Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

The sections shown on this interface are based on the templates UG OBTL+ or PG OBTL+
Note that ONLY sections marked "NEW" in the templates are editable in this "OBTL to OBTL+" mode.
If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to Data Transformation Status for more information.

Expected Implementation in Academic Year	
Semester/Trimester/Others (specify approx. Start/End date)	
Course Author * Faculty proposing/revising the course	Zhao Wenting
Course Author Email	wtzhao@ntu.edu.sg
Course Title	Bioengineering Laboratory 1B
Course Code	BG1802
Academic Units	0
Contact Hours	24
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

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

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Establish your scientific understanding using appropriate laboratory experiments
ILO 2	Convert raw data to a physically meaningful form
ILO 3	Apply appropriate methods to plot, analyse, and represent experimental results and verify principles when applicable
ILO 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 Bioengineering such as concepts of Iodine Thiosulfation [BG1103], Tensile Testing [BG1105], Size Extrusion Chromatography [BG1131], and Plasmid Isolation [BG1131]. The square brackets indicate the courses in which the concepts of the respective experiments are covered.

Reading and References (if applicable)

Lab manuals are provided in NTULearn

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	-				
2	-				
3	Experiment 1	1-4	Lab manual 1		
4	Experiment 2	1-4	Lab manual 2		
5	Experiment 3	1-4	Lab manual 3		
6	Experiment 4	1-4	Lab manual 4		
7	Experiment 5	1-4	Lab manual 5		
8	Experiment 6	1-4	Lab manual 6		
9	Experiment 7	1-4	Lab manual 7		
10	Experiment 8	1-4	Lab manual 8		

Learning and Teaching Approach

Approach	How does this approach support you 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.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Team/Individual	Rubrics	Level of Understanding
1	Continuous Assessment (CA): Assignment(Continuous Assessment)	1, 2, 3, 4	a, b, c, d, e, j, l	100	Individual	Holistic	Multistructural

Description of Assessment Components (if applicable)

Formative Feedback

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

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Communication	Intermediate
Curiosity	Intermediate
Critical Thinking	Intermediate

Course Policy

Policy (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. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

(1) 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.

Policy (Absenteeism)

(2) Absenteesim

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

Policy (Others, if applicable)

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Last Updated Date: 07-04-2025 06:50:00

Last Updated By: Lai Ru Ying

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.

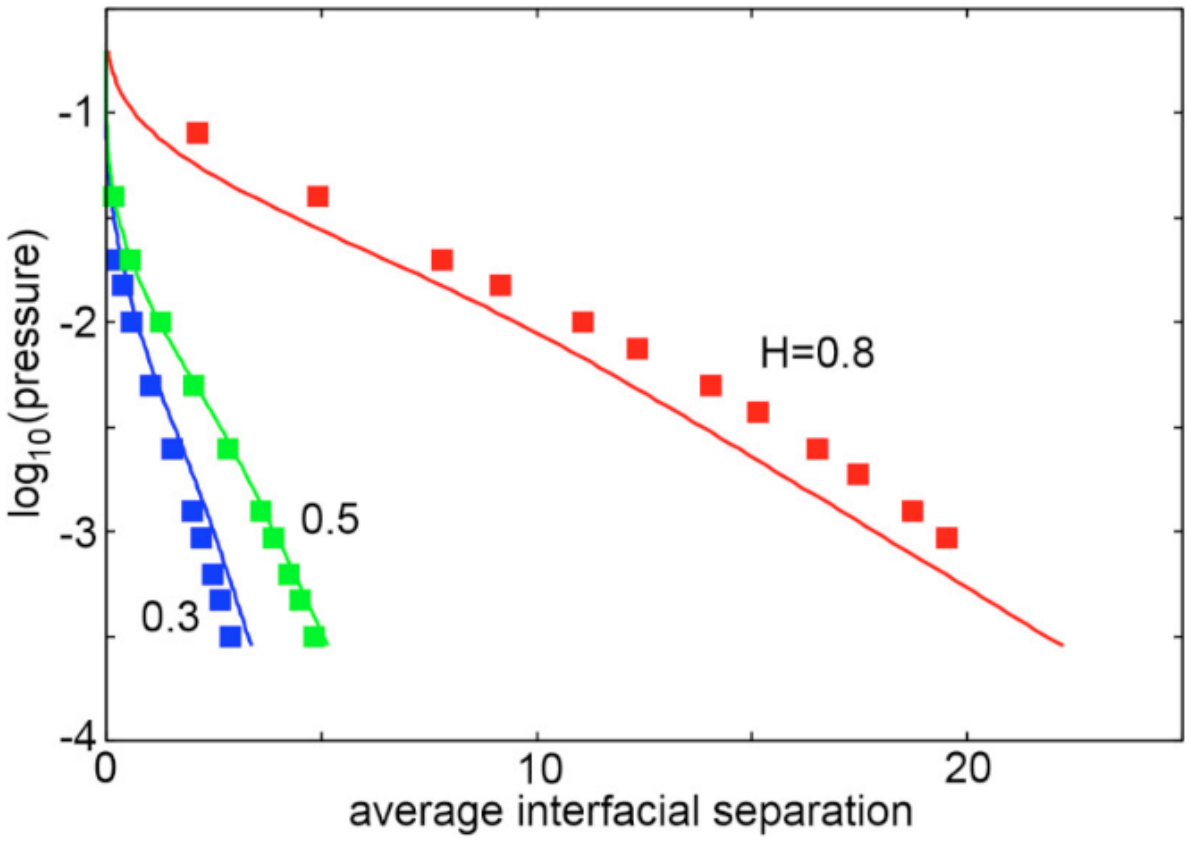

Fig. 1 Comparison between experimental and theoretical data on the relationship between applied squeezing pressure and average interfacial separation.

Mapping of Course ILOs to EAB Graduate Attributes

Course Code & Title	BG1802 Bioengineering Laboratory 1B	
Course Type	UG	

Overview											
(a)	●	(b)	●	(c)	●	(d)	●	(e)	◐	(f)	
(g)		(h)		(i)	◐	(j)		(k)	O		

Legend:

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

Course ILOs		**EAB Graduate Attributes**
1)	Establish your scientific understanding using appropriate laboratory experiments	a, i,
2)	Convert raw data to a physically meaningful form	b, d,
3)	Apply appropriate methods to plot, analyse, and represent experimental results and verify principles when applicable	c, e, i,
4)	Write a formal technical/scientific report to introduce the background, objectives, methodology, discussion of results and conclusions of experiments	a, b, c, d, e, i, k
5)		
6)		

EAB GRADUATE ATTRIBUTES	KNOWLEDGE PROFILE
a) **Engineering Knowledge**: Apply the knowledge of mathematics, natural science, computing and engineering fundamentals, and an engineering specialisation as specified in WK1 to WK4 respectively 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 with holistic considerations for sustainable development. (WK1 to WK4) c) **Design / Development of Solutions**: Design creative solutions for complex engineering problems and design systems, components or processes that meet identified needs with appropriate consideration for public health and safety, whole-life cost, net zero carbon as well as resource, cultural, societal, and environmental considerations as required. (WK5) d) **Investigation**: Conduct investigations of complex problems using research-based knowledge (WK8) 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 problems, with an understanding of the limitations. (WK2 and WK6) f) **The Engineer and the World**: When solving complex engineering problems, analyse and evaluate sustainable development impacts to: society, the economy, sustainability, health and safety, legal frameworks and the environment (WK1, WK5, and WK7). g) **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice and adhere to relevant national and international laws. Demonstrate an understanding of the need for diversity and inclusion (WK9). h) **Individual and Collaborative Team Work**: Function effectively as an individual, and as a member or leader in diverse and inclusive teams and in multidisciplinary, face-to-face, remote and distributed settings (WK9). i) **Communication**: Communicate effectively and inclusively 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, taking into account cultural, language, and learning differences. j) **Project Management and Finance**: Demonstrate knowledge and understanding of engineering 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. k) **Life-long Learning**: Recognise the need for, and have the preparation and ability to (i) engage in independent and life-long learning, and (ii) adapt to new and emerging technologies, and (iii) think critically, in the broadest context of technological change (WK8).	**WK1** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences. **WK2** Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline. **WK3** A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline. **WK4** Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline. **WK5** Knowledge including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts that supports engineering design and operations in a practice area. **WK6** Knowledge of engineering practice (technology) in the practice areas in the engineering discipline. **WK7** Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline such as the professional responsibility of an engineer to public safety and sustainable development. **WK8** Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues. **WK9** Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc with mutual understanding and respect, and of inclusive attitudes.

Reference: EAB Accreditation Manual