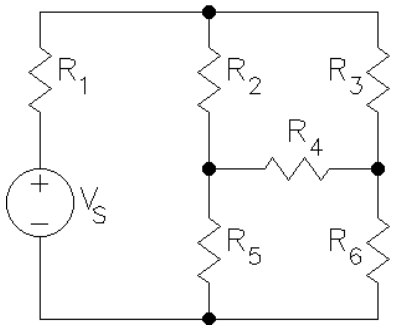
ECE 2210 / 00 homework # 6A Due: a

Nodal Analysis

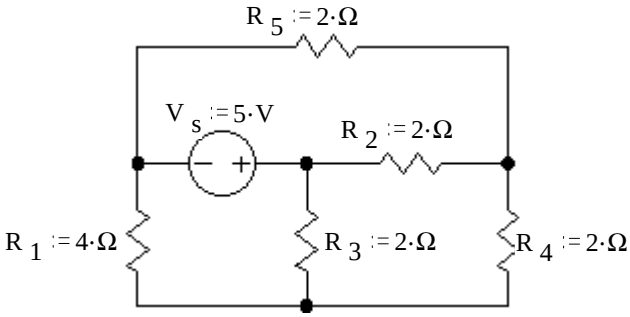
1. a) If you select the bottom node as ground, how many unknown node voltages remain? (Assume V_S is a known quantity.) How many simultaneous equations would you need to solve to analyze this circuit?

   b) Use nodal analysis to find all the necessary simultaneous equations.

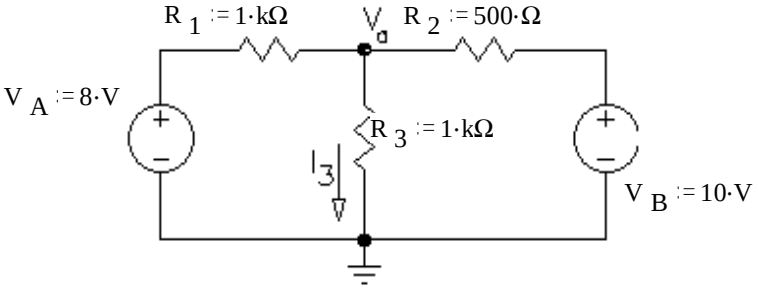


2. a) Use nodal analysis to find all the node voltages.

   b) Your node voltages will depend on your selection of a reference node (ground) as well as your arbitrary node labels, so the grader won't look at these specifically. Use your node voltages to find the potential (voltage) across each resistor. Report the magnitude and polarity of each.

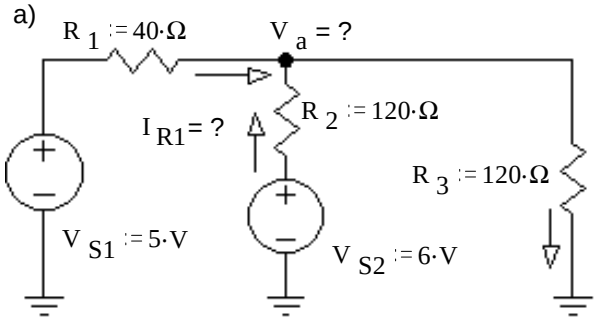


3. Use Nodal analysis to find V_a and use V_a to find I_3.

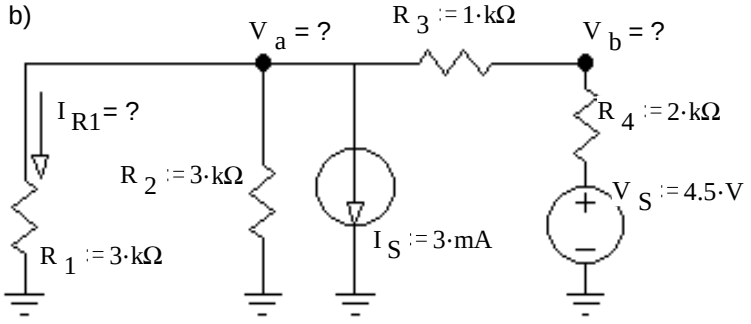


4. Use Nodal analysis to solve following problems: Each problem asks for at least 1 voltage and a current. Use the voltage(s) to find the current.

a)



b)



Don't forget your folder number.

hint: you may be able to eliminate one unknown node for the initial calculation.

Answers

1. a) 3,3 b) $V_a\cdot\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right)-\frac{V_b}{R_2}-\frac{V_c}{R_3} = \frac{V_S}{R_1}$, $\frac{V_a}{R_2}-V_b\cdot\left(\frac{1}{R_2}+\frac{1}{R_5}+\frac{1}{R_4}\right)+\frac{V_c}{R_4} = 0\cdot A$

   $\frac{V_a}{R_3}+\frac{V_b}{R_4}-V_c\cdot\left(\frac{1}{R_3}+\frac{1}{R_4}+\frac{1}{R_6}\right) = 0\cdot A$

2. a) Answer will depend on your choice of ground, so check your answers to part b to see if you did part a right.
   b) $3.077\cdot V$, + bottom , $2.308\cdot V$, + left , $1.923\cdot V$, + top , $0.385\cdot V$, + bottom , $2.692\cdot V$, + right

3. $7\cdot V$, $7\cdot mA$ 4. a) $4.2\cdot V$, $20\cdot mA$ b) $V_a := -1.5\cdot V$ $V_b := 0.5\cdot V$ $I_{R1} := -0.5\cdot mA$

You may not get this homework back before the **1st exam.** Photocopy it if you want to be sure to have it.

ECE 2210 / 00 homework # 6A

ECE 2210 / 00 homework # 6B Due:

Name _____

Batteries

1. As a battery discharges, the source voltage (V_S) _____
   and the internal resistance (R_{int}) _____

2. a) The nominal voltage of a lead acid battery is _____ per cell.
   Is this V_S or V_{term} ? _____

   b) Over-charging a flooded, or wet cell lead acid battery creates what danger"

   c) How many cells does a 12-V car battery ?

3. a) The nominal voltage of a li-ion battery is _____ per cell.

   b) How many cells does a 14.4-V laptop battery have?

4. A 14.4-V laptop battery is rated at 3Ah.
   a) How much energy does it store? Give the answer in two different units.

   b) The battery is dischared at 0.28C. How much current is that?

   c) How long should a full charge last at this rate of discharge?

5. You have 6 18650 li-ion cells, each rated at 2800mAh.
   a) The 6 cells are wired in series. What's the rated voltage?
   What's the rated mAh?
   b) The 6 cells are wired in parallel. What's the rated voltage?
   What's the rated mAh?
   c) Could you wire them up to get a 10.8V battery? If yes how?

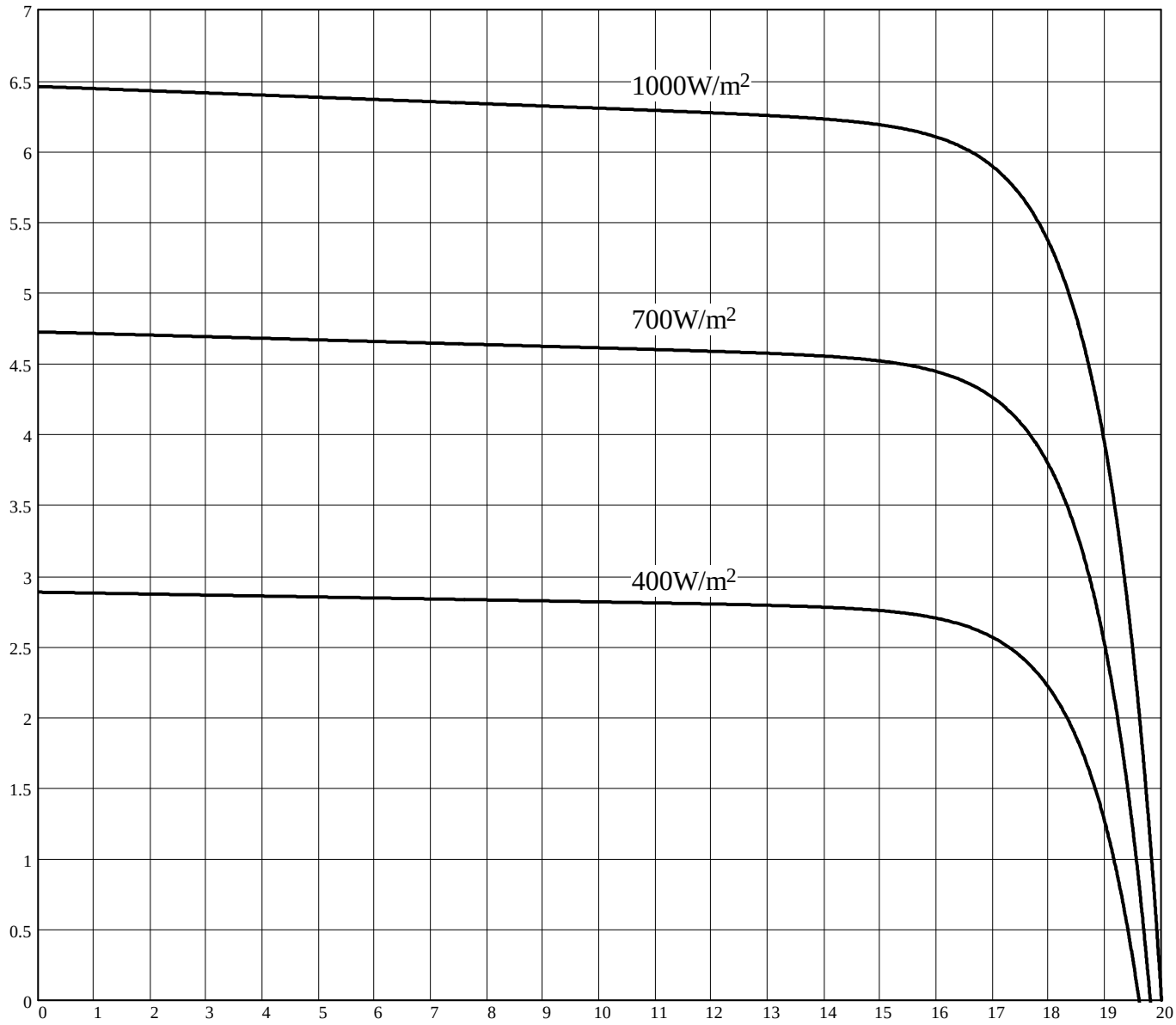
   What's the rated mAh?

6. a) How does a CC-CV power supply operate?

   b) Is it OK to leave a CC-CV power supply hooked to a lead acid or li-ion battery indefinitely? If not, why not?

Solar panels

Problems 7 - 14 refer to the IV curves for a solar panel shown below.



7. Find I_{SC} Find V_{OC}

8. Do your best to estimate the maximum-power point for the $1000 W/m^2$ curve. Find the current (I_{MPP}), voltage (V_{MPP}), and power (P_{MPP}) and the load resistor (R_{load}) that could be hooked to the panel to make it operate at this point.

9. The panel measurements are $0.8m$ x $0.8m$, find the efficiency of this panel

10. What is the likely rated power of this panel?

11. Do your best to estimate the maximum-power point for the other two curves and find that maximum power.

12. The optimum load resistor (R_{load}) you found above is left in place while the irradiance is reduced to $700 W/m^2$. Estimate the power produced by the panel.

    Note: there isn't a nice mathematical way to calculate this, so use this graphical method:
    1. Draw a current vs voltage line for the resistor, a line that starts at 0,0 and has a slope of $1/R_{load}$. Incidentally, this line passes through the maximum-power point for the $1000 W/m^2$ curve.

    2. With an irradiance of $700 W/m^2$ the panel will operate where this line crosses the $700 W/m^2$ curve. Find the voltage, current and power at that point.

13. Using the same load resistor (R_{load}) and irradiance of $400 W/m^2$. Estimate the power power produced by the panel.

14. Compare your answers to problems 12 and 13 to your answers to problem 11.

Answers

1. decreases increases
2. a) $2 \cdot V$ V_{tern} b) fire c) 6
3. a) $3.6 \cdot V$ b) 4
4. a) $43.2 \cdot Wh$ $1.56 \cdot 10^5 \cdot J$ b) $0.84 \cdot A$ c) $3.57 \cdot hr$
5. a) $21.6 \cdot V$ $2800 \cdot mAh$ b) $3.6 \cdot V$ $16800 \cdot mAh$
   c) Two sets of 3 in series. The two sets are then wired in parallel. $5600 \cdot mAh$
6. a) A CC-CV source acts like a constant current source up to a set voltage level. Then it acts as a constant voltage source at that level.
   b) No, a charger needs to shut off once the current decreases to some small value.
7. $6.45 \cdot A$ $20 \cdot V$
8. $5.87 \cdot A$ $17.1 \cdot V$ $100 \cdot 4 \cdot W$ $2.91 \cdot \Omega$
9. $15.7 \cdot \%$
10. $100 \cdot W$
11. $72.5 \cdot W$ $43.8 \cdot W$
12. $60.5 \cdot W$
13. $23.4 \cdot W$
14. Powers are significantly lower because the panel is not operating at the maximum power points.