CAT'S CONUNDRUM PROJECT DOCUMENTATION PACKET:
A Remote Control Vehicle Terrain Navigation Challenge
Multidisciplinary Design

Challenge Overview and Desired Learning Outcomes:

Your team must design and construct a Remote Control Vehicle (RCV) that is capable of navigating the Cat's Conundrum obstacle course[1]. The obstacles, which will directly influence your design objectives and constraints, have been crafted to create dependencies between each of the engineering specialties represented in this class. The necessity of effectively integrating components from each discipline assures students will meet the central goal of the class: to learn multidisciplinary design.

To design one must confront the unknown. Thus, design feels uncertain and therefore unsettling. It is trial by fire, the central battle of which is reducing the infinite and complex into manageable tasks that lead to a meaningful result. However, out of fear that we will fail or get a poor grade or have our shortcomings revealed to our peers we often hasten to reduce the problem's complexity to fit within our comfort zone rather than extending our comfort zone to incorporate the problem. To design fearlessly means you dwell in the unknown and that you accept the struggle needed to rise to the tasks at hand. This is how you grow as an engineer.

Expect to confront a challenge for which you are nominally prepared, but that will require you to extend your knowledge through self-guided research and study. Computer science will be asked to write code just outside your normal experience. All students will be asked to "build" the components they create on paper, thus requiring new skill be learned: soldering, 3D printer, product purchasing, pump installment, coding, etc. In short, as the "expert" on your team, you will be expected to sift through the vast knowledge available to you to find unique solutions to your problem. There is no "correct" solution, but many "incorrect" solutions.

Expected Learning Outcomes:

- Extend your comfort zone through struggle with the unknown.
- Become a self-guided problem solver (aka an engineer)
- Experience design process and be able to converse thoughtfully about alternate design methodologies.
- Practice leadership, communication, and project management in a multidisciplinary setting
- Reduce an open-ended design challenge to manageable, quantifiable problems that allow math and reason to guide your decision-making.
- Develop prototyping skills (and have some fun making stuff)
- Employ discipline specific hard skills to solve real problems.
- Develop your resume for career fair through a portfolio page

Please note, that nowhere does it say our intended learning outcome is to make an RC car. The car is nothing more than a vehicle (pun intended) for learning this process. ***You can learn design regardless of the product you aim to create.*** Keep this in mind as you confront the specific challenges outlined below and in your individual documents.

Discipline Specific Considerations

While you are responsible as a team for the outcome of your product, and therefore have a responsibility to contribute to all aspects of the project, each discipline will be assigned a specific challenge. These specific challenges are nominally within the scope of each discipline; however, everyone will find some aspect of the project asks them to apply their knowledge to problems they have not encountered directly in their schooling to date. The ME/T will design the mechanical body of the RCV; the EE and CompE will design the circuitry necessary to remotely control the vehicle; and the CompSci will code a user interface for a phone or computer that controls the vehicle. In addition, there are two obstacles that will require special attention from the ChemE/BE/BREN and CE/T majors respectively. First, "The Swamp" obstacle will require the design of a pump system that facilitates easy passage of the vehicle through the obstacle and is the purview of the

[1] See Introduction to Cat's Conundrum PowerPoint for photos and addition obstacle course info.

ChemE/BE/BREN. Second, the Sand Bog obstacle will require the CE/T to design and construct a scale "driving deck" for the RCV to navigate over unstable soil. Finally, each obstacle is constructed on a 2'x2' foam square (termed an element) and contains an easy, moderate, and difficult path. Your team must decide the order of the elements and chosen path. For teams with an IMSE/FE, while you can garner more points for navigating harder obstacles, you can also receive points for overall speed on the course, thereby creating an optimization problem that must be mathematically solved. The details for each major are explained in the individual course documents.

Team Specific Considerations

As noted above, there is a challenge for every major. But what if your team does not have an IE, ChemE/BE, CE/T, etc.? If you do not have a particular major represented on your team, your group will not be graded on that component of the project. Finally, note that if you have more than one discipline in your group (i.e. two ME/T, two CE/T, etc.), your will be held to a higher standard for that component of the project. For example, a group with two ME/Ts might be required to produce more CAD designed parts than a team with only one ME/T to receive the same grade.

If you DO NOT have:	**Responsibility**
ME/T	You may purchase any 1/24 RC Rock Crawler Kit[2] (but cannot use the electronics). The Makerspace has a limited supply of Basher Rocksta kits available that may require you to purchase motors[3].
EE, CpE, or CpS	You can purchase a commercial RC Transmitter, Receiver, Electronic Speed Control (ESC), Motor, Servo, and Battery[4].
One CE/T	You do not have to complete the "Sand Bog" driving deck challenge.
Two CE/T	You only design the driving deck for the Sand Bog. Limited design of piling structure underneath.
ChemE/BE	You do not have to attempt "The Swamp".
IE	You will not be held accountable for predetermining the vehicle path based on an optimization of speed and points.
If you have:	**Responsibility**
1) CpS, EE 2) CpS, CpE	CONTROL APP + Electronics (NO commercial RC ESC, Transmitter, Receiver allowed. You must write your own CONTROL APP control).
Any Combination of CpE and EE including loan CpE or EE	NO CONTROL APP + Electronics (NO commercial RC ESC, Transmitter, Receiver allowed. You DO NOT need to write a CONTROL APP. Joystick type controller is acceptable. Consider using Radio Frequency—RF)
One or more CpS	CONTROL APP + Commercial RC ESC[5]. By allowing the use of a commercial ESC, much of the wiring complexity is removed. A suggested wiring diagram is provided in the CpS course document. No

[2] https://hobbyking.com/en_us/basher-rocksta-1-24-4ws-mini-rock-crawler-rtr.html
http://www.losi.com/Products/Default.aspx?ProdID=LOSB0236
http://www.redcatracing.com/Sumo-1-24-Scale-Crawler
https://www.banggood.com/HSP-94480-124-RC-Offroad-Mini-Climber-p-928462.html?ID=510630&cur_warehouse=CN
https://www.horizonhobby.com/product/cars-and-trucks/cars-and-trucks-14524--1/electric-cars-and-trucks/1-24-temper-crawler-rtr--red-white-p-ecx00012t1

[3] https://hobbyking.com/en_us/130-brushed-motor-2pcs-basher-rocksta-1-24-4ws-mini-rock-crawler.html

[4] https://hobbyking.com/en_us/hobby-king-2-4ghz-6ch-tx-rx-v2-mode-2.html
https://www.amazon.com/gp/product/B074V55W9K/ref=oh_aui_detailpage_o03_s00?ie=UTF8&psc=1
https://hobbyking.com/en_us/turnigy-nano-tech-300mah-2s-35-70c-lipo-pack.html
https://www.pololu.com/category/22/motors-and-gearboxes

[5] See details in the CpS documentation.

	RC transmitter or receiver allowed unless controlled by a CONTROL APP that you write.

Overview of Design Process and Prototypes:

While building the RC car should be fun, it is only a vehicle for learning the design process and developing leadership and organizational skills. You will be asked to demonstrate your understanding of the design steps through assignments and prototypes. Throughout the semester, your team must complete 5 design milestones, each demonstrating successive improvement on the project components as detailed in the individual documents. The design process utilized in this class consists of the following steps:

Discover (develop enough background knowledge to define the problem)
Define (problem statement, functional diagram, objectives and constraints)
Ideate (brainstorm, morph charts, Pugh charts, mock-ups)
Prototype (create a comprehensive prototype for testing)
Test (test your prototype and loop back to discover)
Communicate (design documentation)

However, the design process is rarely linear and often requires looping back through these steps iteratively. You will be asked to consider your *objectives*, *constraints*, *and functional requirements*. In addition, during the proof of concept stage, we will ask you to *define* your problem, *research* existing solutions, and *ideate* new approaches. At the completion of the Design Definition, you should have a clear direction for your design and confidence your goals are achievable. Prototype 1 asks you to create a functional prototype vehicle that integrates your earlier ideas. This prototype can be tested and the parts refined to create Prototype 2—a course ready design capable of being presented to a client for testing on the track. In the final deliverable, you will be asked to further refine your design on paper or through CAD drawings while considering “design for x” factors such as design for marketing, manufacturing, user, environment, cost effectiveness, etc.

Design Milestones:

Groups must document that their design meets the requirements of the assignment at each of the 5 milestones.

- Discovery Progress Report = Follow the discipline specific documents for Discovery Progress Report. Answer all of the questions thoroughly and thoughtfully.
- Design Definition Progress Report = Follow the discipline specific documents for Discovery Progress Report. Answer all of the questions thoroughly and thoughtfully. The focus for this milestone should be on demonstrating progress in the form of hands-on testing that helps clarify any mathematical models you have produced or answers specific design questions. You will also be brainstorming design objectives and functionality. Design functionality will serve as the basis for ideation in the Morph chart and design objectives will serve as the criteria against which different designs are judged in the Pugh chart. .
- Prototype 1 Video = Four-minute video detailing test plan execution, value of tests, and results to be watched during class. This is a fully functioning prototype.
- Prototype 2 Demonstration = Vehicle demonstration on Cat's Conundrum Course. This is a refined prototype.
- Final Design Documentation/Portfolio Page

Each of the above assignments is further detailed in your individual documentation.

Budget:

Total out of pocket expense should not exceed $250. Scrounged/Free/donated parts need an estimated cost in your final budget; however, they need NOT count against your $250.

Grading: Your grade will be a weighted balance between individual contributions and group outcomes.