Lab 3

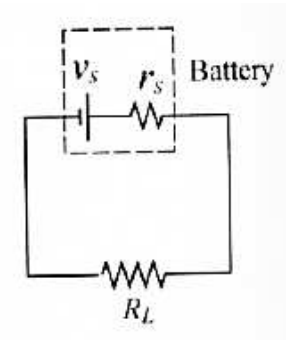
Out: Tuesday, Feb 14th

Problem 3.1

An electrical circuit that includes a voltage source v_s with an internal resistance r_s and a load resistance R_L is shown in the figure. The power P dissipated in the load is given by:

$$P = \frac{v_s^2 R_L}{(R_L + r_s)^2}$$

Plot the power P as a function of R_L for $1 \leq R_L \leq 10\Omega$, given that $v_s = 12V$, and $r_s = 2.5\Omega$.



Problem 3.2

In astronomy, the relationship between the relative luminosity L/L_{Sun} (brightness relative to the sun), the relative radius R/R_{Sun}, and the relative temperature T/T_{Sun} of a star is modeled by:

$$\frac{L}{L_{Sun}} = (\frac{R}{R_{Sun}})^2 (\frac{T}{T_{Sun}})^4$$

The HR (Hertzsprung-Russell) diagram is a plot of L/L_{Sun} versus the temperature. The following data is given:

	Sun	Spica	Regulus	Alioth	Barnard's Star	Epsilon Indi	Beta Crucis
Temp (K)	5840	22400	13260	9400	3130	4280	28200
L/L_{Sun}	1	13400	150	108	0.0004	0.15	34000
R/R_{Sun}	1	7.8	3.5	3.7	0.18	0.76	8

To compare data with the model, use MATLAB to plot a HR diagram. The diagram should have two sets of points. One uses the values of L/L_{Sun} from the table (use asterisk markers), and the other uses values of L/L_{Sun} that are calculated by the equation by using R/R_{Sun} from the table (use circle markers). In the HR diagram both axes are logarithmic. In addition, the values of the temperature on the horizontal axis are decreasing from left to

right. This is done with the command `set(gca,'XDir','reverse')`. Label the axes and use a legend.

Problem 3.3

The monthly payment M of a loan of amount P for N years and an annual interest rate r (in %) can be calculated by the formula:

$$M = P\frac{\frac{r}{1200}}{1-(1+\frac{r}{1200})^{-N}}$$

Write a function that calculates the monthly payment of a loan. Use `M = amort(P,r,N)` as the function name and arguments. The inputs are: `P`, the loan amount; `r`, the annual interest rate in percent; and `N`, the length of the loan in years. The output `M` is the amount of the monthly payment. Use the function to calculate the monthly payment of a 15-year mortgage of $260,000 with an annual interest rate of 6.75%.

Problem 3.4

Write a function `n = randint(a,b)` that gives a random integer `n` within a range between two numbers `a` and `b`.

Problem 3.5

In this problem, you will explore a basic principle of probability known as the Law of Large Numbers (see http://en.wikipedia.org/wiki/Law_of_large_numbers). In short, the LLN says that, as the sample size increases, the mean of the sample will approach the mean of the population from which it was drawn.

Your task is to explore this property by simulating rolling a fair six-sided die a given number of times and determining the average values of the throws.

Create a function called `roll_dice` that takes in an argument `num_throws` and does the following:

- generates `num_throws` rolls of a fair die
- calculates the *cumulative* average of your throws

- plots:
  - the result of each throw
  - the cumulative average after each throw
  - the theoretical average of rolling a regular six-sided die

Save as `roll_dice.m`.

Hint: your graph should similar to the one on the wikipedia page. also you may need the matlab functions: cumsum, plot, and hold