

Lab 2

Out: February 10, 2008

Problem 2.1

Solve the following system of 5 equations using both the `inv()` function and the left division operator (`\`). Read both help documentations and explain in a comment which method is better and why.

$$\begin{aligned}1.5x - 2y + z + 3u + 0.5w &= 7.5 \\3x + y - z + 4u - 3w &= 16 \\2x + 6y - 3z - u + 3w &= 78 \\5x + 2y + 4z - 2u + 6w &= 71 \\-3x + 3y + 2z + 5u + 4w &= 54\end{aligned}$$

Problem 2.2

The mechanical power output P in a contracting muscle is given by:

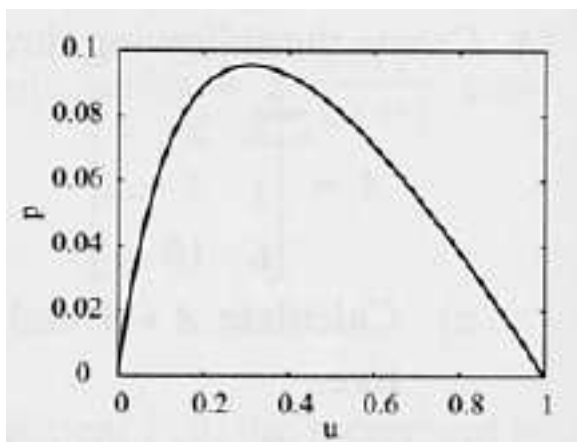
$$P = Tv = \frac{kvT_0(1 - \frac{v}{v_{max}})}{k + \frac{v}{v_{max}}} \quad (1)$$

where T is the muscle tension, v is the shortening velocity (max of v_{max}), T_0 is the isometric tension (i.e. tension at zero velocity) and k is a nondimensional constant that ranges between 0.15 and 0.25 for most muscles. The equation can be written in nondimensional form:

$$p = \frac{ku(1 - u)}{k + u} \quad (2)$$

where $p = (Tv)/(T_0v_{max})$, and $u = v/v_{max}$. A figure with $k = 0.25$ is shown.

- Create a vector u ranging from 0 to 1 with increments of 0.05.



- b. Using $k = 0.25$, calculate the value of p for each value of u .
- c. Using MATLAB built-in function `max`, find the maximum value of p .
- d. Repeat the first three steps with increments of 0.01 and calculate the percent relative error defined by: $E = \left| \frac{P_{max0.01} - P_{max0.05}}{P_{max0.05}} \right| \times 100$.

Problem 2.3

Write a script file that determines the balance in a savings account at the end of every year for the first 10 years. The account has an initial investment of \$1,000 and an interest rate of 6.5% that compounds annually. Display the information in a vector called B.

For an initial investment of A , and interest rate of r , the balance B after n years is given by:

$$B = A \left(1 + \frac{r}{100} \right)^n$$

Problem 2.4

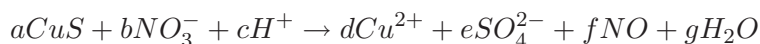
The variation of vapor pressure p (in units of mm Hg) of benzene with temperature in the range of $0 \leq T \leq 42^\circ$ can be modeled with the equation (Handbook of Chemistry and Physics, CRC Press):

$$\log_{10} p = \frac{b + (0.05223 * a)}{T} \quad (3)$$

where $a = -34172$ and $b = 7.9622$ are material constants and T is absolute temperature (K). Write a program in a script file that calculates the pressure for various temperatures. The program should create a vector of temperatures from $T = 0^\circ\text{C}$ to $T = 42^\circ\text{C}$ with increments of 2 degrees, and needs to display a two-column matrix of p and T , where the first column is the temperature values in $^\circ\text{C}$, and the second column is the corresponding pressure in mm HG. (Hint: the conversion from $^\circ\text{C}$ to absolute temperature (K) is: $^\circ\text{K} = ^\circ\text{C} + 273$)

Problem 2.5

The dissolution of copper sulfide in aqueous nitric acid is described by the following chemical equation:



where the coefficients a , b , c , d , e , f , and g are the numbers of each molecule participating in the reaction and are unknown. The unknown coefficients are determined by balancing each atom on the left and right and then balancing the ionic charge. The resulting equations are:

$$a = d, a = e, b = f, 3b = 4e + f + g, c = 2g, -b + c = 2d - 2e$$

There are seven unknowns and only six equations. A solution can still be obtained, however, by taking advantage of the fact that all the coefficients must be positive integers. Add a seventh equation by guessing $a = 1$ and solve the system of equations. The solution is valid if all the coefficients are positive integers. If this is not the case, take $a = 2$ and repeat the solution. Continue the process until all the coefficients in the solution are positive integers.

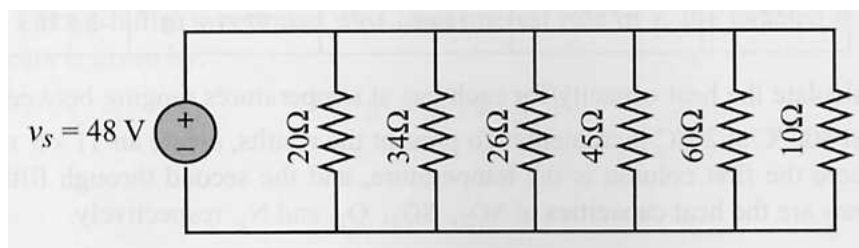


Figure 1: Parallel circuit to be solved.

Problem 2.6

When several resistors are connected in an electrical circuit in parallel, the current through each of them is given by $i_n = \frac{v_s}{R_n}$ where i_n and R_n are the current through resistor n and its resistance, respectively, and v_s is the source voltage. The equivalent resistance, R_{eq} , can be determined from the equation:

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n} \quad (4)$$

The source current is given by: $i_s = v_s/R_{eq}$, and the power, P_n dissipated in each resistor is given by: $P_n = v_s i_n$.

Write a program in a script file that calculates the current through each resistor and the power dissipated in each circuit that has resistors connected in parallel. When the script file runs, it asks the user first to enter the source voltage (look at the MATLAB help file for the 'input' command) and then to enter the resistors' resistance in a vector. The program displays a 2D matrix with the resistance listed in the first column, the current through the resistor in the second, and the power dissipated in the resistor in the third column. Following the 2D matrix, the program displays the source current and the total power. Use the script file to solve the circuit above.