

COURSE CONTENT

Academic Year	2022/2023	Semester	1 / 2
Course Coordinator	Assoc Prof. Kunn Hadinoto Ong		
Course Code	CH4702 / CH4703		
Course Title	Independent Research Project		
Pre-requisites	Nil		
No of AUs	3		
Contact Hours	Practicals: 117 hrs		
Proposal Date	16/1/2020		

Course Aims

The purpose of independent research project (IRP) is to provide you an opportunity to carry out research on topics related to chemical engineering, chemistry, and biotechnology. The projects can be laboratory based, computational, or theoretical. The objectives of IRP are:

1. To offer you opportunities to demonstrate the competence in laboratory work and/or computational/theoretical research
2. To provide platforms for integrating the knowledge gained in various subjects of the degree course.
3. To allow the exercise of the undergraduates' personal qualities such as maturity, initiative and creativity.
4. To apply communication skills, both oral and written, to communicate results, concepts and ideas.
5. To solve problems of a non-routine nature

Intended Learning Outcomes (ILO)

Throughout this project, you are expected, with guidance from their supervisors, to perform experiments and obtain data yourself. Literature review, which provides you with a broader perspective of the work you are engaged in, is an essential part of the project. The projects are also organized with a view to develop your ability to communicate, both verbally and in writing. The verbal skill is developed through constant meetings and discussions with supervisors and assessed via an oral presentation towards the end of the projects. The writing skill is developed through report writing. These reports form the major part of the final assessment. Throughout the IRP exercise, you are trained, when necessary, how to use design experiments, interpret and analyse data in order for a successful completion of the project. You also have to learn to how to optimize the outcomes under various constraints. Your progress is continuously monitored throughout the project duration. It is through these rigorous approaches and procedures that it is ensured that in end of the exercise, you are able to:

1. plan and implement an investigative or developmental project given general objectives and guidelines
2. conduct laboratory / simulation work proficiently to obtain valid and reliable findings
3. analyse data to produce useful information and to draw conclusions by systematic deduction
4. work and study independently on chemical engineering, chemistry, and biotechnology projects
5. communicate results, concepts, analyses and ideas in both written and oral forms

Course Content

N/A

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team /Individual	Assessment rubrics
Continuous Assessment*	1, 2, 3, 4, 5		100%	Individual	
a) Supervisor	1, 2, 3, 4, 5	EAB SLO* a, b, c, d, e, f, g, h, i, k, j, l	60%	Individual	Refer to Appendix 1
b) Moderators for reports and posters	3, 4, 5	EAB SLO* a, b, j, l, j	40%	Individual	Refer to Appendix 2, 3
Total			100%		

Mapping of Course ILOs to EAB Graduate Attributes

Course Intended Learning Outcomes	Cat	EAB's 12 Graduate Attributes*											
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)
	Core	•	•	•	•	•	◐	◐	◐	•	•	◐	š
1. plan and implement an investigative or developmental project given general objectives and guidelines													a, b, c, d, f, g, l
2. conduct some laboratory / computational/theoretical work proficiently to obtain valid and reliable findings													d, e, i
3. analyze data to produce useful information and to draw conclusions by systematic deduction													a, b, c, d, h
4. work and study independently on chemical engineering, chemistry, and biotechnology projects													a, c, h, i
5. communicate results, concepts, analyses and ideas in both written and oral forms													a, b, j, l

Legend:

- Fully consistent (contributes to more than 75% of Intended Learning Outcomes)
- ◐ Partially consistent (contributes to about 50% of Intended Learning Outcomes)
- š Weakly consistent (contributes to about 25% of Intended Learning Outcomes)
- Blank Not related to Student Learning Outcomes

Formative feedback

Formative feedback will be given verbally and/or in writing to you over the semester.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Introduction of Project	You will need to understand the relevant background of the problem, and the motivation of the project.

Literature Review	You need to read up on the related subjects and review what has been achieved critically. The process enables you to work out a suitable scope of the project and be able to support all the decisions taken during the work.
Methodology	This requires you to analyse all factors in the problem and formulate a workable method or approach for the solution, noting dependency of constraints.
Result Analysis and Discussion	You will develop the skills to present the results, obtained from simulation/experiments, in a professional way before students can interpret and discuss the results and draw conclusions.
Conclusion and Recommendation of Future Work	This requires you to review the value of the work completed and the limitations. You will need a higher-level critical thinking to recommend meaningful future work.

Reading and References

- 1) John M. Swales & Christine B. Feak, Academic Writing for Graduate Students, 3rd Edition Essential Tasks and Skills

Course Policies and Student Responsibilities

The intent of this course is to give you experience as an independent researcher, where you will propose experiments to achieve research goals, and mostly solve issues that arise.

Students are to carry out their Independent Research Projects under the supervision of a CCEB faculty, in their laboratory ([Faculty | School of Chemistry, Chemical Engineering and Biotechnology \(CCEB\) | NTU Singapore](#))

Students may complete their IRP outside of CCEB (within Singapore)

- with an external supervisor and a CCEB supervisor, with prior approval by school

Details can be found in the IRP handbook circulated by the Undergraduate Office, prior to IRP registration.

Lab safety is crucial for the smooth running of your research. You need to maintain high standards in ethical research approaches.

Academic Integrity

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the [academic integrity website](#) for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office Location	Phone	Email
Kunn Hadinoto Ong	N1.2 B2 31	6514 8381	kunnong@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Project briefing	1-2	Varies depending upon selected field of research: chosen based on your research with guidance and supervision of your professor.
2~3	Project planning	1-3	
4~11	Project execution	1-4	
12	Final report	3-5	
13	Oral presentation and assessment	5	

Appendix 1: Assessment Criteria for Supervisor

Criteria	<u>Does Not Meet Expectation (<40%)</u>	<u>Below Expectation (40% to 49%)</u>	<u>Meet Expectation (50%-79%)</u>	<u>Exceed Expectation (>80%)</u>
Project Plan/ strategy (includes scientific ability, independence)	No project schedule provided	Project activities were poorly identified and not arranged practically in a project schedule with timeline	Project activities were identified but some were not arranged practically in a project schedule with timeline	Project activities were clearly identified and arranged practically in a project schedule with timeline
	Problem, aim and objectives were not identified and presented	Problem not clearly identified/inaccurate and explanation is too brief, aim and objectives were vague and not addressing research problem	Problem was identified and addressed in a satisfactory manner, aim and objectives were stated and presented the research problem in a satisfactory manner	Problem was clearly addressed, aim and objectives were clearly stated and strongly related to research problem
General initiative (includes attendance, participation)	The student did not understand the project and did not show any self-initiative at all	The student did not understand some parts of the project and did not show self-initiative in handling and planning of the tasks for the project	The student understood most parts of the project and showed some self-initiative in handling and planning of the tasks for the project	The student understood the project well and showed self-initiative in handling and planning of the tasks for the project
	The student did not demonstrate any form of commitment in the work (e.g never meet deadline, less than 2 discussion meetings with supervisor in the semester, etc)	The student was not committed and did not perform most tasks in the project (e.g seldom met deadline, only 3-5 discussion meetings with supervisor in the semester)	The student was committed and performed the tasks in the project in a satisfactory manner (e.g usually met deadline, 6-9 discussion meetings with supervisor in the semester)	The student was very committed and diligent in performing the tasks in the project (e.g consistently met deadline, more than 10 discussion meetings with supervisor in the semester)
Ability to extend ideas and expand on suggestion	The student was partially able to follow existing protocols.	The student was mostly able to follow existing protocols.	The student was fully able to follow existing protocols.	The student was fully able to follow existing protocols

(includes ability to follow protocols)	The work was entirely adapted for previous works	Most work was adapted from previous works, did not demonstrate creativity and critical thinking	Some work was adapted from previous work and/or demonstrated creativity and critical thinking in a satisfactory manner	The concept of the work is original/ novel and/or demonstrated creativity and critical thinking.
Sense of responsibility in making decisions	The student couldn't define current constraints in order to choose a correct path.	The student knew some constraints in order to choose a correct path.	The student knew most constraints in order to choose a correct path.	The student was able to figure out all constraints in order to choose a correct path.
	The student was stuck in one way of doing things.	The student was trying to look for other's views and ways of thinking, but was stuck in one way of doing things.	The student looked for other's views and ways of thinking, and partially implemented those into the decision.	The student was fully open to other's views and ways of thinking rather than being stuck in one way of doing things.
	The student didn't understand the realistic outcomes to which different approaches will lead.	The student partially understood realistic outcomes to which different approaches will lead.	The student mostly understood realistic outcomes to which different approaches will lead.	The student fully understood the realistic outcomes to which different approaches will lead.

Appendix 2: Assessment Criteria for Final Report

<u>Criteria</u>	<u>Unsatisfactory:</u> ≤40%	<u>Borderline:</u> 40% to 49%	<u>Satisfactory:</u> 50% to 69%	<u>Very good:</u> 70% to 89%	<u>Exemplary:</u> ≥90%
Title page	Absent	Evidence of one	Evidence of two	Evidence of three	Title, your name, Submission date, neatly finished with no error
Abstract	Absent	Incomplete or unfocused	States the paper's purpose	Clearly states the paper's purpose	Clearly and concisely states the paper's purpose within the word limit
Introduction	Absent	There is no clear introduction or main topic and the structure of the paper is missing	The introduction states the main topic but doesn't adequately preview the structure of the paper	The introduction states the main topic and previews the structure of the paper	The introduction is engaging, states the main topic and previews the structure of the paper
Body	Absent	Each paragraph fails to develop the main idea	Each paragraph lacks supporting detail sentences	Each paragraph has sufficient detail sentences that develop main idea	Each paragraph has thoughtful supporting detail sentences that develop main idea
Organization-structural development of the idea	NA	No evidence of structure or organization	Logical organization, but organization of ideas not fully developed	Paragraph development present but not perfected	Writer demonstrates logical and subtle sequencing of ideas through well-developed paragraphs
Conclusion	Absent	Incomplete and/or unfocused	The conclusion doesn't adequately restate the thesis	The conclusion restates the thesis	The conclusion is engaging, clearly stating a future direction of the main topic
Mechanics	NA	Numerous and distracting errors in punctuation, capitalization and spelling	Many errors in punctuation, capitalization and spelling	Almost no errors in punctuation, capitalization and spelling	No errors in punctuation, capitalization and spelling
Citation (Figures, tables)	NA	Absent	Few cited works, both text and visual, are done in the correct format	Some cited works, both text and visual, are done in the correct format.	All cited works, both text and visual, are done in the correct format with no errors

				Inconsistencies evident	
Bibliography	Absent	Done in the correct format with many errors. Includes 3 major references	Done in the correct format with some errors. Includes 4 major references	Done in the correct format with few errors. Includes 5 major references	Done in the correct format with no errors. Includes more than 5 major references

Appendix 3: Assessment Criteria for Poster Presentation

Criteria	Does Not Meet Expectation (<40%)	Below Expectation (40% to 49%)	Meet Expectation (50%-79%)	Exceed Expectation (>80%)
Presentation skills	Presentation does not sufficiently present the topic.	Presentation describes the topic.	Presentation describes the topic.	Presentation thoroughly and concisely presents the topic.
	Lack of data to support the positions made / presented data irrelevant to topic.	Poster inadequately used, or figures unable to support the presented position.	Use of poster or additional props emphasises the importance of the topic, with appropriate supporting facts.	Use of poster or additional props greatly emphasises the importance of the topic, with appropriate supporting facts.
Visual Presentation	Not very visually appealing; cluttered; colors and patterns hinder readability	Somewhat cluttered; colors and patterns detract from readability	Overall visually appealing; not cluttered; colors and patterns support readability	Overall visually appealing; not cluttered; colors and patterns enhance readability
	Font sizes/ variations inconsistent/ distracting	Font sizes/variations somewhat inconsistent/distracting	Adequate use of font sizes/ variations to facilitate the organization and readability	Uses font sizes/ variations which facilitate the organization and readability
Content	Graphics (e.g., tables, figures, etc.) do not enhance the text.	Graphics (e.g., tables, figures, etc.) adequately enhance the text.	Graphics (e.g. tables, figures, etc.) enhance the text.	Graphics (e.g., tables, figures, etc.) are engaging and enhance the text.
	Content arrangement is somewhat confusing and does not adequately assist the viewer in understanding	Content arrangement is somewhat confusing and does not adequately assist the viewer in understanding	Content is arranged so that the viewer can understand order without narration	Content is clearly arranged so that the viewer can understand order without narration

	order without narration	order without narration		
Documentation of Sources	Does not cite sources.	Cites some data obtained from other sources. Citation style is either inconsistent or incorrect.	Cites most data obtained from other sources. "Nature" citation style is mostly accurate	Cites all data obtained from other sources. "Nature" citation style is mostly accurate
Q&A	Doesn't not handle questions	Some questions are managed	Most questions are sufficiently managed	Most questions are well managed

Appendix 4: The EAB (Engineering Accreditation Board) Accreditation SLOs (Student Learning Outcomes)

- a) **Engineering knowledge:** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems
- b) **Problem Analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- c) **Design/development of Solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- d) **Investigation:** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- e) **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
- f) **The engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
- g) **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
- h) **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- i) **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
- j) **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- k) **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- l) **Life-long Learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change