriate) into their iCons 4 work, and how this integration has made the student a "whole thinker." (intuitively clear but up to each student to define)

Research and Other iCons 4 Meetings:

- *Faculty Research Advisor*: Each iCons 4 student and their faculty research advisor will determine a research work schedule and a meeting schedule that fits the particular needs of the project and the participants' schedules.

- *Peer Support Teams*: These will meet a minimum of four times during the course of the semester to report on goals, accomplishments, impediments, and plans associated with the research projects. Normally, the four meetings will take place at the beginning of the fall term, the beginning of October, the beginning of November, and at the end of classes, respectively. Team members are expected to contribute ideas and constructive criticisms to support their team-members' projects. Faculty research advisors will generally not attend these meetings. iCons 4 faculty facilitators will ideally attend the first peer meeting for each team, but will not attend future meetings except when necessary to facilitate effective teamwork.
- *Cohort-wide Meetings*: A few meetings of the entire iCons 4 cohort are necessary to coordinate team-building, reflection, and the Senior Expo. These meetings include:
 - Meeting 1 (beginning of Fall):
 - Building peer support teams – what is the mission?
 - Beginning iCons 4 Portfolio – prioritizing course objectives.
 - Meeting 2 (end of Fall):
 - Integrating knowledge/experience – Readings from “*Siddhartha*” by H. Hesse
 - Meeting 3 (middle of Spring):
 - Prepping for Senior Expo – Elements of effective presentations
 - Meeting 4 (end of Spring):
 - The Senior Expo – showtime! This research symposium is the final event in the iCons Program. Each iCons 4 student will present a poster showing key aspects of their iCons 4 research project and their Portfolio. The Senior Expo will be open to the entire University community and to the public at large. Each attendee will be encouraged to provide written assessment of iCons 4 work.

Grading: A given student's grade will be determined by the student's thesis committee (faculty advisor and iCons 4 facilitator), by their peer support team through peer evaluations, by a student's own self-assessment, and by the Senior Expo assessment, according to the following rubric:

Faculty advisor's assessment	50% (for research activity and effort, and Written Thesis)
iCons facilitator's assessment	10% (for problem basis, interdisciplinarity, and all reflections)
Peer support team assessment	10% (pertains to support provided & utilized in peer team)
Self-assessment	10% (pertains to all aspects of iCons 4 work)
Senior Expo assessment	20% (for Research Poster and presentation)

Fulfilling Commonwealth Honors College capstone requirements: For each iCons 4 student who is also in the Commonwealth Honors College (CHC), successful completion of iCons 4 satisfies the CHC's honors thesis requirement, with special grading and archiving considerations as follows:

- Grading: The Written Thesis will receive a grade separate from the course grade; the Thesis grade will be given by the Faculty advisor's assessment (50%) and the iCons facilitator's assessment (10%), normalized to 60% of the total grade and mapped onto the letter-grade scale. *Only Written Theses with grades of B or higher may be archived*, which makes the work widely available in the public domain.
- Archiving: For each iCons/CHC student who has earned the opportunity to archive her/his Written Thesis, she/he will also be required to archive their Research Poster and summative reflections on Academic Development and Integrative Experience (see page 3) to provide a record of both their scholarship and themselves as emerging scholars. They may also choose to archive their summative reflection on Personal Journey, although this is optional.