ECEN 4517/5517

Power Electronics and Photovoltaic Power Systems Laboratory

Lecture 1

Introduction

Course Information

Course:	Power Elec. & PV Power Systems Lab. (ECEN 4517/5517)
Lecture:	M 1-1:50 pm in ECEE 1B32
Laboratory:	Section 1: T 12-3:50 pm in ECEE 1B65 Section 2: W 12-3:50 pm in ECEE 1B65 Section 3: Th 12-3:50 pm in ECEE 1B65
Prerequisite:	ECEN 4797/5797 (Introduction to Power Electronics)
Instructor:	Khurram Afridi Office: ECOT 342 Phone: (303) 492-8905 Email: khurram.afridi@colorado.edu
Office Hour:	M 10-11 am

Teaching Assistants

TA's: T: Ashish Kumar, ashish.kumar@colorado.edu

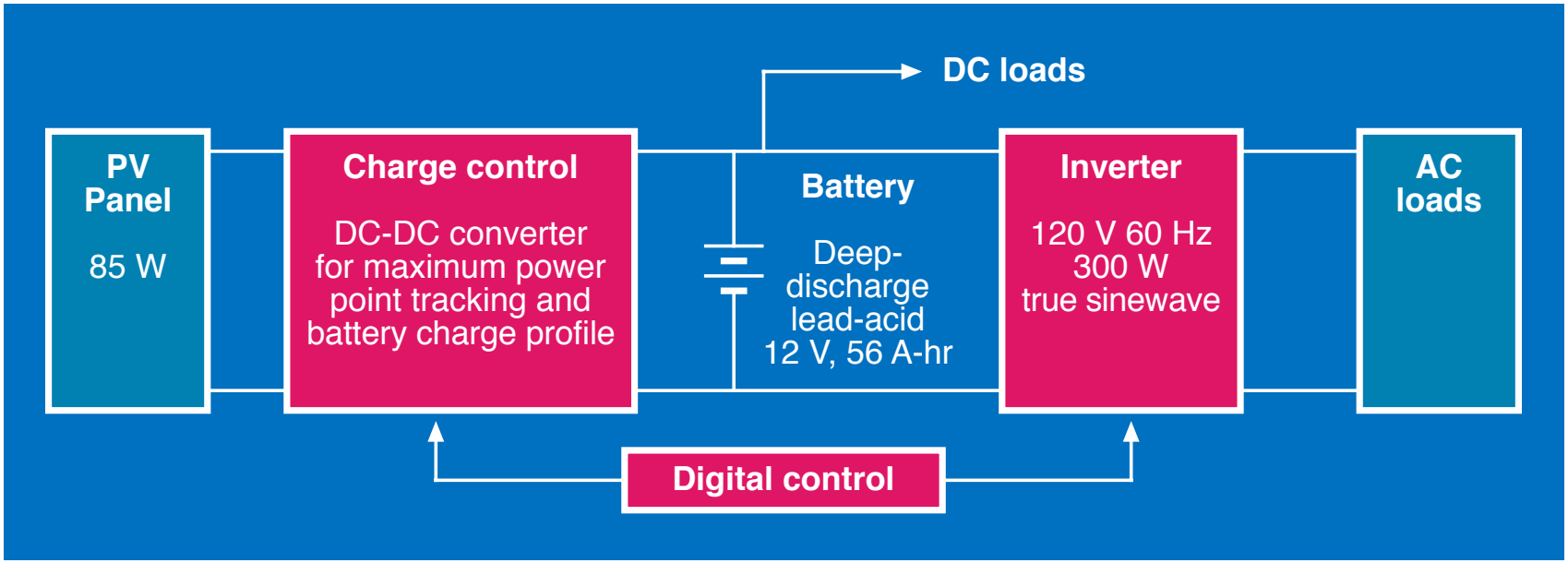
W: Saad Pervaiz, saad.pervaiz@colorado.edu

Th: Sreyam Sinha, sreyam.sinha@colorado.edu

Contact: Use "ECEN 5517" or "ECEN 4517" in subject line of course related emails

Course Objective

- Learn to develop power electronic converters and systems
- Design, build, test and demo a PV system by end of the course



Laboratory Logistics

Groups:
- Experiments done in groups
- Group size: 2 people (may have one 3-person group)
- Up to 10 groups per section

Parts Kit:
- Contains parts needed for experiments
- One kit needed per group; cost around $160
- Available from ECEE electronic store (ECEE 1B10)
- Also need probes, small parts from undergrad circuits lab kit

Lab Access:
- Access via CUID card reader

Lab Bench:
- Three groups will share a bench (one from each section)
- Can store parts in own lockable drawer
- Rent lock and key for semester from electronic store
- Computer login via CU Identikey

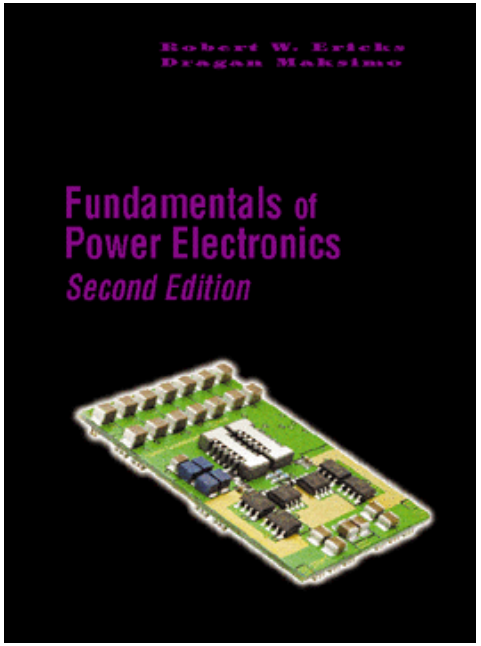
Course Materials

Lecture Slides

- Slides posted on course website after lecture

Textbook

- Erickson and Maksimovic, *Fundamentals of Power Electronics,* second edition
- Copy of the book is on reserve at Gemmill Engineering Library



Additional Resources

- Extensive supplementary learning material on course website

Assessment

Lab Performance and Attendance

- 5 experiments done as a group – ECEN 5517 groups do some extra work

Pre-lab Assignments

- 4 pre-lab assignments done as a group

Lab Reports

- 6 lab reports done as a group (1 of these is simply a signoff sheet)

Quizzes

- 2 in-class quizzes done individually; no collaboration of any form

Expo

- Complete system demo at ECEE Expo as a group

Assessment (Cont.)

Grading

- Lab performance and attendance (individual): 15%
- Pre-lab assignments (group): 15%
  - All 4 pre-lab assignments weighted equally
- Lab reports (group): 40%
  - The 6 lab reports have different weights
  - 10% each for 1, 2 and 3-1; 20% for 3-2; and 25% each for 4 and 5
- Quizzes (individual): 20%
- Expo (group): 10%

Lab Notebook and Lab Reports

Lab Notebook

- Each group should get a lab notebook
- Record all data from every step of procedure
- Adequately document each step

Lab Reports

- Should demonstrate that you understand every step of the experiment
- Discuss every step of the experiment (procedure and calculations)
- Report all data
- Interpret the data
- Lack of discussion or interpretation of data will yield few points
- Clearly annotate waveforms and circuit diagrams, include figure captions
- Messy work will not receive credit
- Concise is good

Online Resources

D2L: https://learn.colorado.edu

- Course information/syllabus, calendar, lecture slides and learning material
- Discussion forum and announcements
- Pre-labs and experiments download
- Pre-labs and lab reports submission
- Deadlines for pre-labs and lab reports are enforced by the system
- Continuously updated, please check frequently
- Login using your CU IdentiKey

Previous Years' Material: http://ece.colorado.edu/~ecen4517

- This year's experiments and pre-labs will be the same
- Excellent resource to see what is coming

Additional Policies and Procedures

Pre-lab Assignment and Lab Report Policies

- No late work will be accepted (except in cases of documented emergencies)
- Collaboration is allowed; however, work turned in must be your own groups
- Details of policies are given on course D2L website

Pre-lab Assignment and Lab Report Submission Procedure

- One pre-lab assignment and one lab report per group
- Write name of every group member and email address on the front page
- Convert to single pdf file; if scanning use b&w at 150-300 dpi
- Submit online via D2L by uploading single pdf
- Keep a copy of your work

Teaching Philosophy

- You are all here to learn!

Announcements

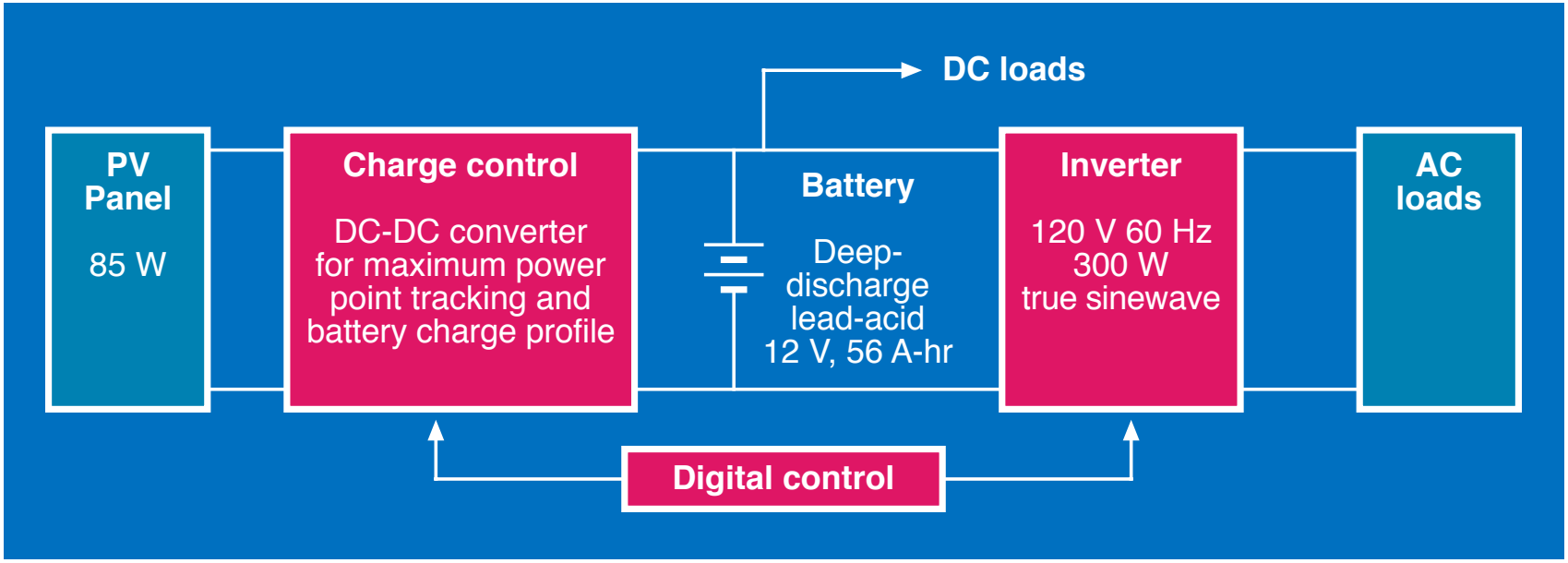
- Key logistical tasks for today:
  - Form groups
  - Select sections

- Week 1 objective is complete Experiment 1
  - Watch Experiment 1 videos asap (available on course website)
  - Experiment 1 has no pre-lab; Hope for sun! In case of bad weather (<250W/m^2 irradiance) follow instructions in Exp. 1 Lab Assignment
  - Experiment 1 Lab Report due by 11:59 pm on Friday January 27, 2017
  - Experiment 3-1 Pre-lab also due by 11:59 pm on Friday January 27, 2017

Course Calendar

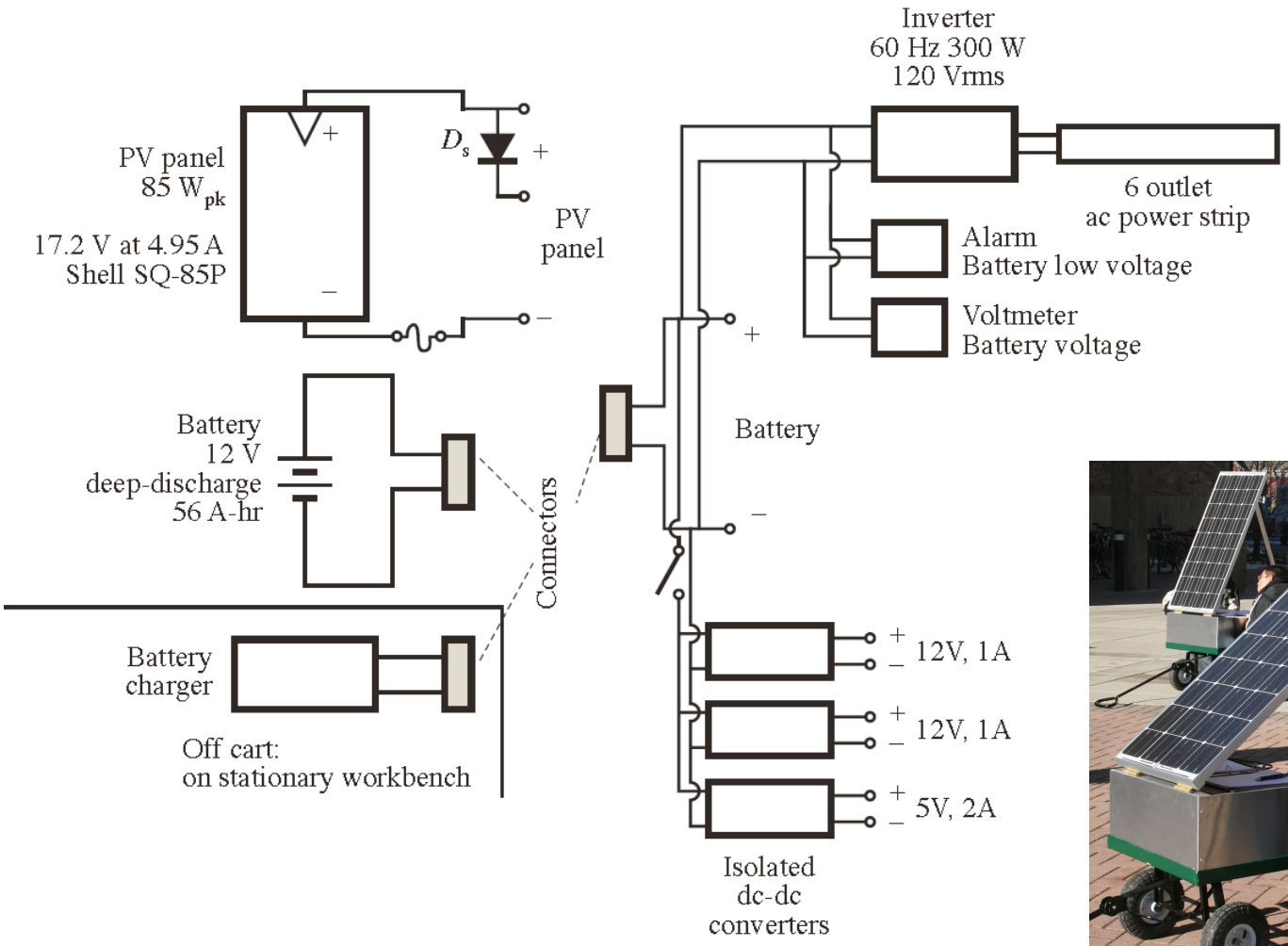
	Monday	Tuesday	Wednesday	Thursday	Friday
January	16: No classes (MLK Jr. Holiday)	17: Lecture 1 (Orientation) **First Day of Classes**	18: Lab Session (Exp 1)	19: Lab Session (Exp 1)	20: Lab Session (Exp 1) – Tuesday Group
	23: Lecture 2	24: Lab Session (Exp 2)	25: Lab Session (Exp 2)	26: Lab Session (Exp 2)	27: **LabReport1 Due** **PreLab3-1 Due**
	30: Lecture 3	31: Lab Session (Exp 3-1)			
February			1: Lab Session (Exp 3-1)	2: Lab Session (Exp 3-1)	3: **LabReport2 Due**
	6: Lecture 4	7: Lab Session (Exp 3-1)	8: Lab Session (Exp 3-1)	9: Lab Session (Exp 3-1)	10:
	13: Lecture 5	14: Lab Session (Exp 3-1)	15: Lab Session (Exp 3-1)	16: Lab Session (Exp 3-1)	17: **PreLab3-2 Due**
	20: Lecture 6	21: Lab Session (Exp 3-2)	22: Lab Session (Exp 3-2)	23: Lab Session (Exp 3-2)	24: **LabReport3-1 Due**
	27: **Quiz 1**	28: Lab Session (Exp 3-2)			
March			1: Lab Session (Exp 3-2)	2: Lab Session (Exp 3-2)	3: **PreLab4 Due**
	6: Lecture 7	7: Lab Session (Exp 4)	8: Lab Session (Exp 4)	9: Lab Session (Exp 4)	10: **LabReport3-2 Due**
	13: Lecture 8	14: Lab Session (Exp 4)	15: Lab Session (Exp 4)	16: Lab Session (Exp 4)	17:
	20: Lecture 9	21: Lab Session (Exp 4)	22: Lab Session (Exp 4)	23: Lab Session (Exp 4)	24: **PreLab5 Due**
	26: No classes (Fall Break)	27: No lab (Fall Break)	28: No lab (Fall Break)	29: No lab (Fall Break)	30:
April	3: Lecture 10	4: Lab Session (Exp 5)	5: Lab Session (Exp 5)	6: Lab Session (Exp 5)	7: **LabReport4 Due**
	10: Lecture 11	11: Lab Session (Exp 5)	12: Lab Session (Exp 5)	13: Lab Session (Exp 5)	14:
	17: Lecture 12	18: Lab Session (Assemble Complete System)	19: Lab Session (Assemble Complete System)	20: Lab Session (Assemble Complete System)	21: **LabReport5 Due**
	24: **Quiz 2**	25: Lab Session (Assemble Complete System)	26: Lab Session (Assemble Complete System)	27: Lab Session (Assemble Complete System)	28:
May	1: Lab Session (Final Demo Prep) – Thursday Group	2: Lab Session (Final Demo Prep)	3: Lab Session (Final Demo Prep)	4: **Expo - Final Demo**	5: **Last Day of Classes**
	8:	9:	10:	11: **End of Semester**	12:

Experiments

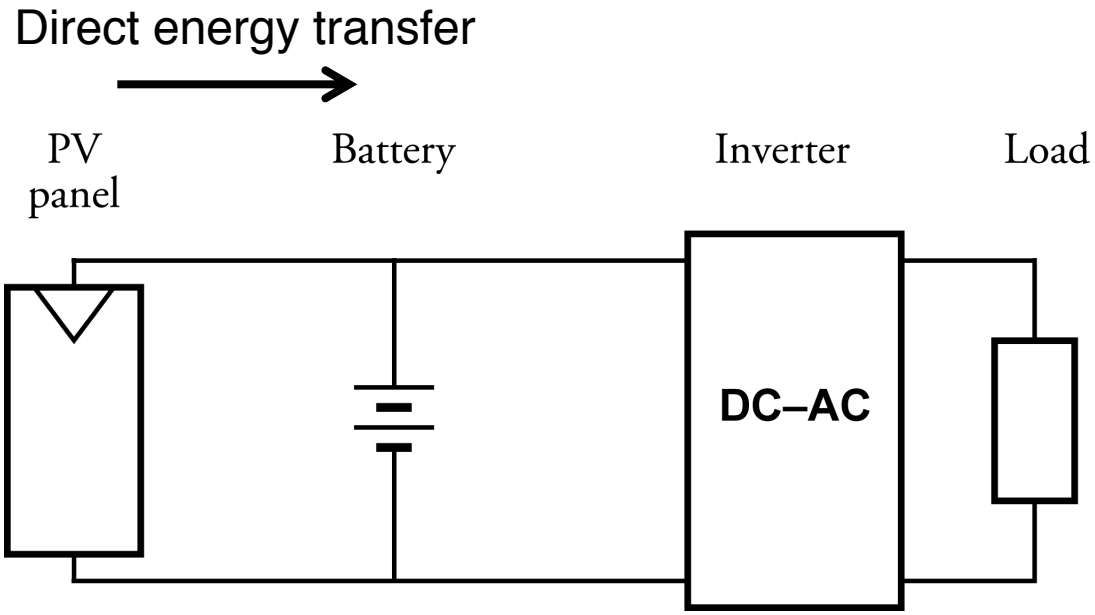


- Exp 1 – PV panel and battery characteristics and direct energy transfer
- Exp 2 – TI MSP430 microcontroller introduction
- Exp 3-1, 3-2 – Buck dc-dc converter for PV MPPT and battery charge control
- Exp 4 – Step-up 12V-200V dc-dc converter
- Exp 5 – Single-phase dc-ac converter (inverter)
- Expo – Complete system demonstration

PV Cart


Inverter
60 Hz 300 W
120 Vrms
6 outlet
ac power strip
Alarm
Battery low voltage
Voltmeter
Battery voltage
PV panel
85 W pk
17.2 V at 4.95 A
Shell SQ-85P
D_s
PV
panel
Battery
12 V
deep-discharge
56 A-hr
Battery
Connectors
Battery
charger
Off cart:
on stationary workbench
12V, 1A
12V, 1A
5V, 2A
Isolated
dc-dc
converters

Experiment 1

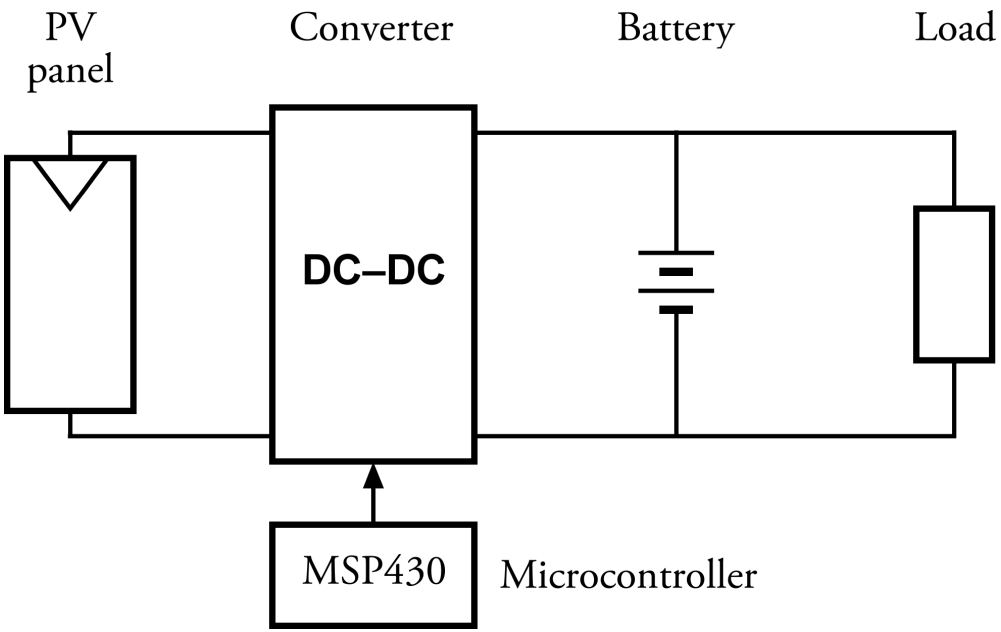


- Model PV panel
- Investigate direct energy transfer system behavior
- Investigate effects of shading
- Observe behavior of lead-acid battery

Experiment 1 - Details

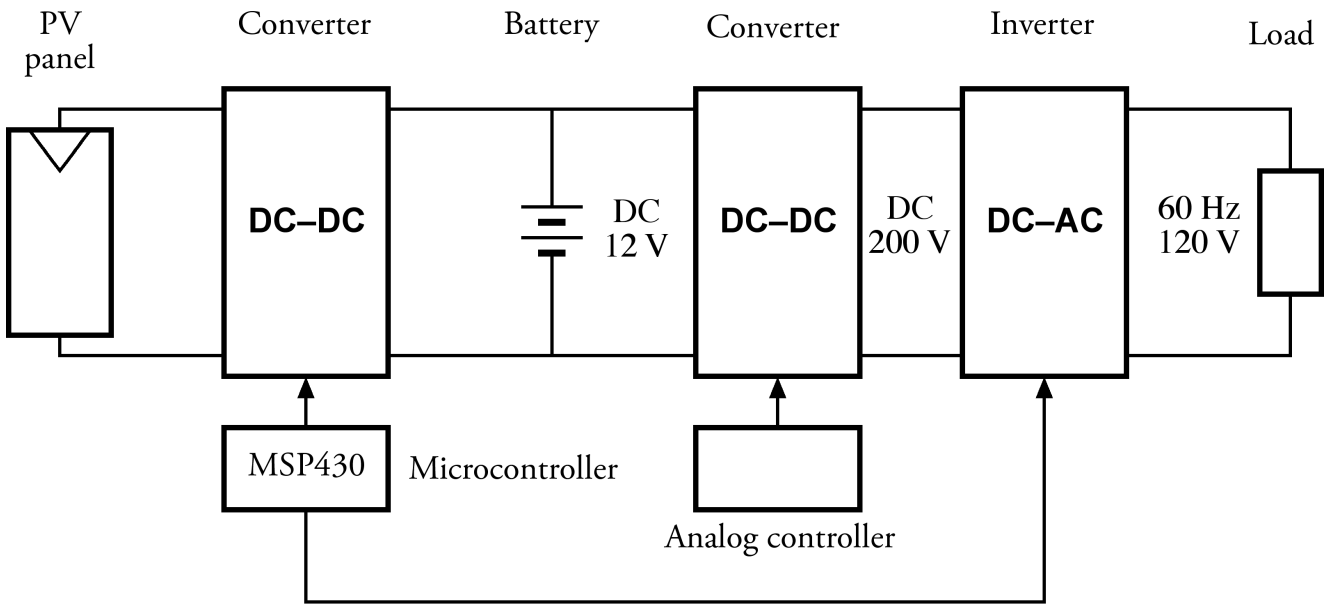
- Characterize the SQ-85 PV panels, and find numerical values of electric circuit model parameters for use now and later in the semester
- Examine effects of shading
- Observe operation of lead-acid battery
- Test the inverter provided
- Charge the battery from the panel, using the Direct Energy Transfer method

Experiments 2 and 3



- Exp 2: Learn to use TI MSP430 microcontroller
- Exp 3-1: Design and construct dc-dc converter system behavior
- Exp 3-2: Employ microcontroller to achieve maximum power point tracking MPPT and battery charge control

Experiments 4 and 5



- Exp 4: Step up battery voltage to 200 Vdc and regulate with an analog feedback loop
- Exp 5: Build inverter to change 200 Vdc in to 120 Vac to drive ac loads

ECEE Expo and Lab Competition

Previous year's competition poster

- Operate your complete system
- Competition: Capture the most energy with your system outside