CONCORDIA UNIVERSITY

FACULTY OF ENGINEERING AND COMPUTER SCIENCE
DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

COURSE OUTLINE

MECH 390- MECHANICAL ENGINEERING DESIGN PROJECT – Winter 2018

LECTURES:

Instructor Section J:	Dr. Dr. Ayhan Ince, Office: EV 4-219
Time & Classroom:	Monday, 8:45 - 11:30, Classroom: FG-B-040
Office Hours:	Wednesdays 10:00-12:00
Phone:	514-848-2424 ex. 4191
E-mail:	ayhan.ince@concordia.ca

Instructor Section T:	Dr. Sivakumar Narayanswamy, Office: EV 4-189
Time & Classroom:	Tuesday, 8:45 - 11:30, Classroom: MB-2.210
Office Hours:	Mondays: 10:00 – 12:00
Phone:	514-848-2424 ex. 7923
E-mail:	nrskumar@encs.concordia.ca

TUTORIALS:

Schedule	Tutor	Tutor contact	Room
JA, Tu 11:45PM - 1:35PM	Mehrdad Sarafrazi	m_sarafr@encs.concordia.ca	H-1065 / H-835
JB, Th 11:45PM - 1:35PM	Amitkumar Mulchandani	ajmulchandani1993@gmail.com	
JC, We 8:45AM - 10:35AM	Nitin Belle	belle.nitin@gmail.com	
JD, We 11:45PM - 1:35PM	Muhammad Ikramullah	k-ikram@hotmail.com	
JE, Fr 8:45AM - 10:35AM	Thomas Padeesseril	thomas.padeesseril@gmail.com	
Schedule	**Tutor**	**Tutor contact**	**Room**
TA, Th 5:45PM - 7:35PM	Ezhil Murugesan	ezhilshaktimuru@gmail.com	H-1065 / H-835
TB, Th 8:45AM - 10:35AM	Abhishek Gupta	abbygupta906@gmail.com	
TC, Tu 3:15PM - 5:05PM	Paul Earnest	payeea@gmail.com	
TD, Mo 3:15PM - 5:05PM	Andrew Jeyaraj	andrewjeyaraj@gmail.com	
TE, Fr 5:45PM - 7:35PM	Akash Sharma	akash.sharma_94@yahoo.co.in	

TEXTBOOK (Required):

"Fundamentals of Engineering Design (2nd Edition)" by Barry Hyman, Pearson, 2002

OBJECTIVES:

The main objective of this course is to present the basic principles employed in the design of mechanical systems

that must satisfy specific design requirements, criteria, constraint, standards, all correlated to satisfy the desired technical performance. A design project that includes the knowledge acquired previously in MECH 344, MECH 343, MECH 244, MECH 243, MECH 311, MECH 313, MECH 211 just to mention few, will be gradually developed during group work while certain tips will be provided during the tutorial periods. The design project will be completed following a selected scheme such that at the end, the entire design documentation as well as the blueprints will be ready to be presented in a final formal presentation, which will be delivered along with the consistent written documentation. During the lecture periods, fundamental design principles and systematic methods will be discussed and presented in real-life design examples. The materials presented during the lectures will help grasping design principles and perform integration of concepts from different disciplines of mechanical engineering.

STUDENT ASSESSMENT & GRADING:

The main objective of the evaluation is to reflect in the right way the effort and the comprehension of the subject of each individual student that must be correctly reflected in the final letter grade. The final grade is made by the addition of the various components of the evaluation process. The following components will be used for calculation of the final grade:

Midterm Tests:

One Midterm test will be held during lecture hours on the week of March 5th. This will be based on the textbook and materials discussed in the class.

Total weightage for the midterm test is 20%

Tutorials:

10 tutorial assignment reports must be submitted.

Note: Tutorials are related to the design of machine elements in terms of CAD design, size and analysis.

Each tutorial 2% - Total for 10 tutorials, 20%

Important: Student missing a tutorial will lose 2% for that week.

Quizzes:

There will be 5 or more surprise quizzes randomly distributed over the course of 13 weeks. No prior information regarding the date or the material for quizzes shall be given.

Note: Tutorials are related to the design of machine elements in terms of CAD design, size and analysis.

Total for Quizzes is 20%

Important: Student not attending lectures will miss the points for that specific quiz.

Design Project:

Design Project is a team based project (Team consisting of 4 or maximum 5 members):

"Design an Amphibian System for HONDA CRV" (details given as Appendix)

The written documentation**, 30%** (due on last day of class)

Team presentation and practical demonstration of the team work during the term-Last day of class, **10%**

The dates for the presentation (combined for sections J and T) will be during the last week of the term

Confidential peer evaluation by team members will be sought to divide the grades among team members based on the participation

NOTE: There will be **no make-up** for the midterm term tests and Tutorials.

GRADUATE ATTRIBUTES

Graduate attributes are skills that have been taught in other classes, which will be used in this project. The way the specific knowledge is applied will be assessed throughout the course through the class tests, tutorial work, project work, presentation – this is through all the components of the course. The attribute assessment is used to improve the quality of teaching and ***it does not affect at all the grades*** (the grading scheme is given above). The grading of the attributes is carried using letter marks A, B, C and F.

For this design project, the following three attributes will be assessed: **Design**, **Investigation**, **Individual and teamwork.**

ATTRIBUTE	INDICATOR	LEVEL OF KNOWLEDGE
Investigation *An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.*	Background and Hypothesis Formulation	ADVANCED
	Designing Experiments	ADVANCED
	Conducting Experiments and Collection of Data	ADVANCED
	Analysis and Interpretation of Data	ADVANCED
Design *An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations*.	Define the objective	INTERMEDIATE
	Idea generation and selection	INTERMEDIATE
	Detailed design	INTERMEDIATE
	Validation and implementation	INTERMEDIATE
Individual and team work *An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.*	Cooperation and work ethics	ADVANCED
	Contribution: Practical/Conceptual	ADVANCED

Note:

Design: The evaluation of the skills that enable all the above activities will be carried out through the tutorial work and the project work. *Investigation:* This evaluation will be carried out through the tutorials 1, 2, 9 and the presentation of the project. *Individual and teamwork*: This evaluation will be carried out throughout the tutorial work, project work and presentation.

Course Learning Outcomes (CLOs):

The project course will facilitate the design teams to get familiar with the design process, the investigative methods to be applied and team work consolidation. It is expected that the work carried out in the project will enhance the ability of the students to analyze a complex problem, to establish the priorities of the identified task required to achieve the targeted objectives, to perform the analysis and come up with feasible solutions that would not pose any risk to the public. The students will also get familiar with the requirements of a design and the essential need to re-iterate the results to realize an acceptable solution. Further, it is expected that the students, through this exercise, will improve their ability to tackle complex design problems – in our case, multidisciplinary – and come up with solutions to overcome the problems through modeling, analysis or through experiment.

It is expected that the students will acquire skills to enable them to work effectively and efficiently in a group of professionals. After completion of this course, one will be able to successfully investigate, analyse and define a set of requirements that are relevant to a product. The student will be able to relate to the significant information available in publications related to the product in question. The student will be able to set to the frame of experiments to validate concepts or learn required values of parameters that are necessary in the design process. He or she will also be able to analyse and use the collected data.

The students will acquire design skills that will be essential in the final year capstone project. They will learn to define objectives of the design in the context of creating new ideas and in the context of the design of a new application. The students will learn the necessary steps to produce a feasible design from ideation to a final product using classical and novel fabrication techniques and they will apply and implement their ideas in the context of teamwork.

The students will be formally exposed for the first time in the program to a sustained requirement of producing the required results as a teamwork. They will learn to divide and equitable share tasks and effectively make use of the information to conceive and build the set objective of a design. All the above skills will be shaping the skills of the future professional engineer.

Course Learning Outcomes mapping to Graduate Attributes:

Course Learning Outcome	Graduate Attribute
From the linguistic description of the project, identify the type of problem, the fundamental specifics and the laws of physics that will be applied towards finding a solution	**Investigation** – Background and hypotheses formulation
For the missing information in the design process, create an experiment, prepare and run it. Ensure the consistency of the experiments	**Investigation** – Design experiments
Use the collected data from the experiments to fill for the missing information and continue refinement of the design process	**Investigation** – Conducting experiments and collect data
Acquire the ability to identify the type of problem and identify for that problem the objectives and their metrics	**Design** – Define objectives
Acquire the ability to use the available data of a problem to formulate hypotheses, identify the theories and formulate a potential path to follow towards a feasible solution	**Design** - Idea generation and selection
Identify the suitable methods that would yield towards a feasible solution of design. Confront the solution with the measurable objectives and adjust the solution towards higher matching of the design with the measurable objectives	**Design** - Detailed design
Apply the solution of the design in the practical application and evaluate the overall performance of the improved design	**Design** – Validation and implementation
The design carried out in groups of four requires intense collaborative interaction and planning which contribute to the team strength	**Individual and team work** – Cooperation and work ethics
The result of the design is presented during the last week in front of the class. The peer teams will evaluate the performance of the individuals and the team throughout the presentation	**Individual and team work** – Contribution: Practical/Conceptual

COURSE LECTURES

Introduction to Engineering Design	Chapters 1 and 2 (Text Book)
Amphibian system for Honda CRV (for the project)	Note
Probabilistic Considerations in Design	Chapter 5 (Textbook)
Project Planning	Chapter 7 (Textbook)
Engineering Economics	Chapter 8 (Textbook)
Decision making	Chapter 9 (Textbook)
Optimum Design	Chapter 10 (Text book) and Note
Case Studies	Note

EVALUATION CRITERIA FOR TUTORIALS AND PRESENTATIONS

A final report that includes the project, all the Tutorial work, all the analysis and the rationale of selecting a certain solution along with the blueprints must be submitted for the final evaluation in the last lecture, which is also the presentation/demonstration day. ***It is the duty of the design group members to convince the tutors and the class instructor that they have judiciously used the knowledge acquired in the courses in the program to acquire the necessary skills to further successfully carry out the Capstone Project.*** The presentation of a team will be held for max 15 min (+ 3 min for Q/A) minutes according to the size of the team. The presentation/demonstration will count for 10% of the grade. ***The criteria that will lead to the grade of the presentation are:***

- The strict timing of the talk – 12 minutes for team of 4 and 15 minutes for teams of 5. Three more minutes will be allotted for questions. Cohesiveness of the group
- Capability to present the essential of the work
- Quality of the slides
- Ability to make the talk interesting.
- The success of the demonstration on site or recorded

The tutorial activity will be assessed by the tutor based on the following criteria:

- Active participation to the design process during tutorial period
- Readiness in the preparation of the required materials for the tutorial
- Tasks accomplishment during the tutorial period
- Correctness of the selection of the engineering tools and procedures to be followed in design
- Accuracy of the evaluation and calculations - when carried out
- Quality of the presentation of the work carried out during the tutorial period
- Interaction with the others team members
- Attitude towards the tutorial activity
- The completeness of the documentation
- Peer review base on the teamwork (the Assigned project grade will be prorated based on the confidential peer evaluation)

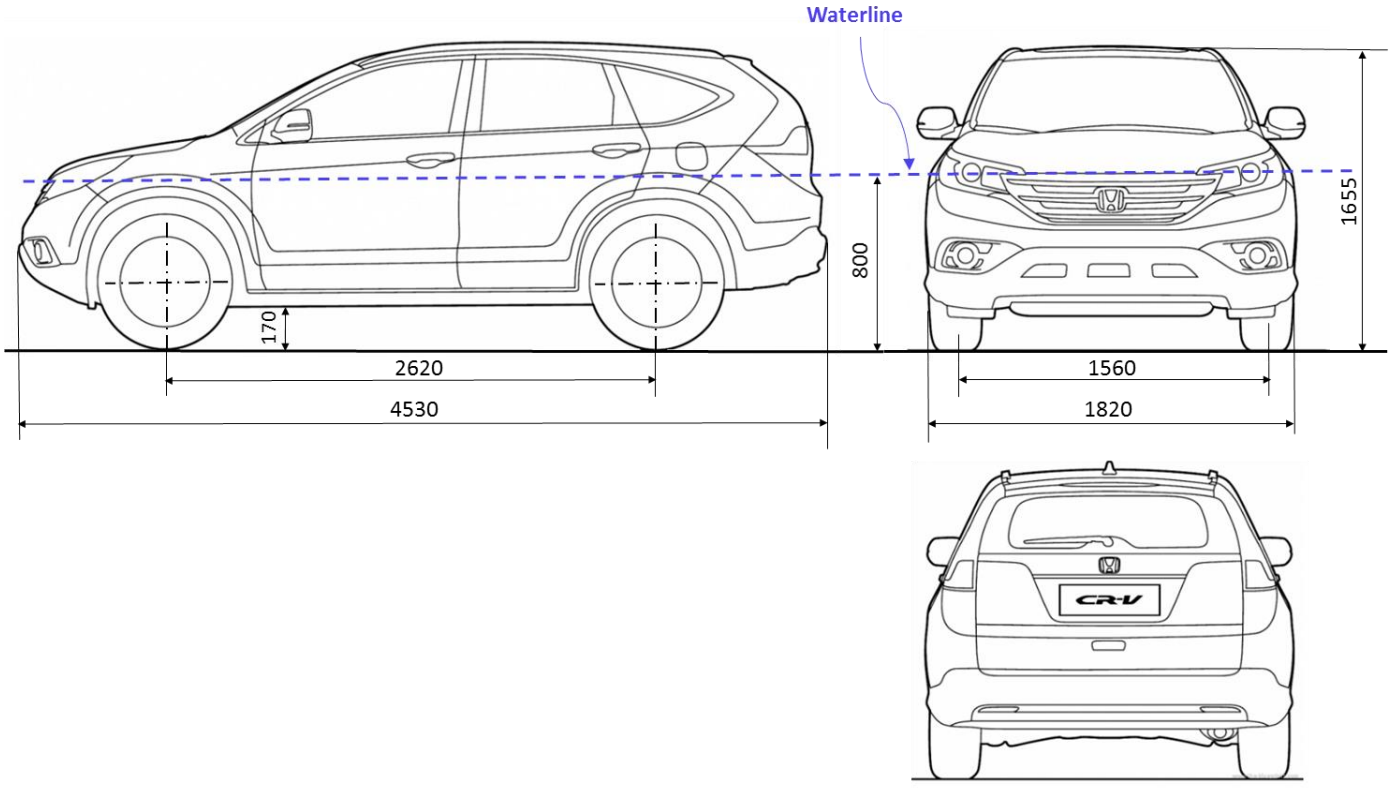
Appendix: Details regarding the Design Project
MAIN DESIGN PROJECT: "Design an Amphibian System for HONDA CRV"

Objective: The design of Honda 4x4 CRV (2014 model) vehicle will be retrofitted to be fully amphibious and propelled in the water at maximum speed of 10 km/h (5.4 knots) by propeller(s) mounted one either side and/or the rear of the vehicle:

The swimming unit may include any power transmission systems such as a gear box, propeller(s) and any other support components/systems required to meet the specified vehicle speed performance in water. The cost of a designed swimming unit will be less than 10,000 CAD in including any modification to the original vehicle design such as interface components/joints transmitting power from wheel ends or differentials.

It is assumed that the original vehicle design is water tight and *buoyancy waterline is shown in Figure below. Teams need to take into account for performance, fuel economy, cost, durability, feasibility and assembly/disassembly elements in their design process. Teams do not need to consider modifying the design of powertrain, cooling and exhaust systems of the vehicle. Peak engine power/torque information is shown below. All other drivetrain information can be found in the vehicle spec. Dimensions are in mm. Teams will need to search any missing information required for the project, if needed reasonable assumptions and solid engineering judgments should be made to determine missing information for the project.*

Horsepower @ rpm (SAE net)	185 @ 7000
Torque (lb-ft @ rpm, SAE net)	163 @ 4400



Specific activities and tasks for the project are listed below.

1. Generate an optimum design solution considering different concept designs for the swimming unit and vehicle interface by taking size, cost, fuel economy, material, durability, weight, environmental factors into account.
2. Select, size and analyze all machine components/elements such as propeller, pulley, chain, gears, shaft, and bearings for optimum design. Teams should consider various design factors for standard machine elements when designing the unit.
3. Analysis
   - Show calculation and design process for selection of machine elements/parts/components of the swimming unit.
   - Estimate the fatigue life of the shaft(s).
   - Develop a computer analysis tool (Excel or MATLAB) for calculation and analysis and sizing for the transmission system including all machine elements.
4. Complete 3D modeling of the complete design using CAD software.
5. Produce design parts/assembly with ½ or 1/4 scale using 3D printer(s).
6. Each team will submit a 3D printing design assembly of the unit and its interface with the vehicle, a hard copy and an electronic copy of the final project report and an electronic copy of analysis tool(s) and CAD file(s) created (a USB flash drive) on the day they present their work.
7. The presentations shall be held on Monday April 16th and Tuesday April 17th, 2018. The details of the time each team will present will be announced a week or two before the scheduled presenations.

Teams' assessment for the project will be based on following learning outcomes.

1. An ability to generate design solutions for complex, given engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, and economic, environmental, cultural and societal considerations
2. Ability to apply fundamentals engineering theory/knowledge to perform load analyses on machine elements/assemblies, stress analyses on machine elements.
3. Design, size and analyze machine elements, machine element/assemblies and the complete unit. Select standard elements.
4. An ability to use techniques, skills and modern engineering tools, as computer software, 3D printer, CAD software necessary for modern engineering practice.
5. Students will demonstrate the ability to seek and learn new material outside the class. (Demonstrate good engineering judgment for analysis and assumptions made)
6. The report assessment will take into account the completeness of the documentation (ex. table of contents, abstract, introductions, design methodology, conclusion, references and appendices …).
7. The student will be able to set to the frame of experiments to validate concepts or learn required values of parameters that are necessary in the design process. He or she will also be able to analyze and use the collected data.
8. They will learn to define objectives of the design in the context of creating new ideas and in the context of the design of a new application. The students will learn the necessary steps to produce a feasible design from ideation to a final product using classical and novel fabrication techniques and they will apply and implement their ideas in the context of teamwork. Work effectively as part of a design team
9. They will learn to divide and equitable share tasks and effectively make use of the information to conceive and build the set objective of a design. All design skills gained will be shaping the skills of the future professional engineer.
10. Have the good communication skills: orally, graphically as well as in writing.
11. The project report will be 30 pages for section from 1-7. Additional information such as detail calculation, analysis, drawing of individual parts and etc. will be provided in Appendices. The report format and structure will be based on followings.

Project Report:

A. Structure of the report
1) Abstract
2) Title Page
3) Table of Contents
4) List of Figures & List of Tables
5) Preface
6) Main Body of the Report (The Introduction / objectives /concept designs / analysis/ discussion/ conclusions Chapter)
7) List of References
8) Appendices
9) Expectations of Originality & team members signature

B. Layout
1) Headings
2) Legibility of Graphics
3) Font size (Times New Roman:12)
4) Mechanics (Pagination / Spacing (1.5 lines) / Quotations Marks and Other Punctuation / Equations in the text / Capitalization of Words / Typeface and Size / Binding)

C. Consider the following while report writing
1) In-text Referencing (referencing Quotations, Paraphrases of information and Graphics)
2) Reference Page Layout
3) Referencing Different Types of Sources
4) Plagiarism