NANYANG TECHNOLOGICAL UNIVERSITY SINGAPORE

COURSE CONTENT

Academic Year	2024/2025	**Semester**	2
Course Coordinator	Assoc. Prof. Tan Thatt Yang Timothy		
Course Code	CH1802		
Course Title	Chemical and Biomolecular Engineering Laboratory 2		
Pre-requisites	Nil		
No of AUs	1		
Contact Hours	0 hours lecture, 0 hours tutorial, 24 hours Laboratory		
Proposal Date	31 May 2019		

Course Aims

This laboratory course aims to provide practical applications to reinforce theories and concepts taught in first year of chemical and biomolecular engineering.

Intended Learning Outcomes (ILO)

By the end of this course, you should be able to:

1. Establish your scientific understanding using appropriate laboratory experiments
2. Convert raw data to a physically meaningful form
3. Apply appropriate methods to plot, analyse, and represent experimental results and verify principles when applicable
4. Write a formal technical/scientific report to introduce the background, objectives, methodology, discussion of results and conclusions of experiments

Course Content

Laboratory experiments are related to lab techniques and analysis tools in field of Chemical and Biomolecular Engineering such as the use of UV spectroscopy **[CH2102]**, Nuclear Magnetic Resonance (NMR) spectroscopy **[CH2102]**, Fourier-transform infrared (FTIR) spectroscopy **[CH2102]**, the concepts of Iodine Thiosulfation **[CH1104]**, Combustion **[CH1104]**, Bomb Calorimetry **[CH1104]**, Vapor Liquid Equilibrium **[CH1108]**, Size Exclusion Chromatography **[CH1131]**, and Organic Synthesis **[CH2102]**. The square brackets indicate the courses in which the concepts of the respective experiments are covered.

Assessment (includes both continuous and summative assessment)

Component	Course LO Tested	Related Programme LO or Graduate Attributes	Weighting	Team /Individual	Assessment rubrics
Continuous Assessment (100%)	1, 2, 3, 4	a, b, c, d, e, j, l	100%	Individual	See Appendix 1
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)
CH1802 Chemical and Biomolecular Engineering Laboratory 2	Core	●	●	●	●	●				◐	●		o

1. Establish your scientific understanding using appropriate laboratory experiments	EAB SLO* a, b, c, d, e, i
2. Convert raw data to a physically meaningful form	EAB SLO* a, b, c, d, e
3. Apply appropriate methods to plot, analyse, and represent experimental results and verify principles when applicable	EAB SLO* a, b, c, d, e

4. Write a formal technical/scientific report to introduce the background, objectives, methodology, discussion of results and conclusions of experiments	EAB SLO* j, l

Legend:

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

Formative feedback

Marker's report on lab report submission will be available in NTUlearn at the end of the semester.

Learning and Teaching approach

Approach	How does this approach support students in achieving the learning outcomes?
Laboratory	Questions related to the specific topics are provided in each experiment lab manual. Experiment are to be conducted and the results obtained will be utilized to answer the questions posted. A report will need to be generated to provide the background, objectives, methodology, discussion of the results obtained and a conclusion of the findings.

Reading and References

Lab manuals are provided in NTULearn

Course Policies and Student Responsibilities

General: You are expected to adhering to Health Safety and Environment (HSE) instructions, especially in following safe operating procedures and training, for your own safety and health and that of your colleagues or fellow students. Staff and students shall report unsafe conditions/equipment or practices to supervisors for remedial actions.

You are also expected to read the respective lab manuals before attending the lab sessions and participate in the assigned lab sessions. You are expected to submit logsheet or formal report based on lab schedule and respective lab group. Logsheet submission deadline will be 12 midnight, 7 days from the date of experiment while formal report submission deadline will be 12 midnight, 14 days from the date of experiment. Guidelines on the structure of formal report are given in **Appendix 2**.

Absence from lab sessions with officially approved leave will be allowed to do makeup at the of the semester. If you are absent from a lab session without valid leave of absence, you will receive zero mark in the particular lab experiment and report submitted will not be graded.

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
Tan Thatt Yang Timothy	N1.2-B1-22	6316 8829	TYTAN@ntu.edu.sg

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
3	Experiment 1	1, 2, 3, 4	Lab manual 1
4	Experiment 2	1, 2, 3, 4	Lab manual 2
5	Experiment 3	1, 2, 3, 4	Lab manual 3
6	Experiment 4	1, 2, 3, 4	Lab manual 4
7	Experiment 5	1, 2, 3, 4	Lab manual 5
8	Experiment 6	1, 2, 3, 4	Lab manual 6
9	Experiment 7	1, 2, 3, 4	Lab manual 7
10	Experiment 8	1, 2, 3, 4	Lab manual 8

Appendix 1: Assessment Criteria

	Exceptional (10-8)	Admirable (6-7)	Acceptable (4-5)	Poor (1-3)
Overall presentation	Appropriate as a piece of scientific writing. Words were chosen carefully and appropriately. Sentence structure was clear and easy to follow. The report is free of spelling, punctuation, and grammatical errors .	Minimal awkward phrasing or word choices. Report is easy to read and constructed properly. Evidence of editing with less than three grammatical and/or spelling errors.	Many passages are phrased poorly, contained awkward word choices, or many long sentences. Narrative is disorganized in many places. Multiple grammatical and/or spelling errors.	Poorly organized narrative with frequent awkward phrases and poor word choices. Sentences are too long or short. Lacks cohesion, style and fluidity. Frequent spelling and grammatical errors.
Introduction	A cohesive, well-written summary of the background material pertinent to the experiment with appropriate references. Purpose of the experiment is clearly stated. References are used properly.	Mostly complete but does not provide context for minor points. Contains relevant information but certain information is not cohesive. Some references are provided.	Certain major introductory points are missing (ex: background, theory, etc.) or explanations are unclear and confusing. Few references are provided.	Very little background information is provided and/or information is incorrect. No reference is provided.
Methodology	Contains details on how the experiment was performed and the procedures followed. Written in the correct tense.	Narrative includes most important experimental details but is missing some relevant information.	Missing several experimental details or some incorrect statements.	Several important experimental details are missing. Or copied directly from the lab manual.
Results	All figures, graphs, and tables are numbered with appropriate captions. All tables, figures, etc. are explicitly mentioned in the text. Relevant experimental data are presented which are used in the discussion.	All figures, graphs, and tables are correctly drawn, but some have minor problems that could be still be improved. All data and associated figures, etc. are mentioned in the text. Most relevant data are presented.	Most figures, graphs, and tables are included, but some important or required features are missing. Certain data reported are not mentioned in the text or are missing. Captions are not descriptive or incomplete.	Figures, graphs, and tables are poorly constructed; have missing titles, captions or numbers. Certain data reported are not mentioned in the text. Important data missing.
Discussion/ Conclusions	Demonstrates a logical, coherent working knowledge and understanding of important experimental concepts, forms appropriate conclusions based on interpretations of results, includes applications of and improvements in the experiment, references collected data and analysis, refers to the literature when appropriate, and demonstrates accountability by providing justification for any errors. Address all specific questions posed in the lab manual.	Demonstrates an understanding of the majority of important experimental concepts, forms conclusions based on results and/or analysis but either lacks proper interpretation, suggests inappropriate improvements in the experiment, refers to the literature insufficiently, or lacks overall justification of error. Address most of the specific points or questions posed in the lab manual.	While some of the results have been correctly interpreted and discussed, partial but incomplete understanding of results is still evident. Student fails to make one or two connections to underlying theory. Address some of the specific points or questions posed in the lab manual.	Does not demonstrate an understanding of the important experimental concepts, forms inaccurate conclusions, suggests inappropriate improvements in the experiment, refers to the literature insufficiently, and lacks overall justification of error. Address none of the specific points or questions posed in the lab manual.
References	All sources (information and graphics) are accurately documented in consistent format.	All sources are accurately documented, but format is not consistent. Some sources are not accurately documented.	All sources are accurately documented, but many are not in consistent format. Most sources are not directly cited in the text.	All sources are accurately documented but not directly cited in the text.

Appendix 2: Guidelines on the structure of Formal Report

A. GENERAL INSTRUCTIONS:

1. Be prepared for your laboratory work; study the Manual beforehand and read up the theory.
2. No marks will be given for copied material and/or copied reports.
3. Be relevant in content, concise in expression and correct in the use of English. Grades will depend on the quality of the report, not quantity.
4. The formats set out below will be used to record all laboratory experiment. If there are modifications or special requirements for a particular experiment, your Supervisor will give you the necessary instructions.

B. FORMAL REPORTS:

Assume that your reader is a *fellow student* who is not familiar with the specific work you are reporting. It consists of the following sections.

1. *Title Page*
   Should include Title of Experiment, Name, Group Number, and Date of lab experiment
2. *Aim*
   Describe the objectives of the experiment.
3. *Abstract*
4. *Principles*
   This section prepares the reader to understand the report.
5. *Equipment and Materials*
   Give a brief description of the equipment and materials you used. If detailed descriptions are required, they should be placed in the *Appendix.* Illustrations by *simple diagrams* may save you a long description. Provide titles and label your diagrams clearly and refer to them in your text by using a clear numbering system (eg. Fig. 1 A Pressure Transducer).
6. *Procedure*
   Describe briefly in the correct sequence the important aspects of the procedure you adopted to conduct the experiment and obtain the results, explaining any modifications you have made to the instructions in the Manual. Use the *past tense* to report on the procedure.
7. *Results*
   This section usually includes
   (a) observations;
   (b) sample calculation(s); and
   (c) results of your calculation (tabulated and/or presented graphically).
   To present your data or results clearly, make sure that proper titles or lead-in statements are used and appropriate explanations are given. Some types of laboratory work are descriptive and the results will not be quantitative, hence, you may describe the key observations and results in prose paragraphs. Some experiments are required to use assigned software to process data and plot graphs.
8. *Discussion (not more than five pages)*
   In this section, you discuss the findings and results of your work. You might want to explain any differences between your measurements and theoretical predictions by comparing the theoretical curve with the experimental curve. You might want to account for any errors and suggest improvements through modification to the experiment/project equipment, procedure or precautions to be taken. You may draw deductions from the results.
9. *Conclusion*
   Briefly (not more than half a page) present the conclusions you have reached as a result of your work; or state to what extent the objectives of the project have been met. It is not a repetition of the *Discussion* but a statement of the key point(s) or inferences logically deduced from the results and discussions.
10. *Appendix*
    Any detailed technical information, for example, the theory and derivations, description of equipment referred to but not put in the main text, will be appended at the end of the report. It should also include all graphs, tables etc. not directly needed in the main sections of your report but which may be useful information for the reader. The appendices are lettered in the order in which they are mentioned in the text (Eg. Appendix A) and labelled with appropriate titles, (Eg. Appendix A. Method Used to Calibrate Pressure Transducer).

C. USE OF GRAPHIC ILLUSTRATIONS IN REPORT WRITING

1. Graphics provide important illustrations in technical reports. They are classified and numbered as *Tables* and *Figures.* Both tables and figures can be incorporated into the text of the report or attached under the Appendix section, according to their relative importance.
2. *Tables* are used to record data taken from readings or to present quantitative findings. They are hence numbered and referred to exclusively as tables. For example: Table 1 Results of fiberglass impellers endurance test at variable rpm
3. *Figures* include all other illustrations used in the report, such as diagrams, schematics, flow charts, statistical charts, graphs and photographs. They should be numbered clearly according to their order of appearance in the report. For example:
   Fig. 1 Test rig with three degrees of freedom
   Fig. 2 Flow chart of instruments used in the experimental set up
   Fig. 3 Lateral force spectra at difference angles of incidence
4. In the use of graphic illustrations in the report, the following points should be observed:
   (i) All tables and figures must be numbered.
   (ii) A title should be devised (in a noun phrase) for every table/figure.
   (iii) Every illustration should be complete with proper legends and labels.
   (iv) Units used must be accurate and where possible, SI Units should be used.
   (v) Scales for the figures should be appropriately devised. For example, to allow comparison of results, the scales of four graphs can be reduced so as to be able to display them within the same page.
   (vi) An illustration used in the text should be well integrated with a lead-in sentence or phrase in front. For example:
      Figure 1 illustrates the forces on a triangular building for a given wind direction.
      Figure 2 shows the test rig which allows a semi-rigid model to oscillate.
      Figure 3 shows a flow chart of the instruments used in the collection of data. The variations of tip displacements with reduced velocity are shown in Figures 4 to 6.
   (vii) Relevant explanations or interpretations should immediately follow the illustrations.
   (viii) Illustrations used in the appendices should be mentioned in the text so that proper reference can be made.
5. A sample figure used as an illustration in a report is attached.

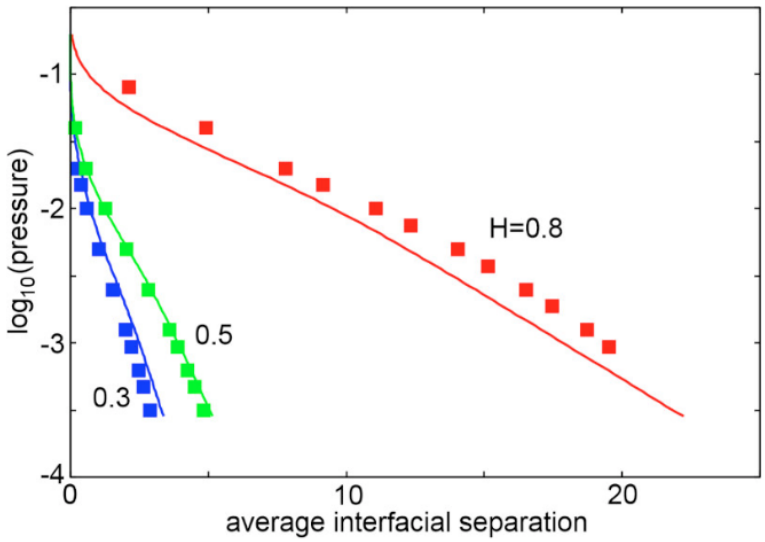

Fig. 1 Comparison between experimental and theoretical data on the relationship between applied squeezing pressure and average interfacial separation.