ECE 2210

Electrical Engineering for Nonmajors
Spring 2019 Class Syllabus

Instructor: Arn Stolp
Office: MEB 2262
Phone: U of U: 581-4205
Only if it's important: Cell: (801) 657-7766
E-mail: arnstolp@ece.utah.edu (I rarely check my e-mail, so let me know by some other method if you send me email that I need to read.)
Office hours: My "office hours" are the problem sessions. Otherwise, it's catch me if you can. I'm usually around until at least 2:00 p.m. M, W, & F. If I'm not in my office, check the lab. To increase your chances, talk to me in class to say when you'd like to see me. I teach another class right after this one M, W, F.

Web Site: http://www.ece.utah.edu/~ece2210/

Required books and lab supplies:
Practical Electronics for Inventors, 3rd or 4th Ed, by Paul Scherz
6 required class material packs (available on website) & Ring binder
Lab notebook (bound or spiral)
Breadboard & Lab parts available for purchase at lab (~$16 on your U-card)
Prerequisites: MATH 2250 and PHYCS 2220

Introduction:

In case you haven't noticed, you're surrounded by electrical and electronic devices. Electrical motion, measurement and control are powerful and cheap, so they're used everywhere and are part of every technical career, including yours. Maybe you can find a job where other people make all the decisions concerning wiring, power distribution, electric motors, communications systems, instrumentation, and control; but do you *really want* that? Do you really *want* to be the clueless one?

ECE 2210 will introduce you to some of the basics of electrical engineering. This may not seem important now, but I think you will find these concepts very useful in your future classes and jobs. Besides, they'll help you pass the FE exam, and that should be of immediate concern.

I teach concepts and the use of those concepts to solve problems, not formulas and memorization. The hands-down easiest way get a good grade in this class is to learn those concepts.

This class consists of:

Lectures: W & F 9:40 -10:30 am in WEB L103

Lectures set the direction and tone of the class and cover more than the written material. You will be held accountable for everything discussed in the lectures, so your attendance is important.

Problem Sessions: M 9:40am in WEB L103 & W _____ in _____

We cover a lot of material in this class and there is rarely enough lecture time to work examples or to answer your questions in detail. I will not cover new material in the problem session, so you can get by without coming, but I think you'll find it worth your while.

Textbook:

The text contains a great deal of practical, useful information beyond the theoretical material we cover in this class. It should prove to be a good reference. The reading page numbers are for the 3rd edition (4th edition page may be a little different).

Supplementary Packets (in place of class handouts):

I've supplemented the textbook with packs of class material which you will download from the class web site (http://www.ece.utah.edu/~ece2210/). You should have received a class email with links. The packets are separated into class notes, homework assignments, and lab instructions. The packets available now will cover the first half of the class, additional packets will be available in March. Much of this material is also available individually on the web site. You will probably want to print much of this material. You can sign on to computers in the lab with the same user name and password you use (or can get) in the Engman computer lab (the one in WEB, floor L2). Then you can use the printers in the lab. The packets are designed to be printed on both sides of the pages. Please conserve paper and weight in your backpack.

Homework, homework, and more homework: 100 pts.

Expect a homework assignment for each lecture, to be turned in twice-a-week, usually on Mondays and Thursdays, all from the Homeworks packet. Homework will be your main study tool. As such, I'll give you all the answers so that you can check your work immediately. In fact, you'll have to self-correct your homework. If you can't get the answer, check the web site for corrections, study some more, come to the problem session, ask for help, or see the posted solutions. Sometimes I even post solutions *before* the homework is due. So, you might ask, "Why is it handed in and 'graded'?". Well, to answer a question with a question, "Would you even do it otherwise?"

Your homework should be neat and clear and show all your work. For most problems the grader will simply check to see that you've done it and that your paper shows the enough work to get the answer. Only a few problems will be checked in greater detail. You may collaborate with others to learn how to do the homework, but will need to hand in your own work. Copying or allowing another student to copy your work is considered cheating.

You will probably learn more from doing the homework than any other part of this class. If you thoroughly understand the homework, you will know what the class is about, and the exams should give you no trouble.

On the 2nd floor of MEB, in center hallway, you'll find some lockers with slots in the doors. Drop your homework in the ECE 2210 HOMEWORK locker by 5:00 p.m. of the due date. I will accept *some* late homework for *some* credit. Bring it directly to me, and don't do it habitually. Solutions will be posted in a in my office window. Graded homework, lab notebooks and exams will be returned to a file cabinet in MEB 2101 according to a folder number you will receive later. Once you get your number, you should write it on the upper left-hand corner of everything you hand in. Your material will be an unlocked

drawer and will **not be secure**. If you want your material returned to a locked location, simply remove your file and slip it under my office door.

Midterms: 300 pts.

You will take three 50-minute midterms throughout the semester. They will cover material up to the time of the test. My exams are designed to see if you learned concepts and problem solving strategies and whether you can work with them, sometimes in new and different ways. Don't try to memorize formulas or specific problems. Exams also cover what you learn in the labs. All exams are closed book, closed notes, no phones, tablets or computers allowed. The class may be split into two or more rooms on exam days, listen in class for details.

Final: Thursday, 4/25/19, 8:00 -10am 180 pts.

The final will be comprehensive with greater emphasis on the most recent material. There will be a review Wednesday, 4/24, 1:00pm probably in WEB L103, listen in class for details.

Labs: MEB 2265 120 pts.

Lab will be held every week, beginning the second week and including the last week of class. Many of the subjects covered in lab aren't covered anywhere else in class, so make sure you pay attention and read the lab instructions. You will have to keep a laboratory notebook as a requirement of the lab. Your lab TA will collect and grade these notebooks.

Two labs will be replaced by a special lecture during lab time.

Labs are **not optional.** For each lab that you miss or fail (< 60% score), your final grade will suffer a **half letter drop** (5% of possible points). Be sure to make-up any labs you miss or fail.

Grades:

	Pts
Homework:	100
Labs:	120
Midterms:	300
Final:	180
Total:	700
Failed lab:	-35
Cheating:	-700

% of total	Grade
> 93	A
90-93	A-
87-90	B+
83-87	B
80-83	B-
77-80	C+
73-77	C
70-73	C-
67-70	D+
63-67	D
60-63	D-
< 60	E

If you want any deviations from the normal requirements (say credit for labs, you've done before) you will need to see me before the work would normally be due and get an agreement *in writing*. You'll need to turn in your copy of the agreement with your final, so I'll remember to grade you properly.

COLLEGE OF ENGINEERING GUIDELINES

Spring Semester 2019

Americans with Disabilities Act (ADA)

The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities. If you need accommodations in a class, reasonable prior notice needs to be given to the instructor and to the Center for Disability Services, 162 Olpin Union, 581-5020 (V/TDD) to make arrangements for accommodations. All written information in a course can be made available in alternative format with prior notification to the Center for Disability Services.

Adding Classes

Please read carefully: All classes must be added within two weeks of the beginning of the semester (deadline: Friday, January 18, January 11 for session I). Late adds will be allowed January 19-28, requiring only the instructor's signature. Any request to add a class after January 28, will require signatures from the instructor, department, and Dean, and need to be accompanied by a petition letter to the Dean's office.

A $50 FEE WILL BE ASSESSED BY THE REGISTRAR'S OFFICE FOR ADDING CLASSES AFTER January 28.

Withdrawal Procedures

See the web page for details: http://registrar.utah.edu/academic-calendars/

See the Class Schedule or web for more details. Please note the difference between the terms "drop" and "withdraw". Drop implies that the student will not be held financially responsible and a "W" will not be listed on the transcript. Withdraw means that a "W" will appear on the student's transcript and tuition will be charged.

Drop Period – No Penalty

Students may DROP any class without penalty or permission until Friday, January 18, 2019.

Withdrawal from Full Term Length Classes

Students may WITHDRAW from classes without professor's permission until Friday, March 8, 2019.

Between January 19 and March 8, a "W" will appear on the transcript AND tuition will be charged. Refer to Class Schedule, Tuition and Fees for tuition information..

Withdrawals after March 8 will only be granted due to compelling, nonacademic emergencies. A petition and supporting documentation must be submitted to the Dean's Office, 1602 Warnock Engineering Building. Petitions must be received before the last day of classes (April 23, 2019).

Withdrawal from Session I & Session II

See the web page for details: http://registrar.utah.edu/academic-calendars/spring2019.php

Repeating Courses

When a College of Engineering class is taken more than once, only the grade for the second attempt is counted. Grades of W, I, or V on the student's record count as having taken the class. Some departments enforce these guidelines for other courses as well (e.g., math, physics, biology, chemistry). Attempts of courses taken at transfer institutions count as one attempt. This means a student may take the course only one time at the University of Utah. Courses taken at the University of Utah may not be taken a second time at another institution. If a second attempt is needed, it must be at the University of Utah. Please work with your department advisor to determine the value of repeating courses. Students should note that anyone who takes a required class twice and does not have a satisfactory grade the second time may not be able to graduate. It is the responsibility of the student to work with the department of their major to determine how this policy applies in extenuating circumstances.

Appeals Procedures

See the Code of Student Rights and Responsibilities, located in the Class Schedule or on the UofU Web site for more details

Appeals of Grades and other Academic Actions

If a student believes that an academic action is arbitrary or capricious he/she should discuss the action with the involved faculty member and attempt to resolve. If unable to resolve, the student may appeal the action in accordance with the following procedure:

1. Appeal to Department Chair (in writing) within 40 business days; chair must notify student of a decision within 15 days. If faculty member or student disagrees with decision, then,
2. Appeal to Academic Appeals Committee (see http://www.coe.utah.edu/current-undergrad/appeal.php for members of committee). See II Section D, Code of Student Rights and Responsibilities for details on Academic Appeals Committee hearings.

ECE 2210

A. Stolp

Tentative

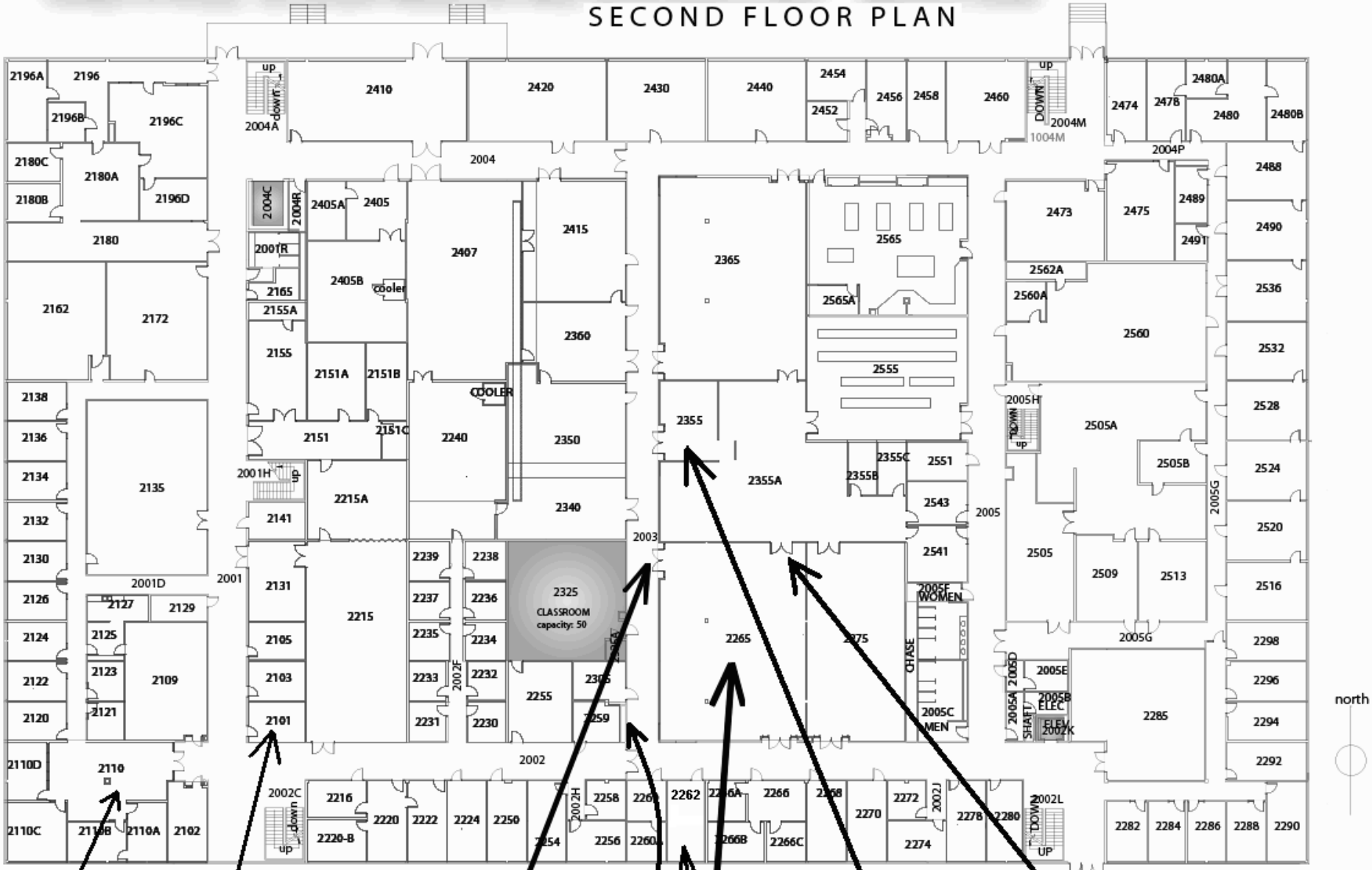
01/04/19

COURSE SCHEDULE

Week		Date	lect	Topics	Textbook (3rd ed.)
1	W	01/09	1	Introduction, Basic electrical units & symbols, Kirchhoff's laws	Ch1, 2.1-3, 2.17
	F	01/11	2	Resistance, Ohm's law, Power, Resistors in parallel & series	2.5-7, 2.11-12, 3.5
2	W	01/16	3	Voltage and current dividers, Sources, Nodes, Grounds, Branches, Meters	2.10, 2.12-16
	F	01/18	4	Superposition, Practical voltage and current sources	2.18, 3.2
3	M	01/21		Martin Luther King Day	
	W	01/23	5	Thevenin & Norton Equivalent Circuits, Max power transfer	2.19
	F	01/25	6	Thevenin & Norton Equivalent Circuits	notes
4	W	01/30	7	Networks, Nodal analysis	2.17, notes
	F	02/01	8	Introduction to AC & Signals	2.29
5	W	02/06	9	Capacitors, RC first order transients	2.23, 3.6
	F	02/08		Exam 1	
6	W	02/13	10	Inductors, Resonance, RL first order transients	2.24, 2.30, 3.7
	F	02/15	11	First order transients	2.34
7	M	02/18		Presidents Day	
	W	02/20	12	Steady-state Sinusoids, Phasors, & Complex numbers	2.25-26
	F	02/22	13	Phasors, Impedance, & AC circuits	2.27
8	W	02/27	14	AC circuit examples	2.29-30
	F	03/01	15	Filters & Bode plots	2.31-33, notes
9		lab lect	16	Second order transients, Laplace Impedance, Transfer functions	2.34, notes
	W	03/06		Exam 2	
	F	03/08	17	Second order transients, Time-domain solutions	notes
10	M	03/11		Spring Break	
	F	03/15			
11	W	03/13	18	Second order transients, Initial and final conditions	notes
	F	03/15	19	Second order transient examples, Systems	notes
12	W	03/27	20	Diodes basics, Diodes in DC circuits	4.2
	F	03/29	21	Diodes in AC circuits, Rectification	4.2, notes
13	W	04/03	22	Diodes, Transistors	4.3
	F	04/05	23	Transistors & Switching circuits	4.3, notes
14		lab lect	24	Operational Amplifiers	Ch 8
	W	04/10		Exam 3	
	F	04/12	25	Operational Amplifiers	Ch 8
15	W	04/17	26	RMS and AC Power	2.21-22
	H	04/18		ME Design Day in Union ballroom, Attendance is required for HW DD	
	F	04/19	27	AC Power, Transformers	2.28, 3.8
	M	04/22		Problem Session at normal class time	
16	W	04/24		Problem Session at normal class time / Review, 1:00pm in _____	
	H	04/25		Final Exam, 8:00am	

MERRILL ENGINEERING BUILDING (BLDG. 064)

SECOND FLOOR PLAN



ECE office

Homework, labs and exams are returned to a file cabinet in MEB 2101

Door with card access

Lockers for homework and lab notebooks

Lab

Arn's Office (MEB 2262)
(Homework solutions will be posted here)

Stockroom to buy parts

Checkout Window

ECE 2210 Spring Semester, 2019

01/04/19

Week	Month	Mon	Tue	Wed	Thur	Fri
1	Jan	7 First Day of Spring Classes	8	9 First class	10	11
2		14	15	16	17	18 Last day to add or drop 2210
3		21 Martin Luther King Day	22	23	24	25
4		28	29	30	31	1 Last day to withdraw 2200
5	Feb	4	5	6	7	8 Exam 1
6		11	12	13	14	15
7		18 Presidents Day	19	20	21	22
8		25	26 Last 2200	27	28	1 Lab lecture 3:05
9	Mar	4	5 Lab lectures 10:45 & 2:00 Exam Review 4:00	6 Exam 2 Lab lecture 12:00	7 Lab lecture 8:30 Lab lecture 3:05	8 Last day to withdraw 2210
8		11 Spring Break, find some sun	12	13	14	15
		18	19	20	21	22
9		25	26	27	28	29
10	April	1	2	3	4	5 Lab lecture 3:05
11		8	9 Lab lectures 10:45 & 2:00 Exam Review 4:00	10 2210 Exam 3 Lab lecture 12:00	11 Lab lecture 8:30 Lab lecture 3:05	12
12		15	16	17	18 ME Design Day in Union bldg	19 Last day to reverse CR/NC 2210
13		22	23 Last Day of Classes	24 Reading Day ECE 2210 prob ses Final Review 1:00	25 Finals begin ECE 2210 8:00am ME 2030 10:30 ME 2450 1:00	26
14	May	29 ME 2650 8:00	30 ME 2650 8:00	1 ME 2550, 3610-2 8:00 ME 2010, 3300 10:30	2 Freedom	3

ECE 2210 Spring Semester, 2019

Note: Check these final dates and times for yourself

ECE 2210 Spring Semester, 2019 Homeworks & Labs

01/04/19

Week	Month	Mon	Tue	Wed	Thur	Fri
1	Jan	7	8	9	10	11
2		14 HW 1	15 Lab 1	16 Lab 1	17 HW 2 Lab 1	18 Lab 1
3		21 Martin Luther King Day	22 Lab 2	23 Lab 2	24 HW 3 Lab 2	25 Lab 2
4		28 HW 4	29 Lab 3	30 Lab 3	31 HW 5 Lab 3	1 Lab 3
5	Feb	4 HW 6	5 Lab 4	6 Lab 4	7 HW 7 Lab 4	8 Exam 1 Lab 4
6		11 HW 8	12 Lab 5	13 Lab 5	14 HW 9 Lab 5	15 Lab 5
7		18 Presidents Day	19 HW 10 Lab 6	20 Lab 6	21 Lab 6	22 HW 11 Lab 6
8		25	26 Lab 7	27 HW 12 Lab 7	28 Lab 7	1 Lab lecture 3:05
9	Mar	4 HW 13	5 Lab lectures 10:45 & 2:00 Exam Review 4:00	6 Exam 2 Lab lecture 12:00	7 Lab lecture 8:30 Lab lecture 3:05	8 HW 14 Lab 7
		11 Spring Break	12	13	14	15
10		18 HW 15	19 Lab 8	20 Lab 8	21 HW 16 Lab 8	22 Lab 8
11		25 HW 17	26 Lab 9	27 Lab 9	28 HW 18 Lab 9	29 Lab 9
12	April	1 HW DO1	2 Lab 10	3 Lab 10	4 Lab 10	5 HW DO2 Lab lecture 3:05
13		8	9 Lab lectures 10:45 & 2:00 Exam Review 4:00	10 2210 Exam 3 Lab lecture 12:00	11 Lab lecture 8:30 Lab lecture 3:05	12 HW TR1 Lab 10
14		15 HW OA1	16 Lab 11	17 Lab 11	18 HW OA2 Lab 11 ME Design Day in Union bldg	19 Lab 11
15		22 HW DD, HW PA1	23 Lab extra day HW PA2 (may be held until final)	24 Reading Day ECE 2210 prob ses Final Review 1:00	25 Finals begin ECE 2210 8:00am	26
16	May	29	30 ECE review 3:30	1	2 Freedom	3

ECE 2210 Spring Semester, 2019 Homeworks & Labs

ECE 2200/10 Lecture 1 Introduction to Electrical Engineering for non-majors

A. Stolp
12/30/11
8/24/15

2200 = 1/2 semester (Civil, Mining)

ECE 2200 Without the Physics is hard, Plan on it!

Decide today when you will take the **FINAL**: Bad option: Final in your last lab session, Start labs this Thurs.
2nd option: Final with 2210 exam 2 on 3/6. Start labs next week.

If you don't take the later final you will have to start labs **Thursday, THIS WEEK**

2210 = Full semester (Mechanical, Chemical, Mat. Sci, etc.)

Labs start **next week**

2210 Final Thursday, April 25, 8:00am.

Make sure you are registered for the right class (2200 or 2210) and that you have the right syllabus.

BOTH

Bring a lab notebook and a U-card loaded with $15 to 1st lab.

Homeworks are due by 5:00 pm in locker _____ (see map for location of lockers)
WARNING: HWs are often due on non-class days.

Problem sessions M, 9:40 in regular classroom W, _____

Copy packets are on class website, check your email and/or syllabus for links

How to survive

1. Easiest way to get through school is to actually learn and retain what you are asked to learn.
   Even if you're too busy, don't lose your good study practices.
   What you "just get by" on today will cost you later.

   Don't fall for the "I'll never need to know this" trap. Sure, much of what you learn you may not use, but you will need some of it, some day, either in the current class, future classes, or maybe sometime in your career. Don't waste time second-guessing the curriculum, It'll still be easier to just do your best to learn and retain what is covered.

2. Don't fall for the "traps".
   Homework answers, Problem session solutions, Posted solutions, Lecture notes.

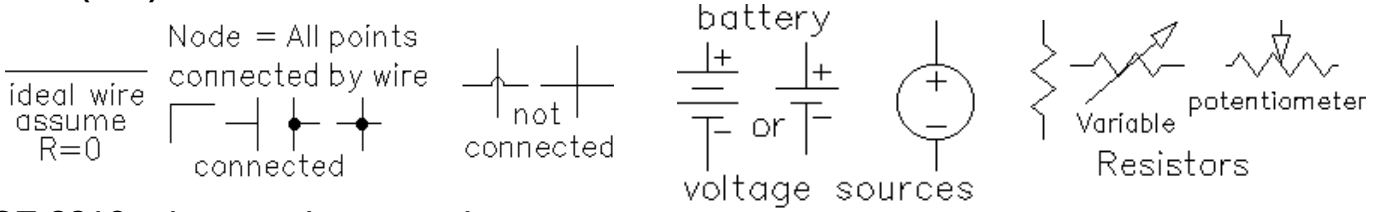
3. KEEP UP! Use calendar.

4. Make "permanent notes" after you've finished a subject or section and feel that you know it.

Lecture

Basic electrical quantities	**Letter used**	**Units**	**Fluid Analogy**
Charge, actually moves	Q	Coulomb (C)	m^3
Current, like fluid flow	$I = \frac{Q}{sec}$	Amp (A, mA, μA,...)	$\frac{m^3}{sec}$
Voltage, like pressure	V or E	volt (V, mV, kV,...)	$Pa = 1 \cdot \frac{N}{m^2}$
Resistance 	$R = \frac{V}{I}$	Ohm (Ω, kΩ, MΩ,...)	
Conductance 	$G = \frac{1}{R}$	Siemens (S, also mho, old unit)	
Power = energy/time	$P = V \cdot I$	Watt (W, mW, kW, MW,...)	W

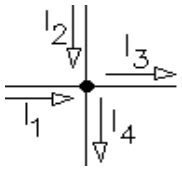
Symbols (ideal)



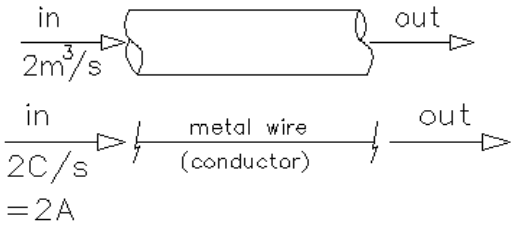
ECE 2210 Lecture 1 notes p2

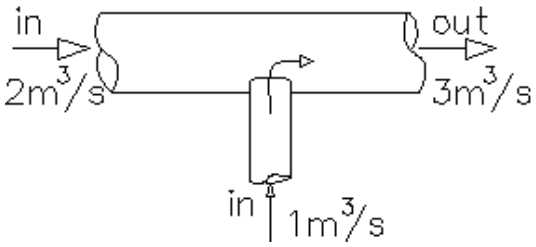
KCL, **K**irchhoff's **C**urrent **L**aw

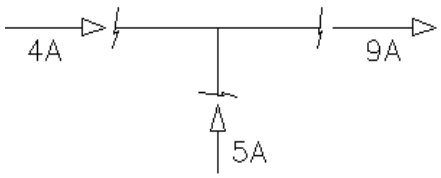
$I_{in} = I_{out}$ of any point, part, or section

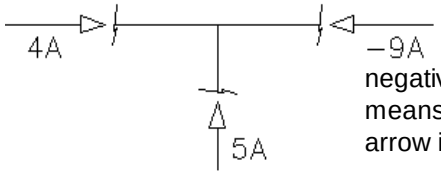


$$I_{in} = I_{out}$$
$$I_1 + I_2 = I_3 + I_4$$

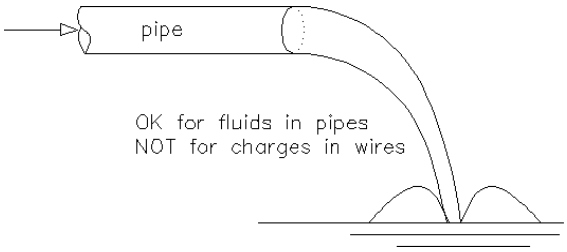








negative current means the direction arrow is wrong



Conductors Nonconductors

Massless fluid in our analogy

No gravity effects No Bernoulli effects

Reasonable because:

Electron mass is $9.11 \cdot 10^{-31} \cdot kg$

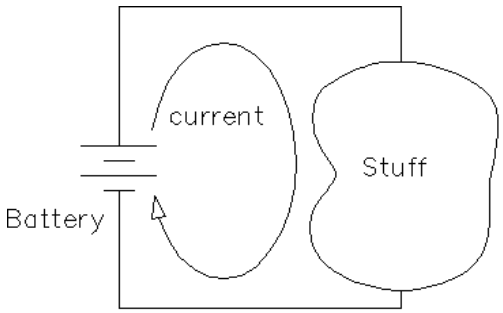
Election charge is $-1.6 \cdot 10^{-16} \cdot C$

Negative charge flows in negative direction

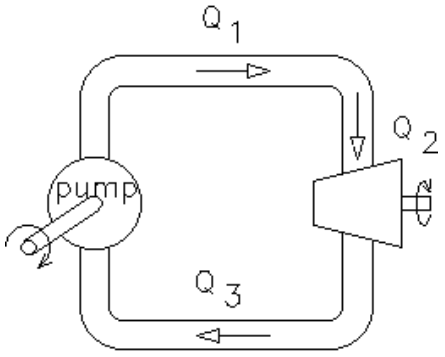
Battery also obeys KCL

No accumulation of charge anywhere, so it must circulate around.

Leads to the concept of a "Circuit"



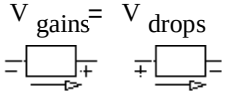
A circuit



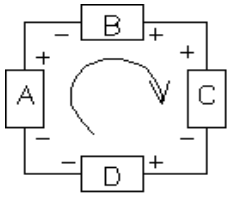
Voltage is like pressure

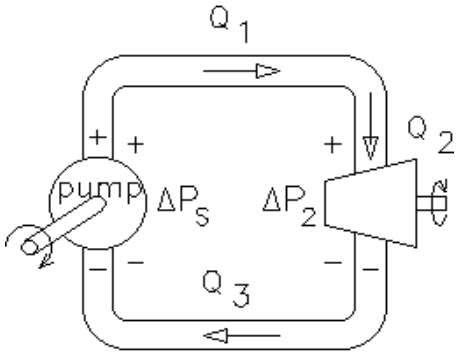
KVL, **K**irchhoff's **V**oltage **L**aw

$V_{gains} = V_{drops}$



around any loop





ECE 2210 Lectures 2 & 3 notes

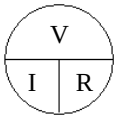
A. Stolp
1/28/06,
9/5/08

Ohm's law (resistors)

$V = I \cdot R$

$I = \frac{V}{R}$

$R = \frac{V}{I}$ definition of resistance and the unit "Ω"



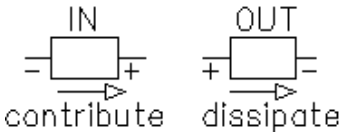
Power

flow $\frac{m^3}{sec}$ pressure $\frac{N}{m^3}$ flow x pressure: $\frac{m^3}{sec} \cdot \frac{N}{m^2} = \frac{m}{sec} \cdot \frac{N}{1} = \frac{N \cdot m}{sec} = \frac{Joule}{sec} = W$ = power

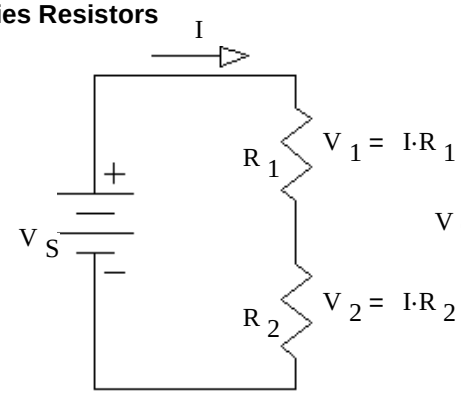
same for electricity power $P = I \cdot V$

Power dissipated by resistors: $P = V \cdot I = \frac{V^2}{R} = I^2 \cdot R$

$P_{IN} = P_{OUT}$



Series Resistors



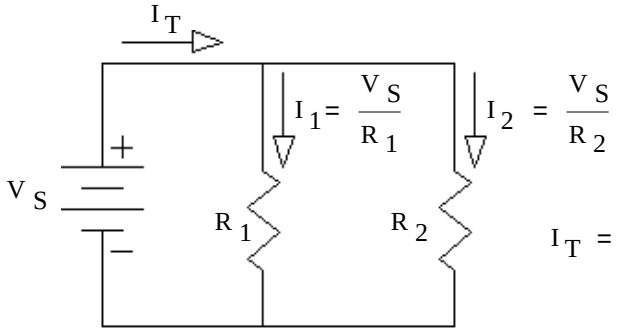
$V_T = V_1 + V_2$

$R_{eq} = \frac{V_T}{I} = \frac{V_1 + V_2}{I} = \frac{V_1}{I} + \frac{V_2}{I} = R_1 + R_2$

$R_{eq} = R_1 + R_2$

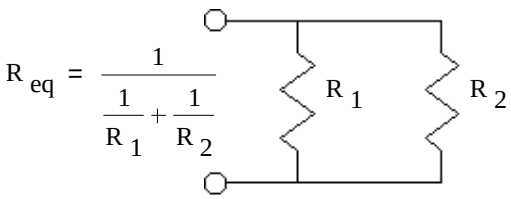
Resistors are in series if and only if exactly the **same current** flows through each resistor.

Parallel Resistors

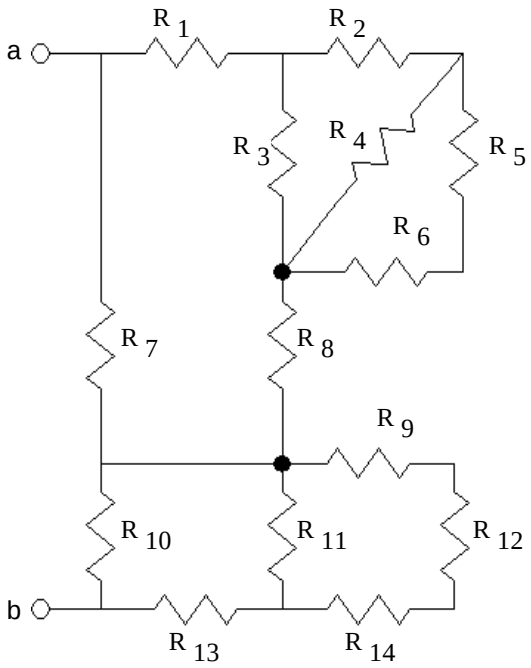


$I_T = \frac{V_S}{R_1} + \frac{V_S}{R_2}$

$R_{eq} = \frac{V_S}{I_T} = \frac{V_S}{\frac{V_S}{R_1} + \frac{V_S}{R_1}} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$

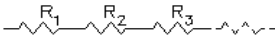


Resistors are in parallel if and only if the **same voltage** is across each resistor.



All resistor-only networks can be reduced to a single equivalent, but not always by means of series and parallel concepts.

Voltage Divider



series: $R_{eq} = R_1 + R_2 + R_3 + \ldots$

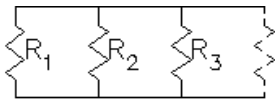
Exactly the **same current** through each resistor

Voltage divider:

$$V_{Rn} = V_{total} \cdot \frac{R_n}{R_1 + R_2 + R_3 + \ldots}$$

Current Divider

parallel: $R_{eq} = \dfrac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$

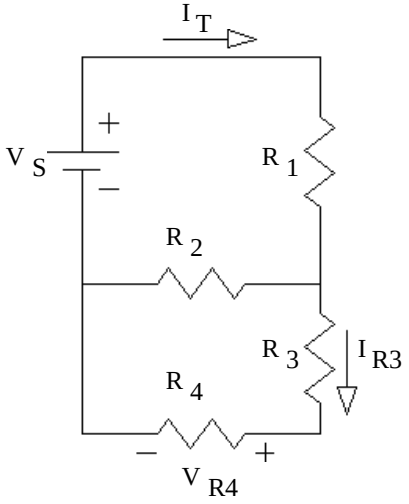


Exactly the **same voltage** across each resistor

current divider:

$$I_{Rn} = I_{total} \cdot \frac{\frac{1}{R_n}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots}$$

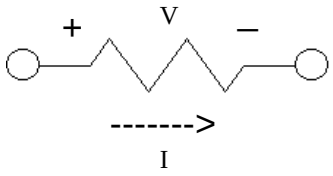
May have to combine some resistors first to get series and parallel resistors to use with divider expressions.

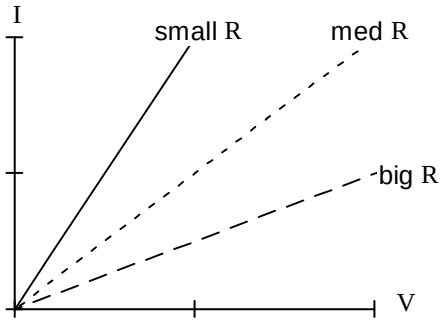


$V_{R4} =$

$I_T =$

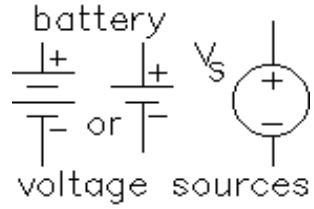
$I_{R3} =$



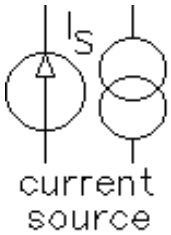


$$R = \frac{1}{\text{slope}} = \frac{\Delta V}{\Delta I}$$

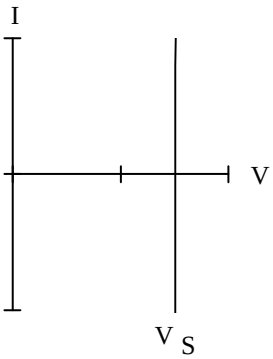
Sources

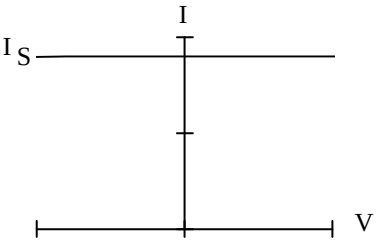


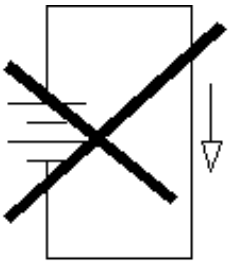
Battery Cell



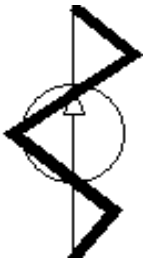
Less intuitive, less like sources we are used to seeing.



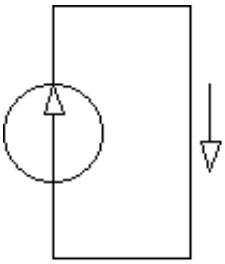




Doesn't make sense with for ideal voltage sources and ideal wires

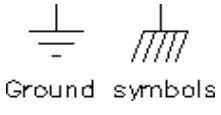


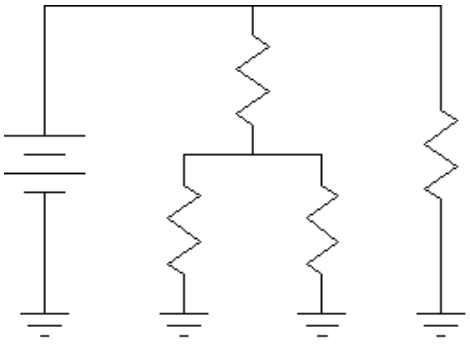
Doesn't make sense for ideal current sources

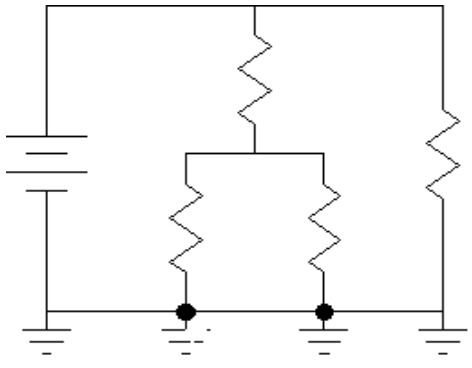


Must have a path for the current to flow

Ground

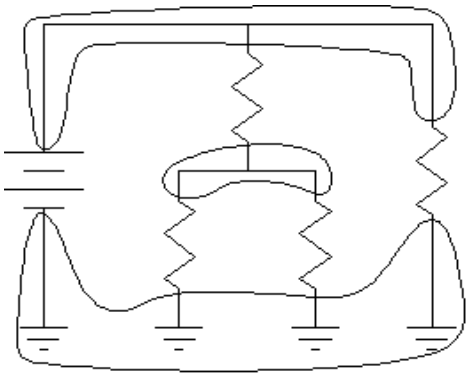






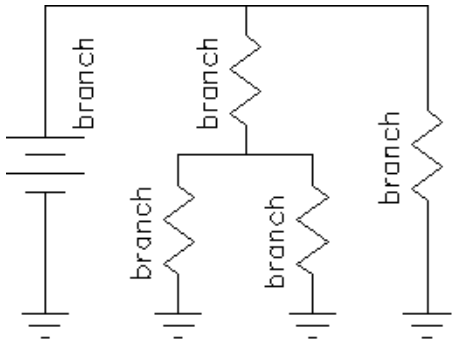
Ground is considered zero volts and is a reference for other voltages.

Node = all points connected by wire, all at same voltage (potential)

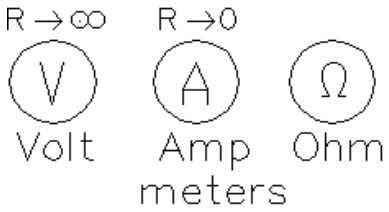


ground is a node

Branch = all parts with the same current



Meters

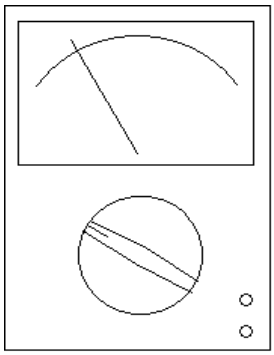


idealy: voltmeter — open

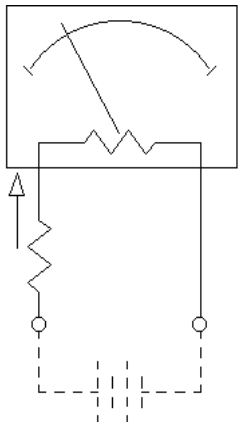
ammeter — short

Analog meters

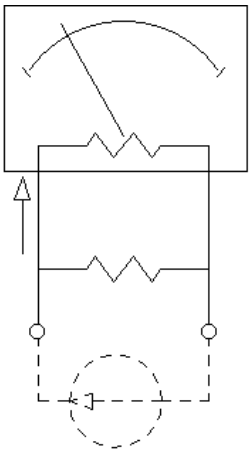
multimeter



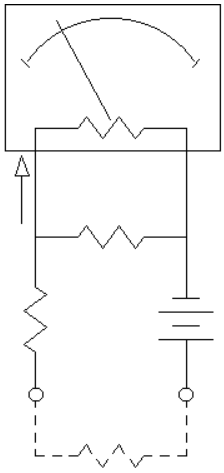
voltmeter



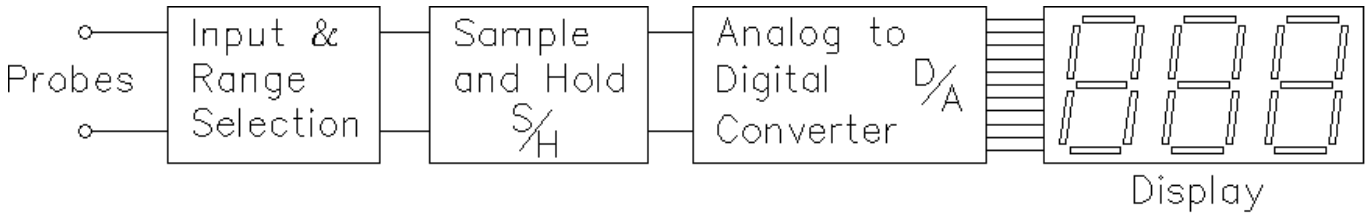
ammeter



Ohmmeter



Digital meter



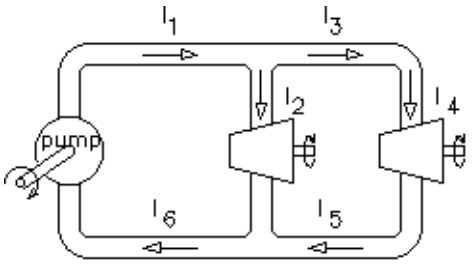
Folder Number_____ Name_____ a5

ECE 2210 / 00 homework # 1 Due: Monday, 1/14/19

There are a number of lockers on the 2nd floor of the MEB, in the center hallway. These lockers have slots cut in their doors so that homework and lab notebooks can be dropped through the slots. Turn in your homework in the locker marked "ECE 2210/00 Homework". (Sometimes lockers are separated as "ECE 2200 Homework" and "ECE 2210 Homework", look carefully the first time.) Homework is due by 5:00 p.m. on the due date

The following problems are not meant to be hard. You should be able to do most of them in your head with no special formulas or calculations. In fact you should find them rather dumb and trivial. That's the point, I want to drill these concepts into your head so that you'll find them easy.

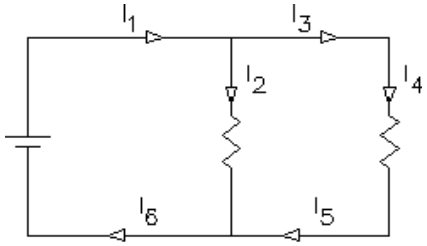
1. The figure at right shows a hydraulic system with a pump that converts rotational energy to fluid energy and two turbines which convert that energy back to rotational energy. Do NOT assume that the turbines are equal in size. This is a closed system containing an incompressible fluid with no places for that fluid to collect; i.e. flow in = flow out of any point or object. Kirchhoff's current law applies. The volumetric fluid flows are indicated by the arrows.



$I_1 := 0.01 \cdot \frac{m^3}{s}$ $I_2 := 0.007 \cdot \frac{m^3}{s}$

I_3 = _____ I_4 = _____ I_5 = _____ I_6 = _____

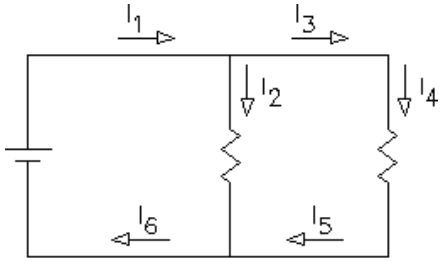
2. The figure at right shows an electrical circuit with a battery that converts chemical energy to electrical energy and two resistors which convert that electrical energy to heat energy. Do NOT assume that the resistors are equal in size. *All* electrical circuits are closed systems containing incompressible charges with no places for those charges to collect; i.e. flow in = flow out of any point or object. Kirchhoff's current law applies. . The electrical currents are indicated by the arrows.



$I_1 := 0.01 \cdot A$ $I_2 := 0.007 \cdot A$

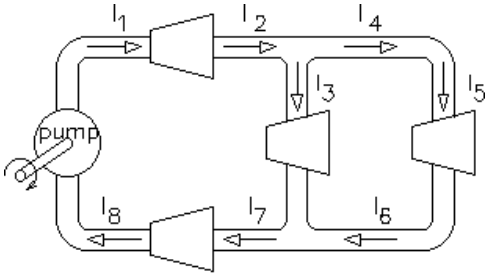
I_3 = _____ I_4 = _____ I_5 = _____ I_6 = _____

3. The figure at right shows a similar electrical circuit only now the electrical currents are indicated by the arrows next to the wires. This is a more common way to show the current flow because a little arrow in the wire is too easily confused with the electrical symbol for a diode. You'll learn about diodes later.



$I_2 := 20 \cdot mA$ $I_5 := 14 \cdot mA$

I_6 = _____ I_1 = _____ I_3 = _____ I_4 = _____

4. 

$I_3 := 0.004 \cdot \frac{m^3}{s}$ $I_5 := 0.001 \cdot \frac{m^3}{s}$ I_4 = _____

I_2 = _____ I_1 = _____ I_6 = _____

I_7 = _____ I_8 = _____

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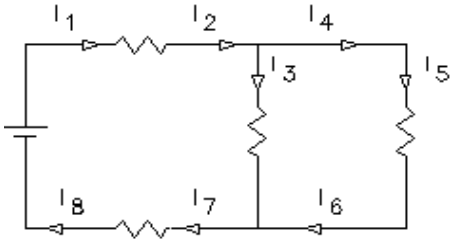
5.

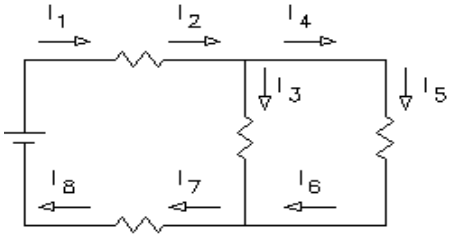


$I_3 := 4.5 \cdot mA$ $I_5 := 1.2 \cdot mA$ $I_4 =$ _____

$I_2 =$ _____ $I_1 =$ _____ $I_6 =$ _____

$I_7 =$ _____ $I_8 =$ _____

6. Again, a similar electrical circuit with the electrical current arrows in the more common position, next to the wires.

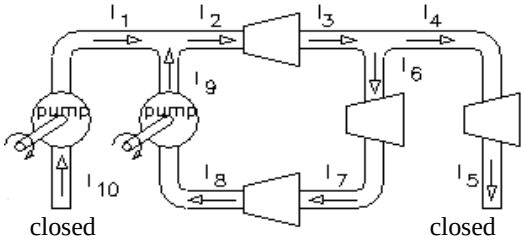


$I_6 := 0.03 \cdot A$ $I_7 := 0.08 \cdot A$ $I_8 =$ _____

$I_1 =$ _____ $I_2 =$ _____ $I_3 =$ _____

$I_4 =$ _____ $I_5 =$ _____

7.

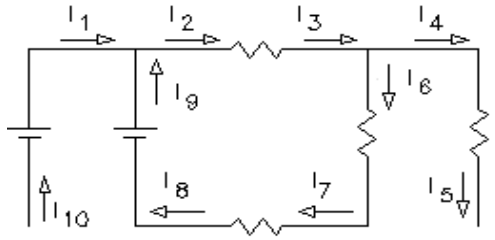


$I_9 := 0.04 \cdot \frac{m^3}{s}$ $I_1 =$ _____ $I_2 =$ _____

$I_3 =$ _____ $I_4 =$ _____ $I_5 =$ _____

$I_6 =$ _____ $I_7 =$ _____ $I_8 =$ _____ $I_7 =$ _____ $I_{10} =$ _____

8.

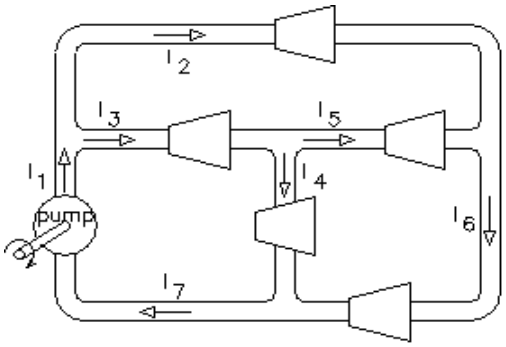


$I_9 := 0.06 \cdot A$ $I_1 =$ _____ $I_2 =$ _____

$I_3 =$ _____ $I_4 =$ _____ $I_5 =$ _____

$I_6 =$ _____ $I_7 =$ _____ $I_8 =$ _____ $I_7 =$ _____ $I_{10} =$ _____

9.

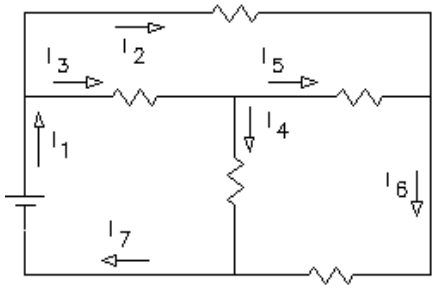


$I_4 := 0.05 \cdot \frac{m^3}{s}$ $I_5 := 0.014 \cdot \frac{m^3}{s}$ $I_6 := 0.03 \cdot \frac{m^3}{s}$

$I_1 =$ _____ $I_2 =$ _____

$I_3 =$ _____ $I_7 =$ _____

ECE 2210 / 00 homework # 1, p.2

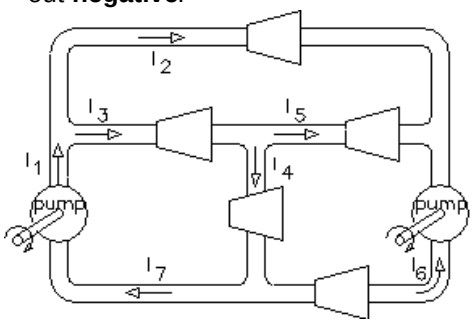
10. 

$I_4 := 20 \cdot mA$ $I_5 := 10 \cdot mA$ $I_6 := 22 \cdot mA$

$I_1 =$ _____ $I_2 =$ _____

$I_3 =$ _____ $I_7 =$ _____

11. Careful here, there are now two pumps. Also, given the flow arrows shown, one or more of the flows must come out **negative**.

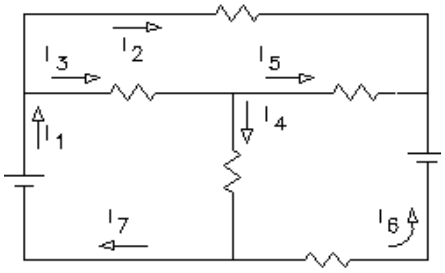


$I_2 := 0.005 \cdot \frac{m^3}{s}$ $I_6 := 0.03 \cdot \frac{m^3}{s}$ $I_7 := 0.015 \cdot \frac{m^3}{s}$

$I_1 =$ _____ $I_3 =$ _____

$I_4 =$ _____ $I_5 =$ _____

12. What does a negative fluid flow physically mean?

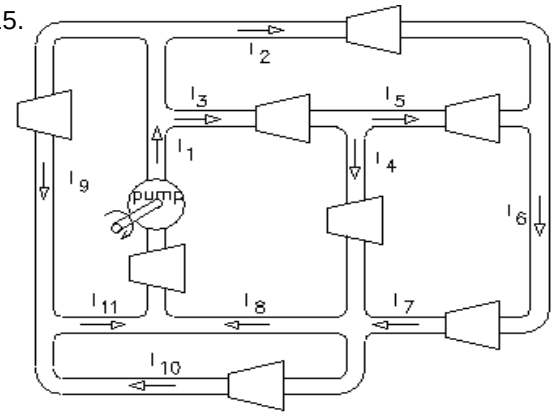
13. 

$I_1 := 0.01 \cdot A$ $I_5 := -20 \cdot mA$ $I_6 := 35 \cdot mA$

$I_2 =$ _____ $I_3 =$ _____

$I_4 =$ _____ $I_7 =$ _____

14. What does a negative electrical current physically mean?

15. 

$I_4 := 0.05 \cdot \frac{m^3}{s}$ $I_5 := 0.03 \cdot \frac{m^3}{s}$ $I_7 := 0.045 \cdot \frac{m^3}{s}$

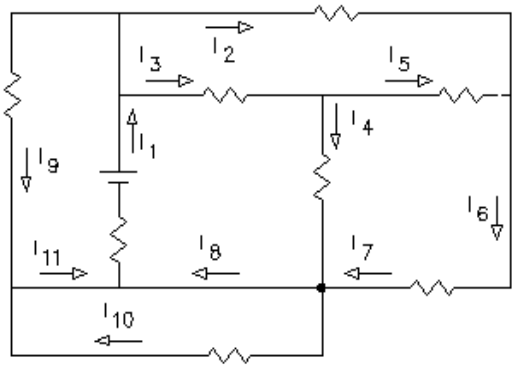
$I_9 := 0.06 \cdot \frac{m^3}{s}$ $I_1 =$ _____

$I_2 =$ _____ $I_3 =$ _____

$I_6 =$ _____ $I_8 =$ _____

$I_{10} =$ _____ $I_{11} =$ _____

16.



$I_1 := 100 \cdot mA$ $I_2 := 50 \cdot mA$ $I_3 := 30 \cdot mA$

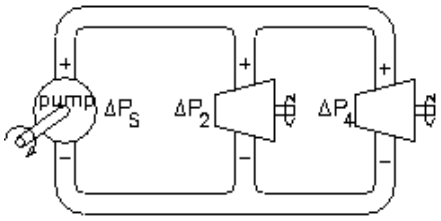
$I_6 := 66 \cdot mA$ $I_4 =$ _____

$I_5 =$ _____ $I_7 =$ _____

$I_8 =$ _____ $I_9 =$ _____

$I_{10} =$ _____ $I_{11} =$ _____

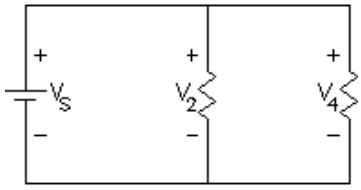
17. The figure at right shows the pressure differentials across elements in a hydraulic system. The side indicated by the + sign is the higher pressure side. Conversely, - indicates the lower pressure. ΔP_S is the pressure difference supplied by the pump (S for **S**ource). ΔP_2 is the pressure difference driving the left turbine and ΔP_4 is the pressure difference driving the right turbine. Assume no pressure losses or discontinuities in the pipes, joints, or corners; i.e. all connected pipes are at exactly the same pressure. Finally, the fluid has no mass, so gravity and Bernoulli can go take a hike.



$\Delta P_S := 12 \cdot \frac{N}{m^2} = 12 \cdot Pa$ $\Delta P_2 =$ _____ $\Delta P_4 =$ _____

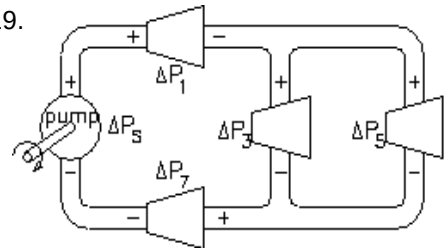
Yes, I know that these are ridiculously low pressures for a hydraulic system.

18. The figure at right shows the voltage differentials across elements in an electrical circuit. The side indicated by the + sign is the higher voltage side. Conversely, - indicates the lower voltage. V_S is the voltage supplied by the battery. V_2 is the voltage across the left resistor and V_4 is the voltage across the right resistor. You may assume no voltage drops across any of the wires or connections in practically *all* electrical schematics; i.e. all connected wires are at exactly the same voltage (electrical potential).



$V_S := 12 \cdot V$ (V = volts) $V_2 =$ _____ $V_4 =$ _____

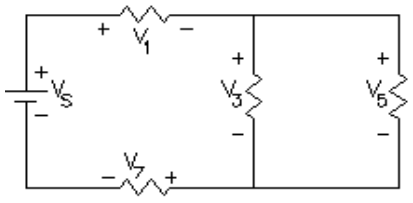
19.



$\Delta P_S := 400 \cdot kPa$ $\Delta P_1 := 180 \cdot kPa$ $\Delta P_3 := 100 \cdot kPa$

$\Delta P_5 =$ _____ $\Delta P_7 =$ _____

20.



$V_1 := 10 \cdot V$ $V_5 := 3 \cdot V$ $V_7 := 2 \cdot V$

$V_S =$ _____ $V_3 =$ _____

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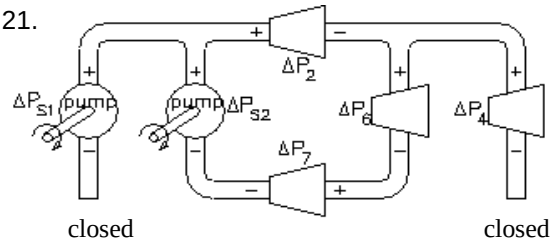
21.

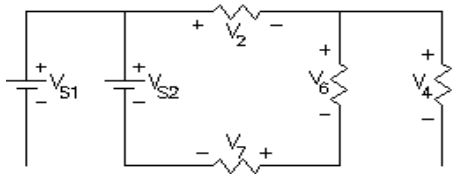


$\Delta P_{S1} := 200 \cdot kPa$ $\Delta P_{S2} := 150 \cdot kPa$

$\Delta P_{2} := 50 \cdot kPa$ $\Delta P_{6} := 60 \cdot kPa$

ΔP_4 = _____ ΔP_7 = _____

22.

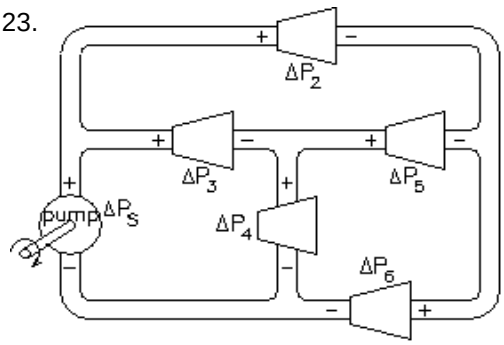


$V_{S1} := 6 \cdot V$ $V_{2} := 2 \cdot V$

$V_{6} := 2.4 \cdot V$ $V_{7} := 3.2 \cdot V$

V_{S2} = _____ V_4 = _____

23.



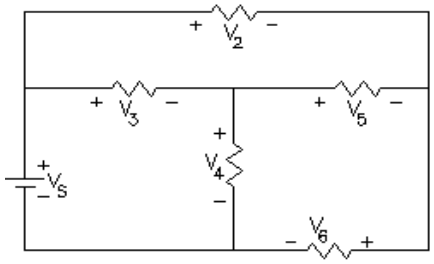
$\Delta P_{3} := 120 \cdot kPa$ $\Delta P_{4} := 80 \cdot kPa$ $\Delta P_{6} := 110 \cdot kPa$

ΔP_S = _____ ΔP_2 = _____

ΔP_5 = _____

24. What does a negative pressure difference physically mean?

25.

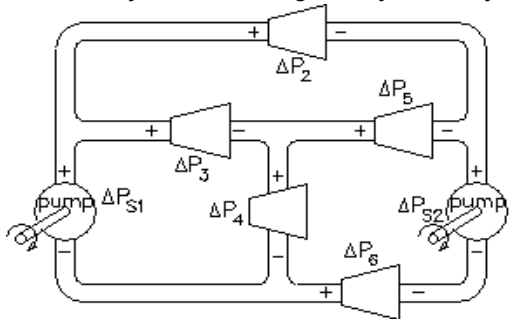


$V_{3} := 2.3 \cdot V$ $V_{5} := 0.5 \cdot V$ $V_{6} := 3.2 \cdot V$

V_S = _____ V_2 = _____

V_4 = _____

26. Watch your + and - signs very carefully now.



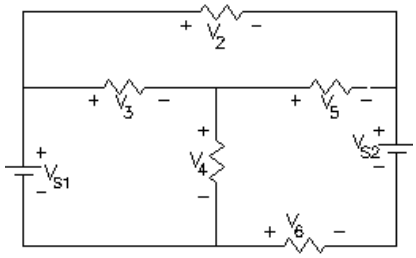
$\Delta P_{2} := 140 \cdot kPa$ $\Delta P_{3} := 230 \cdot kPa$

$\Delta P_{4} := 50 \cdot kPa$ $\Delta P_{6} := 210 \cdot kPa$

ΔP_{S1} = _____ ΔP_{S2} = _____

ΔP_5 = _____

27.



$V_{S1} := 14 \cdot V$ $V_{S2} := 3 \cdot V$ $V_{2} := 6 \cdot V$ $V_{3} := 4 \cdot V$

V_4 = _____ V_5 = _____

V_6 = _____

Think about the current through the 2nd battery. What is happening to that battery?

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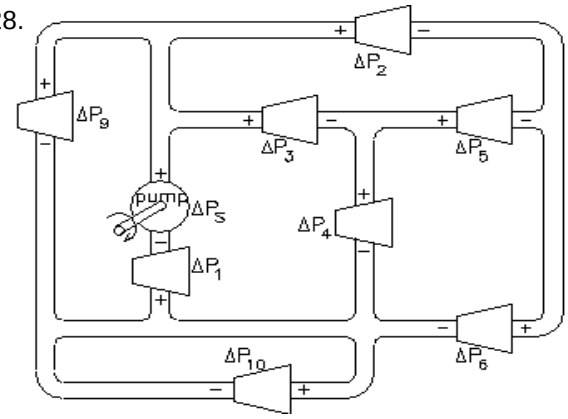
28.



$\Delta P_1 := 200\cdot kPa$ $\Delta P_2 := 1100\cdot kPa$

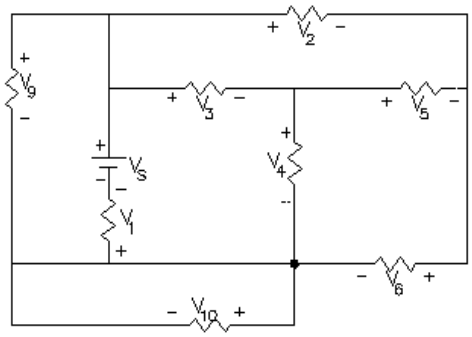
$\Delta P_3 := 600\cdot kPa$ $\Delta P_9 := 1800\cdot kPa$

$\Delta P_S =$ _____ $\Delta P_4 =$ _____

$\Delta P_5 =$ _____ $\Delta P_6 =$ _____

$\Delta P_{10} =$ _____

29.



$V_S := 18\cdot V$ $V_3 := 6\cdot V$ $V_4 := 8\cdot V$ $V_5 := 2\cdot V$

$V_1 =$ _____ $V_2 =$ _____

$V_6 =$ _____ $V_9 =$ _____

$V_{10} =$ _____

Answers

1. $I_3 = I_4 = I_5 := 0.003\cdot\frac{m^3}{s}$, $I_6 := 0.01\cdot\frac{m^3}{s}$

2. $I_3 = I_4 = I_5 := 0.003\cdot A$, $I_6 := 0.01\cdot A$

3. $I_6 = I_1 := 34\cdot mA$, $I_3 = I_4 := 14\cdot mA$

4. $I_4 = I_6 := 0.001\cdot\frac{m^3}{s}$, $I_1 = I_2 = I_7 = I_8 := 0.005\cdot\frac{m^3}{s}$

5. $I_4 = I_6 := 1.2\cdot mA$, $I_1 = I_2 = I_7 = I_8 := 5.7\cdot mA$

6. $I_1 = I_2 = I_8 := 80\cdot mA$, $I_3 := 50\cdot mA$, $I_4 = I_5 := 30\cdot mA$

7. $I_1 = I_{10} = I_4 = I_5 := 0\cdot\frac{m^3}{s}$, $I_2 = I_3 = I_7 = I_8 := 0.04\cdot\frac{m^3}{s}$

8. $I_1 = I_{10} = I_4 = I_5 := 0\cdot A$,
$I_2 = I_3 = I_7 = I_8 := 0.06\cdot A$

9. $I_1 = I_7 := 0.080\cdot\frac{m^3}{s}$, $I_2 := 0.016\cdot\frac{m^3}{s}$, $I_3 := 0.064\cdot\frac{m^3}{s}$

10. $I_1 = I_7 := 42\cdot mA$, $I_2 := 12\cdot mA$, $I_3 := 30\cdot mA$

11. $I_1 := 0.015\cdot\frac{m^3}{s}$, $I_3 := 0.010\cdot\frac{m^3}{s}$, $I_4 := 0.045\cdot\frac{m^3}{s}$, $I_5 := -0.035\cdot\frac{m^3}{s}$

12. Actual flow is in direction opposite to the arrow direction.

13. $I_2 := -15\cdot mA$, $I_3 := 25\cdot mA$, $I_4 := 45\cdot mA$, $I_7 := 10\cdot mA$

14. "

15. $I_1 := 0.155\cdot\frac{m^3}{s}$, $I_2 := 0.015\cdot\frac{m^3}{s}$, $I_3 := 0.080\cdot\frac{m^3}{s}$, $I_6 := 0.045\cdot\frac{m^3}{s}$, $I_8 := 0.095\cdot\frac{m^3}{s}$, $I_{10} := 0\cdot\frac{m^3}{s}$, $I_{11} := 0.060\cdot\frac{m^3}{s}$

16. $I_4 := 14\cdot mA$, $I_5 := 16\cdot mA$, $I_7 := 66\cdot mA$, $I_8 := 80\cdot mA$, $I_9 := 20\cdot mA$, $I_{10} := 0\cdot mA$, $I_{11} := 20\cdot mA$

17. $\Delta P_2 = \Delta P_4 := 12\cdot Pa$

18. $V_2 = V_4 := 12\cdot V$

19. $\Delta P_5 := 100\cdot kPa$, $\Delta P_7 := 120\cdot kPa$

20. $V_S := 15\cdot V$, $V_3 := 3\cdot V$

21. $\Delta P_4 := 0\cdot kPa$, $\Delta P_7 := 40\cdot kPa$

22. $V_{S2} := 7.6\cdot V$, $V_4 := 0\cdot V$

23. $\Delta P_S := 200\cdot kPa$, $\Delta P_2 := 90\cdot kPa$, $\Delta P_5 := -30\cdot kPa$

24. The actual + & - should be reversed from those on drawing

25. $V_S := 6\cdot V$, $V_2 := 2.8\cdot V$, $V_4 := 3.7\cdot V$

26. $\Delta P_{S1} := 280\cdot kPa$, $\Delta P_{S2} := 350\cdot kPa$, $\Delta P_5 := -90\cdot kPa$

27. $V_4 := 10\cdot V$, $V_5 := 2\cdot V$, $V_6 := -5\cdot V$ battery is charging

28. $\Delta P_S := 2000\cdot kPa$, $\Delta P_4 := 1200\cdot kPa$, $\Delta P_5 := 500\cdot kPa$, $\Delta P_6 := 700\cdot kPa$, $\Delta P_{10} := 0\cdot kPa$

29. $V_1 := 4\cdot V$, $V_2 := 8\cdot V$, $V_6 := 6\cdot V$, $V_9 := 14\cdot V$, $V_{10} := 0\cdot V$

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Folder Number_____ Name_____ a5

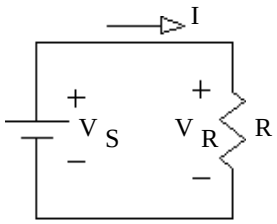
ECE 2210 / 00 homework # 2 Due: Thur, 1/17/19

Don't forget: Write your folder number in the upper-left corner of ALL your homework.

Graded homework, labs and exams will be returned to a file cabinet in MEB 2101, filed by your alphabetically-assigned folder number.

You may do the following problems here or on your own paper. But, since you have the answers,
you MUST show your work to get credit.

1. Ohm's law
   Consider the figure at right
   For each of the cases below, find the missing value.



   a) $I := 0.01 \cdot A$ $V_R := 4 \cdot V$ $R = ?$

   b) $I := 50 \cdot mA$ $R := 560 \cdot \Omega$ $V_R = ?$

   c) $V_R := 12 \cdot V$ $R := 1.5 \cdot k\Omega$ $I = ?$

2. Power and Ohm's law. Same circuit as above. For each of the cases below, find the missing values.

   a) $I := 5 \cdot mA$ $R := 2 \cdot k\Omega$ $V_R =$ $P_R =$

   b) $V_R := 25 \cdot V$ $R := 100 \cdot \Omega$ $I =$ $P_R =$

   c) $V_R := 20 \cdot V$ $I := 0.01 \cdot A$ $R =$ $P_R =$

   Ignore the fact that the following items run on AC

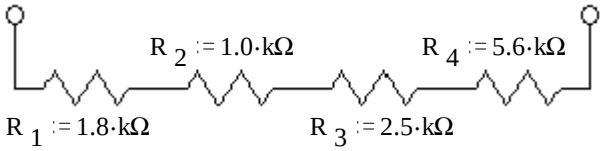
   d) $P_R := 900 \cdot W$ $V_R := 120 \cdot V$ $I =$ $R =$
   Toaster

   e) $P_R := 1500 \cdot W$ $R := 9.6 \cdot \Omega$ $I =$ $V_S =$
   Hair drier

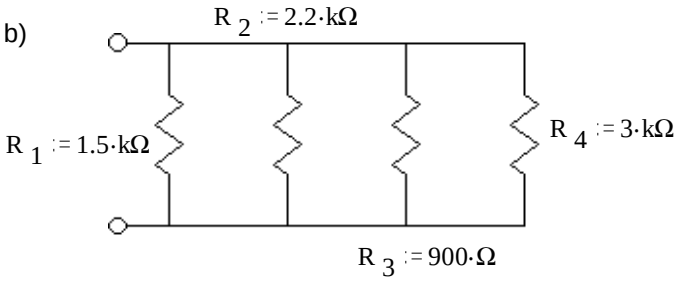
   f) $P_R := 2500 \cdot W$ $I := 10.5 \cdot A$ $R =$ $V_S =$
   Electric oven

3. Find the equivalent resistance of each of these networks, i.e. what would an ohmmeter read if hooked to the terminals.

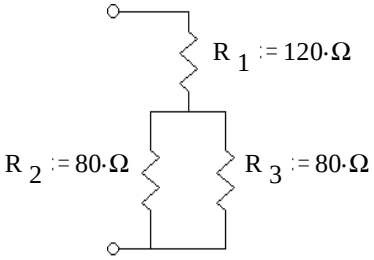
   a)



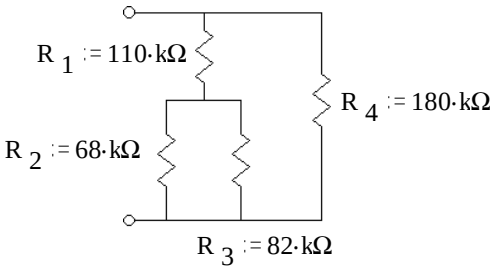
b)



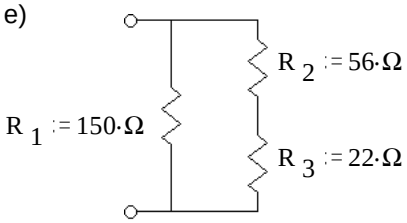
c)



d)



e)



Don't forget: Write your <u>folder number</u> in the upper-left corner of your homework.

<u>Answers</u>

1. a) $R := 400\cdot\Omega$ b) $V_R := 28\cdot V$ c) $I := 8\cdot mA$
2. a) $V_R := 10\cdot V$ $P_R := 50\cdot mW$ b) $I := 0.25\cdot A$ $P_R := 6.25\cdot W$ c) $R := 2.0\cdot k\Omega$ $P_R := 200\cdot mW$
   d) $I := 7.5\cdot A$ $R := 16\cdot\Omega$ e) $I := 12.5\cdot A$ $V_S := 120\cdot V$ f) $R := 22.7\cdot\Omega$ $V_S := 238\cdot V$
3. a) $R_{eq} := 10.9\cdot k\Omega$ b) $R_{eq} := 390\cdot\Omega$ c) $R_{eq} := 160\cdot\Omega$
   d) $R_{eq} := 81\cdot k\Omega$ e) $R_{eq} := 51.3\cdot\Omega$