DEVELOPMENT OF A SOLAR-POWERED VEHICLE
ECE DEPARTMENT FALL 2019

EE 309S 15960
EE 362S 16525
ASE 379L 13550
ME 379M 18160

Instructor: Professor Gary A. Hallock
EER 3.814
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Office hours prior to lab at PRC or by appointment

Teaching Assistant: Corey Hulse

Time and Place: 1) MW 5 – 6:30 PM ECJ 1.222
2) Sat 2:00 – 5:00 PM Pickle Research Center ECB (also known as Bldg 16)

Approved Technical Elective:

- Power (EE 362S)
- Electronics (EE 362S)
- Robotics/Controls (EE 362S, 362K prerequisite)
- Academic Enrichment (EE 362S)
- Career Gateway Elective (ME 379M)
- Approved Technical Elective (ASE 379L)
- Other areas with permission of your advisor

Textbook:

ASC/FSGP 2019 Regulations
Download or view at www.americansolarchallenge.org (click on Regulations)

Websites:

- https://www.longhornracing.org (UT combustion, electric, and solar)
- http://www.americansolarchallenge.org/ (ASC website)
- team Google drive (you will need to be invited in)

Course Grade:

- Project: 50 % (effort and accomplishment about equal)
- Oral presentation: 10 %
- Written report: 10 %
- Notebook: 15 %
- Attendance: 15 %

This is a projects course, and your project determines most of your grade. You must keep an engineering notebook, where dated entries indicate your progress through the semester. You will give an oral presentation close to the end of the semester, and turn in a written report (5-25 pages) on your work. Your oral and written reports should contain what each team member personally accomplished during the semester.

This is a 3 credit hour course, and the general "rule of thumb" is 3 hours of outside work per course credit hour. Since this course will have no assigned homework and no exams, you should plan approximately 9 hours per week of work on your project and the solar car effort. This is to be documented in your engineering notebook, as described later.

The "effort" component of your project grade will be determined by the amount of time you spend on your project:

> 3 hours a week average documented effort = "C"
> 5 hours a week average documented effort = "B"
> 7 hours a week average documented effort = "A"

Documented means adequately described in your engineering notebook. The "accomplishment" part of your grade is successful completion of your project. Does it work, is it finished, does it meet specifications, etc. The course TA will periodically review your notebook with you.

Your project effort does not include our Monday class (class time is included in the attendance part of your grade). It DOES include your project work on Wednesdays, Saturdays, and of course all other times you work on your project. Be careful not lose your engineering notebook!

Our 3 hours of scheduled lab work on Saturday afternoon and 1.5 hours of design work on Wednesday is insufficient for a high grade. It is expected that groups will find additional times to meet during the week and/or weekends (the solar car student organization will be at Pickle most of Saturday for example). You can also work individually on your project as appropriate. You will need to be flexible, which is part of working as a group.

OVERVIEW

The objective of this course is the development of unique, high tech solar cars for the American Solar Challenge (ASC) and the Formula Sun Grand Prix (FSGP). Our last completed car is called *TexSun*. It represents about a 4 year effort, and first competed in FSGP 2013. Design work on our new car, *BeVolt*, has dominated our work over the past two years. FSGP is a track race and has been held in Austin at the Circuit of the Americas (COTA) five times (2013, 2014, 2015, 2017, and 2019). We also raced *TexSun* in the cross-country ASC race in July 2014.

Typically a new solar car is about a 3 year effort. We are now in the middle of the process, with many designs completed and significant building in progress. Our goal is to complete BeVolt for FSGP/ASC next summer (possibly to be held at COTA). Projects this semester are primarily on BeVolt, although FSAE Electric is part of the class.

TexSun followed *Solorean* and *Solar Steer*. We have team members very dedicated to this work, through the student organization (UTSVT) which has merged with LHR (Longhorn Racing). We have a few local alumni that were involved with all or most of these vehicles. *BeVolt* will be a very competitive solar car. This is an exciting time for the UT solar car team, as we have an extensive history and our next car can be more competitive. We have a lot to do. If you become interested in this work beyond this semester you are welcome to stay with the solar car team and help race our new car next summer.

This course is unique in a number of ways. It is interdisciplinary, with students from ECE, ME, ASE, and other engineering and non-engineering departments. This is how real engineering gets done. You are encouraged to be involved with work outside of your major. This is both interesting and good preparation for your engineering career. We also have a mix of students from freshman through seniors, with a wide range of abilities. What you get out of this course is primarily determined by the time and effort you put into it. In addition, freshman (for example) are not expected to undertake projects as sophisticated as seniors can undertake. We have a wide range of projects available.

Our course is coupled with the solar car student organization. Experienced team members will lead or provide guidance on projects (a number of the students in the solar car class are LHR/UTSVT team members). Our Teaching Assistant will also assist you. It is your responsibility to be putting effort into this course. If you are having trouble making progress on your project be sure to discuss this with the TA and myself.

FORMAT

The format of the course includes lectures (Monday), subgroup meetings (Wednesday), and laboratory work (Saturday). Each of you will develop an overall understanding of the theory, design, operation, and construction of a solar electric vehicle. Although we will focus on a solar car, much of what we discuss is relevant to electric and electric/hybrid vehicles (battery systems, motors, for example) and terrestrial solar power (solar arrays, power trackers, for example). These should be an important part of your future, and many of you here have strong interest in these topics. In addition, you will develop in-depth knowledge in a particular focused area through your project.

A number of topics will be covered in the course lectures. We will begin with an introduction to solar cars. We will discuss solar car raycing and the American Solar Challenge and Formula Sun Grand Prix. We will discuss raycing history, and UT raycing. Then we will discuss the overall modeling of a solar car. This will include topics such as aerodynamics, rolling resistance and losses, and the main electrical system. We are also planning some guest lectures.

We will next look at several systems in detail. We will study solar array design, covering solar cell fundamentals, efficiency, temperature effects, coatings, and shading. We will discuss electric motors, and their suitability for electric vehicles. We will look at battery technologies, including lead-acid, nickel-cadmium, nickel-metal-hydride, lithium-ion, lithium-polymer, and lithium iron phosphate. This will include battery modeling, charge-discharge characteristics, and basic chemistry. We will investigate car aerodynamics, including body shape effects, Reynolds number, drag calculations, and air flow. We will look at chassis design, covering topics such as the suspension, drive train, and steering.

CLASS

Our class on Mondays will be a lecture. I will discuss the topics previously mentioned. Please come to this class to hear my lecture. Do not do homework, surf the web, e-mail, etc. Otherwise you will not receive attendance credit in your grade. I will try to keep this material interesting.

Our class on Wednesday will be subteam meetings and lab work. You will meet with your subteam on design activities, EER lab work, web research, discussion, purchasing, planning for the Saturday lab, etc.

For the final 2 weeks or so of class we will devote the Monday and Wednesday class time to final report oral presentations. These presentations will be done by the subteams, with each

member participating. We will discuss the format further, but essentially a PowerPoint presentation with about 5 - 10 minutes allocated for each subteam member.

Our work on Saturday is done at our solar car shop and lab at UT's research campus, the Pickle Research Center (PRC). We have an electrical lab, mechanical shop, and a meeting area. TexSun is also stored there. Most parking at PRC is "Any UT permit required at all times". PRC is also accessible using the Capitol Metro bus service (# 803 Rapid), which is free to UT students and staff. Finally, some UTSVT team members typically give rides from the main campus.

This Saturday, (8/31), I and other team members will be at Pickle and you are welcome to come out (this Saturday is optional). We can provide an introduction to the solar car, shop, and UTSVT team members. We will officially start the class lab on Saturday, Sept. 7. Please talk to team members who lead projects that interest you. For new people, you will turn in a project preference sheet and then be assigned to a subteam.

PROJECTS

Each student will undertake one main project. Some projects are more complex than others. Some projects involve upper division skills (ex. microcomputer programming) and are more suitable to 362/379 students. Other projects are less complex and suitable for students without these skills. Most projects will be undertaken by several people as a team. We also have work that everyone can participate in. An example of this is body construction, where many people can contribute when we do a layup.

A diverse number of projects are available, which span electrical, mechanical, and aerospace. If you are taking this course for a technical area elective you should keep that in mind when you request a project. The semester goes by fast and we must get organized quickly to allow adequate time for projects.

Schedule:

8/28 (today): Review Course Descriptor and list of projects (project preference sheet distributed)

8/31 (Saturday, Pickle ECB/Bldg 16, optional): Come meet UTSVT team members and discuss projects.

9/2 (Monday) Labor Day Holiday

9/4 (Wednesday): Discuss projects

9/7 (Saturday): First official lab at Pickle. Discuss projects with team leaders. Meet with subteam(s) of interest. Turn in your project preference sheet to Prof. Hallock by the end of class.

9/9 (Monday): Receive project assignment. Lecture

9/11 (Wednesday) Lecture

9/14 (Saturday) Meet with your project group at Pickle. Discuss your project with Prof. Hallock, TA, and UTSVT members.

9/16 (Monday) Lecture today and remaining Mondays.

9/18 (Wednesday) Begin in-class design and lab work.

11/13 (Wednesday) – Submit final report outline (to Prof. Hallock and TA via email).

11/27 (Wednesday) – no class (Thanksgiving break).

11/30 (Saturday) – no lab (Thanksgiving break).

12/2 (Monday) – Subteam presentations.

12/4 (Wednesday) – Subteam presentations.

12/9 (Monday) – Subteam presentations, Course Instructor Survey.

12/13 (Friday) – Final report due (pdf via email to Prof. Hallock and TA) and turn in notebook to Prof. Hallock.

ENGINEERING NOTEBOOK

Each student must keep an engineering notebook. This is the primary way you document your progress through the course. This must be a bound or spiral notebook (not loose leaf). The pages in your notebook must be numbered (you may number them yourself if necessary). Your engineering notebook is to be separate from your class notes. Make sure it is neat and legible. Your TA will periodically review your notebook when meeting with you on Wednesdays and Saturdays.

Your engineering notebook is to be kept in real time; i.e., make entries on a daily basis whenever you work on your project. An entry must be dated and indicate the amount of time spent. The entry should summarize what was done on that day. Sketches, summaries of meetings, calculations, ideas, etc. are all appropriate for your notebook. Record decisions you or your group make and any other important information.

At the beginning of your notebook paste in the weekly summary sheet (handout). Enter your weekly hours at the end of each week. This will allow you to easily keep track of your effort in the course. For the purpose of your grade, it is your average weekly effort that will count. You may spend less time on your project some weeks (example, you have an exam in another course) and make it up the following week. Your notebook will be turned in to me at the end of the semester. I will be happy to return your notebook to you after grading.

What can you do now? Suggestions:

1. Look over solar car websites.
2. Read the ASC 2020 regulations (go to ASC website, click on Regulations, click on *2020 American Solar Challenge Regulations).* BeVolt must strictly follow these regulations.
3. If you do not have a car, figure out the Capital Metro bus route you will use to get to Pickle. Locate ECB on the UT Pickle Research Center map.
4. *Review the list of projects and think about the type of project you would like to do this semester.*

PURCHASING

It is likely that you will need to purchase components for your project. Most of our purchasing is done using our University Procard. There is a set of rules that must be followed, which I will discuss with anyone doing purchasing. We don't expect you to use personal funds for solar car work. However, we do not have a mechanism to reimburse personal expenses used to purchase parts for the solar car.

Evaluation: The course will be evaluated using the standard UT course/instructor evaluation forms. Your comments are very important.

Disabilities: The University of Texas at Austin provides, upon request, appropriate academic adjustments for qualified students with disabilities. For more information, contact the Division of Diversity and Community Engagement, Services for Students with Disabilities, 471-6259, http://www.utexas.edu/diversity/ddce/ssd/.

Drop Policy: The 4th class day is the last day of the official add/drop period. After this date, changes in registration may require the approval of the department chair and usually the student's dean.

Class Web Sites and Student Privacy: Web-based, password-protected class sites are associated with all academic courses taught at the University. Electronic class rosters are a component of these sites. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar, Main Building, Room 1.

Safety: All occupants of University buildings are required to evacuate when a fire alarm and/or an official announcement is made indicating a potentially dangerous situation within the building. Familiarize yourself with all exit doors of the classroom and building. Remember that the nearest exit may not be the door you used when entering the building. If you require assistance in evaluation, inform your instructor in writing during the first week of class. Do not re-enter a building unless given instructions by emergency personnel.