Redesigning Outcomes-Based Mechanical Engineering Course Syllabus Using the Constructive Alignment Approach

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ABSTRACT

The field of Mechanical Engineering is one of the earliest disciplines within the realm of engineering, having acquired a distinct identity during the nineteenth century. This study constitutes an ongoing endeavor aimed at enhancing the quality of Mechanical Engineering education. As the foundation for this revision, the authors have undertaken an evaluation of the existing syllabi for three major Mechanical Engineering courses, employing a constructive alignment approach. Pertinent data were collected through the analysis of existing documents, interviews, and consultations with the instructors of these ME major courses. Thematic analysis was employed to scrutinize the gathered data. The resultant insights were utilized to formulate a novel course syllabus that is attuned to the requisites and objectives of the university, while adhering to the Outcomes-Based Teaching and Learning Framework established by the Philippine Commission on Higher Education.

Keywords: *Education, Outcomes-Based, Engineering Education, Course Syllabus, Constructive Alignment.*

Introduction

There has been a global paradigm shift in higher education teaching, transitioning from a teacher-centered approach to a student-centered one. This shift is largely influenced by extensive research focusing on teaching and learning methods, particularly highlighting the efficacy of active-based learning. A prominent educational model aligned with this student-centered philosophy is Outcome-Based Teaching and Learning (OBTL), which centers on achieving learning outcomes through targeted educational activities. As a result, numerous educational institutions have begun to explore and integrate the outcomes-based approach into their academic frameworks.

In the Philippines, the Commission on Higher Education (CHED) has characterized the Bachelor of Science in Mechanical Engineering (BSME) program in its memorandum order (MO) 97 of 2017 as outcomes-based. The program's outcomes are aligned with the standards set by the US Accreditation Board for Engineering and Technology (ABET), with Higher Education Institutions (HEIs) mandated to adhere to the stipulated minimum requirements as per the CMO.

Notably, the Cebu Institute of Technology University (CIT University) has achieved Autonomous Status, the highest recognition bestowed by CHED upon academic institutions demonstrating commitment to excellence, sustainability, and advancement. Additionally, CIT University has displayed proactive endeavors in seeking accreditation from the Philippine Association of Colleges and Universities Commission on Accreditation (PACUCOA) in recent years. In fact, the university has earned distinction for holding the highest number of accredited programs within Region VII.

To ensure and uphold the quality of education, CIT University has established its Research and Development (R&D) initiative for Teaching and Learning. This initiative is dedicated to enhancing pedagogical approaches, delivery methods, quality assurance systems for teaching and learning processes, program assessment, curricular studies, student success, tracer studies, evaluation of graduate competencies, and the provision of academic and non-academic support services and systems.

This study contributes significantly to the pursuit of quality education by evaluating and proposing innovations within one of the university's flagship programs. The BSME program at CIT University aims to produce graduates who are not only competent in their profession but are also committed to lifelong learning, scientific exploration, and equipped to meet both local and international professional demands. These graduates are expected to demonstrate self-motivation, leadership capabilities, adherence to professional ethics, and responsible engagement within the community. While the university has implemented the BSME Curriculum 2017, a substantial portion of the course syllabus remains an adaptation of the 2008 Curriculum's syllabus. Moreover, there has been limited revision to align the syllabus design with the OBTL framework. Consequently, this study seeks to evaluate and innovate the existing course syllabus for two BSME courses, employing a constructive alignment approach to establish a model for other courses.

Specifically, the study aims to devise an inventive course syllabus for Engineering Thermodynamics and Combustion Engineering by evaluating the existing syllabus using a constructive alignment approach. The research endeavors to address the following key research questions:

1. To what extent do the contents of the existing course syllabus, including the course outline, intended learning outcomes, teaching, and learning activities, and assessments, align with the CHED MO program outcomes, course learning outcomes, course description, and CIT BSME program educational objectives?

2. What is the discernible level of cognitive processing and knowledge dimension evident within the existing course syllabus, particularly concerning performance indicators?

3. How do the existing course syllabus and the syllabus adopted by other local and international universities differ?

4. Based on the research findings, what actionable recommendations can be put forth to enhance the existing course syllabus?

In essence, this study aims to bridge the gap between theory and practice, enhancing the alignment of the BSME curriculum with contemporary educational paradigms and ensuring the production of competent, adaptable, and ethically conscious engineering professionals.

Literature Review

The motivation behind this literature review is to develop an innovative course syllabus for Engineering Thermodynamics and Combustion Engineering by assessing the existing syllabus using a constructive alignment approach. First, the author laid down the foundation of constructive alignment by citing pieces of literature focusing on the rationale behind it, the implementation of constructive alignment by different institutions, and the challenges encountered in doing so. Since constructive alignment has five major components namely: (a) course learning outcomes, (b) intended learning outcomes, (c) teaching and learning activities, (d) assessment tasks and content/resources; the author tried to look upon several pieces of literature to gather information on these different components to support to the development of the new and improved CIT University course syllabus for Engineering Thermodynamics and Combustion Engineering.

Constructive Alignment

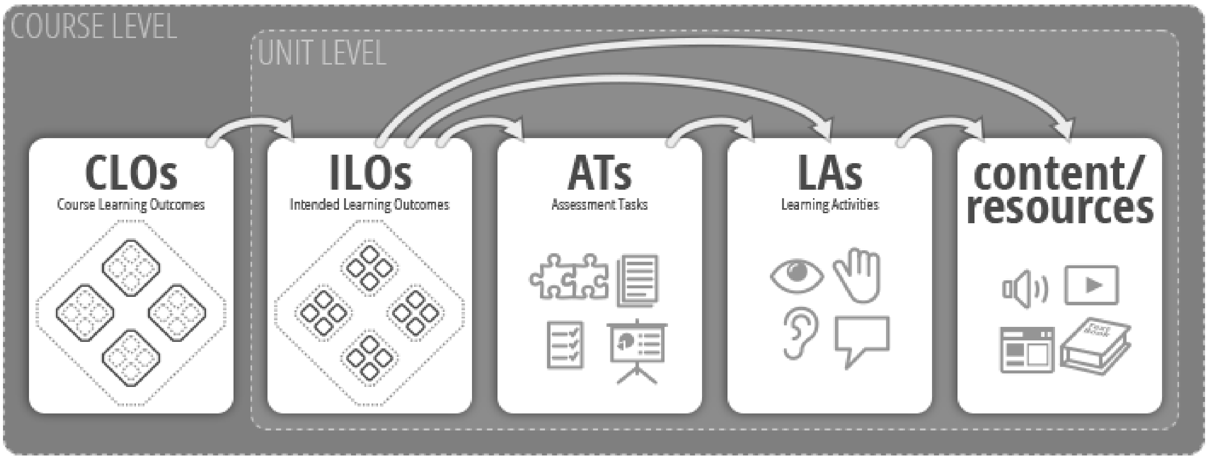

Figure 1: Constructive Alignment Diagram
Note: A visual representation of constructive alignment (Biggs, J. (2014). From Constructive alignment diagram, Beale Gurney & Nell Rundle, CC BY-SA

Constructive alignment is a methodical alignment of the “intended learning outcomes, teaching and learning activities and assessment tasks” which requires the students to participate in the learning activities to build their knowledge as constructed using “their own existing schemata” (Biggs, 2014; Biggs & Tang, 2011). According to Biggs (2014), it is a teaching method which is outcome-based while Morcke, Dorman, and Eika (2012) supported this by saying that the framework amplifies the development of outcome-based education by having a very good emphasis on learning and teaching process. According to Nightingale, Carew, and Fund (2007), there are two key elements of constructive alignment. The first one is that learning stems from the learners “as they gain meaning” through the activities and the second one is that teaching becomes effective when there is target learning outcome supported by relevant activities.

Biggs and Tang undertaken the first university-wide implementation of constructive alignment at the Polytechnic University of Hong Kong from 2002. The aim is to achieve improvement in student learning outcomes through “teaching quality and institutional support and systems” (Ruge, Tokede & Tivendale, 2019).

The benefit of constructive alignment was shown in the study of Cheung, Kwong, Su, Wang, and Wong (2013). They investigated whether the “adoption of constructive alignment has any effect on the students’ learning approaches”. Based on the result, the students who are exposed to a more aligned courses have higher chances of adopting deep learning method in their study of a course.

A study conducted by Ewe, Ng, and Thian (2018), capitalized on the constructive alignment framework and created “detailed and practical curriculum design model to aid the development of graduate student’s capabilities”. The authors emphasized the need for communicating strong reasons for change despite the challenges of implementing the framework due to the repetitive “process of alignment at level of program and module development”.

There are only 34 from 245 syllabi analyzed by Chan (2021) from three Hongkong Universities included wide range of competencies in the intended outcomes. The outcomes are connected to both traditional and experiential pedagogies but were not assessed accordingly. The challenges in implementing constructive alignment are due to the “program leaders' conceptions of holistic competencies”, the limited capabilities of instructor, and the issues on assessing competencies. They added the importance of training all levels of engineering instructors on different areas like holistic competency development, “industrial experiences, and expectations, developing top-down and bottom-up educational reforms to improve the engineering curricula”, etc.

Koster, Schalekamp, and Meijerman (2017) gave six steps in implementing an outcomes-based education. First is to adopt a competency model that summarizes the competencies needed to be developed. Second is to define the learnings outcomes intended to be achieved. Third is the developmental of curriculum that integrates and shows the progression of competency. Fourth is the selection of appropriate assessment activities. Fifth is the design of educational environment like “the learning activities and experiences and teaching methods. Finally, the continuous review and improvement of the module and the curriculum”.

Subject outlines from several Australian universities were analyzed by Nightingale, Carew, and Fund (2007) and found out that engineering professors are still very dependent on examinations the assessment of students. The examination uses different question types but still limited in accurately assessing other important competencies. Also, the “assessment tasks are not aligned to the learning objectives”. Finally, the study showed that applying constructive alignment to the design of the subject assisted the academics to improve the assessment methods that actively engage the students with different learning experiences and achieve the desired learning outcomes better. The Revised Taxonomy (Anderson & Krathwohl, 2001) as shown in Table 1 was used to evaluate the subject outlines.

Table 1: Revised Bloom’s Taxonomy (Anderson and Krathwohl, 2001)

The knowledge Dimensions	The Cognitive Process Dimension					
	1. Remember	2. Understand	3. Apply	4. Analyze	5. Evaluate	6. Create
A) Factual Knowledge						
B) Conceptual Knowledge						
C) Procedural Knowledge						
D) Metacognitive Knowledge						

In the Revised Bloom’s Taxonomy, the knowledge dimensions “encompassed four categories: factual knowledge includes the essential terminology, constants, symbols, and sources of information; conceptual knowledge includes the principles, classifications, models, theories, and structures; procedural knowledge which includes how to do something, algorithms, techniques, methods, and criteria used to select proper methods; and metacognitive knowledge which includes the awareness of educational strategies, strategies to improve learning, knowledge of one’s own abilities and weaknesses, ability to recognize higher and lower-level thinking”.

Outcomes-Based Education Initiatives

The City University of Hong Kong (n.d.) considered the outcome-based method to student learning as a student-centered approach. The method includes stating the expected learning outcomes and conducting assessment to know if the students have achieved the learning outcomes. The rationale behind this is that by clearly understanding and articulating the "intended learning outcomes, the design of effective curriculum, implementation of relevant and appropriate teaching, learning assessments tasks" can be facilitated.

In the Philippines, the initiative to establish an outcomes-based education in higher education is first promoted for engineering programs (CHED, 2012). Also, this was reinforced as CHED see the importance of making the Philippines Mechanical Engineering education updated with international trends (Belino, 2011). It issued a memorandum order (MO) last 2017 regulating the HEIs that offer BS Mechanical Engineering. The MO laid down the requirements of all colleges and universities offering BSME to make sure that graduates demonstrated the achievement of the program outcomes (PO) based on the Accreditation Board for Engineering and Technology (ABET) requirements. The PO includes the following: "(a) an ability to apply knowledge of mathematics, science, and engineering; (b) an ability to design and conduct experiments, as well as to analyze and interpret data; (c) an ability to design a system, component, or process to meet desired needs within realistic constraints; (d) an ability to function on multi- disciplinary teams; (e) an ability to identify, formulate and solve engineering problems; (f) an understanding of professional and ethical responsibility; (g) an ability to communicate effectively in both Filipino and English languages; (h) an understanding of the impact of engineering solutions in a global and societal context; and (i) an ability to use techniques, skills, and modern engineering tools necessary for mechanical engineering practice." The CHED MO also provided the minimum required Course Learning Outcomes for the subjects Engineering Thermodynamics and Combustion Engineering as shown in Table 2.

Table 2: Course Learning Outcomes for Engineering Thermodynamics and Combustion Engineering

Engineering Thermodynamics 1	Engineering Thermodynamics 2	Combustion Engineering
a) Identify the different properties of pure substance, ideal gas, and real gas. b) Apply thermodynamics concepts and principles in analyzing and solving problems. c) Apply the laws of thermodynamic in analyzing problems. d) Evaluate the performance of thermodynamic gas cycles.	a) Apply the concepts of Thermodynamics in analyzing Power cycles. b) Determine the physical and thermodynamic properties of ideal gas mixtures, real gases, and mixtures of gases and vapor. c) Evaluate the performance of vapor power cycles and gas power plants and standard air-power cycles.	a) Explain basic combustion and stoichiometric process. b) Perform stoichiometric analysis of various gaseous, liquid, and solid fuels. c) Apply thermodynamic principles in analyzing the performance of internal combustion engines. d) Evaluate the principles, operations, maintenance, and design of internal combustion engines.

It is necessary to align the course learning outcomes to those required by CHED for the graduates of the BSME program to be able to compete with local and international standards. A study conducted by Belino (2011) cited different local and international accreditation agencies and their plan to change from input-based to outcomes-based accreditation.

The first one is the Philippines Technological Council (PTC). Through its arm, Accreditation and Certification Board for Engineering and Technology (ACBET), PTC accredits engineering programs through the policies, methods, and authorities as stated in its Certification and Accreditation System for Engineering Education (CASEE). The accreditation of the engineering program is recognized internationally through the Washington Accord (ptc.org.ph, n.d.). There is also private voluntary accreditation which aims to bring the standards of the educational institutions above the prescribed minimum requirements set by the government. Three agencies that accredits engineering schools are "Philippine Accrediting Association of Schools, College and Universities (PAASCU); the Philippine Association of Colleges and Universities- Commission on Accreditation (PACUCOA; and Accrediting Agency of Chartered Colleges and Universities (AACUP)". PAASCU and PACUCOA are on the way of going outcomes-based accreditation. An international accreditation, ABET, Inc., is recognized by the Council for Higher Education Accreditation and is one of the most prestigious accreditation organizations based in United States. "It accredits college and university programs such as computing, applied science, engineering, and technology" (abet.org, n.d.).

Student-Centered Teaching and Learning Activities

Halperin's study (as cited in Catalano, 1997) showed that majority of the classroom activities nowadays in higher education still reflect traditional style of teaching because students are passively receiving information from the instructors. To shift from this approach to a more student-centered one, Catalano (1997) identified several roles of a teacher in student-centered education. The first role is in exemplifying thinking and processing skills. The teacher can do this by verbally processing how the students think, do, hear, and make sense of the learning material and search for a solution to problems. The second role is in identifying where they want their students to be cognitively. In Bloom's taxonomy (Bloom, 1956), thinking begins "in the lower levels (knowledge and comprehension) to the highest levels (synthesis and evaluation)". Aschner and Gallagher (1965) divided thinking modes "into memory, convergent thinking, divergent thinking, and evaluation. The teacher should be aware of the level of thinking needed by the students" in doing the teaching, learning, and assessment activities and should explain this to the students. The third role is to make questions that encourages student exploration and growth. Instead of asking the common question "Are there any questions?", the instructor must ask questions that would compel the student(s) to show what is being learned. This can happen by allocating enough time so that the learners could leverage "of the quiet times to" create "own questions". Also, the teacher must take "periodic breaks in class asking students to summarize what had been" discussed. Lastly, learners must be encouraged to ask relevant questions and teachers role model such behavior. The fourth role is in utilizing visual tools to aid students in seeing how information can be interconnected and teaching them to use these tools. This idea stems from the fact that the right hemisphere of the human brain is visual. Mind mapping or graphic organizing are examples of visual tool that are very useful in a student-centered classroom. It is appropriate at different situations such as an overview of the course, review sessions before exams, end of the course, etc. It helps to organized information and to generate insights. Computers, audio, video playback systems, etc. can also be incorporated to the visual tools. The fifth role is in providing group-learning settings. Positive interdependence, "individual accountability, appropriateness of the assignment, teacher performs as facilitator, explicit attention to social skills, and emphasis on face-to-face problem solving" are the critical features of group learning (Cooper et al.,1992). Weimer (1996) added that group-learning situations should have many opportunities for inclusion (quantity), the more students engaged the better (extent) and deep rather than shallow student participation (depth). The sixth role is in using analogies and metaphors. An example of this is in teaching Thermodynamics where the instructor could explain the concepts of energy, availability of energy, and the second law in concepts that the students could relate like gross income, net income, and the passage of time. The objective is to help students in creating their own metaphors to explain new concepts that they have encountered. Finally, the seventh role is in providing a safe mechanism for indirect dialogue between teacher and student(s). The teacher can use for example a discovery sheet to hear students' opinions and facilitate open and honest communication. It can be given after exams, in new subject topics, or during a tough lesson, etc. This exchange of ideas, thoughts, and feelings can create a classroom environment free from indifference and with a sense of community.

In their book entitled "Teaching Engineering", Wankat and Oreovicz (2015) suggested several teaching and learning activities that can be implemented in an engineering class.

Problem solving

This method can be integrated in existing engineering courses without the need of having another course in problem solving. Illustrating the strategy is important when the teacher is solving problems in class and in the handouts provided to the students. The author added that the teacher must show that problem solving is not necessarily a neat process. This can be done by allowing the students to select the problem you will solve in front of the class or to solve problems you have not encountered before. The book offered many strategies in problem solving that the teacher can implement.

Lectures

There is still an argument whether the number of lectures should be increased or decreased in improving engineering education. If done properly, lecture can have many advantages such as having the audience as the focus, versatility and flexibility, easy updating, simple technology, acceptable and common, can integrate learning principles, can include assessment and rapid feedback, live contact, can include hands-on or demos, professor-efficient, time-efficient, instructor control, anyone can lecture, "potentially outstanding for motivation and for conveying information", stimulating, and student learning can be high. However, in most cases, becoming an excellent lecturer is hard and can lead to the following disadvantages: audience are ignored, inappropriate lecture style, stagnation, technical errors, student passivity, few learning principles may be satisfied, boredom, inadequate preparation or over preparation, lack of individualization, etc. In doing lectures, the following ideas can be utilized as a guide in selecting the lecture material: include key points and general concepts, lecture on topics that students find to be very interesting, include hard topics like topics that are not properly discussed in the textbooks, tackle important topics not covered in other learning materials, include a lot of examples, and select material that is suitable in terms of depth and simplicity. To sustain student engagement in lectures, it is also important to consider doing the following: ask questions, shift to a Socratic approach by asking them questions, let students summarize the very important points in the lecture on a piece of paper, give a short check-up quiz, or facilitate a group activity. The teacher can also take advantage of giving post lecture quiz, inviting guest lecturers, and feedback lectures. The lecture method is very effective when the objective "is to have students learn the three lowest levels of Bloom's taxonomy, but it is not the best approach for higher level cognitive objectives such analysis, evaluation, problem solving, and critical thinking".

Discussion

This is commonly utilized in social sciences education. Several scientific evidence shows that this approach is not an effective method for transferring facts and data in comparison to lectures. The good thing about discussion is that it can be better than lecture in inculcating "analysis, synthesis, evaluation, problem solving, and critical thinking". When the goal of the teacher is to work on higher-order thinking skills, engineering teachers can consider discussion as a teaching method. This includes activities such as brainstorming, small cooperative groups, engineering problem solving discussion, among others.

Cooperative Group Learning

Students can work cooperatively as a group to comprehend the learning material, do homework, accomplish projects, and review for examinations. Research says that this method is suitable in achieving higher-order cognitive objectives (Johnson et al., 1991; Smith, 1986, 1989). This method is common in engineering especially in doing laboratory works and design projects.

Panels

This method can be used to start a question-and-answer activity by having three or four experts on open ended questions. This method has been used in professional seminars on topics like how to do job hunting, what happens in job interviews, what the work in the industry is like, what industry looks from young engineers, how to obtain research funding, and how to achieve tenure. It can also be utilized for controversial engineering topics like "those where technology and policy interact".

Modified Debates

This method can be useful when a topic has two or more sides. Examples of debatable topic is competing designs or controversial engineering technology. It is a very good way to engage students in the learning material, improve communication skills, and exert collaborative effort.

Quiz shows

This can be done by using Trivial Pursuit, Jeopardy, or College Bowl where students can participate individually or as a group. Like in many competitive activities, this quiz shows works better if the participants are evenly matched. The teacher will serve as the quiz master.

Field trips and visits

This method is still not commonly utilized in majority of engineering subjects. It is essential for students to see real equipment or manufacturing operations. This experience can transform abstract concepts more real, and the field trip can be encouraging to a lot of students.

Tutored Videotape Instruction

This method was originally produced at Stanford University (Gibbons et al., 1977). Here a video is developed in the campus in a similar manner as that of the television.

Computer-Aided Instruction

A computer is utilized to teach the learning material to the learner. Simons (1989) "identifies three major modes for CAI". The first one is the drill-and-practice mode where is a learner is given question or problem, the student answers, and the computer gives feedback on the answer. The second one is the tutorial mode which contains learning material and can be a substitute for lecturing and textbooks. It contains sample problems and images, include questions and problems, and have abundant feedback compared to the first mode. The third mode is simulation using computer program.

Design

The activities that can be considered as design are those that (a) develops a system, process, or component to achieve a specific goal, (b) repetitive "process which uses decision making with economics and uses mathematical, scientific, and engineering principles", (c) involves goal setting, analysis, synthesis, evaluation, fabrication, testing, and reporting, (d) gives "student problems that are often open-ended", need use of design procedures and "creative problem solving", need creation "of the problem statement and an economic comparison" of different "solutions, and may need detailed system details" (ABET, 1989). Design projects can be implemented to teach design. Here, group of students are "given a design problem" and tasked to make the design. "Engineers learn design through designing" which makes this procedure appropriate. The problem needs to be open-ended to be considered design. Aside from design projects, case studies can be implemented since this is appropriate for design and non-design classes. Teacher may give case studies to students for reporting or for discussion (Henderson et al., 1983). There are many case studies which involves ethical questions and can serve as springboard for discussion. It can also aid in introducing the engineering profession which motivates some students. The relevance of the subject being studied can be inculcated to the students in introductory engineering classes.

Student-Centered Assessments

In his book entitled Teaching for Quality Learning at University, Biggs (2003) answered several questions that student-centered teachers may have in implementing assessments. Instead of asking many questions, he said that a crucial consideration that teacher should ask is "What are your objectives? He added that the best assessment method is the one that best achieves the intended learning outcomes.

Essay Examinations

This method is suitable to assess higher order thinking skills and for evaluating declarative knowledge. It is an open-ended exam where students can express thoughts and views with supporting details.

Assignments, term paper, and take-home

This method is appropriate to assess declarative knowledge. The advantage is that students are given ample time to construct ideas and do not have to depend in memory. Thus, it motivates deeper learning where learner may use several sources and synthesize information better. The problem is the issue of plagiarism which can be solve by providing shorter time for submission.

Multiple-choice tests

It is the most used objective test to assess declarative knowledge. This method can theoretically assess high-level cognitive skills but in actual practice is not. The disadvantage of MC is that it can encourage the use of game-playing strategies for students to answer the question. It is most convenient but can be more "useful as supplement to other assessment methods".

Ordered outcome items

It looks like MC but instead of choosing one correct choice from the options, the learner is required to answer all the sub-items (Masters, 1987). The sub-items are organized into increasing level of difficulty that shows progressive level of learning. The stem should give all the information needed to answer all the sub-items

Practicum

This can demonstrate the competence needed in actual situation like handling experiment in the laboratory, machining, and developing machines. It is more valid if the practicum is closer to the actual scenario in the field. The challenge with practicum is that it can distort reality since students behave differently when being assess from the way they would if they were not being assessed.

Presentation and Interviews

The students are "evaluated based on the content and the delivery of the content". The seminar for example if properly conducted can provide ample opportunities for formative discussion and peer assessment. The disadvantage is when teacher uses this method as a "poor substitute for teaching". "Student presentations" are highly suitable for assessing functional knowledge than "declarative knowledge". The "poster presentation follows the conference format" where a learner or groups display their output following the format provided by the teacher. This method gives outstanding "opportunities for peer-assessment", and for quick "feedback of results". The interview method is widely used in evaluating research papers. The student researchers make a thesis and defend in panel of experts.

Critical incidents

In this method, the learner reports critical incidents that make them think deeply on the topic. The student explain why they find this instance important, how it happen, and what can be done regarding it. Through this, the teacher can understand how students interpreted and use the lesson.

Project

It targets the "functioning knowledge". It can be a simple or complicated project and commonly done by "group of students". The instructor can assign the task of each member or give them the freedom to agree as a group. The challenge with this method is that "individual students too easily focus only on their own specific task, not really understanding other components, or how they contribute to the project".

Reflective journal

This method can be used in professional subjects. Students record any instances, thoughts or insights that are important to the topic. It is a valuable tool in evaluating the judgement of the students as to the relevance of the topic and their capacity to think upon their experience on the lesson.

Case study

In some fields, this is an ideal way of knowing how learners can put their "knowledge and professional skills into practice". It can be done with the supervision of an adviser or independently by the learner.

Portfolio assessment

The learner showcases best outputs "in relation to the intended learning outcomes". They can think and evaluate outputs and describe how it match the objectives.

In assessing large classes, the following methods can be useful:

Concept maps

This helps the teacher know the level of understanding of the students in a particular topic.

Venn diagrams

It is like concept maps but is simpler in expressing relationships between concepts.

Three-minute essay

It is a reflective activity by which teacher ask question such as "What is the main lesson I knew today?" This can help in assessing how students interprets the information for formative assessment or if students have right interpretation of the topic as summative assessment.

Short answer examinations

The learners respond in note form. The advantage of this method over MC is that it is less prone to game-playing strategies, it needs "active recall rather than just recognition" and it is easier to create though harder to score.

Gobbets

It includes important part of the lesson that learners should be familiar and must respond (Brown and Knight 1994). It can include items like photograph of a machine or an engine part. The learner must identify the gobbet, explain its context, its importance, what can they relate it to, etc.

Letter to a friend

The learner tells an imaginary or actual friend, who will be taking the course next year on their own experience of the lesson or activity (Trigwell and Prosser 1990).

Cloze tests

It is useful in evaluating student's reading comprehension. A passage is selected "that can only be understood if the topic under discussion is understood."

Table 3: Some Assessment Tasks and the Kinds of Learning Assessed

Assessment mode	Most likely kind of learning assessed
Extended prose, essay type	
Essay exam	Rote, equation spotting, speed structuring
Open book	as for exam, but less memory, coverage
Assignment, take home	read widely, interrelate, organize, apply, copy
Objective test	
Multiple choice	Recognition, strategy, comprehension, coverage
Ordered outcome	hierarchies of understanding
Performance assessment	
Practicum	Skills needed in real life
Seminar, presentation	Communication skills
Posters	Concentrating on relevance, application
Interviewing	Responding interactively
Critical incidents	Reflection, application, sense of relevance
Project	Application, research skills
Reflective journal	Reflection, application, sense of relevance
Case study, problems	Application, professional skills
Portfolio	Reflection, creativity, unintended outcomes
Rapid assessment (large classes)	
Concept maps	Coverage, relationships
Venn diagrams	Relationships
Three-minute essay	Level of importance, sense of relevance
Gobbets	Realizing the importance of significant detail
Short Answer	Recall units of information, coverage
Letter to a friend	Holistic understanding, application, reflection
Cloze	Comprehension of main ideas

Course Content

Wankat and Oreovicz (2015) mentioned that in required subjects the content must make the subject suit into the entire curriculum. Engineering departments generally create agreement on the content a learner needs to undergo prior to completing the degree. The content needs to appear somewhere in the curriculum. Since some courses are pre-requisite of the other courses, appropriate prerequisite content must be tackled. The following steps can be taken in selecting the course content: (a) align with other faculty, (b) know what is required for other courses, (c) communicate in detail what content are found in prerequisite courses and know what they are able to do after they taken the prerequisite courses, (d) communicate the outline with other teachers teaching the subject, (e) make sure that important material is not omitted when doing subject revisions or changing the textbook, (f) communicate with engineers in industry to know what content they utilize and do not, (g) make the content accessible in computers for easy updating. After outlining the course content, it is necessary to check the hierarchy of objectives the teacher want to include. The time allotted for every topic relies on the depth of coverage and objectives. The teacher must plan the level of delivery taking into consideration the learner's maturity and plan the important intended learning outcomes for each topic.

Methodology

This study employed a descriptive-evaluative design to review the existing course syllabus and determine doable revisions or suggestions based on criteria embodied in CHED documents and mandates and other relevant information from the literature reviewed in this study. Based on Table 4, there are five phases done to come up with the new course syllabus. The Assessment phase follows the constructive alignment approach. This paper emphasized the details of the first and second phases in the results and discussion. The third, fourth and final phases are in the conclusion and recommendation of this paper.

Table 4: Phases on Course Syllabus Revision

Key activities	Resources	Primary Participants
Phase 1. Assessment of existing course syllabus using constructive alignment: a) Reviewed CHED program outcomes (PO) to embed Program Educational Objectives (PEO) b) Mapped course learning outcomes (CLO) to PEO and PO c) Mapped topic intended learning outcomes (ILO) to CLO and Revised Bloom's Taxonomy d) Mapped course outline (CO) to ILO e) Mapped learning activities (LA) to ILO f) Mapped Assessment Tasks (AT) to ILO	CHED Memorandum Order Existing Course Syllabus	Department head ME Faculty Members
Phase 2. Benchmarking activities: a) Compare existing course syllabus course outline, course description and course learning outcomes to CHED MO b) Gather course outline from local and international universities c) Gather relevant topics to embed in proposed course syllabus	Existing Course Syllabus from local and international universities CHED Memorandum Order	Department head ME Faculty Members
Phase 3: Consultation with subject teachers		Department head ME Faculty Members

Phase 4. Course Syllabus Refinement activities: a) Refinement of CLO b) Refinement of CO c) Refinement of ILO d) Refinement of AT e) Refinement of LA	Department head ME Faculty Members
Phase 5: Final Assessment	Department head ME Faculty Members

Results and Discussion

To know whether the contents of the existing course syllabus conform to the CHED MO and CIT program educational objectives; the course syllabus were assessed using a constructive alignment approach based on the Outcomes-Based Teaching and Learning (OBTL) Framework.

Phase 1. Assessment of existing course syllabus

The first phase of the research is the assessment of the existing course syllabus. In Table 5, the program educational objectives were reviewed in alignment with CHED MO's required program outcomes. One hundred percent (100%) of the PO fell within the PEO set by the department. It means that the PEO is geared towards achieving the PO. Forty-two percent (42%) of the PO can be achieved through objective 1, 25% can be achieved through objective 2, and 33% can be achieved through objective 3. The PEO are general statements of what the program is preparing the student for in terms of career and professional development. According to CHED, it be reviewed on periodic basis for continuing improvement.

Table 5: Mapping of ME Program Educational Objectives and CHED Program Outcomes

Program Educational Objectives	Link to Program Outcomes
Objective 1: Competent to practice the profession and pursue graduate study and/or research work.	a) Apply knowledge of mathematics, engineering sciences, and physical/natural sciences to solve mechanical engineering problems. b) Design and/or conduct experiments, as well as to analyze and interpret data. e) Identify, formulate, and solve engineering problems. f) Recognize the need for and engage in life-long learning. k) Use appropriate techniques, skill, and modern engineering technology necessary for the practice of mechanical engineering.
Objective 2: Trained to meet the local and global demands of the professions.	c) Design a system, component, or process to meet desired needs within identified realistic constraints. h) Understand the importance of engineering solutions in a global, economic, environmental, and societal context. j) Aware of contemporary issues.
Objective 3: Self-motivated, able to lead others, and uphold the code of ethics of the profession as well as his responsibilities in the community.	d) Work effectively as a team in multi-disciplinary and multi-cultural teams. f) Recognize the professional, social, and ethical responsibility. g) Able to communicate effectively. l) Know the principles of engineering management, and able to manage projects in a multi-disciplinary environment.

In Table 6.1 to 6.3, the course learning outcomes of the three subjects were reviewed in alignment with the PEO and PO. From Table 6.1, one hundred percent (100%) of the CLO of Engineering Thermodynamics 1 is aligned to objective 1 of PEO, and 100% is aligned with PO "a" and "e" of CHED. This is a good indication since the subject is designed to be an introductory course to a program outcome and met the minimum requirement of CHED to achieve PO "a" and "e". However, the CLO can still be improved to meet objective 2 and objective 3 under PEO and meet more CHED PO. The same is true for Engineering Thermodynamics 2 (Table 6.2) and Combustion Engineering (Table 6.3).

Table 6.1: Mapping of Engineering Thermodynamics 1 Course Learning Outcomes to CIT ME Program Educational Objectives and CHED PO

Course Learning Outcomes	Program Educational Objectives	Program Outcomes
CLO1. Describe the terminology, concept, and principles of thermodynamic system, and define and compare the different forms of energy.	*Objective 1*	*a, e*
CLO2. Explain the laws of thermodynamics as applied to close and open systems.	*Objective 1*	*a, e*
CLO3. Evaluate thermodynamics systems involving ideal gas processes.	*Objective 1*	*a, e*
CLO4. Analyze and compute problems of a thermodynamic cycle involving ideal gas.	*Objective 1*	*a, e*
CLO5. Evaluate how much of available energy can be converted to useful work undergoing cyclic change.	*Objective 1*	*a, e*

Table 6.2: Mapping of Engineering Thermodynamics 2 Course Learning Outcomes link to CIT ME Program Educational Objectives and CHED PO

Course Learning Outcomes	Program Educational Objectives	Program Outcomes
CLO1. Demonstrate ability to use thermodynamic relations and the physical property tables and charts for the determination of properties of phase transformations of water, ideal gas mixtures, real gases, and mixtures of gases and vapor, evidenced by correct plotting of states in a thermodynamic diagram, and drawing of schematic diagram of cycle components.	*Objective 1*	*a, e*
CLO2. Apply the concepts of the Laws of Thermodynamics in analyzing mechanical equipment and components of power cycles.	*Objective 1*	*a, e*
CLO3. Evaluate the thermodynamic properties of gas and vapor mixtures in various air-conditioning processes.	*Objective 1*	*a, e*

Table 6.3: Mapping of Combustion Engineering Course Learning Outcomes to CIT ME Program Educational Objectives and CHED PO

Course Learning Outcomes	Program Educational Objectives	Program Outcomes
CLO1. Describe the different types of fuels, its properties, and composition.	*Objective 1*	*a, e*
CLO2. Compare theoretical combustion processes at different air requirement.	*Objective 1*	*a, e*
CLO3. Conduct combustion product composition analysis.	*Objective 1*	*a, e*
CLO4. Describe the classifications and operation of internal combustions engines.	*Objective 1*	*a, e*
CLO5. Apply thermodynamic principles in evaluating engine performance.	*Objective 1*	*a, e*

The primary focus of OBTL is the statement of regarding what learners can do after taking the topic also called the Intended Learning Outcomes (ILO). For constructive alignment, the ILO should help in achieving the CLO. It should also cover different levels of cognitive process and knowledge level dimensions of the revised Bloom's Taxonomy so that students are involved with various modes of learning attain the required learning outcomes (Nightingale, Carew, & Fund, 2007).

For Engineering Thermodynamics 1, Table 7.1 shows that 64% of the ILO is aligned to the CLO. In terms of the cognitive process dimension of revised Bloom's Taxonomy, 90% of the ILO are on the lower level (53% Remember, 17% Understand, 20% Apply) while the remaining 10% are on the higher level (7% Analyze, 3% Evaluate, and 0% Create). In terms of the knowledge level dimensions, 75% is in the lower level (25% Factual, 50% Conceptual) and the remaining 25% is in the higher level (25% procedural, 0% Metacognitive). There is clear evidence that the ILO can still be improved to align it with the CLO and cover higher levels of the cognitive process and knowledge level dimensions.

Table 7.1: Mapping of Engineering Thermodynamics 1 Intended Learning Outcomes to Course Learning Outcomes

Intended Learning Outcomes	Course Learning Outcomes	Cognitive Process Dimension	Knowledge Level Dimension
Identify the thermodynamic terminology.	CLO1	Remember	Factual
Describe concept of thermodynamics.	CLO1	Remember	Conceptual
Describe the properties of a thermodynamic system in a state of equilibrium as well as those undergoing a process or a cycle.	CLO1	Remember	Conceptual
Describe the relationship between mass and energy.	Not aligned	Remember	Conceptual
Describe the three state of matter and its property.	Not aligned	Remember	Conceptual
Use of property table and chart.	Not aligned	Apply	Procedural
Engineering system of units & SI units.	Not aligned	Apply	Procedural
Differentiate vapor from gas.	Not aligned	Understand	Factual
Describe the laws of Ideal Gas.	Not aligned	Remember	Conceptual
Solve problem involving processes involving Ideal Gas.	CLO3	Apply	Procedural
Identify & differentiate the different forms of energy.	CLO1	Remember, Understand	Factual
State and explain the first law of thermodynamics.	CLO2	Remember, Understand	Factual

Apply the first law of thermodynamics in a close and open systems.	CLO2	Apply	Procedural
Solve problem on each thermodynamic system.	CLO2	Apply	Procedural
Describe a thermodynamic system involving Ideal Gas undergoing a process.	CLO3	Remember	Conceptual
Describe the different gas laws and derive the equation of state of an ideal gas.	CLO3	Remember	Conceptual
Analyze and compute problems on ideal gas processes.	CLO3	Analyze	Procedural
Describe 2nd Law of Thermodynamics.	CLO2	Remember	Conceptual
Explain the difference between the Kelvin-Planck statement and the Clausius statement of the Second Law of thermodynamics.	CLO2	Understand	Factual
Understand the concept of irreversibility, availability, and entropy.	Not aligned	Understand	Factual
Describe the operation of a heat engine and a refrigerator/heat pump.	Not aligned	Remember	Conceptual
Define the conversion of efficiency of power and reversed cycle.	Not aligned	Remember	Factual
Describe the concept of entropy and irreversibility.	Not aligned	Remember	Conceptual
Solve problem on power and reversed thermodynamic cycle.	CLO5	Apply	Procedural
Describe the processes in a thermodynamic cycle.	CLO5	Remember	Conceptual
Describe the Carnot cycle and its performance.	CLO5	Remember	Conceptual
Compare the thermal efficiency of thermodynamic cycles.	CLO5	Evaluate	Conceptual
Analyze and compute problems of thermodynamic ideal gas cycles	CLO4	Analyze	Conceptual

For Engineering Thermodynamics 2, Table 7.2 shows that 88% of the ILO is aligned to the CLO. In terms of the cognitive process dimension of revised Bloom's Taxonomy, 53% of the ILO are on the lower level (12% Remember, 6% Understand, 35% Apply) while the remaining 47% are on the higher level (12% Analyze, 29% Evaluate, and 6% Create). In terms of the knowledge level dimensions, 59% is in the lower level (18% Factual, 41% Conceptual) and the remaining 41% is in the higher level (29% procedural, 12% Metacognitive). There is clear evidence that the ILO needs only little improvement to align it with the CLO. The ILO can cover an even distribution of the cognitive process and knowledge level dimensions.

Table 7.2: Mapping of Engineering Thermodynamics 2 Intended Learning Outcomes to Course Learning Outcomes

Intended Learning Outcomes	Course Learning Outcomes	Cognitive Process Dimension	Knowledge Level Dimension
Describe the Kelvin–Planck statement of the 2nd Law of Thermodynamics	CLO2	Remember	Conceptual
Apply the 1st and 2nd Laws of Thermodynamics to cycles.	CLO2	Apply	Procedural
Describe the processes involved in a Rankine cycle.	CLO2	Remember	Conceptual
Examine ways how to improve the efficiency of a basic Rankine vapor power cycle.	CLO2	Analyze	Metacognitive
Evaluate vapor cycle using the 1st and 2nd Laws of Thermodynamics.	CLO2	Evaluate	Conceptual
Estimate the effects of i) reheating steam before re-introduced to the steam engine, and of ii) regenerative heating on cycle thermal efficiency.	CLO2	Evaluate	Conceptual
Evaluate the effects on cycle thermal efficiency if these two modifications on the cycle are combined altogether.	CLO2	Evaluate	Procedural
Evaluate combined, binary and cogeneration cycles.	CLO2	Evaluate	Conceptual
Plot the states of different gas power cycles in a thermodynamic diagram.	CLO1	Apply	Metacognitive
Evaluate the performance of gas, and combined power cycles.	CLO2	Evaluate	Conceptual
Use the various principles involved in analyzing compressible flows through different mechanical devices.	Not aligned	Apply	Factual
Analyze the effect of back pressure on the operation of a converging–diverging nozzle on mass flow rate.	Not aligned	Analyze	Conceptual
Differentiate a real gas from an ideal gas.	CLO1	Understand	Factual
Develop a method of evaluating the h, u, and s of real gases using generalized enthalpy and entropy departure charts.	CLO1	Create	Factual
Calculate the thermodynamics parameters of atmospheric air.	CLO3	Apply	Procedural
Use the Psychrometric Chart as a tool to determine the properties of atmospheric air.	CLO3	Apply	Procedural
Apply the principles of the conservation of mass and energy to various air-conditioning processes.	CLO3	Apply	Procedural

For Combustion Engineering, Table 7.3 shows that 100% of the ILO is aligned to the CLO. However, none of the ILO is aligned with CLO1. In terms of the cognitive process dimension of revised Bloom's Taxonomy, 67% of the ILO are on the lower level (17% Remember, 17% Understand, 33% Apply) while the remaining 34% are on the higher level (17% Analyze, 17% Evaluate, and 0% Create). In terms of the knowledge level dimensions, 58% is in the lower level (25% Factual, 33% Conceptual) and the remaining 42% is in the higher level (42% procedural, 0% Metacognitive). There is clear evidence that the ILO can still be improved to link all the CLO and cover higher levels of the cognitive process (Create) and knowledge level (Metacognitive) dimensions.

Table 7.3: Mapping of Combustion Engineering Intended Learning Outcomes to Course Learning Outcomes

Intended Learning Outcomes	Course Learning Outcomes	Cognitive Process Dimension	Knowledge Level Dimension
Perform combustion reaction analysis.	CLO3	Apply	Procedural
Compare the Orsat analysis from the theoretical combustion gas analysis.	CLO3	Evaluate	Procedural
Evaluate and identify the product gas analysis from the type of fuel used.	CLO3	Evaluate	Conceptual
Relate the effect of hydrocarbon fuel to combustion gas composition and "green gas" emission control requirement.	CLO3	Analyze	Conceptual
Recall the thermodynamic operation Otto and Diesel cycles.	CLO2	Remember	Conceptual
Describe and relate the air-standard cycle to actual IC engines	CLO2	Remember	Conceptual
Analyze and compute the thermal efficiency of ideal IC engines.	CLO4	Analyze	Procedural
Differentiate IC engines according to its performance parameters.	CLO5	Understand	Factual
Perform energy distribution analysis of IC engines.	CLO5	Apply	Procedural
Determine and compute performance parameters of IC engines	CLO5	Apply	Procedural
Differentiate IC engines operation from other combustion engines	CLO4	Understand	Factual
Perform a comparative study of their advantages and disadvantages	CLO4	Apply	Factual

For constructive alignment, the Course Outline needs to be selected to achieve the ILO. Tables 8.1, 8.2, and 8.3 showed that majority of the content of the course is aligned with the intended learning outcomes. Some parts of the course outline need to be revised to align it with the ILO such as "Engineering System of Units & SI Units" which is not link to any of the course outline in the topic "Pure Substance". This ILO, however, can be transferred to the topic "System of Units". The same procedure can also be done with the other ILOs that are not aligned.

Table 8.1: Mapping of Engineering Thermodynamics 1 Course Outline to Intended Learning Outcomes

Course Outline	Intended Learning Outcomes	Alignment
Topic 1: Concept and Definitions 1) Thermodynamic Systems and Working Substance 2) Properties and State of a Substance 3) System of Units 4) Process and Cycle 5) Law of Conservation of Mass & Energy Concept	ILO1. Identify the thermodynamic terminology. ILO2. Describe concept of thermodynamics. ILO3. Describe the properties of a thermodynamic system in a state of equilibrium as well as those undergoing a process or a cycle. ILO4. Describe the relationship between mass and energy.	Aligned Aligned Aligned Aligned
Topic 2: Properties of Pure Substance 1) Phase Diagrams 2) Changes of Phase 3) Tables & Charts of Properties/Computerized Tables 4) Ideal-Gas Laws 5) Compressibility Factor	ILO1. Describe the three state of matter and its property. ILO2. Use of property table and chart. ILO3. Engineering system of units & SI units. ILO4. Differentiate vapor from gas. ILO5. Describe the laws of Ideal Gas. ILO6. Solve problem involving processes involving Ideal Gas.	Aligned Aligned Not aligned Aligned Aligned Aligned
Topic 3: First Law of Thermodynamics 1) Concepts of Energy & Conservation of Energy 2) Expression of 1st Law of Thermodynamics for a substance undergoing a change of state	ILO1. Identify & differentiate the different forms of energy. ILO2. State and explain the first law of thermodynamics. ILO3. Apply the first law of thermodynamics in a close and open systems. ILO4. Solve problem on each thermodynamic system.	Aligned Aligned Aligned Aligned
Topic 4: Processes of Ideal Gas 1) Closed System 2) Open Steady State Steady Flow Systems	ILO1. Describe a thermodynamic system involving Ideal Gas undergoing a process. ILO2. Describe the different gas laws and derive the	Aligned Aligned

	equation of state of an ideal gas. ILO3. Analyze and compute problems on ideal gas processes.	Aligned
Topic 5: Second Law of Thermodynamics & concept of Entropy 1) Heat Engine & Heat Pump 2) Statement of the 2nd Law of Thermodynamics 3) Reversible & Irreversible Processes 4) Thermal Efficiency & Coefficient of Performance 5) Machines and Perpetual Motion Machines 6) Inequality of Clausius 7) Entropy Generation 8) Exergy (Availability) and Irreversibility	ILO1. Describe 2nd Law of Thermodynamics. ILO2. Explain the difference between the Kelvin-Planck statement and the Clausius statement of the Second Law of thermodynamics. ILO3. Understand the concept of irreversibility, availability, and entropy. ILO4. Describe the operation of a heat engine and a refrigerator/heat pump. ILO5. Define the conversion of efficiency of power and reversed cycle. ILO6. Describe the concept of entropy and irreversibility. ILO7. Solve problem on power and reversed thermodynamic cycle.	Aligned Aligned Aligned Aligned Aligned Aligned Aligned
Topic 6: Gas Power Cycles 1) Three-Process Cycle 2) Carnot Cycle 3) Otto Cycle 4) Diesel Cycle 5) Ericsson Cycle 6) Sterling Cycle 7) Brayton Cycle	ILO1. Describe the processes in a thermodynamic cycle. ILO2. Describe the Carnot cycle and its performance. ILO3. Compare the thermal efficiency of thermodynamic cycles. ILO4. Analyze and compute problems of thermodynamic ideal gas cycles.	Aligned Aligned Aligned Aligned

Table 8.2: Mapping of Engineering Thermodynamics 2 Course Outline to Intended Learning Outcomes

Course Outline	Intended Learning Outcomes	Alignment
Topic 1: Course Orientation, & Review on the Thermodynamic Cycle a) 2nd Law of Thermodynamics b) Carnot Power Cycle	ILO1. Appreciate the significance of the course in relation to Mechanical Engineering practice. ILO2: Describe the Kelvin–Planck statement of the 2nd Law of Thermodynamics. ILO3. Apply the 1st and 2nd Laws of Thermodynamics to cycles.	Aligned Aligned Aligned
Topic 2: Steam Power Cycle Analysis a) Review on the Use of Tables & Chart, processes	ILO1. Describe the processes involved in a Rankine cycle. ILO2: Examine ways how to improve the efficiency of a	Aligned Aligned

b) Review on Processes of pure Substances c) Ideal Rankine Cycle d) Actual Rankine Cycle e) Improving Cycle Efficiency	basic Rankine vapor power cycle; and ILO3: Evaluate vapor cycle using the 1st and 2nd Laws of Thermodynamics.	Not aligned
Topic 3: Improved Steam Power Cycle a) Ideal and Actual Reheat Cycle b) Ideal and Actual Regenerative Cycle ✓ Open Feedwater Heater (OFWH) ✓ Closed Feedwater Heater (CFWH) c) Ideal and Actual Reheat-Regenerative Cycle d) Cogeneration Cycle e) Binary Vapor Cycle	ILO1: Estimate the effects of i) reheating steam before re-introduced to the steam engine, and of ii) regenerative heating on cycle thermal efficiency. ILO2: Evaluate the effects on cycle thermal efficiency if these two modifications on the cycle are combined altogether. ILO3: Evaluate combined, binary and cogeneration cycles.	Aligned Aligned Aligned
Topic 4: Air-Standard Gas Power Cycles a) Otto Cycle b) Diesel Cycle c) Stirling Cycle d) Ericsson Cycle e) Atkinson cycle f) Brayton Cycle g) Combined Gas–Vapor Power Cycle	ILO1: Plot the states of different gas power cycles in a thermodynamic diagram. ILO2: Evaluate the performance of gas, and combined power cycles.	Aligned Aligned
Topic 5: Gas Compression Analysis • Analyzing One-Dimensional Steady Flow in Nozzles and Diffusers • Flow in Nozzles and Diffusers of Ideal Gases with Constant Specific Heats • Effect of Back Pressure: Converging-Diverging Nozzle	ILO1: Use the various principles involved in analyzing compressible flows through different mechanical devices. ILO2: Analyze the effect of back pressure on the operation of a converging–diverging nozzle on mass flow rate.	Aligned Aligned
Topic 6: Real Gases • Compressibility factor • Evaluating Changes in Entropy, Internal Energy, and Enthalpy • p–v–T Relations for Gas Mixtures	ILO1: Differentiate a real gas from an ideal gas. ILO2: Develop a method of evaluating the h, u, and s of real gases using generalized enthalpy and entropy departure charts.	Aligned Aligned
Topic 7: Properties of Gas and Vapor Mixtures • Specific and Relative Humidity of Air • Dew-point Temperature, Adiabatic Saturation and Wet-bulb Temp. • The Psychrometric Chart • Air-Conditioning Processes	ILO1: Calculate the thermodynamics parameters of atmospheric air. ILO2: Use the Psychrometric Chart as a tool to determine the properties of atmospheric air. ILO3: Apply the principles of the conservation of mass and energy to various air-conditioning processes.	Aligned Aligned Aligned

Table 8.3: Mapping of Combustion Engineering Course Outline to Intended Learning Outcomes

Course Outline	Intended Learning Outcomes	Alignment
Topic 1: Fuels and Combustion 1. Thermochemistry a. Theoretical Combustion with 100% air b. Theoretical Combustion with excess air c. Theoretical Combustion with deficient air 2. Orsat Analysis of Combustion Product 3. Fuels & Types a. Fuel Self-Ignition Temperature b. Octane Number and Engine Knock c. Cetane Number d. Composition analysis Engine 4. Emissions and Air Pollution	ILO1. Perform combustion reaction analysis. ILO2. Compare the Orsat analysis from the theoretical combustion gas analysis. ILO3. Evaluate and identify the product gas analysis from the type of fuel used. ILO4. Relate the effect of hydrocarbon fuel to combustion gas composition and "green gas" emission control requirement.	Aligned Aligned Aligned Aligned
Topic 2: Air-Standard Internal Combustion Engine Cycle 1. Otto Cycle 2. Diesel Cycle	ILO1. Recall the thermodynamic operation Otto and Diesel cycles. ILO2. Describe and relate the air-standard cycle to actual IC engines. ILO3. Analyze and compute the thermal efficiency of ideal IC engines.	Aligned Aligned Not aligned
Topic 3: Internal Combustion Engine Classifications 1. Two-Stroke & Four –Stroke 2. Engine Operating Characteristics 1. Engine Parameters 2. Work, Torque & Power 3. Mean Effective Pressure 4. Air-Fuel Ratio 5. Engine Efficiencies 6. Emissions Index 3. Energy Distribution of IC Engines	ILO1. Differentiate IC engines according to its performance parameters. ILO2. Perform energy distribution analysis of IC engines. ILO3. Determine and compute performance parameters of IC engines.	Aligned Aligned Aligned
Topic 4: Combustion Engines a. External Combustion Engine b. Gas-Turbine	ILO1. Differentiate IC engines operation from other combustion engines. ILO2. Perform a comparative study of their advantages and disadvantages.	Aligned Aligned

Once the ILO has been established, the next step is to design the Teaching and Learning Activities (TLA). The TLA is any activity that stimulates, encourages, or facilitates the learning of one or more ILOs. The data gathered for Engineering Thermodynamics 1 as shown in Table 9.1 cannot specify whether the TLA is aligned with the ILO. The activities are too broad. The learning activities can be improved to make them more specific. It can also be observed that the teacher did not employ varied learnings activities. Halperin (as cited in Catalano, 1997) found out that many classroom activities today are still traditional where students passively receive wisdom from the professor. Aside from discussion and lecture, the teacher can engage the students in other learning activities that will help achieve the intended learning outcomes.

Table 9.1: Mapping of Engineering Thermodynamics 1 Intended Learning Outcomes to Learning Activities

Learning Activities	Intended Learning Outcomes	Alignment
Learning Activities 1: • Lecture using Multimedia • Interactive Discussion	ILO1. Identify the thermodynamic terminology. ILO2. Describe concept of thermodynamics. ILO3. Describe the properties of a thermodynamic system in a state of equilibrium as well as those undergoing a process or a cycle. ILO4. Describe the relationship between mass and energy.	Cannot be specified
Learning Activities 2: • Lecture using Multimedia • Interactive Discussion	ILO1. Describe the three state of matter and its property. ILO2. Use of property table and chart. ILO3. Engineering system of units & SI units. ILO4. Differentiate vapor from gas. ILO5. Describe the laws of Ideal Gas. ILO6. Solve problem involving processes involving Ideal Gas.	Cannot be specified
Learning Activities 3: • Lecture using Multimedia • Interactive Discussion	ILO1. Identify & differentiate the different forms of energy. ILO2. State and explain the first law of thermodynamics. ILO3. Apply the first law of thermodynamics in a close and open systems. ILO4. Solve problem on each thermodynamic system.	Cannot be specified
Learning Activities 4: • Lecture using Multimedia • Interactive Discussion	ILO1. Describe a thermodynamic system involving Ideal Gas undergoing a process. ILO2. Describe the different gas laws and derive the equation of state of an ideal gas.	Cannot be specified

	ILO3. Analyze and compute problems on ideal gas processes.	
Learning Activities 5: • Lecture using Multimedia • Interactive Discussion	ILO1. Describe 2nd Law of Thermodynamics. ILO2. Explain the difference between the Kelvin-Planck statement and the Clausius statement of the Second Law of thermodynamics. ILO3. Understand the concept of irreversibility, availability, and entropy. ILO4. Describe the operation of a heat engine and a refrigerator/heat pump. ILO5. Define the conversion of efficiency of power and reversed cycle. ILO6. Describe the concept of entropy and irreversibility. ILO7. Solve problem on power and reversed thermodynamic cycle.	Cannot be specified
Learning Activities 6: • Lecture using Multimedia • Interactive Discussion	ILO1. Describe the processes in a thermodynamic cycle. ILO2. Describe the Carnot cycle and its performance. ILO3. Compare the thermal efficiency of thermodynamic cycles. ILO4. Analyze and compute problems of thermodynamic ideal gas cycles.	Cannot be specified

The data gathered for Engineering Thermodynamics 2 as shown in Table 9.2 shows that majority of the TLA is aligned with the ILO. Unlike the first subject, the teacher employed more varied and specific learning activities that are more suitable to the ILO.

Table 9.2: Mapping of Engineering Thermodynamics 2 Intended Learning Outcomes to Learning Activities

Learning Activities	Intended Learning Outcomes	Alignment
Learning Activities 1: a) Student Profiling, LMS Orientation, and Setting of Expectations b) Discussions on ✓ Kelvin Plank Statement ✓ Heat Engine, both reversible	ILO1. Appreciate the significance of the course in relation to Mechanical Engineering practice. ILO2: Describe the Kelvin–Planck statement of the 2nd Law of Thermodynamics. ILO3. Apply the 1st and 2nd Laws of Thermodynamics to cycles.	Aligned Aligned Not Aligned

Learning Activities 2: a) Homework Reading b) Demonstrations on plotting of states and processes in a t-s diagram, and application of the 1st of Thermodynamics. c) Discussions, & Demonstrations in analyzing cycle performance	ILO1. Describe the processes involved in a Rankine cycle. ILO2: Examine ways how to improve the efficiency of a basic Rankine vapor power cycle; and ILO3: Evaluate vapor cycle using the 1st and 2nd Laws of Thermodynamics.	Aligned Aligned Not aligned
Learning Activities 3: a) Homework Reading b) Discussions, & Demonstrations in analyzing cycle performance	ILO1: Estimate the effects of i) reheating steam before re-introduced to the steam engine, and of ii) regenerative heating on cycle thermal efficiency. ILO2: Evaluate the effects on cycle thermal efficiency if these two modifications on the cycle are combined altogether. ILO3: Evaluate combined, binary and cogeneration cycles.	Aligned Aligned Aligned
Learning Activities 4: a) Homework Reading b) Discussions, & Demonstrations in analyzing cycle performance	ILO1: Plot the states of different gas power cycles in a thermodynamic diagram. ILO2: Evaluate the performance of gas, and combined power cycles.	Aligned Aligned
Learning Activities 5: a) Discussions, Demonstrations and Analyzes	ILO1: Use the various principles involved in analyzing compressible flows through different mechanical devices. ILO2: Analyze the effect of back pressure on the operation of a converging–diverging nozzle on mass flow rate.	Aligned Aligned
Learning Activities 6: a) Discussions, Demonstrations and Analyzes	ILO1: Differentiate a real gas from an ideal gas. ILO2: Develop a method of evaluating the h, u, and s of real gases using generalized enthalpy and entropy departure charts.	Aligned Aligned
Learning Activities 7: a) Discussions, Demonstrations and Analyzes	ILO1: Calculate the thermodynamics parameters of atmospheric air. ILO2: Use the Psychrometric Chart as a tool to determine the properties of atmospheric air. ILO3: Apply the principles of the conservation of mass and energy to various air-conditioning processes.	Aligned Aligned Aligned

The data gathered for Combustion Engineering as shown in Table 9.3 cannot specify whether the TLA is aligned with the ILO. The learnings activities can be improved to make them more specific. Aside from discussion and lecture, the teacher can engage the students in other learning activities found in the literature cited in this study that will help achieve the intended learning outcomes such as cooperative learning where students work together and develop higher-order cognitive skills (Johnson et al., 1991; Smith, 1986, 1989).

Table 9.3 Mapping of Combustion Engineering Intended Learning Outcomes to Learning Activities

Learning Activities	Intended Learning Outcomes	Alignment
Learning Activities 1: a) Lecture using OH Projector b) Interactive Discussion	ILO1. Perform combustion reaction analysis. ILO2. Compare the Orsat analysis from the theoretical combustion gas analysis. ILO3. Evaluate and identify the product gas analysis from the type of fuel used. ILO4. Relate the effect of hydrocarbon fuel to combustion gas composition and "green gas" emission control requirement.	Cannot be specified
Learning Activities 2: a) Lecture using OH Projector b) Interactive Discussion	ILO1. Recall the thermodynamic operation Otto and Diesel cycles. ILO2. Describe and relate the air-standard cycle to actual IC engines. ILO3. Analyze and compute the thermal efficiency of ideal IC engines.	Cannot be specified
Learning Activities 3: a) Lecture using OH Projector b) Interactive Discussion	ILO1. Differentiate IC engines according to its performance parameters. ILO2. Perform energy distribution analysis of IC engines. ILO3. Determine and compute performance parameters of IC engines.	Cannot be specified
Learning Activities 4: a) Lecture using OH Projector b) Interactive Discussion	ILO1. Differentiate IC engines operation from other combustion engines. ILO2. Perform a comparative study of their advantages and disadvantages.	Cannot be specified

The final OBTL component is the Assessment Tasks (AT) which quantifies how learners can apply their competencies in solving actual world problems, design, showcase creativity, and communicate effectively, among others. It can tell how the ILO has been met. As shown in Table 10.1 to 10.3, there is not enough evidence to specify the alignment of the assessment tasks with the ILO especially for Engineering Thermodynamics 1 and Combustion Engineering. It is also noticeable that the assessment tasks are the same in all the ILO for each of the subjects. Most of the assessment tasks are leaning towards an objective type of test. This is a good indication of a need to improve the existing methods of assessment. As a guide in doing this, the teacher can use Table 3 which shows the different modes of assessment and the corresponding kind of learning being assessed. Biggs (2003) mentioned that the best assessment is the one that best met the goals.

Table 10.1: Mapping of Engineering Thermodynamics 1 Assessment Tasks and Intended Learning Outcomes

Assessment Tasks	Intended Learning Outcomes	Alignment
Assessment Tasks 1: a) Seatwork b) Assignment/ Homework, & Research work c) Written Exam	ILO1. Identify the thermodynamic terminology. ILO2. Describe concept of thermodynamics. ILO3. Describe the properties of a thermodynamic system in a state of equilibrium as well as those undergoing a process or a cycle. ILO4. Describe the relationship between mass and energy.	Cannot be specified
Assessment Tasks 2: a) Seatwork b) Assignment/ Homework, & Research work c) Written Exam	ILO1. Describe the three state of matter and its property. ILO2. Use of property table and chart. ILO3. Engineering system of units & SI units. ILO4. Differentiate vapor from gas. ILO5. Describe the laws of Ideal Gas. ILO6. Solve problem involving processes involving Ideal Gas.	Cannot be specified
Assessment Tasks 3: a) Seatwork b) Assignment/ Homework, & Research work c) Written Exam	ILO1. Identify & differentiate the different forms of energy. ILO2. State and explain the first law of thermodynamics. ILO3. Apply the first law of thermodynamics in a close and open systems. ILO4. Solve problem on each thermodynamic system.	Cannot be specified

Assessment Tasks 4: a) Seatwork b) Assignment/ Homework, & Research work c) Written Exam	ILO1. Describe a thermodynamic system involving Ideal Gas undergoing a process. ILO2. Describe the different gas laws and derive the equation of state of an ideal gas. ILO3. Analyze and compute problems on ideal gas processes.	Cannot be specified
Assessment Tasks 5: a) Seatwork b) Assignment/ Homework, & Research work c) Written Exam	ILO1. Describe 2nd Law of Thermodynamics. ILO2. Explain the difference between the Kelvin-Planck statement and the Clausius statement of the Second Law of thermodynamics. ILO3. Understand the concept of irreversibility, availability, and entropy. ILO4. Describe the operation of a heat engine and a refrigerator/heat pump. ILO5. Define the conversion of efficiency of power and reversed cycle. ILO6. Describe the concept of entropy and irreversibility. ILO7. Solve problem on power and reversed thermodynamic cycle.	Cannot be specified
Assessment Tasks 6: a) Seatwork b) Assignment/ Homework, & Research work c) Written Exam	ILO1. Describe the processes in a thermodynamic cycle. ILO2. Describe the Carnot cycle and its performance. ILO3. Compare the thermal efficiency of thermodynamic cycles. ILO4. Analyze and compute problems of thermodynamic ideal gas cycles.	Cannot be specified

Table 10.2: Mapping of Engineering Thermodynamics 2 Assessment Tasks and Intended Learning Outcomes

Assessment Tasks	**Intended Learning Outcomes**	**Alignment**
Assessment Task 1: a) Problem Solving	ILO1. Appreciate the significance of the course in relation to Mechanical Engineering practice. ILO2: Describe the Kelvin–Planck statement of the 2nd Law of Thermodynamics. ILO3. Apply the 1st and 2nd Laws of Thermodynamics to cycles.	Not Aligned Not Aligned Cannot be specified

Assessment Task 2: a) Problem Solving	ILO1. Describe the processes involved in a Rankine cycle. ILO2: Examine ways how to improve the efficiency of a basic Rankine vapor power cycle; and ILO3: Evaluate vapor cycle using the 1st and 2nd Laws of Thermodynamics.	Not Aligned Not aligned Aligned
Assessment Task 3: a) Problem Solving	ILO1: Estimate the effects of i) reheating steam before re-introduced to the steam engine, and of ii) regenerative heating on cycle thermal efficiency. ILO2: Evaluate the effects on cycle thermal efficiency if these two modifications on the cycle are combined altogether. ILO3: Evaluate combined, binary and cogeneration cycles.	Aligned Aligned Aligned
Assessment Task 4: a) Problem Solving	ILO1: Plot the states of different gas power cycles in a thermodynamic diagram. ILO2: Evaluate the performance of gas, and combined power cycles.	Aligned Aligned
Assessment Task 5: a) Problem Solving	ILO1: Use the various principles involved in analyzing compressible flows through different mechanical devices. ILO2: Analyze the effect of back pressure on the operation of a converging–diverging nozzle on mass flow rate.	Aligned Aligned
Assessment Task 6: a) Problem Solving	ILO1: Differentiate a real gas from an ideal gas. ILO2: Develop a method of evaluating the h, u, and s of real gases using generalized enthalpy and entropy departure charts.	Not Aligned Aligned
Assessment Task 7: a) Problem Solving	ILO1: Calculate the thermodynamics parameters of atmospheric air. ILO2: Use the Psychrometric Chart as a tool to determine the properties of atmospheric air. ILO3: Apply the principles of the conservation of mass and energy to various air-conditioning processes.	Aligned Aligned Cannot be specified

Table 10.3: Mapping of Combustion Engineering Assessment Tasks and Intended Learning Outcomes

Assessment Tasks	Intended Learning Outcomes	Alignment
Assessment Tasks 1: a) Assignment/ Homework, and Research (library and/or internet) Work b) Written Exam	ILO1. Perform combustion reaction analysis. ILO2. Compare the Orsat analysis from the theoretical combustion gas analysis. ILO3. Evaluate and identify the product gas analysis from the type of fuel used. ILO4. Relate the effect of hydrocarbon fuel to combustion gas composition and "green gas" emission control requirement.	Cannot be specified
Assessment Tasks 2: a) Assignment/ Homework, and Research (library and/or internet) Work b) Written Exam	ILO1. Recall the thermodynamic operation Otto and Diesel cycles. ILO2. Describe and relate the air-standard cycle to actual IC engines. ILO3. Analyze and compute the thermal efficiency of ideal IC engines.	Cannot be specified
Assessment Tasks 3: a) Assignment/ Homework, and Research (library and/or internet) Work b) Written Exam	ILO1. Differentiate IC engines according to its performance parameters. ILO2. Perform energy distribution analysis of IC engines. ILO3. Determine and compute performance parameters of IC engines.	Cannot be specified
Assessment Tasks 4: a) Assignment/ Homework, and Research (library and/or internet) Work b) Written Exam	ILO1. Differentiate IC engines operation from other combustion engines. ILO2. Perform a comparative study of their advantages and disadvantages.	Cannot be specified

Phase 2. Benchmarking activities

The second phase of the study is the comparison of the existing course syllabus with the CHED MO and local and international course syllabus. It was agreed by the faculty members that the selection of topics should be consistent and satisfies the course description and course learning outcomes of CHED MO. The reasons behind this are to ensure that CIT University BSME graduates can compete with the graduates of other universities here in the Philippines, to give students more chances of being accepted to local and international schools should they choose to transfer or continue graduates studies, and to satisfy local and international accreditation requirements.

For Engineering Thermodynamics 1 as shown in Table 11.1, the existing course syllabus has been revised. In terms of the course description, most of the keywords in CHED MO such as "pure substance", "ideal and real gas", "laws of thermodynamics", "processes and cycles", and "vapor and gas cycles" is also reflected but enriched and specified in CIT syllabus. In terms of course learning outcomes, most of the CLO in the CIT syllabus is entirely different from the CHED MO. For the course outline, the only topic that is not included in the CIT syllabus is the CHED MO's "real gases". The topics have been rearranged and some are integrated into a single topic. Based on the above-mentioned results, there is a need to align the course learning outcomes and include the topic 'real gases" in the CIT syllabus.

Table 11.1: Comparison of Engineering Thermodynamics 1 CHED MO and Existing CIT Course Syllabus

CHED MO	CIT
Course Description: A course dealing with the thermodynamic properties of pure substance, ideal and real gases and the study and application of the laws of Thermodynamics in the analysis of processes and cycles. It includes introduction to vapor and gas cycles.	**Course Description:** The course deals with the relationships of different forms of energy. It emphasizes the application of thermodynamic laws applied to both close and open systems. The scope of the course covers thermodynamic properties of pure substance, ideal gas and real gas, energy concepts, laws of thermodynamics, and processes & cycles involving ideal gas. It presents the basic concepts on how heat can be transformed into work or vice-versa.
Course Learning Outcomes: CLO1. Identify the different properties of pure substance, ideal gas, and real gas. CLO2. Apply thermodynamics concepts and principles in analyzing and solving problems. CLO3. Apply the laws of thermodynamic in analyzing problems. CLO4. Evaluate the performance of thermodynamic gas cycles.	**Course Learning Outcomes:** CLO1. Describe the terminology, concept, and principles of thermodynamic system, and define and compare the different forms of energy. CLO2. Explain the laws of thermodynamics as applied to close and open systems. CLO3. Evaluate thermodynamics systems involving ideal gas processes. CLO4. Analyze and compute problems of a thermodynamic cycle involving ideal gas. CLO5. Evaluate how much of available energy can be converted to useful work undergoing cyclic change.
Course Outline: 1. Introduction	**Course Outline:** 1. Course Orientation
2. Basic principles, concepts, and definition.	2. Concepts and Definition
3. First law of thermodynamics.	3. Properties of Pure Substance
4. Ideal gases and ideal gas laws.	4. First Law of Thermodynamics
5. Processes of ideal gases	5. Processes of Ideal Gas
6. Properties of pure substance	6. Second Law of Thermodynamic and Concept of Entropy
7. Processes of pure substance	7. Gas Power Analysis
8. Second law of thermodynamics	
9. Introduction to gas and vapor cycles.	
10. Real Gases	

For Engineering Thermodynamics 2 as shown in Table 11.2, the existing course syllabus has been revised. In terms of the course description, the teacher adapted the CHED MO in the CIT syllabus. In terms of course learning outcomes, the first and the last CLO from CHED MO have been modified and specified. The last statement in the CIT syllabus is not aligned with the course description since the topic “air-conditioning processes” is not yet introduced in Thermodynamics 2. For the course outline, the teacher included all the required topics but in a more condensed form. Based on the above-mentioned results, there is a need to align the course learning outcomes in the CIT syllabus.

Table 11.2: Comparison of Engineering Thermodynamics 2 CHED MO and Existing CIT Course Syllabus

CHED MO	CIT
Course Description: This course is aimed to further enhance the student's knowledge regarding the principles of Thermodynamics by using these principles in practical application specifically in the field of power generation. This includes the study of real gases, properties of gas and vapor mixtures and introduction to reactive systems.	**Course Description:** This course is aimed to further enhance the students' knowledge regarding the principles of Thermodynamics by using these principles in practical application specifically in the field of power generation. This includes study of real gases, properties of gas and vapor mixtures and introduction to reactive systems. .
Course Learning Outcomes: CLO1. Apply the concepts of Thermodynamics in analyzing Power cycles. CLO2. Determine the physical and thermodynamic properties of ideal gas mixtures, real gases, and mixtures of gases and vapor. CLO3. Evaluate the performance of vapor power cycles and gas power plants and standard air-power cycles.	**Course Learning Outcomes:** CLO1. Demonstrate ability to use thermodynamic relations and the physical property tables and charts for the determination of properties of phase transformations of water, ideal gas mixtures, real gases, and mixtures of gases and vapor, evidenced by correct plotting of states in a thermodynamic diagram, and drawing of schematic diagram of cycle components. CLO2. Apply the concepts of the Laws of Thermodynamics in analyzing mechanical equipment and components of power cycles. CLO3. Evaluate the thermodynamic properties of gas and vapor mixtures in various air-conditioning processes.
Course Outline: 1. Review the Thermodynamic Cycle	**Course Outline:** 1. Course Orientation, & Review on the Thermodynamic Cycle
2. Simple Rankine Cycle	2. Steam Power Cycle Analysis
3. Improving Rankine Cycle Efficiency	3. Improved Steam Power Cycle Analysis
4. Actual Rankine Cycle	4. Air-Standard Gas Power Cycles
5. Ideal and Actual Reheat Cycle	5. Gas Compression
6. Ideal and Actual Regenerative Cycle	6. Real Gases
7. Ideal and Actual Reheat-Regenerative Cycle	7. Properties of gas and vapor mixtures
8. Binary Cycles (Combined Power Cycle)	
9. Topping or Superposing Cycles	
10. Incomplete Expansion Engine	
11. Other Gas Power Cycles	
12. Gas compression Analysis	
13. Real Gases	
14. Properties of gas and vapor mixtures	

For Combustion Engineering as shown in Table 11.3, the existing course syllabus has been revised. In terms of the course description, several topics have been included in the CIT syllabus but the required topics such as "compression and combustion charts", "engine components", "engine design" have been omitted. In terms of course learning outcomes, the required CLO's 1, 2, and 4 are not reflected in the CIT syllabus. For the course outline, the teacher did not reflect required topics such as "principles of Thermodynamics, "mixture of gases", "engine testing and performance", and "engine design". There is a need to align the course description, course learning outcomes, and course outline.

Table 11.3: Comparison of Combustion Engineering CHED MO and Existing CIT Course Syllabus

CHED MO	CIT
Course Description: The course deals with principles involved in combustion, carburetion, and fuel injection; fundamentals and basic principles of combustion processes, compression and combustion charts, fuels, (manifolds) engine components, engine performance and combustion engine design.	**Course Description:** It is a study of combustion process which covers fuel and its properties, chemical reaction in combustion, combustion analysis and combustion gases composition analysis. The course deals also with the principles of internal combustion engines, carburetion, fuel injection, combustion engine performance parameters and its operation with due consideration of its effect to the environment.
Course Learning Outcomes: CLO1. Explain basic combustion and stoichiometric process. CLO2. Perform stoichiometric analysis of various gaseous, liquid, and solid fuels. CLO3. Apply thermodynamic principles in analyzing the performance of internal combustion engines. CLO4. Evaluate the principles, operations, maintenance, and design of internal combustion engines	**Course Learning Outcomes:** CLO1. Describe the different types of fuels, its properties, and composition. CLO2. Compare theoretical combustion processes at different air requirement. CLO3. Conduct combustion product composition analysis. CLO4. Describe the classifications and operation of internal combustions engines. CLO5. Apply thermodynamic principles in evaluating engine performance.
Course Outline: 1. Principle of Thermodynamics	**Course Outline:** 1. Fuels and Combustion
2. Mixture of Gases	2. Air-Standard Internal Combustion
3. Handling of Gaseous Fuels Handling of Volatile Liquid Fuels Handling of Fuel Oils	3. Internal Combustion Engine Classifications
4. Combustion of Fuels	4. External Combustion Engines
5. Theoretical Cycles	
6. Engine Testing and Performance	
7. Engine Design	
8. External Combustion Engine	

Conclusion and Recommendation

It is imperative to maintain an ongoing assessment of the BSME program to ensure alignment with the stipulations of the Philippine Commission on Higher Education (CHED) and to contribute effectively to the goals of Cebu Institute of Technology University (CIT). The analysis of the current course syllabus reveals a lack of full conformity to the CHED Memorandum Order (MO) and CIT BSME program's educational objectives in terms of course learning outcomes, course descriptions, and course outlines. Furthermore, the existing course syllabus demonstrates a cognitive process and knowledge dimension that predominantly falls within the lower levels of the revised Bloom's taxonomy, whereas engineering courses inherently necessitate the cultivation of higher-order cognitive skills and knowledge dimensions. Developing crucial engineering competencies like creativity, critical thinking, and innovative problem-solving mandates engaging students in activities that transcend these higher cognitive levels (Goel & Sharda, 2004). Comparing the course syllabus with those of local and international universities unveils a similarity between the existing syllabi and those of local institutions, yet significant discrepancies exist when compared to international counterparts. In light of the study's findings and the insights garnered from consultations with subject teachers, the following recommendations are proposed: (a) Revise and enhance the obligatory course description, course learning outcomes, and course outline as outlined in the CHED Memorandum Order, and (b) Foster elevated cognitive processes and heightened knowledge dimensions among students by incorporating these aspects into the intended learning outcomes, diversifying pedagogical approaches, and aligning assessments with the intended learning objectives.

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