

**ECE 461(3Credits) /462(1Credit) Power Systems
Fall 2020 Schedule and Grading**

Tuesday, August 25th to Thursday, Dec 13th

SEE <http://www.calendar.colostate.edu/>

Class time: 12:30 to 1:45 PM Tues / Thur Room: D102 (Physics wing).

Please forgive long syllabus, but with 461 lectures and a 462 lab there are lots of issues to cover.

Instructors teaching philosophy

- ECE Students are the most important people at CSU.
- Not dependent on faculty.
- Faculty is dependent on them.
- Not an interruption of our work.
- They are the purpose of being at CSU.
- Students are doing us a favor when they come to our office.
- We are not doing them a favor by serving them.
- Students are part of our business, not outsiders.
- Not just a CSU ID number.
- They are flesh and blood human beings with feelings and emotions.
- Students come to us with their needs and wants.
- It is our job to address them with courteous and attentive treatment.
- Students are the life blood of this and every university.
- Without them we would close our doors.
- **DON'T EVER FORGET THIS**

Disclaimer Notice:

Use this syllabus to guide you through the semester but realize that up to date in class announcements always supersede this preliminary guide.

If you have further questions ask me in class so everybody benefits.

Instructor: Prof. George Collins, **Email:** gcollins@enr.colostate.edu

TA for 462 and grader for 461: Natnael.Woldai@colostate.edu

GROUP FORMATION

Divide yourselves into **student groups as students have different schedules.**

I have already divided the class into **two random student groups for Thursday Question and Answer (Q/A) secessions** that will be live and face to face in the classroom at first and later delivered remotely but synchronously via MS Teams to the entire class. This forms the first student group/

For doing 461HW, 461 PSSE Labs, and 461Pop Quizzes choose groups via **CANVAS People Upload to CANVAS** all solutions to 461 HW sets, 461 Pop Quizzes, and 461 PSSE exercises. This forms the second student group. **GROUP EFFORT** is key to ECE 461. Form groups of up to 4-8 students to complete:

1. 461 HW assignments
2. 461Pop Quizzes
3. 461PSSE exercises

1) Write your solutions in MS Powerpoint. Number of slides may vary depending upon the solutions.

2) Only group leader will submit the final ppt of 461 HW, 461 POPQUIZ and 461 PSSE labsthrough canvas.

Form 462 lab groups, which could be a **third student group**

Finally Talks # 1 and #2 will form a **fourth student group** that you choose to populate on CANVAS on the dates of the corresponding talks, which **MUST be recorded in MS Teams** (Microsoft tutorials teach how to accomplish this **recording requirement**), so that all students can benefit from both your recorded talks.

***Practice makes perfect** Presentation skills too can be honed through repetition, listening to talks and critique of your own talks. My goal is to get you ready for a job in industry where communication skills are crucial.*

Send recorded MS Teams report of **talks 1 and 2 via CANVAS**. For Talk # 2 start reading **H. Narain and L. Gyugyi “Understanding FACTS AC Transmission Systems” IEEE press 2000**

Do this formation of 461 groups ASAP and on CANVAS give the **lists of group members** to both the grader and me after choosing them on CANVAS.

461 HW POP Quiz and PSSE lab due dates

HW Due Dates

HW #1 – **Sept 3**

HW #2 – **Sept 10**

HW #3 - **Sept 17**

HW #4 – **Oct 8**

HW #5 -, **Oct 15**

HW #6 – **Oct 22**

HW #7 – **Oct 29 (Optional)**

HW #8 –**Nov 19 (Optional)**

Pop Quiz Due Dates

- Pop Quiz #1 – September 1
- Pop Quiz #2 - September 8
- Pop Quiz #3 -, September 15
- Pop Quiz #4 - September 22
- Pop Quiz #5 - October 13
- Pop Quiz #6 - October 20
- Pop Quiz #7 -, October 27 (Optional)
- Pop Quiz #8 - November 10 (Optional)

461 PSSE Labs and due dates below

LAB #	DUE Date
1	Oct 15
2	Oct 22
3	Oct 29
4	Nov 19 (Optional)

ECE462 Motor Lab Due Dates

462 Motor Lab Teaching Assistant (TA): Natnael.Woldai@colostate.edu

There will be 4 Motor Labs (Tentative).

TA will assign motor labs after you form lab groups. **Lab times/hours for each 462 group to do the lab will be decided in early fall as well as respective due dates.** Form your 462 motor lab groups ASAP to get desired lab times as published by the 462 TA. 462 Lab report for each experiment should be submitted directly to the TA, as an attachment to his email.

Decide your group members and leader of the group among yourselves. Elected group leaders will send the list of confirmed group members. Also please try to maintain equal number of members in each group before sending the list of confirmed group members.

Note: If you are entertaining a job in Power here is a website for you with an 18-minute video from IEEE that provides an overview of power engineering: Happy Viewing!

<http://www.ieee.org/portal/ieeetv/viewer.html?progID=70345>

Text Book: Electrical Machines, Drives and Power Systems, Theodore Wildi

Class website: <http://www.engr.colostate.edu/ECE461>

461 COURSE OBJECTIVES

This course will teach basic power generation, transmission and distribution, with the perspective of INCREASED energy efficiency in both generation and consumption of electrical energy. As motors consume >60 % of grid power more efficient motor designs and motor drives will be addressed. As well we will cover as the increased role of emerging alternative sources of electrical energies and the challenges to grid stability and load cycle problems these create. A move to all electric cars or even hybrid vehicles would save significant energy, due to the inefficiency of internal combustion engines, but only if we optimize car electric motors .car batteries and motor drives. These are all problematic. This course will discuss all these emerging issues and more.

SEE http://www.teslamotors.com/display_data/twentyfirstcenturycar.pdf

The materials in this class each year are 1/4 new, hence, you need view the recorded lectures for each week before you to come to **Thursday class** which will be an Q/A secession on 461 and 462 topics, either live and face to face in the class room or via MS Teams depending on CSU COVID levels.

There is no class on Tuesdays but you need to contribute to CANVAS Discussions. A lot of changes are occurring in the power industry and I want to inform you so you can get a better job.

The class notes are password protected and user name and password are:

Username: Student

Password: Power!

462 Motor Labs: Hours to be arranged for each Student Group

GROUP EFFORT is key to 462. Form groups of up to 4-8 students

462 Motor Lab Teaching Assistant (TA): Natnael.Woldai@colostate.edu

There will be 4 Motor Labs (Tentative). .

Look at some motor animations on this site:

<http://www.ece.umn.edu/users/riaz/animations/listanimations.html>

A particularly good one is:

[Sinusoidally distributed windings and fields in a 3-phase ac machine](#)

Tentative 462 lab due dates are as follows.

Motor Lab # 1 Due September 11

Motor Lab #2 Due October 2

Motor Lab #3 Due October 16

Motor Lab #4 Due **November 6**

ECE 462 GRADING CRITERIA:

1. Four Motor Labs: 25% each for a total of 100%

TA will assign motor labs after you form lab groups. Lab times/hours for each group to do the lab will be decided as well as respective due dates. Form your 462 motor lab groups ASAP to get desired lab times. Lab report for each experiment should be submitted to the TA within the deadline.

SEE: http://www.engr.colostate.edu/ECE462/course_info.shtml

*If you are experiencing difficult situations that are affecting, or could potentially affect, your academic success, please contact **Student Case Management** as soon as possible (<http://www.studentcasemanagement.colostate.edu/> E203 Newsom Hall, 970-491 8051). Difficult situations can include issues such as medical, mental health, personal or family crisis, illness, or injury. If students request extensions or considerations due to difficult situations, I typically require documentation from Student Case Management. In addition, I urge students to contact me in advance of deadlines about such issues.*

For making referrals, their contact information is:

Student Case Management
E203 Newsom Hall
970-491-8051

vpsa_student_case_management@colostate.edu
<http://www.studentcasemanagement.colostate.edu/>

461 Grading Summary:

- 1. HW Assignments: 11 %**
- 2. Talk / Paper # 1: 20%**
- 3. Talk / Paper #2: 40 %**
- 4. Pop Quizzes: 20%**
- 5. PSSE Labs: 9 %**

WARNING TO STUDENT USERS OF CANVAS

Canvas gives grades even for partial assignments completed. Look in Canvas. Note that the grading group subtotals do display at the bottom right, so if students are sharp they will know that this reflects their scores for only say 40% of their grade not 100% for example. If not careful to look, they may see misread CANVAS attempts to give grades dynamically during the semester.

TOTAL 100 points and is the basis of the normal 461 grade. However, I provide up to EXTRA CREDIT assignments for class participation in CANVAS Discussions.

A detailed explanation of all the assignments related to ECE461 is given below:

2. HW Assignments:

(11% of final grade) Eight group Homework assignments @ 10 pts each will comprise 11 % of the final grade. Send homework to the grader (TA) within the deadline.

3. Talk / Paper #1:

Talk/paper # 1: (20 points of final grade: 15 for talk and 5 for paper both of which you send to CANVAS

PPT Talk OUT OF 15 AS FOLLOWS:

1. TECHNICAL ACCURACY 7/15
2. Slide ORGANIZATION 4/15
3. CLARITY OF MATERIAL-SHORT LIST OF TOPICS IN DEPTH COVERAGE BETTER THAN MANY TOPICS VERY SHALLOW COVERAGE 2/15
4. PROPER SPELLING GRAMMAR REFERENCES 1/15
5. FOLLOWING THE MEMOS ON TOPICS TO BE COVERED 1/15

And send Revised PPT slides to [Collins only](#) by email attachment

WORD PAPER GRADE OUT OF 5 AS FOLLOWS:

1. TECHNICAL ACCURACY 2/5
2. PAPER ORGANIZATION 1/5
3. CLARITY OF MATERIAL-SHORT LIST OF TOPICS IN DEPTH COVERAGE BETTER THAN MANY TOPICS VERY SHALLOW COVERAGE 1/5
4. PROPER SPELLING GRAMMAR REFERENCES .5/5
5. FOLLOWING THE MEMOS ON TOPICS TO BE COVERED .5/5

4. Talk / Paper #2 :

Presentations Advice Steve Jobs Style

When you give a presentation, you face at least two hurdles.

First, you need to sell yourself as a credible spokesperson on your topic. Audiences need to believe in you-and that's hard enough.

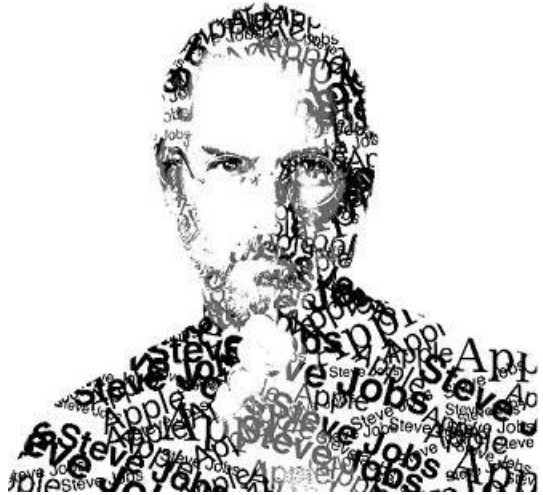
Second, you need to sell your ideas so that people come away inspired, persuaded and enlightened.

Steve Jobs did both-with incredible skill. Widely considered one of the most gifted presenters ever, Jobs understood how to deliver memorable speeches in a seemingly effortless, engaging manner. His conversational tone, simple yet compelling word choice

and masterful use of slides and other props helped reinforce his message in winning ways.

You'll learn how to develop key skills, including how to:

- **Integrate Aristotle's "Big Three"-logos/ethos/pathos-to win over audiences.** Learn how to blend logic, credibility and emotion to enliven your remarks.
- **Convey big ideas or central themes via multiple channels.** From audience giveaways to props to slides, apply the Steve Jobs approach and align all available tools to drive home key points so that people cannot help but remember them-and buy into them.
- **Think in threes.** To explain complex processes (from chemical reactions to financial formulas), learn to cluster your main points in threes. Your audiences will thank you.
- **Use bluntness and directness.** Rather than drop hints or dance around controversial positions, follow Steve Jobs' example and state your case boldly and succinctly.
- **Embrace simple language.** If you need to explain complex ideas, you must speak in complex terms. Right? Well, Steve Jobs was a master at communicating complicated concepts in unmistakably clear words. Develop tools to translate your speech into plain English that's compelling and hard for anyone-of any background or educational level-to ignore.
- **Start staff meetings with an edge.** Steve Jobs did not begin staff meetings with touchy-feely happy talk. Instead, he often provoked people or expressed disappointment in some aspect of the team's performance. But by the end of the meeting, everyone left in a positive frame of mind-inspired and validated. Find out how Jobs pulled that off.
- **TALK #2 (40 % of grade: 35 PPT talk and 5 WORD PAPER)**



PPT Presentation is grades as follows out of 35:

1. TECHNICAL ACCURACY 23/35
2. PPT Slide ORGANIZATION 8/35
3. CLARITY OF MATERIAL-SHORT LIST OF TOPICS IN DEPTH COVERAGE BETTER THAN MANY TOPICS VERY SHALLOW COVERAGE 2/35
4. PROPER SPELLING GRAMMAR REFERENCES 1/35
5. FOLLOWING THE MEMOS ON TOPICS TO BE COVERED 1/35

WORD PAPER GRADE OUT OF 5 AS FOLLOWS:

- 1. TECHNICAL ACCURACY 2/5
- 2. PAPER ORGANIZATION 1/5
- 3. CLARITY OF MATERIAL-SHORT LIST OF TOPICS IN DEPTH COVERAGE BETTER THAN MANY TOPICS VERY SHALLOW DOVERAGE 1/5
- 4. PROPER SPELLING GRAMMAR REFERENCES .5/5
- 5. FOLLOWING THE MEMOS ON TOPICS TO BE COVERED .5/5

All students are advised to be present in class and learn from others' talks. For details on the format and contents of the paper, refer to the "Talk Paper Guidelines" document available on the ECE461 course website:

<http://www.engr.colostate.edu/ECE461/FA14/ECE461%20Talk%20Paper%20Guidelines.pdf>

5. Pop Quizzes:

(20% of final grade) I count 20% for eight weekly 461 class pop quizzes @ **100 points** each, to be done as a group. Pop Quizzes will be assigned every week and due on Thursdays of the following week. **Send Pop Quizzes to TA**

6. PSSE Labs:

(9% of final grade) **Four PSSE laboratory experiments @ 10 points each will comprise 9% of the final grade. All four PSSE lab reports will be due during the two weeks of Talk 1, Tues. September 24 to Thur. October 5 2018 (Week 6 & 7). Send PSSE labs to TA through Canvas.**

As far as the assignments for ECE462 lab with 1 credit are concerned:

MOTOR LABS: Four motor labs will be conducted by students and their reports each comprising of **25%** each for four labs, submitted from Sep 11 to Nov 6, as already mentioned above to the grader as email attachments.

Grader: Natnael.Woldai@colostate.edu

Beware that both talk # 1 on SCADA/ Smart Grid as well as talk # 2 on "FACTS" you need to start background preparations for this ASAP. For groups that choose "Variable frequency Motor Drives" for both 461 and 562 you can split your efforts into both Talk # 1 (basics) and

talk # 2 (details). Note that the two talks and associated papers accounts for 60% of the final 461 grade. You can earn extra points as outlined in class, and as some students need a better 461 grade for various reasons—here is a chance to earn it, by doing what is explained below.

Positive Class Participation in CANVAS Discussions. Up to an additional 5 extra points on the final grade are available,

GROUP EFFORTS

Notice that group/team efforts are required in both these courses. Power companies value communication skills (oral and written) HIGHLY so ECE461 will help prepare you for the real world by requiring talks to be recorded in MS Teams. Your technical presentations will be GROUP efforts to simulate your next environment —industry. This group effort is purposeful to get students familiar with the MS Teams protocols that they will SOON encounter in industry. In your TALKS : talk # 1”SCADA versus the smart grid technologies (SG)” and Talk 2 “Flexible AC Transmission (FACTS) . I judge renewable/green energy claims beyond 20-30 % total energy generation are starting to be more “pixie dust” than reality. For starters realize that “capacity factors” for wind and solar are typically <25%,. Why? Because, the sun shines only for a part of the day and the wind blows intermittently. You and your group can dispute that. But you make your own determinations.

ACADEMIC INTEGRITY

This course will adhere to Academic Integrity Policy of CSU General Catalog and Student Conduct code. It is expected in this course that all students will not give, receive or use any unauthorized or undocumented assistance in their group efforts as well as individual efforts. All appropriate sources need to be referenced and it's best to do in IEEE format for references/sources. For details go to: <http://catalog.colostate.edu/general-catalog/policies/students-responsibilities/#academic-integrity> All problems will be handled according to CSU policies. See: <http://tilt.colostate.edu/integrity/faqs/howShouldI.cfm>

PREAMBLE ON SEVERAL WEB SITES FOR BACKGROUND ON ELECTRIC POWER

Some Web videos on energy and power engineering are given below for your pleasure. This is optional and not required. <http://www.youtube.com/watch?v=vqgNri6oEdc>

A fun demonstration of the enormous POWER behind the grid as shown by switch opening on a 500,000 volt line when air breakdown is 30kV/ cm, causing a meter long arc (a flash over) in open air that ignites the air with plasma. Workman/lineman have been seriously burned or blinded by these meter long arcs. Respect high voltage. When trees come close to power lines this also causes flash over events. Tree trimming near power lines is required by the federal government

Here is an 18-minute video that provides an overview of power engineering:
<http://www.ieee.org/portal/ieeetv/viewer.html?progID=70345>

Here is a website dedicated to the “smart grid” a term of some ambiguity:
<http://www.smartgridnews.com/artman/publish/index.html>.

See another website:

http://antwrp.gsfc.nasa.gov/apod/image/0011/earthlights_dmsp_big.jpg to grasp the energy use situation on earth any given evening. Just increasing transformer operating efficiency in transmission and distribution by 1% would save trillions of dollars per year in energy costs, reduce greenhouse gas and CO₂ emissions, and reduce the need to build new power plants. That is 1% of 3 TW= 30 GW or 30 GW power plants that would not have to be operating.

Moreover surprising to some, inefficient energy use is becoming ILLEGAL, such as use of incandescent light bulbs in 2012. See for example:

http://www.energy.ca.gov/commissioners/rosenfeld_docs/index.html and
http://www.efficientpowersupplies.org/efficiency_news.asp

EPA, CEC (California energy commission) and DOE energy star programs are but several examples, as are the federal laws that require the states to get 7.5 % of electricity needs by 2013, peaking at 20% from renewable sources. Some wags say, as renewables are still requiring subsidies, long term overuse of renewables is a form of “green energy suicide”. Finally, if you want get Cambridge University professor’s skeptical /realistic but cold air attitude on the LIMITATIONS of “Green Energy” see: <http://www.withouthotair.com/>.

Finally a website for all that describes energy in a cosmic perspective:

http://www.evworld.com/library/energy_numbers.pdf

COST – “the four letter word’ plays a key role in this course. Cost is just an economic word for the common good. So all energy sources must be cost competitive and all “improvements” to the grid must have a discussion about cost/benefit tradeoffs.

WHEW! If you visited all the background sites you are ready to engage with the real 461 academic course and the assignments/grades are key

ECE461 Homework Assignments

Refer to the textbook for detailed statement of HW problems.

<u>HW #</u>	<u>Problem #</u>
1 due 3 Sept	Chapter 3 - #22, 24, 26 Chapter 5 - #19, 20, 21, 22, 23
2 due 10 Sept	Chapter 7 - #26, 27, 28, 29
3 due 17 Sept	Chapter 8 - #28, 30, 34, 35

4 due 8 Oct	Chapter 9 - #7, 8, 9, 10
5 due 15 Oct	Chapter 10 - #34, 35, 36, 37
6 due 22 Oct	Chapter 11 - #12, 13, 14, 15
7 due 29 Oct (Optional)	Chapter 12 - #11, 12, 13, 15
8 due 19 Nov (Optional)	Chapter 27 - #6, 9, 13, 19

Get started on the PSSE labs, ask all your doubts to the TA, since all of them are due in a span of two weeks' time.

TALKS Procedure: 4 Group Talks on Four Separate days

Sign up your group members for desired talk date in CANVAS PEOPLE. Sign up group members for both talks 1 and 2.

Talk 1 occurs week 6 and seven of the semester as listed in CANVAS MODULES. Talk 2 occurs week 11 and 12 as found in CANVAS MODULES.

We meet via MS Teams for the talks with a unique MS Teams link. This link is different from the link for regular Thursday Q/A.

Student's situations are unique so that student TALKS FOR THE COURSE may employ three different modalities but they all have to be integrated into one final group talk/presentation:

1. Present live using MS Teams.
2. Prerecord your individual talk on MS Teams.
3. Prerecord your individual Talk on PPT with audio option.

The group presents the talk student by student on MS Teams and I critique ALL the presentation. Your groupmates take notes on suggested corrections.

You then submit by uploading one week later the Improved PPT slides as one file for the entire group via CANVAS ASSIGNMENTS for a grade.

TALK #1

Prof. Collins will deliver one detailed prerecorded lecture on SCADA in the CANVAS MODULES. From **September 22 to October 1**, student groups will present **their prerecorded MS Teams talk # 1 and all groups talk on the same topic SCADA versus**

the Smart grid. ALL student groups report on the SAME topic, SCADA (<20% of talk # 1) AND SMART GRID (>80% Talk # 1)

Part one: “OLD (40 years of experience) SCADA SYSTEM (<20% of Talk # 1 grade) to set the stage for smart grid by realizing the grid is already very smart and automated too. SCADA has wide use in industry process control, outside the power industry as well.

Part Two: Smart grid trends and promises (>80 % of Talk # 1 grade). Show how the smart grid does more than the old SCADA at lower cost and faster, if you can. Key here is to cover **Phase Measurement Units (PMU)**, which are the only true new addition to the “smarter grid” equipment as compared to SCADA. A second illustration the old serial port interfaces were RS 232 and 485, which are still legacy serial ports with great noise immunity (232 has 6 volt noise region between one and a zero bit allowing operation in a utility environment), however bit transfer speeds are low. In your paper/talk include the **NEW I² C serial interface** used in the smart grid, and discuss its application to utility environments. After talk # 1 on Collins returns to lecture via prerecorded lectures found in CANVAS MODULES.

TALK #2:

FACTS will give you an overview of the modern grid and issues that are driving change.

Each student group creates a Prerecorded MS Teams Talk # 2 from **November 3 to November 12**. It will count **for 40% of the final grade**”. This is the “capstone” portion of 461 and is to be started ASAP due to its complexity

I again will deliver an overview INTRODUCTORY lecture on “FACTS” to better prepare groups for TALK # 2. It can be found in CANVAS Modules

Two types of power flow optimization will be covered:

- a. AC Source to AC Source power flows
- b. AC source to passive loads power flow
- c. A breakdown of the two types of compensation:
 - Series Compensation

- Shunt compensation

NOW for what your group MUST include in **Talk # 2 “FACTS”, which provides real time dynamic compensation of AC transmission lines for increased power flow, better voltage control and improved grid stability.**

TALK #2 CHOICE #1: FACTS

- (40 % of talk #2 grade) 3 Phase inverters/converters and how power electronic drives allow independent control of amplitude and phase to provide desired compensation. Show how Voltage Source Converters (VSC) provide grid frequency AC voltage injection, in either series or shunt, with both variable amplitude and phase using a DC source and switches (SCR’s or IGBT’s). (20 % of talk #2 grade) Shunt Compensation, which also has as a key building block a VSC.
- (60 % of talk #2 grade) Explain in detail how a UPFC combines a VSC driven series compensation (SSSC) and a VSC driven shunt compensator (STATCOM) to form a UPFC, which is able to:
 - Independently control simultaneously either active or reactive power injected to the line.
 - Act as a shunt compensation and phase shifting device simultaneously.

Special Talk # 2 opportunity for students in BOTH 461 and 562
TALK #2 CHOICE #2: VARIABLE FREQUENCY MOTOR DRIVES

Alternatively groups for talk # 2 may present on “Variable Frequency Motor Drives”. Due the importance of variable frequency motor drives student groups can choose this topic for both Talk/paper # 1 prerecorded in MS Teams by your student group

Motors and motor drives are key technologies for a variety of reasons. First >60% of grid energy goes to motors. Moreover, improvements in efficiency from input AC power to Torque- RPM mechanical energy at loads is an on-going green revolution as it creates “Megawatts” of saved energy that need not be generated. Electric cars will also be more competitive with these “variable frequency” motor drive improvements.

So a special opportunity is offered to students in both 461 and 562 courses to do talk # 2 on **student prerecorded MS Teams.**

An emphasis list of items to cover is given below for 461 presentations and a different list of items for 562 student presentations.

461 TALK # 2 Required High Points:

- Describe the Z_{IN} , V_{IN} and I_{IN} seen by the power electronics drives (e.g. the motor’s electrical input characteristics) versus the varying T_{OUT} – N_{OUT} curves of the mechanical load for:
 - Brushless DC Motor (BDCM)
 - Synchronous motor
 - Permanent magnet Synchronous motor (PMSM)

d. Induction motors

In short review the $T_{OUT}-N_{OUT}$ vs $V_{IN} - I_{IN}$ curves for the four most used motors.

2. Provide web links to manufacturers spec and application notes and their major arguments to justify the separate claims that “PMSM” technology is the best versus “BDCM” technology is best versus Synchronous or induction motors. This is easily resolved by distinguishing what mechanical loads each technology is best suited for. Do this for the four the chosen motors at the three mechanical load levels of :
 - a. Low HP < 1 HP
 - b. Medium HP < 10HP
 - c. High HP > 100 HP
3. Commercial motor control systems consist of: sensors, command and control chips and power train drives.
 - a. Describe in detail spatial location, type and output levels from the sensors for rotor position and other motor parameters needed for control decisions.
 - b. Give three commercial motor control chips or board level hardware control systems.
 - c. Compare and contrast the advantages and limitations as well as cost of high power switch hardware in the drive train employing :
 - I. Thyristors
 - II. IGBT's
 - III. IGCT's and it's variants of MOS control

Go to manufacturer's websites and get specs for the high power switches as well as application sheets for motor drive applications with these same switches and their control drive electronics.

- d. Provide two examples of commercial power train electronics from switch drives to variable 3 phase output $V(f)$ from power switches.

562 Presentations Required High Points:

1. Explain the cost and reliability considerations for the motor centric items listed in 461 point #1 as well as the best of the breed for applications at the three HP levels for the four motor varieties:
 - a. Brushless DC Motor (BDCM)
 - b. Synchronous motor
 - c. Permanent magnet Synchronous motor (PMSM)
 - d. Induction motors
2. Explain in detail the differences and advantages as well as disadvantages of DSP vs FPGA vs microprocessor control methodologies and switch algorithm flexibility as well as cost.
3. Discuss the R-L-C components both within and external to motors as regards their maximum operating voltages, currents and frequencies.

NOTE: For group efforts Microsoft TEAMS recorded presentations go to MS website for how to record MS Teams.

1. Commercial motor control systems consist of: sensors, command and control IC chips and power train drives.
 - a. Describe in detail spatial location, type and output levels from the sensors for rotor position and other motor parameters needed for control decisions on motors.
 - b. Give three commercial motor control chips or board level hardware control systems.
 - c. Compare and contrast the advantages and limitations as well as cost of high power switch hardware in the drive train employing:
 - I. Thyristors and Triacs
 - II. IGBT's
 - III. IGCT's and it's variants of MOS gate control of a switch

Go to manufacturer's websites and get specs for the high power switches as well as application sheets for motor drive applications with these same switches and their control drive electronics.

- d. Provide two examples of commercial power train electronics from switch drives to variable 3-phase output $V(f)$ from power switches.

GRADE DISTRIBUTION

Our final grading approach will be more traditional with both + and - letter grades to achieve a sliding curve and a distribution of grades. In an ideal statistical world we would seek in a class grade distribution as follows. .Grading will be curved with students above one standard deviation above median receiving an "A", students below the median and above one standard deviation below the median receiving a "C". 2 standard deviations below the median will receive a "D", 3 standard deviations below will receive a "F", and anything lower will receive an "F".

A-F GRADING SUMMARY with plus minus fine tuning for 461

Letter grades for ECE 461 are on an F to A scale with plus minus fine tuning on all letter grades.

<u>Score (X)</u>	<u>Letter Grade</u>
------------------	---------------------

X > 100	A+
X > 96	A
X > 93	A-
X > 91	B+
X > 86	B
X > 83	B-
X > 81	C+
X > 59	C
X < 59	F

No C minus grades allowed

SCHEDULE AND DUE DATES SUMMARY

Talk #1 Dates (Week 6 & 7) assuming four student groups **22 Sept to 1 Oct**

Talk #2 Dates (Week 12 & 13) assuming four student groups **3 Nov to 12 Nov**

Note: Talk papers and revised PPT slides are due one week after your group presents. So, each group has a difference submission date for talk papers and slides. Submit the talk papers and revised PPT slides **ONLY** to me via email gcollins@engr.colostate.edu

HW Due Dates

HW #1 – Sept 3

HW #2 – Sept 10

HW #3 - Sept 17

HW #4 – Oct 8

HW #5 -, Oct 15

HW #6 – Oct 22

HW #7 – Oct 29 (Optional)

HW #8 – Nov 19 (Optional)

Pop Quiz Due Dates

Pop Quiz #1 – September 1

Pop Quiz #2 - September 8

Pop Quiz #3 -, September 15

Pop Quiz #4 - September 22

Pop Quiz #5 - **October 13**
Pop Quiz #6 - **October 20**
Pop Quiz #7 - **October 27 (Optional)**
Pop Quiz #8 - **November 10 (Optional)**

461 PSSE Labs and due dates below

LAB #	DUE Date
1	Oct 15
2	Oct 22
3	Oct 29
4	Nov 19 (Optional)

ECE462 Motor Lab Due Dates

462 Motor Lab Teaching Assistant (TA):

There will be 4 Motor Labs (Tentative). Tentative due dates are as follows.

Motor Lab # 1 Due **September 11**

Motor Lab #2 Due **October 2**

Motor Lab #3 Due **October 16**

Motor Lab #4 Due **November 6**

TA will assign motor labs after you form lab groups. Lab times/hours for each group to do the lab will be decided as well as respective due dates. Form your 462 motor lab groups ASAP to get desired lab times. Lab report for each experiment should be submitted to the TA within the deadline