Mechanical Engineering Concurrent Degree/Advanced Diploma Agreement

Project #: 2017-06

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Table of Contents

2. Executive Summary

A project has been developed by St. Clair College, in partnership with the University of Windsor, in which a concurrent agreement for students in the Mechanical Engineering degree program are able to earn the Mechanical Engineering Technology advanced diploma by attending a customized delivery of courses at St. Clair College during off-semesters, by focusing on complementary practical hands-on technical skills. By attending St. Clair College during their off-semesters, students will obtain practical hands-on skills in addition to the theoretical concepts developed during their studies at the University of Windsor; which are both appealing attributes that employers are in frequent search of. In the past, students have transferred from the Mechanical Engineering Technology program at St. Clair College to the University of Windsor's Mechanical Engineering degree program. There is a high success rate for these transfer students completing the Mechanical Engineering program at the University of Windsor. Of the many students who apply for Co-Op positions in the Mechanical Engineering Degree program at the University of Windsor, a significant amount of these students are denied access due to the competitive nature in the selection of applicants. Students who are not in the Co-Op program can complete the concurrent agreement during their off-semesters. The concurrent agreement will provide the students with valuable hands-on technical skills. As well, University of Windsor's Mechanical Engineering degree program consists of many international students. Due to the barriers associated with employing these international students, it is more difficult for them to obtain employment. By offering this concurrent agreement, the international students have the option to gain additional credentials, which will better their chances of finding employment in North America as well as keeping them occupied while attempting to gain citizenship into Canada. It is expected that a sufficient amount of students will be interested in applying for this concurrent agreement.

The Concurrent Degree/Advanced Diploma agreement will require the university students to attend the St. Clair College during three off-semesters: (1) the summer off-semester between the second year, second semester and the third year, first semester; (2) the winter off-semester between the third-year first and second semesters; and (3) the fall semester prior to entering their fourth-year, first semester. Prior to the analysis, a selection of seventeen courses was made based on their hands-on practical course work. Of the courses not in the pre-selection of the agreement, further analysis was necessary to justify their absence in the curriculum.

When mapping courses for the Engineering Technologies at St. Clair College, two types of learning outcomes are necessary in the analysis: Program Vocational Learning Outcomes (VLOs) and Course Learning Outcomes (CLOs). The Program Vocational Learning Outcomes are general outcomes that must be met for all engineering technology programs. The Course Learning Outcomes are course-specific learning outcomes that define the topics that are assessed and taught in each course. These are the two types of learning outcomes assessed in the analysis for developing the concurrent agreement.

An initial attempt at matching the learning outcomes between the two institutions proved to be unsuccessful due to the significant differences in learning outcomes. A thorough analysis, which is specific to each course, was necessary. The pre-analysis for Program Vocational Learning Outcomes was obtained by comparing the St. Clair College courses which were not in the discussion of the curriculum.

It was important to justify the absence of these courses in the curriculum via direct course comparison and proving that there were no sufficient gaps present in the comparative analysis. After the analysis, all courses which were absent in the curriculum were justified via VLO and CLO analysis.

Seventeen courses were pre-selected for inclusion in the concurrent agreement curriculum. After the VLO analysis, none of the seventeen courses were eliminated from the discussion. As for the CLO analysis, thorough course comparison was achieved by carefully considering the Course Learning Outcomes of each St. Clair College Course and comparing them with course outlines from the Mechanical Engineering Degree program at the University of Windsor. After the analysis of CLOs, two courses were eliminated from the concurrent agreement curriculum.

The final curriculum contains fifteen courses. The students will be required to complete five courses each semester during their studies at St. Clair College. Upon completion of the concurrent agreement, graduates will be equipped with the intended hands-on skills they obtain at St. Clair College as well as theoretical concepts they learn at the University of Windsor.

3. Project Purpose and Goals

The University of Windsor and St. Clair College of Applied Arts and Technology have both received feedback from industry that the best engineering job candidates are those who have gained both theoretical and practical hands-on engineering knowledge. Graduates who possess both credentials are highly sought after as they are "well-rounded". Building stronger engineering programs is critical for our community, which has been built on innovation in manufacturing and technology. Both institutions are committed to completing this initiative and an investment from ONCAT would assist in accelerating its development and implementation. In addition to creating a better Student Pathway, as highlighted in the ONCAT proposal, "Advanced Diploma to Degree Engineering Bridge Agreement", the goal for this project is to develop an alternative pathway for students who start at the University of Windsor in the Bachelor of Applied Science Mechanical Engineering degree to achieve the St. Clair College advanced diploma credential in addition to their degree concurrently, with the overall goal of achieving both credentials in four years. The primary benefit of this goal is to develop a highly marketable and effective engineering graduate who has hands-on and practical skills in various machining processes, advanced computer-aided design, precision measuring equipment, computer numerical control (CNC) machining, coordinate measuring machine (CMM), etc.; skills that are not part of a typical undergraduate Mechanical Engineering degree. To achieve this goal, there is need to identify learning outcomes in the advanced diploma program that are not covered by the curriculum of the engineering degree program. This analytical study will be utilized to create a customized delivery of the required curriculum, to be delivered at the College in off-semesters for the engineering program, as an alternative pathway for students who do not enter into or fail to find a placement in the optional cooperative education (Co-Op) program at the University of Windsor. There are many students who do not achieve placement in the Co-Op program, and initial feedback suggests students would consider this type of agreement to help make them more marketable. Both institutions would market this joint agreement together as a unique concurrent engineering, or "Con-Eng" offering, replacing what would typically take additional years of time in existing traditional college-to-university engineering agreement pathways.

4. Pathway Development

a. Methodology

Pre-selection of courses

A pre-selection of courses is made due to the intended purpose of the Concurrent Degree/Advanced Diploma agreement; courses which provide hands-on practical practices. This is just a general overview of the courses which may be offered and further analysis may modify this selection. A paragraph for each pre-selected course follows to justify their presence in the discussion for the agreement.

Evaluation of Program Learning Outcomes (PVLO)

The engineering technology programs at St. Clair College consist of Program Vocational Learning Outcomes: a general overview of learning outcomes that are unique to the courses present in the engineering technology courses. In this step, an evaluation of the Program Vocational Learning Outcomes is made on a course-by-course basis. Once all learning outcomes are considered for each course, they are tallied up into their corresponding sections to obtain an overall frequency. Due to the generality of these learning outcomes, a comparison can be made with the university courses via direct-course-comparison based off of the general description of the courses.

Direct course comparison

In this step, courses are compared from the two institutions that contain similarities. The evaluation of these courses is only necessary for the courses not in the discussion of the pre-selection for the concurrent agreement since it is necessary that the students are exposed to the learning outcomes during their studies at the university. Once these courses, which are not present in the pre-selection, are compared with the university courses, the Program Vocational Learning Outcomes not covered during the Concurrent Degree/ Advanced Diploma are justifiably covered at the university, thus, do not need to be present in the agreement of discussion.

Evaluation of Course Learning Outcomes

Course Learning Outcomes are specific learning outcomes covered in each course. Evaluating these courses and comparing with university courses on the course topics basis further justifies the courses selected and not selected for the agreement. In this step, necessary modifications for the curriculum are clearly identified and the course selection can be straightforwardly refined. The college courses and their Course Learning Outcomes are tabulated and the university courses that cover the topics are tabulated according to the learning outcomes. This step clearly justifies the presence and absence of the courses selected for the concurrent agreement.

Final Selection of Courses

Once the analysis of both, Program Vocational Learning Outcomes and Course Learning Outcomes are complete, the final selection of courses and course topics can be made.

b. Program comparison and analysis

For Mechanical Engineering Students at the University of Windsor interested in attending St. Clair College's Mechanical Engineering Technology – Automotive Product Design to obtain a joint Degree/Advanced Diploma in both, Mechanical Engineering and Mechanical Engineering Technology, upon completion of their B.A.Sc. at the University of Windsor, a series of existing St. Clair College Course will be offered which the students are required to completed; modifications to these courses may occur if necessary. With St. Clair College implementing Co-Op terms for the Mechanical Engineering Technology - Automotive Product Design students, the university students will be attending the college for three semesters: the spring semester between their conventional 2B and 3A semesters, during the Winter semester between their 3A and 3B semesters and finally, during the Fall semester between 3B and 4A. If the required course timeslots do not lie within the scheduled Co-Op timeslots, there will be separate offerings for those courses. A pre-selection of courses has been made, based on providing hands-on workshops and exposure to software that the students have not experienced during their studies at the University of Windsor. The following are proposed courses that may be offered during the above-mentioned three semesters. A more thorough analysis of the Program Vocational Learning Outcomes and Course Learning Outcomes will follow which may, in turn, refine the course selections.

Descriptions of the pre-selected courses

Semester 1:

MET 202 – PC CAD II – GD&T:

- Other than brief introductions to GD&T during their studies at the University of Windsor, students who take MET 202 will have a more thorough and practical knowledge of the topic than the average university student. GD&T is a very important aspect in the manufacturing industry which is typically neglected for most mechanical engineering students.

MET 248 – Manufacturing Processes & Workshop:

- This course introduces students to hands on manufacturing experience. The course begins with health and safety in the workplace, then an introduction to manufacturing machines such as lathes, conventional and non-conventional vertical milling machines and finally, hands on working with lathes and vertical milling machines. Unlike any course offered during their four years of study at the university, this course will help students with their fourth year capstone project as well as any manufacturing type positions they may encounter during their working careers.

MET 137 – Mechanical Drafting:

- Although they are exposed to drafting in the first semester of at the University of Windsor, it is only an introduction and MET 137 exposes the students to more complex parts as well as different views such as auxiliary and projection views.

MET 181 – Inspections Methods – CMM:

- This course introduces the students to using precision measuring tools such as vernier calipers, micrometers, scales, sine bars and CMM. CMM is a commonly used precision measuring tool in industry and due to the practicality of this course; it is chosen to be one of the proposed courses discussed for the transition.

MET 471 – Fluid Power:

- The B.A.Sc. Mechanical Engineering program at the University of Windsor exposes students to several theoretical fluid mechanics courses. MET 471 is a practical fluid course which introduces students to fluidic devices such as pumps and valves. This course requires students to draw fluidic circuits on CAD software and also consists of hands on laboratory which involves working with physical pneumatic systems. Students who take this course are equipped with a more practical sense of how fluidics are used to transmit power and do work in industrial applications.

Semester 2:

MET 328 – CATIA I:

- This course introduces the students to the design software, CATIA. What makes this course different from the CATIA courses offered at the University of Windsor is the complex sketches that the students are required to draw. The course stresses methods of constraining the drawings such that if any changes are made, which is a common occurrence in industry, the entire part will modify accordingly; which will reduce the overall time it takes to make revisions.

MET 332 – Driveline & Transmission Design I:

- This course introduces topics such as the manufacturing and design of vehicle drivelines and transmissions. Students are required to use freehand drawing techniques to prepare mechanical engineering sketches, as well as thorough explanations of the automotive components present in an automotive driveline and transmission. Due to the practicality of this course, it has been chosen to be in the discussion for a possible course offered in one of the transition semesters.

MET 548 – Engine Design I:

- This course introduces engine topics such as the evolution of the heat engine, the operation of IC engines, the components of engines, fuels and lubricants present in engines and many more. This course prepares students for the Engine Design II course offered during their second transition semester.

MET 448 – Manufacturing Processes II:

- This course introduces the students to different types of plastics and the processes in manufacturing these plastics. Other topics of this course include: colouring, finishing, using fillers, recycling and joining plastics. Students are also exposed to the history and future of the plastics. The above topics are topics that are not present in the Mechanical Engineering program at the University of Windsor and may prove to be viable during their working careers.

MET 529 – Brake Design:

- This course introduces topics such as dynamic weight distribution while accelerating and braking. The students are required to complete a project in which they choose a car and perform a full analysis of the design for its braking system. This course also introduces many different braking systems as well their benefits and shortcomings.

MET 658 – Finite Element Analysis:

- During their third year in the Mechanical Engineering at the University of Windsor, students are required to complete a course called Computer Aided Engineering in which they learn both Kinematic DMU and Finite Element Analysis (FEA) using CATIA as the software. In the industry CATIA is not commonly used software for Finite Element Analysis. MET 658 introduces the students to FEA using the software ANSYS, which is more commonly used in industry. In the 21st Century, engineers commonly use software to perform calculations to reduce time and cost; the more software a student is exposed to, the more marketable they are.

Semester 3:

MET 430 – CATIA II

- This course is a project based CATIA course which requires students to be fluent in CAD topics such as assembly, wireframe and surfacing; which are necessary tools in designing automotive bodies and assemblies. Although the University of Windsor does offer an advanced CAD course, it does not provide the emphasis on the above topics to able the students to design automotive parts; which may be a task appointed to them in the automotive industry.

MET 510 – Jig & Fixture Design:

- MET 510 is a design specific course which introduces the uses of jigs and fixtures. The students are given a mechanical part which are finished with milled surfaces as well as dowel pins and tapped holes and are required to design a fixture to produce this part in mass production using minimal setups while still maintaining appropriate tolerances for the finished product; the parts given usually require the proper use of tooling balls which are completely neglected during the studies at the university and commonly used in industry.

MET 543 – Mould Design:

- Unlike any course offered during their four years of undergraduate studies at the University of Windsor, MET 543 not only introduces the students to how moulds work, it explains important components such as ejection pins for simply removing the pieces from the mould and fluid channels which are used for heat transfer to remove heat from the moulds and evenly and efficiently solidify the parts. This course also compliments Manufacturing Processes II, which they take during their first semester at St. Clair College, which explains the process of injecting the polymers into the moulds. Similar to Jig & Fixture Design, students are given a product made from a plastic injection mould and are required to design a mould to produce that part for mass production.

MET 443 – Suspension & Steering Design:

- This practical course thoroughly addresses the designing process of the steering and suspension of a vehicle. Aside from the midterm and final examination during this course, students are also responsible for designing a vehicle's suspension and steering system as well as the frame. The students are also responsible for a kinematic mock-up up for their design to ensure they use correct parameters for their steering and suspension. This course also consists of hands on activities in which students are exposed to inspection, identification and the operation of suspension and steering systems and components.

MET 637 – Driveline & Transmission Design II:

- This is a course which covers advanced topics in the automotive drivelines and transmissions. This course offers hands on laboratory experience involving drivelines and transmissions. The main reason this course is of discussion other than the hands on laboratory exercises is that it is a project based course which exposes them to practical topics and will benefit the students who decide to work in the automotive sector. Students are also invited to the SAE World Congress which will be beneficial in networking their capabilities.

MET 648 – Engine Design II:

- A more hands on take to engine design than Engine Design I (MET 548). Students are responsible to not only learn more theory but are responsible for a research project. The research project involves the students grouping in teams of two where they disassemble an engine and set them up on a flow bench to analyse the import heads. Initially the heads have a rough cast iron finish. After the initial test, they're responsible for making a mould of the import heads to closely analyse the surface finish. Students are then responsible for grinding and polishing the import heads to a smooth finish, setting them back up on the flow bench and thoroughly analysing the gains achieved from their smooth finish from the original cast iron finish. This course is a very practical course in which they get their hands dirty and become familiar with the parts as well as the assembly of a vehicle's engine; they are also exposed to the importance of fluid flow through the imports to achieve greater horsepower and efficiency while still maintaining turbulent flow which is essential for mixing the air with the fuel prior to combustion.

Evaluation of Program Learning Outcomes

To obtain a diploma in the Mechanical Engineering Technology – Automotive Product Design program at St. Clair College, students are required to be exposed to a certain number of Program Vocational Learning Outcomes (VLO's) as well as Course Learning Outcomes (CLOs) associated with each course. Aside from the seventeen selected courses that may be offered to the University of Windsor students that are aiming to obtain both, a degree and diploma, it is important to evaluate the courses taken during their studies at the university, to ensure that the required number of assessed VLO's are met. The following is an analysis of assessed Program Vocational Learning Outcomes for the 3 years in the Mechanical Engineering Technology – Automotive Product Design program, with the exception of the above courses listed above. Since the University's Graduate Attributes differ from the College's Vocational Learning Outcomes, a thorough analysis of the direct course comparison as well as course outlines, where applicable, is required to obtain VLO's from the University of Windsor's courses. Unlike the AU required for the university students to obtain an accredited bachelor's degree, there is no requirement for the number of hours of exposure to the VLOs. It is important that students are simply assessed on the VLOs via testing, assignments and or laboratories.

There are thirteen different Programs Vocational Learning Outcomes present at St. Clair College numbered from one to thirteen. The following is the list of the thirteen VLOs assessed in the Engineering Technologies at St. Clair College:

1. Monitor compliance with current legislation, standards, regulations and guidelines.
2. Plan, co-ordinate, implement and evaluate quality control and quality assurance procedures to meet organizational standards and requirements.
3. Monitor and encourage compliance with current health and safety legislation, as well as organizational practices and procedures.
4. Develop and apply sustainability* best practices in workplaces.
5. Use current and emerging technologies* to implement mechanical engineering projects.
6. Analyze and solve complex mechanical problems by applying mathematics and fundamentals of mechanical engineering.
7. Prepare, analyze, evaluate and modify mechanical engineering drawings of automotive components and other related technical documents.
8. Design and analyze mechanical components, processes and systems by applying fundamentals of mechanical engineering.
9. Design, manufacture and maintain mechanical components according to required specifications.
10. Establish and verify the specifications of materials, processes and operations for the design and production of automotive and other mechanical components.
11. Plan, implement and evaluate projects by applying project management principles.
12. Develop strategies for ongoing personal and professional development to enhance work performance.
13. Apply business principles to design and engineering practices.

An evaluation for the learning outcomes based off of each Mechanical Engineering Technology course has been made. The following are the courses at St. Clair College that the students in this concurrent agreement will not need complete, as well as the assessed Program Vocational Learning Outcomes denoted by an “X” under the VLO number:

CHM 161A: Chemistry I

1	2	3	4	5	6	7	8	9	10	11	12	13
		X			X	X	X		X			

MET 139: PC CAD I

1	2	3	4	5	6	7	8	9	10	11	12	13
				X		X						

MTH 128: Technical Mathematics I

1	2	3	4	5	6	7	8	9	10	11	12	13
					X							

PHY 168: Physics

1	2	3	4	5	6	7	8	9	10	11	12	13
				X	X	X	X					

MET 227: Applied Engineering I

1	2	3	4	5	6	7	8	9	10	11	12	13
				X	X	X	X					

MET 243: Analysis of Electrical Circuits

1	2	3	4	5	6	7	8	9	10	11	12	13
X			X									X

MTH 158: Geometry

1	2	3	4	5	6	7	8	9	10	11	12	13
					X	X						

MTH 203: Differential Calculus

1	2	3	4	5	6	7	8	9	10	11	12	13
					X							

MET 317: Metallurgy

1	2	3	4	5	6	7	8	9	10	11	12	13
	X	X		X			X	X	X			

MET 327: Applied Engineering II

1	2	3	4	5	6	7	8	9	10	11	12	13
				X	X	X	X				X	

MTH 404: Integral Calculus

1	2	3	4	5	6	7	8	9	10	11	12	13
					X							

MET 438: Fluid Mechanics

1	2	3	4	5	6	7	8	9	10	11	12	13
					X		X					

MET 439: Strength of Materials

1	2	3	4	5	6	7	8	9	10	11	12	13
X	X			X	X	X	X	X	X			

MET 521: Thermodynamics

1	2	3	4	5	6	7	8	9	10	11	12	13
					X		X		X			

MET 542: Mechanics of Mechanisms

1	2	3	4	5	6	7	8	9	10	11	12	13
				X	X		X					

MET 541: Heat Transfer

1	2	3	4	5	6	7	8	9	10	11	12	13
					X		X		X			

MET 623: Mechanics of Materials & Machines

1	2	3	4	5	6	7	8	9	10	11	12	13
				X	X		X					

MET 629: Machine Design

1	2	3	4	5	6	7	8	9	10	11	12	13
X				X	X	X	X	X	X	X	X	X

This concludes the Program Vocational Learning Outcomes for the courses not selected in the joint degree/diploma curriculum. The following table represents the frequency of each Program Vocational Learning Outcome for the above courses:

PVLOs	1	2	3	4	5	6	7	8	9	10	11	12	13
Frequency	3	2	2	1	9	15	8	12	3	6	1	2	2

Direct Course Comparison:

The following are direct course comparisons for courses which are not in the discussion of the concurrent degree/advanced diploma agreement.

CHM 161A: Chemistry I

This course can be directly compared with the first year chemistry course taken at the University of Windsor: 59-110 Topics in General Chemistry. In fact, 59-110 consists of laboratories in which students are exposed to hands on chemistry assignments which is not present in CHM 161A. As a result, VLO numbers 3,6,7,8 and 10 are completely accounted for with the addition of a few more if needed in the step 2 of the analysis.

MET 139: PC CAD I

This course can be compared directly with 85-133 Engineering and Design. In this course, aside from the drafting portion of the course, students are responsible for completing 2-D AutoCAD drawings, which is the main focal point of MET 139. As a result, all VLOs are accounted for.

MTH 128: Technical Mathematics I

Since all of the topics covered in this course are required knowledge by the university students prior to entering the Bachelors of Applied Science in Mechanical Engineering program at the University of Windsor, the VLOs are eliminated from the analysis.

PHY 168: Physics

This course can be related to 64-141- Introductory Physics II. In fact, aside from the more advanced topics covered in this course, there is also laboratories that are required in Introductory Physics II which is absent in PHY 168. As a result, all of the learning outcomes are accounted for as well as additional learning outcomes present in the laboratories if necessary.

MET 227: Applied Engineering I

This course focuses on static engineering problems, similar to the topics covered in 85-111 Engineering Mechanics. With both, the similar topics covered as well as the similar structures of the courses, all learning outcomes are accounted for.

MET 243: Analysis of Electrical Circuits

Aside from not applying the concepts of differential and integral calculus as well as linear algebra in Analysis of Electrical Circuits, a direct course comparison can be made with 85-234 – Electrical & Computing Fundamentals. Both courses, even though they use different software, also include a computational aspect in the course. As a result, all learning outcomes are accounted for.

MTH 158: Geometry

Once again, topics in this course are knowledge required by all university students prior to entering the Bachelors of Applied Science program. However, if you were to compare with any course at the university it would be 62-215 - Vector Calculus. In this course, students are required to calculate gradients in 3-D as well as topics using cylindrical and spherical coordinates which use the knowledge covered in MTH 158 with the addition of multivariable calculus. As a result, all learning outcomes are met.

MTH 203: Differential Calculus

All of the topics as well as a similar structure exists with 62-140 – Differential Calculus, which requires the university students to solve more complex problems. As a result, all learning outcomes are met.

MET 317: Metallurgy

This course consists of similarities with 85-219 – Introduction to Engineering Materials. One aspect that Introduction to Engineering Materials does not incorporate is hands on material laboratories. Instead, the course provides engineering material data in which the students are required to use theory to complete the lab reports. To compensate for the learning outcomes associated with the hands on laboratory present in MET 317, the laboratories from Topics in General Chemistry can projected to cover the remaining learning outcomes. As a result, all learning outcomes are accounted for.

MET 327: Applied Engineering II

This course focuses on kinematic and dynamic problems associated with engineering applications. A direct course comparison with 92-210 – Dynamics can be made. In addition to the similar topics covered, Dynamics also requires students to design and build a mechanical part as well as compete against their fellow colleagues with their finished product, which is absent in MET 327. In addition to all learning outcomes being met, the design aspect of Dynamics can be projected to compensate for similar learning outcomes not met in another course.

MTH 404: Integral Calculus

This course can be directly compared to 62-141 – Integral Calculus. As a result, all learning outcomes are met.

MET 438: Fluid Mechanics

This course can be compared to both, a portion of 85-120 – Engineering Thermofluids and 85-233 Fluid Mechanics I. In fact, both of the courses consist of hands on labs that are not present in MET 438. All learning outcomes are met.

MET 439: Strengths of Materials

Both the structure of the above course as well as all topics with the addition of some topics is present in 85-218 – Mechanics of Deformable Bodies. As a result, all learning outcomes are met.

MET 521: Thermodynamics

The courses 85-120 – Engineering Thermofluids and 85-212 – Thermodynamics cover all topics in MET 521, with similar structures with an addition to hands on labs associated with 85-120 which are not present in MET 521. All learning outcomes are met.

MET 542: Mechanics of Mechanisms

Aside from the topics covered in 92-210 – Dynamics, the remaining topics are covered in 92-421 – Machine Dynamics. MET 542 – Mechanics of Mechanisms does consist of a design related project. The design related project from 92-210 Dynamics can be projected to compensate for the associated learning outcomes. Thus, all learning outcomes are met.

MET 541: Heat Transfer

This course can be directly compared with the more advanced 92-328 Heat Transfer course. Both courses have similar topics, with more topics present in 92-328, as well as course structure. As a result, all learning outcomes are met.

MET 623: Mechanics of Materials & Machines

All of the topics in this course, with the exception of static and dynamic balancing, are covered in either 85-218 Mechanics of Deformable Bodies or 92-311 – Stress Analysis I. The topic of static and dynamic balancing is covered in 92-323 – Machine Dynamics. All program learning outcomes are met.

MET 629: Machine Design

Between the courses 92-421 – Machine Design and 92-411 – Design for Failure Prevention; all topics are covered from MET 629 – Machine Design. In addition, MET 629 – Machine Design consists of a design-related group project. A design project is present in 92-411 – Design for Failure Prevention. As a result, all learning outcomes are met, respectfully.

After the direct-course-comparison evaluation, there are no further steps required to ensure the necessary Program Vocational Learning Outcomes are met. Not only would including the courses involved in the evaluation to the joint degree/advanced diploma be redundant for the university students to take, it is unnecessary to achieve any learning outcomes aside from the courses selected in the degree/advanced diploma curriculum.

Evaluation of Course Learning Outcomes

To further justify the above direct-course-comparison as well as the selected courses for the joint-degree/advanced diploma agreement, a thorough course mapping in relation to the Course Learning Outcomes (CLO) will follow with the exception of the following courses: Technical Mathematics 1, Physics, Geometry, Differential Calculus Integral Calculus, Driveline and Transmission Design I & II, Brake Design, Engine Design I & II, Suspension & Steering Design, Jig & Fixture Design and Mould Design. Technical Mathematics 1 and Geometry cover topics in mathematics that are "pre-requisites" for entering the program. The Physics course covers topics that are present in university level physics courses which is required for the students to complete prior to entering the university. Differential and Integral Calculus are offered at the university in a more advanced structure. As for the automotive courses, this joint-degree-diploma option will be offered to all focuses in Mechanical Engineering: Automotive option, General option, Environmental option, Materials option and Aerospace option. Furthermore, aside from the few similar topics covered in 94-330 – Automotive Engineering Fundamentals, which is an automotive option course only, the deliverance of the St. Clair College courses are more hands on and will not be redundant for the Automotive option students to partake in. As for Jig & Fixture Design and Mould Design, which are unique to St. Clair College when comparing with University of Windsor, no further analysis is required to justify their existence in the concurrent degree/advanced diploma agreement. Aside from the exceptions, the following are CLO analysis for the remaining courses of discussion:

CLO Mapping for courses in the pre-selection of the curriculum

MET 202: PC CAD II GD&T

As shown in Table 1 of the Appendix, there are several CLOs met from 85-133 and 85-230 in Table 1, they are not covered to the extent that is present with MET 202. Furthermore, 85-230 uses only CATIA to cover the above learning outcomes; PC CAD II uses AutoCAD, widely used CAD software in industry. Most importantly are the topics in GD&T, they are only briefly covered in 85-133, which is insufficient in regards to industry standards.

MET 248: Manufacturing Processes & Workshop

Of the CLOs that are met in Table 2 of the Appendix, they are not delivered in an applied manner. The main focus of MET 248 is the hands-on machining, which is not present at the University of Windsor.

MET 137: Mechanical Drafting

Even though several CLOs are covered between 85-133 and 85-230, as shown in Table 3 of the Appendix, they are only briefly introduced and MET 137 covers the topics more thoroughly at a more advanced level.

MET 181: Inspection Methods - CMM

It can be concluded from Table 4 in the Appendix that a sufficient amount of CLOs are not covered at the University of Windsor.

MET 471: Fluid Power

The majority of the CLOs in Table 5 of the Appendix are not accounted for at the University of Windsor.

MET 328: CATIA I

It can be concluded that the majority of CLOs in Table 6 of the Appendix from MET 328 are met with 85-230 – Advanced Engineering Design. The main difference between the two courses is that CATIA I is a more advanced level CAD course. A possible solution to avoid redundancy is to eliminate CATIA I from the list of offered courses and create a hybrid CATIA course to close the gaps between the two CATIA courses in one single course.

MET 448: Manufacturing Processes II

Aside from the CLOs covered from 85-219 – Introduction to Engineering Materials, which only briefly covers topics related to the properties of polymers and polymer matrix composites, it does not cover processing these materials which is of great emphasis in MET 448. The results are shown in Table 7 of the Appendix.

MET 658: Mapping for MET 658

Aside from using different software, MET 658 is directly related to 92-459 – Computer Aided Engineering as far as topics covered. As a result from the CLO mapping in Table 8 of the Appendix, MET 658 can be justifiably removed from the join-degree-diploma curriculum. Even though the software ANSYS is commonly used in industry, it is mostly used for thermofluid applications and not FEA.

MET 430: CATIA II

The CLOs covered from 85-230, shown in Table 9 of the Appendix, are at a much simpler level, similar to the results in Table 6. The gaps of MET 430 and MET 328 can be covered in the span of one course-load.

This concludes the Course Learning Outcome mapping necessary for evaluating the concurrent degree/advanced diploma curriculum. With the elimination of MET 658 – Finite Element Analysis and mapping topics from MET 430 and MET 328 into one single course, the courses selected for the joint-degree-diploma are justified. The final step is to evaluate the Course Learning Outcomes from the necessary courses which are not in the discussion for the joint-degree-diploma curriculum to justify their absence.

CLO Mapping for courses absent from the curriculum

CHM 161A: Chemistry I

As can be concluded from Table 10 of the Appendix, all CLOs are met with 85-119 – Topics in General Chemistry.

MET 139: PC CAD

It can be concluded from Table 11 of the Appendix that there are numerous gaps between the material delivered in MET 139 compared with 85-133 – Engineering & Design as well as 85-230 – Advanced Engineering Design. Another important note is that 85-133 – Engineering & Design does not always expose students to AutoCAD. It is important to cover these gaps to ensure that when they're exposed to the topics in PC CAD II – GD&T, they're equipped with the necessary skills to successfully complete the course. A possible solution is to extend the weekly hours in PC CAD II – GD&T and take some time to address these shortcomings prior to delivering the more advanced topics associated with PC CAD II – GD&T.

MET 227: Applied Engineering I

As can be concluded from Table 12 of the Appendix, all Course Learning Outcomes are met.

MET 243: Analysis of Electrical Circuits

All Course Learning Outcomes are met with 85-234 – Electrical & Computing Fundamentals, as shown in Table 13 of the Appendix.

MET 317: Metallurgy

Aside from the processing techniques covered in MET 317, 85-219 – Engineering Materials Fundamentals covers all Course Learning Outcomes. 85-219 covers the theoretical topics of materials in a more in-depth manner than MET 317; which is common for the average engineering program at a university. It cannot be justified to add MET 317 to the joint-degree-diploma curriculum to cover the processing techniques. The results are shown in Table 14 of the Appendix.

MET 327: Applied Engineering II

All but a few Course Learning Outcomes are met. Even though not all CLOs are met, all course topics are covered and it would be repetitive to add MET 327 into the joint-degree-diploma curriculum. The Results are shown in Table 15 of the Appendix.

MET 438: Fluid Mechanics

As can be shown in Table 16 of the Appendix, all of the Course Learning Outcomes from MET 438 are covered at the University of Windsor.

MET 439: Strengths of Materials

As can be concluded from Table 17 of the Appendix, all CLOs from MET 439 are met between 85-218 – Mechanics of Deformable Bodies and 92-311 – Stress Analysis I.

MET 521: Thermodynamics

All Course Learning Outcomes from MET 521 are met with the three course numbers listed in Table 18 of the Appendix.

MET 542: Mechanics of Mechanisms

With the exception of using computer software to analyse the displacement of four bar mechanisms as well as the topics of cam followers, all CLOs are met. Having the students take this course to cover one topic is unjustifiable. Furthermore, the students at the university are exposed to more kinematic and dynamic problems than the students at the college. As a result, this course will not be offered in the joint-degree-diploma curriculum. The results are shown in Table 19 of the Appendix.

MET 541: Heat Transfer

Between, 85-120 – Engineering Thermofluids and 92-328 – Heat Transfer, all CLOs are covered for MET 541, as shown in Table 20 of the Appendix.

MET 623: Mechanics of Machines & Materials

All Course Learning Outcomes are covered from Table 21 of the Appendix.

MET 629: Machine Design

All Course Learning Outcomes from MET 629 are covered at the University of Windsor. The results are shown in Table 22 of the Appendix.

This concludes the necessary analysis for the courses not in the discussion for the joint-degree-diploma curriculum. With the elimination of MET 658 – Finite Element Analysis and MET 328 – CATIA I from the joint-degree-diploma curriculum and modifying PC CAD II – GD&T and CATIA II to accommodate the gaps from PC CAD I and CATIA I, the final 15 joint-degree-diploma courses in their corresponding semesters are as follows: Note: Courses in italics are designed-specific courses which cover gaps from two or more courses.

Final selection of courses for the Concurrent Degree/Advanced Diploma Agreement

Semester 1:

- *MET 2XX –PC CAD I/ PC CAD II – GD&T*
- MET 248 – Manufacturing Processes & Workshop
- MET 137 – Mechanical Drafting
- MET 181 – Inspection Methods – CMM
- MET 471 – Fluid Power

Semester 2:

- *MET 3XX – CATIA I/CATIA II*
- MET 332 – Driveline & Transmission Design I
- MET 548 – Engine Design I
- MET 448 – Manufacturing Processes II
- MET 529 – Brake Design

Semester 3:

- MET 510 – Jig & Fixture Design
- MET 543 – Mould Design
- MET 443 – Suspension & Steering Design
- MET 637 – Driveline & Transmission Design II
- MET 648 – Engine Design II

c. Implementation process and timelines

The concurrent agreement is expected to take off in the spring of 2018 following the approval of Senior Operating Group at St. Clair College.

5. Summary of Pathway Created

Students enrolled in the Mechanical Engineering Degree program at the University of Windsor will have the option of enrolling in a Concurrent Degree/Advanced Diploma Agreement at St. Clair College during their off-semesters. The students will take five courses per semester at St. Clair College and following their graduation of their undergraduate studies at the University of Windsor, will be designated with an Advanced Diploma in Mechanical Engineering Technology in addition to their Bachelors of Applied Science in Mechanical Engineering.

6. Appendix

Table 1: CLO Mapping for MET 202

	St Clair College Course	Uof W
CLO#	MET 202: PC CAD II GD&T	Course Code
1	Demonstrate skills in Metric and Imperial Systems.	85-133
	Draw 2D and 3D CAD geometry referencing both World and User defined Coordinate Systems	85-230
	Create 3D CAD assembly models.	85-230
	Select and draw appropriate fasteners using standard thread and fastener tables.	85-230
2	Create Standard Assembly drawings.	85-230
	Create Exploded assembly drawings	85-230
	Create Assembly section drawings.	
	Identify parts of an assembly and document their properties using Ballooning and material lists	85-230
3	Dimension and detail drawings to facilitate manufacture of mechanical parts.	85-230
	Apply Surface finish symbols to detail drawings.	
	Apply Limit, plus/minus and deviation tolerances to important part dimensions.	
	Use ISO &/or ANSI standard dimensioning symbols (c'bore, c'sink, depth, etc.).	
4	Identify clearance, interference and transition fits.	
	Utilize the basic hole and shaft systems.	85-230
	Calculate limits of size for mating parts using the fits and tolerance tables.	
5	Choose appropriate Geometric Dimensioning & Tolerancing symbols to define part features.	
	Determine maximum and minumum material conditions and apply appropriate symbols on prints	

Table 2: CLO Mapping for MET 248

	St Clair College Course	U of W
CLO#	**MET 248: Manufacturing Processes & Workshop**	**Course Code**
1	Adhere to machine shop safety rules by wearing required personal protective equipment (PPE)	59-110
	Practice good housekeeping including proper storage of tools & equipment	
	Use all necessary guards and shields as necessary to prevent damage to equipment, others and self	59-110
2	Identify and use micrometers, verniers, gages and dial indicators as required for dimensional products	92-311
	Use cutting tools applicable to various machines required to machine projects to blue prints	
	Select and use handtools such as hacksaws, files, scribers, rulers,combination squares and other tools	
	Perform layout procedures by transferring dimensions from part prints to projects using measuring tools	
	Distinguish between a metric drawing and an inch drawing.	85-133
	Compare shop work to engineering drawing.	
3	Calculate feeds and speeds to maximize machining operations.	
	Calculate depth of cut requirements for various machining operations.	
4	Discuss lean manufacturing principles as they relate to manufacturing processes.	91-201
	Identify the presence or absence of lean manufacturing in specific industrial process.	91-201
	Identify lean manufacturing aspects that should be applied to improve a specific industrial process	91-201
	Compare product data from the process before and after implementation of lean manufacturing principals	91-201
	Prepare quality control charts from product data.	91-201
5	Identify different materials commonly used in the manufacturing process (i.e. steel, cast iron)	85-219
	Identify the benefits of different materials used in the manufacturing process.	85-219
	Describe different methods of processing steel and cast iron.	
	Examine steels and cast iron utilizing various methods.	
	Match the most suitable material to a particular manufacturing process.	85-218
6	Explain how the final product influences the choice of manufacturing process.	
	Recognize the benefits of the manufacturing process and how it relates to a finished product.	
	Explain how the finished product directs the choice of steel or cast iron materials.	
	Examine the differences between manufacturing processes such as casting and foundry processes	
	Identify the benefits of foundry processes such as casting and forging.	

Table 3: CLO Mapping for MET 137

	St Clair College Course	UofW
CLO#	**MET 137: Mechanical Drafting**	**Course Code**
1	Identify appropriate drawing tools	85-133
	Identify orthograpghic views	85-133
	Prepare paper template to industry standards	
	Use drawing tools ie. triangles	
	Organize orthographic views	85-133
	Produce orthographic views	85-133
2	Recognize the metric system of measurement	85-133
	Recognize the Imperial system of measurement	85-133
	Apply conversions in order to move between the Metric system and the Imperial system of measurment	
3	Recognize the standard orthographic views	85-133
	Produce the standard orthographic views using mechancial drawing tools	
4	Recognize when a sectional view is required	85-230
	Recognize when an auxilary view is required	
	Produce a section view using mechanical drawing tools	85-230
	Produce an auxilary view using mechanical drawing tools	
5	Recognize a fastener type	
	Select the correct fastener from the standard fastener tables	
	Apply the correct fastener to the correct orthographic view	
6	Determine what is a tolerance	85-133
	Demonstrate how a tolerance is used	85-133
	Apply tolerances to the correct orthographic view(s)	

Table 4: CLO Mapping for MET 181

	St Clair College Course	Uof W
CLO#	**MET 181: Inspection Methods - CMM**	**Course Code**
1	Recognize a micrometer as measuring tool	92-311
	Recognize a vernier gage as a measuring tool	
	Recognize a dial gage as a measuring tool	
	Demonstrate the proper use of a micrometer, vernier gage and a dial gage	
2	Recognize a gage block	
	Demonstrate the proper use of a gage block	
	Calculate gage block measurements	
3	Recognize measuring error	92-324
	Determine measuring error	92-324
4	Identify different types of geometric features	
	Determine the appropriate measuring tool/gage to use to check a geometric feature	
5	Recognize tolerances on a drawing	85-133
	Practise calculating reliability of a tolerance	
6	Recognize a Rockwell Hardness Tester	
	Identify material types which require a Rockwell hardness Tester	
	Test different materials using a Rockwell Hardness Tester	85-219
7	Explain the advantages of X-Ray inspection and when it should be used	
	Explain the benefits of ultrasonic inspection and when it shuld be used	
	Explain the benefits of liqid penetrant inspection and when it should be used	
8	Recognize a Coordinate Measuring Machine	
	Demonstrate the necessary steps to prepare a part for inspection by the coordinate measuring machine	

Table 5: CLO Mapping for MET 471

	St Clair College Course	U of W
CLO#	MET 471: Fluid Power	Course Code
1	Identify the basic fluid properties in a fluid power systems and the relationship between them	85-120
	Identify the relationship between fluid properties and fluid systems' parameters.	
	Select appropriate formulas to solve for identified fluid parameters.	85-120
2	Describe the function and operation of common components used in fluid power circuits.	
	Represent fluid power components using standard schematic symbols.	
	Create and modify simple fluid power circuit schematics.	
	Use CAD software to simulate simple fluid power circuits.	
3	Design and draw fluid power circuits for simple specified tasks.	
	Analyze the functions and sequence of operation of various fluid power circuits.	
	Analyze the result of fluid circuit modification to system's performance and operation.	
4	Work safely with fluid power equipment.	
	Identify fluid power systems' components and connections.	
	Construct and test simple fluid power circuits using trainers.	
	Modify fluid power systems' connections to specified operational changes.	
	Troubleshoot and maintain fluid power circuits and components.	
	Record and analyze the parameters of fluid power systems performance.	
5	Follow established format and guidelines to written reports.	85-233
	Demonstrate proper writing skills and technical writing competence appropriate to given guidelines	85-119
	Use computer/CAD software to create written reports.	

Table 6: CLO Mapping for MET 328

	St Clair College Course	U of W
CLO#	MET 328: CATIA I	Course Code
1	Navigate the CATIA environment	85-230
	Employ CATIA's interface and file management	85-230
2	Create and modify constraints	85-230
	Edit sketch geometry	
	Perform 2D operations on sketches	85-230
3	Create and modify solid models	85-230
	Perform 3D operations and transformations on solid models	85-230
4	Apply and modify material properties for solid models	85-230
	Measure geometric and mechanical properties of solid models	85-230
5	Project 3D solid models into the drafting environment	85-230
	Create and edit borders and title blocks	85-230
	Save and plot detailed views	85-230

Table 7: CLO Mapping for MET 448

	St Clair College Course	U of W
CLO#	**MET 448: Manufacturing Processes II**	**Course Code**
1	Descibe the development of plastic materials.	
	Recognize the various polymerization reactions.	
	Explain the relevance of a plastic material to the final product.	
2	Catagorize plastics based on their properties	85-219
	Examine various plastics processing techniques.	
	Identify the suitable process for individual plastic material.	
3	Describe the properties associated with different plastics.	85-219
	Identify chemical bonding and thermal stability.	85-219
	Describe the possibilities of improving properties.	
	Compare the flow chart for property improvement.	
4	Analyze each product with respect to the production technique.	
	Identify the industry standards for plastic products.	
	Recognize and list the limitations of common plastic materials	
5	Explain material availability and selection.	
	Identify the properties of materials to be modified for industrial applications.	
	Discuss reagents and their role in property enhancement.	
	Evaluate industrial requirements of materials	
6	Explain the processing techniques such as Injection molding, Extrusion, and Foaming.	
	Relate the process to the property of the plastic to be used.	85-219
	Discuss the disadvantages of certain fabrication techniques.	
7	Identify the safety requirements during synthesis and production.	
	Discuss the steps involved in waste management	
	Recognize the proper precautions needed during processing.	
8	Discuss the advantages of composite materials over regular plastics.	85-219
	Discuss the various polymer matrix composites and other composite materials.	85-219
	Examine the the different applications of Polymer composites.	85-219

Table 8: CLO Mapping for MET 658

	St Clair College Course	U of W
CLO#	**MET 658: Finite Element Analysis**	**Course Code**
1	Conduct stress analysis using FEM.	92-459
	Conduct deformation analysis using FEM.	92-459
	Identify the basic FEA principles used by commercial FEA software such as ANSYS.	92-459
2	Creating CAD models within ANSYS.	
	Interface ANSYS with other common CAD software such as CATIA.	
3	Generate FEA models.	92-459
	Identify and apply specified loads and boundary conditions to FEA models.	92-459
	Assess simulation output for accuracy and correctness and adjust model parameters and/or part design for better results	92-459
	Generate FEA reports to common engineering formats.	92-459

Table 9: CLO Mapping for MET 430

St Clair College Course		U of W
CLO#	MET 430: CATIA II	Course Code
1	Create solid models of mechanical parts in accordance with sound design methodology	85-230
	Use advanced techniques to create fully constrained sketches	
	Perform advanced operations and editing techniques on solid models	
2	Create 3D wireframe geometry and surfaces	
	Modify and transform 3D wireframes and surfaces	
	Create or modify solids based on 3D wireframes and surfaces	
3	Redefine the parameters of solid components within the context of an assembly	85-230
	Retrieve and use catalogue and standard components	85-230
	Apply and modify assembly constraints	85-230
	Analyze, troubleshoot and modify assemblies	
4	Create and modify detailed views of parts	85-230
	Create and modify assembly drawings	85-230
	Create and modify Insert Bill of Materials	85-230

Table 10: CLO Mapping for CHM 161A

St Clair College Course		U of W
CLO#	CHM 161A Chemistry I	Course Code
1	Compare various measurement systems, including SI system.	85-119
	Demonstrate dimensional analysis.	85-119
	Solve problems using correct significant figures and units.	85-119
	Convert between units, using correct significant figures.	85-119
2	Explain atomic structure.	85-119
	Name the sections of the periodic table.	85-119
	Describe periodic relationships between elements.	85-119
	Explain fundamental chemical properties, laws and bonding.	85-119
	Summarize the structure of a given element using its electronic configuration.	85-119
	Use fundamental chemical laws to write correct chemical names and formulas.	85-119
3	Review standard nomenclature systems, including common, Stock and IUPAC.	85-119
	Identify chemical formulas, using a systematic approach.	85-119
	Name chemical compounds using standard systems.	85-119
4	Demonstrate the scientific method to problem solving.	85-119
	Define stoichiometric terms, including mole concept, and Avogadro's number.	85-119
	Write balanced chemical reaction equations, which could include redox and net ionic equations	85-119
	Explain the principles of solution formation.	85-119
	Identify the common gas laws.	85-119
	Apply stoichiometric methods to solve problems relating to moles and molecules.	85-119
	Solve problems relating to limiting reagents and % yield.	85-119
5	Examine various solution concentration terms.	85-119
	Explain general properties of gases.	85-119
	Solve for molar mass, atomic mass and moles.	85-119
	Calculate solution and dilution concentrations.	85-119
	Solve gas law problems, including Dalton's law of partial pressures.	85-119
	Determine empirical and molecular formulas given % composition.	85-119

Table 11: CLO Mapping for MET 139

	St Clair College Course	U of W
CLO#	MET 139 PC CAD	Course Code
1	Create 2D CAD geometry	85-133
	Perform file functions to save and retrieve part files	85-133
	Modify CAD geometry using transformation commands	
	Manipulate the screen display of a part model	
	Use menus and shortcut keys in AutoCAD	85-133
	Interpret a simple mechanical drawing	85-133
	Utilize Model space and Layout space	85-133
	Choose correct borders and titleblocks	85-230
	Create and edit blocks	
	Demonstrate the differences between absolute and relative positioning	85-133
2	Apply appropriate tolerances and material specifications to mechanical drawings	
	Manipulate the World Coordinate and User Coordinate systems	85-133
	Utilize correct mechanical drafting terminology	85-133
	Compile a standard material list that would comply with Industry Standards	85-230
3	Create 3D wireframe and solid mechanical parts	85-230
	Utilize World and User coordinate systems.	
	Use advanced modeling and solid editing commands to produce primitive elements and complex forms	85-230
4	Create views & viewports	
	Prepare orthographc, auxilliary and sections views in Layout mode from 3D models	85-133

Table 12: CLO Mapping for MET 227

	St Clair College Course	U of W
CLO#	MET 227 Applied Engineering I	Course Code
1	Identify and apply the relationship between mass and weight as they relate to two dimensional and three dimensional systems in equilibrium.	85-111
	Identify the reaction forces that are present due to various types of supports such as pins, rollers, fixed supports, slots, ball and socket joints, cables, smooth surfaces and rough surfaces, and properly show these forces on a Free Body Diagram.	85-111
	Define tension and compression as they relate to two force members and properly show these forces on a Free Body Diagram.	85-111
	Differentiate between two force and multi-force members and demonstrate the ability to draw Free Body Diagrams of these.	85-111
	Differentiate between trusses and frames and demonstrate the ability to draw Free Body Diagrams of trusses, frames, joints, sections, and members as required to analyze trusses and frames	85-111
	Identify and apply the relationship between Normal Forces and Friction Forces, and indicate these forces on Free Body Diagrams.	85-111
	Resolve vectors into horizontal and vertical components, or components that are parallel and perpendicular to an inclined plane using reference angles and slopes.	85-111
	Determine the resultant of multiple force vectors using the vector component method, sketches of vector polygons together with geometry and trigonometry, and vector poygons drawn to scale	85-111
	Define and identify reaction forces, point loads, distributed loads, and properly indicate these on Free body diagrams.	85-111
	Define and identify moments and couples and properly indicate these on Free Body Diagrams.	85-111
	Define coefficient of friction and demonstrate it's relationship to static friction, kinetic friction, impending motion, and angle of friction.	85-111
2	Calculate the area and perimeter of basic geometric shapes such as rectangles, triangles and circles, and combinations of these basic geometric shapes without referring to formula sheets.	85-111
	Define centroid as it applies to lines and areas and relate this to center of gravity, and distributed loads	85-111
	Determine the location of the centroid of a simple line or area using reference tables.	85-111
	Determine the location of the centroid of a composite line or area using the reference tables and weighted averaging.	92-210
	Define moment of inertia and radius of gyration as they apply to areas.	92-210
	Determine the moment of inertia and radius of gyration of a simple geometric area, compound geometric area and structural cross section using reference tables.	92-210
3	From the given information in a problem, identify and label both the known and unknown values in terms of the variables used in statics.	85-111
	Make appropriate assumptions and identify those assumptions in the problem solution.	92-210
	Draw the Free Body Diagram or Diagrams required for the solution, including all forces and dimensions.	85-111
	From the Free Body Diagram(s) use the principles of static equilibrium to develop and solve the equations required to quantify the unknowns in the problem.	85-1111
	From the Free Body Diagram(s) use the principles of static equilibrium to develop and solve the vector polygons required to quantify the unknowns in the problem.	85-111
4	Identify the units for the basic quantities of length, mass, force, torque, and moment of inertia in the U.S. Customary and S.I. systems of measurement.	85-111
	Apply the concept of unity factors to convert measurements to alternate units within the U.S. Customary System, with the S.I. system and between these two systems of measurement.	85-111
	Properly set up equations to ensure consistency of units.	85-111
5	Set up, level and calibrate laboratory equipment as required in the handout.	
	Follow experimental procedures as a member of a small group.	92-311
	Measure physical quantities such as length , mass and weight and correctly represent the precision and accuracy of these quantities using uncertainty.	92-324
6	Organize and tabulate measured values and calculated results using spreadsheet software.	92-311
	Express numerical results using correct units, direction, precision and uncertainty.	85-111
	Relate the experimental results to the theoretical values an determine the percent error.	92-311
	Provide sample calculations to illustrate how the calculated results were obtained.	92-311
	Create structured lab reports using word processing and spreadsheet software in accordance with the report requirements for this course.	85-218

Table 13: CLO Mapping for MET 243

	St Clair College Course	UofW
CLO#	MET 243: Analysis of Electrical Circuits	Course Code
1	Work with electrical units and prefixes	85-234
	Analyse the ac voltage/current alternating wave form	85-234
	Determine and measure values of current and voltage	85-234
	Recognize electrical hazards and practice proper safety procedures	85-234
2	Describe characteristics of resistors, capacitors and inductors	85-234
	Employ computer software to simulate basic ac/dc circuits using resistors, capacitors and inductors	85-234
	Use basic electrical instruments to measure resistance, capacitance, and inductance	85-234
	Use basic electrical instruments to measure voltages and currents	85-234
	Describe basic approach to troubleshooting	85-234
3	Use Ohm's Law to determine voltage, current and resistance	85-234
	Use Watt's law to calculate power in electric circuits	85-234
	Apply Kirchoff voltage and current laws	85-234
	Simplify circuits using Thevenin's theorem	85-234
	Apply the superposition theorem	85-234
4	Identify and analyze purely resistive, capacitive, and inductive circuits	85-234
	Identify and analyze circuits with resistors, capacitors, and/or inductors	85-234
	Determine total resistance, capacitance, and inductance in a given circuit	85-234
	Determine voltage, current and power in a given circuit	85-234
	Discuss application of basic resistors/capacitors/inductors circuits	85-234
5	Follow established format and guidelines to written reports	85-234
	Demonstrate proper writing skills and technical writing competence appropriate to given guidelines	85-234
	Use computer/software to create written reports that include circuitry diagrams	85-234

Table 14: CLO Mapping for MET 317

	St Clair College Course	U of W
CLO#	MET 317: Metallurgy	Course Code
1	Discuss the difference between metals and nonmetals.	85-219
	Examine crystalline structures.	85-219
	Formulate bonding in metals.	85-219
2	Discuss the physical and mechanical properties of metals.	85-219
	Explain the methods of alloy formation	85-219
	Identify the improved properties of alloys from that of their constituent elements.	85-219
3	Explain the processing of steels.	
	Catagorize the different types of steels.	85-219
	Discuss their properties and applications.	85-219
4	Explain the difference between ferrous and non ferrous alloys.	85-219
	Identify the industrially important non ferrous alloys.	
	Discuss the process of extractions of different important metals.	
	Describe their properties relevant to applications.	85-219
5	Define phases and phase diagrams.	85-219
	Analyze the binary phase diagrams.	85-219
	Identify known phases in the iron-carbon phase diagram.	85-219
6	Define engineering materials	85-219
	Explain properties of engineering materials based on their industrial application.	85-219
7	Explain some of the important non metallic materials.	85-219
	Discuss materials like ceramics, plastics and composite and their industrial importance.	85-219
	Recognize some of the relevant properties and the processing techniques for industrial applications	

Table 15: CLO Mapping for MET 327

	St Clair College Course	U of W
CLO#	MET 327 Applied Engineering II	Course Code
1	Identify and apply the relationships between displacement, velocity, acceleration and time to uniform velocity and uniform acceleration problems involving linear projectile and/or angular motion	92-210
	Identify and apply the relationships between linear motion and angular motion of components in mechanical systems.	92-210
	Identify and apply the relationships between force, mass and acceleration as they relate to components in a mechanical system involving linear and/or angular motion.	92-210
	Define potential energy, kinetic energy and work by a uniform forceand work by a variable force as they relate to mechanical systems involving linear and/or angular motion .	92-210
	Apply the principle of conservation of energy as it relates to mechanical systems involving linear and/or angular motion.	92-210
	Identify and apply the relationships between energy, power, and efficiency in mechanical systems involving linear and/or angular motion.	92-210
	Identify and apply the relationships between impulse and momentum in mechanical systems involving linear and/or angular motion.	92-210
	Apply the principle of conservation of momentum to inelastic collisions	92-210
	Solve kinetic problems using the inertia method, the work energy method and the impulse and momentum method.	92-210
2	Identify the units for basic quantities of time, displacement, velocity, acceleration, force, mass, energy and power in the U.S. Customary systems of measurement as well as the S.I. system.	92-210
	Apply the concept of unity factors to convert measurements to alternate units within the U.S. Customary system, within the S.I. system and between these two systems.	92-210
	Properly set up equations to ensure consistencey of units.	92-210
3	Utilize a sketch of a vector polygon together with concepts of geometry and trigonometry to determine magnitues and directions for displacement, velocity, acceleration, impulse and momentum	
	Utilize CAD software to produce scale drawings of vector polygons to determine magnitues and directions for displacement, velocity, acceleration, impulse and momentum.	
4	From the given information in a problem, identify and label both the known and unknown values in terms of the variables used in dynamics.	92-210
	Use charts and tables to identify values not specifically stated in the problem but required for the solution.	92-210
	Make appropriate assumptions and identify those assumptions in the problem solution.	92-210
	Select and solve the appropriate equation to complete the analysis or design.	92-210
5	Set up, level and calibrate laboratory equipment as required in the handout.	
	Follow experimental procedures as a member of a small group.	85-218
	Measure physical quantities such as length, time and mass and correctly represent the precision and accuracy of these quantities using uncertainty.	92-324
	Express the results of the calculations using appropriate uncertainty	92-324
	Relate the experimental results to the theoretical predictions and determine the percent error	85-218
6	Organize and tabulate measured values and calculated results using spreadsheet software.	85-218
	Express numerical results using correct units, direction and precision.	92-324
	Provide sample calculations to illustrate how calculated results were obtained.	92-210
	Create structured lab reports using word processing software.	85-311
7	Demonstrate respect for supervisors and colleagues in laboratory and other working environments.	92-210
	Work cooperatively in small groups, contributing to the organization, delegation and completion of assigned tasks.	92-210

Table 16: CLO Mapping for MET 438

	St Clair College Course	UofW
CLO#	MET 438 Fluid Mechanics	Course Code
1	Define and calculate specific weight, specific gravity, mass density of a liquid.	85-120
	Convert between S.I. Metric and Imperial (US customary) system of units.	85-120
	Define and calculate the absolute and kinematic viscosity of various fluids from the flat plate theory or from Saybolt Seconds Universal.	85-233
2	Define the relationship between absolute pressure, gage pressure, and atmospheric pressure and perform related calculations.	85-120
	Describe the properties of air at standard atmospheric pressure.	85-120
	Define the relationship between a change in elevation and the change in pressure in a fluid.	85-233
	Describe how a manometer works and how it is used to measure pressure	85-233
	Describe a U-tube manometer, a differential manometer, a well-type manometer, and an inclined well-type manometer and perform related calculations.	85-233
	Describe a barometer and how it indicates the value of the local atmospheric pressure.	85-233
	Calculate pressure changes for a column of fluid due to elevation changes.	85-233
3	Interpret the continuity, Bernoulli's and general energy equations.	85-233
	Calculate and measure flow rates of a moving fluid from readings taken with different manometers	85-233
	Use Bernoulli's, continuity and general energy equations to explain the energy changes in an fluid system and perform related calculations.	85-233
	Construct an energy diagram between two points in a dynamic fluid system.	85-233
	Differentiate between laminar and turbulent flow by calculating friction losses using the Reynolds' number, relative roughness factor and Moody diagram.	85-233
	Calculate the Reynolds number for noncircular cross sections using the hydraulic radius radius	85-233
	Calculate minor energy losses in fluid systems by applying velocity pressure and accepted loss coeficients.	85-233
	Calculate minor energy losses in fluid systems by applying velocity pressure and accepted loss coeficients	85-233
	Calculate energy losses (friction and minor) in series and parallel systems of pipes.	85-233
	Determine whether a given system is Class I, Class II, or Class III pipe series and based on the class calculate the flow rate or velocity, pressure drop, elevation or pipe size.	85-233
4	Calculate the pressure head of a pump/fan.	85-233
	Calculate the efficiency of a pump/fan.	85-233
	Interpret the mechanical efficiency of a pump/fan as related to the power input and ouput	85-233
	Calculate the power required by a pump/fan.	85-233
5	Calculate the force exerted on a plane area by a pressurized gas and static fluid.	85-233
	Calculate the resultant force exerted on a rectangular wall and any sumerged plane area by a static fluid and indicate its location and direction on the diagram.	85-233
	Define the center of pressure and show its location on a diagram.	85-233
	Calculate the total resultant force on a curved surface including the effect of the pressure head over the liquid.	85-233
	Define buoyancy and stability and the conditions necesary for a body to be stable when completely submerged or floating on a fluid.	85-233
	Calculate forces related to buoyancy, metacenter and their location.	85-233
	Derive the force equation using Newton's second law and use it to calculate the force exerted on stationary objects and bends in pipelines as well as moving objects such as vanes of a pump impeller	85-233
6	Define pressure and friction drag, lift, drag coefficient, lift coefficient, dynamic pressure, and stagnation point.	85-233
	Derive the expression of the drag force on a body moving relative to a fluid.	85-233
	Determine the value of the pressure drag coefficient for cylinders, spheres and other shapes	85-233
	Calculate the pressure drag force and lift force on bodies moving relative to a fluid.	85-233
	Calculate the magnitude of the friction drag force on smooth spheres.	85-233

Table 17: CLO Mapping for MET 439

St Clair College Course		UofW
CLO#	MET 439: Strength of Materials	Course Code
1	Assess mechanical properties of materials applicable for required design.	85-218
	Interpret various data charts related to the properties.	85-218
	Collect relevant data and propose them for suitable designs	85-218
2	Define mechanical properties like stress and strain.	85-218
	Analyze the conditions under which mechanical properties such as stress and strain are developed in different materials.	85-218
	Assess the designs under stress and strain.	85-218
3	Account for the forces acting on machine parts.	85-218
	Integrate the forces causing stress and strain.	85-218
	Evaluate unknown forces.	85-218
	Recognize the forces at different mechanisms which may lead to failure.	92-311
4	Define the principle of torsion.	85-218
	Analyze the shear points produces by torque.	85-218
	Calculate the shear stress in different types of shafts.	85-218
5	Locate magnitude and directions of different types of loads.	85-218
	Compute shear and bending in beams due to the external forces.	85-218
	Represent graphically, the sheer force and bending moments.	85-218
	Review the maximum shear and bending points.	92-311
6	Explain the types of cross-sections of beams.	85-218
	Identify the maximum bending point and its deflection.	85-218
	Compute the bending stress over the cross-section.	85-218
7	Define thermal properties of materials.	85-218
	Evaluate stress an strain as a result of temperature variation.	85-218
	Analyze proper safety factors for machine designs.	85-218
8	Recognize the magnitude and directions of multiple stresses in machine parts.	85-218
	Compute and locate the stress points on an element.	92-311
	Illustrate the stresses on a Mohr's circle.	92-311
	Compare the theoretical calculations with the illustration	85-218
9	Identify proper conversion factors for different stresses and Modulii	85-218
	Cite calculated data in required system.	92-311

Table 18: CLO Mapping for MET 521

	St Clair College Course	U of W
CLO#	**MET 521: Thermodynamics**	**Course Code**
1	Select appropriate formulas to solve identified or derived variables from provided formula both related and non related	85-120
	Use and manipulate charts and diagrams in order to solve specific problems	85-212
	Relate the physical properties of thermodynamic systems such as: temperature, pressure, volume, to practical systems	85-120
2	List specific properties and corresponding units of measurement (both S.I. Metric and English Engineering)	85-120
	Use specific charts and tables to hypothesize the state of a working fluid	85-212
	Determine which tables to analyze through the given data in a problem	85-212
3	Use and manipulate charts and diagrams in order to solve specific problems	92-317
	Determine which tables to analyze through the given data in a problem	92-317
	Create a list of givens, and extract data from charts and tables from these givens to solve problems	85-212
4	Use and manipulate charts and diagrams in order to solve specific problems	92-317
	Create a list of givens, and extract data from charts and tables from these givens to solve problems	85-212
	Determine which tables to analyze through the given data in a problem	85-212
5	Relate the physical properties of thermodynamic systems such as: temperature, pressure, volume, to practical systems	85-120
	List specific properties and corresponding units of measurement (both S.I. Metric and English Engineering)	85-120
	Explain in words the ongoings of the changes of state	85-120
6	List the associated formulae	85-120
	Extract data from specific tables and charts	85-212
	Determine whether a gas is steady or non-flow	85-212
7	Use and manipulate charts and diagrams in order to solve specific problems	92-317
	Compare results to that of the data found in specific tables and charts	92-317
	Identify and manipulate the appropriate formulas	92-317
8	Use and manipulate charts and diagrams in order to solve specific problems and to compare results	92-317
	Determine which curves to follow in the specified chart	92-317
	Select and record the data found using the charts	85-212
9	Describe in words the on-goings of the particular cycle	85-212
	Select the appropriate cycle	85-212
	Use formulas to solve for the specified problems	85-212
10	Select appropriate formulas to solve identified or derived variables from provided formula both related and non related	85-212
	Select and record the data found using the charts	85-212
	Analyze the solutions solved by using formulas, compared to those found by using charts	85-212

Table 19: CLO Mapping for MET 542

	St Clair College Course	U of W
CLO#	**MET 542: Mechanics of Mechanisms**	**Course Code**
1	identify the different types of mechanisms.	92-210
	Classify linkage mechanisms.	92-210
	Determine the mobility of mechanisms	92-210
2	Identify the different types of joints and links.	92-210
	Employ a given diagram representation of links and joints to draw kinematic diagrams of simple common mechanisms	92-210
3	Identify the different types of slider-crank and four-bar mechanisms	92-210
	Conduct cycle and displacement analyses, analytically and using the computer, on slider-crank and four-bar mechanisms.	
	Construct motion curves at the output locations on slider-crank and four-bar mechanisms.	
	Conduct velocity and acceleration analyses on slider-crank and four-bar mechanisms.	92-210
	Employ the metric and imperial systems in engineering analysis and design	92-210
4	Identify types of cams and followers.	
	Construct displacement diagram of followers.	
	Apply parametric representation of cams describing the cam motion.	
	Generate cam profiles to prescribed follower motions.	
	Employ the metric and imperial systems in engineering analysis and design	
	Identify the geometric properties and analyze the motion of the Geneva Mechanism.	
5	Identify the most common types of gears.	92-323
	Identify the geometric parameters of gears.	92-323
	Conduct motion analysis of geared mechanisms.	92-323
	Conduct force analysis of geared mechanisms.	92-421
	Analyze simple and compound gear trains.	92-323
6	Identify the common types of power screws.	92-421
	Determine the torque requirement and efficiency of power screws	92-421
	Employ the metric and imperial systems in engineering analysis and design	92-421

Table 20: CLO Mapping for MET 541

	St Clair College Course	U of W
CLO#	MET 541: Heat Transfer	Course Code
1	Define the major differences between heat transfer through conduction, convection and radiation	85-120
	Identify a system that is undergoing heat transfer through either conduction, convection or radiation and list the relevant data associated with that system	85-120
	Identify the relationship of the physical properties of heat transfer such as temperature, pressure, and volume to practical systems and perform related calculations	85-120
	Gather data from saturation tables in order to solve specific problems with respect to conduction, forced and natural convection and radiation	92-328
	Select the appropriate formulas to solve for variables related to conduction, convection or radiation	85-120
2	Calculate Fourier's Law from given and extracted data using relevant formulas	92-328
	Calculate the heat transfer rate through conduction, using the Equivalent Resistance Method	92-328
	Explain how the Equivalent Resistance Method is directly related to Fourier's Law, with the given thermal conductivity of a material in question	85-120
	Determine which tables to analyze to solve heat flux problems	92-328
	Select variables from experimental data related to heat flux	92-328
3	Use appropriate charts and tables to extract data related to heat conduction through pipes and composite walls	92-328
	Solve for resistances of given materials that are setup in a composite wall, be it in parallel or in series	92-328
	Extract data for the proportionality constant of specific materials from related tables	92-328
	Use and manipulate formulas, charts and diagrams in order to solve for heat transfer by conduction through composite walls that are setup in series or in parallel	92-328
	Calculate the heat transfer rate by conduction through hollow cylinders (unisulated and insulated) by identifying relevant data, and applying those variables to the formula derived from Fourier's Law	85-120
4	Define and calculate convection rates by either natural or forced convection	92-328
	Identify and explain the relevance of the coefficient of heat transfer or film coefficient for problems related to heat transfer by convection	92-328
	Identify the difference(s) between laminar flow and turbulent flow convection	92-328
	List specific properties related to laminar, turbulent and forced convection and corresponding units of measurement (both S.I. Metric and English Engineering)	92-328
	Use formulas related to Nusselt's Number, Prandtl's Number and Grashof's Number to solve for solving heat transfer coefficients of convection, be it laminar or turbulent flow	92-328
	Solve for Nusselt's number by using both tabulated and given data, and applying the values to the appropriate formula(s)	92-328
	Define the numerical lowest value of Reynold's number which signifies laminar flow	92-328
	Select the proper formulas to use in calculating the heat transfer rate by convection with respect to the raw data given	92-328
	Compare calculated laminar, turbulent and forced convection results to that of the data found in specific tables and charts	92-328
5	Solve for the heat transfer rate due to radiation, of a blackbody in both S.I. Metric and English Engineering units.	92-328
	Identify and select a list of data from specific standard thermodynamic tables and charts for emissivity factors and geometric factors.	92-328
	Identify the differences in setups of the interchange of specific radiation heat transfer problems.	92-328
	Compare calculated results to data found in specific tables and charts with respect to heat transfer of a black body due to radiation.	92-328
	Use tabulated values to solve for specific scenarios related to infinite parallel planes, completely enclosed bodies, parallel and equal squares.	92-328
6	Define and describe the processes of heat exchangers that are in either parallel or counter-flow	92-328
	Solve for the resistance of a heat exchanger that is in either parallel or counter flow	92-328
	Solve for the overall heat transfer coefficient in both S.I. Metric and English engineering units	92-328
	Solve for the heat transfer coefficient of the outside and/or inside surface of a heat exchanger	92-328
	Calculate the true mean temperature difference of a heat exchanger	92-328
	Calculate the log mean temperature difference of a heat exchanger	92-328
	Identify the primary variables required to solve specific problems related to combined modes of heat transfer	92-328

Table 21: CLO Mapping for MET 623

	St Clair College Course	U of W
CLO#	MET 623: Mechanics of Materials & Machines	Course Code
1	Define the terms column, end fixity factor, effective length, slenderness ratio, column constant and buckling.	92-311
	Compute values of the slenderness ratio and column constant and use these to determine if a column is long or short.	92-311
	Compute the critical buckling load for long columns using the Euler Formula and for short columns using the J. B. Johnson Formula	92-311
	Apply a design factor to the critical load to determine the allowable load.	92-311
	Design columns to safely carry axial compressive loads.	92-311
	Analyze columns that are initially crooked to determine the critical load	92-311
	Analyze eccentrically loaded columns.	92-311
2	Evaluate deformations and stresses caused by axial loads and thermal expansion in members comprised of two materials.	85-218
3	Determine when stress concentrations exist and specify suitable values for stress concentration factors.	92-411
	Use stress concentration factors in design.	92-411
4	Determine the classification of a pressure vessel as thin-walled or thick walled.	92-311
	Calculate the hoop stress, longitudinal stress, and radial stress developed in thin-walled and thick-walled spherical and cylindrical pressure vessels due to internal fluid pressure	92-311
	Determine the maximum shear stress developed in the wall of a pressure vessel.	92-311
5	Identify probable modes of failure for riveted, bolted and welded connections.	92-411
	Analyze centrally and eccentrically loaded riveted or bolted joints to determine the load capacity in tension, shear and bearing.	92-411
	Analyze centrally and eccentrically welded joints to determine the load capacity.	92-411
	Design riveted, bolted and welded connections.	92-411
6	Determine the torque required to raise or lower a load using a power screw.	92-411
	Compute the power required to drive a power screw and it's efficiency.	92-411
	Specify suitable ball screws for a given set of requirements, including speed load and life	92-411
	Calculate the torque required to drive a ball screw and it's efficiency.	92-411
7	Define the terms, clutch, brake, clutch coupling, fail-safe break and clutch brake module.	92-421
	Specify the required capacity of a clutch or brake to reliable drive a given system.	92-421
	Perform the design and analysis of plate type, caliper disc, cone, drum and shoe, and band brakes and clutches.	92-421
8	Identify the units for the basic quantities of length, mass, force, torque, stress, moment of inertia, mass moment of inertia, energy and power in the U.S. Customary and S.I. systems of measurement.	92-210
	Apply the concept of unity factors to convert measurements to alternate units within the	92-210
	U.S. Customary System, with the S.I. system and between these two systems of measurement.	92-210
	Properly set up equations to ensure consistency of units.	92-210

Table 22: CLO Mapping for MET 629

St Clair College Course		U of W
CLO#	MET 629: Machine Design	Course Code
1	Conduct stress analysis for combined loading cases.	92-411
	Analyze basic loaded machine elements for fatigue failures.	92-411
	Implement general design procedures for different types of loading schemes.	92-411
	Employ the metric and imperial systems in engineering analysis and design.	92-411
	Use basic computer programs and design analysis software.	92-459
2	Identify the basis for gear selection.	92-421
	Conduct gear strength design and analysis.	92-421
	Implement gear selection to prescribed manufacturers' procedures.	92-421
	Use basic mechanical design and analysis software.	92-459
3	Identify the basis for the machine element selection. (bearings, couplings, seals, belts,chains)	92-421
	Follow engineering guidelines for selection and analysis. (bearings, couplings, seals, belts,chains)	92-421
	Use basic mechanical design and analysis software. (bearings, couplings, seals, belts,chains)	92-421
4	Employ basic engineering principles to ensure functional, safe, reliable, economical, and easy to manufacture design.	92-411
	Cooperate and coordinate with team members to complete the project in a timely manner.	92-411
	Demonstrate oral and written communication following engineering and industrial format.	92-418