PHYS 371 - Assignment III

Celil Buğra Karacan

Deepartment of Physics, Bilkent University

(Dated: October 29, 2018)

I. INTRODUCTION

A. Question I

Calculating angles in FIG. 1. in terms of $M_1, M_2, M_3; l_1, l_2, l_3, l_4$ was the assignment. System is in static equilibrium and ropes have their respective tensions: T_1, T_2, T_3, T_4.

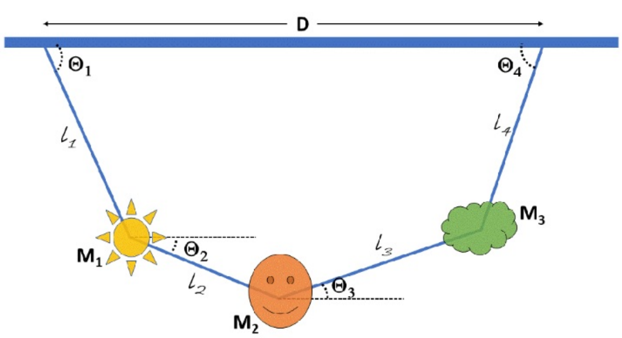

FIG. 1. Question-I diagram.

B. Question II

Electrical circuit with six currents to be determined using given voltage and resistance values. Question explicitly suggested using matrices drawn from Kirchoff's laws.

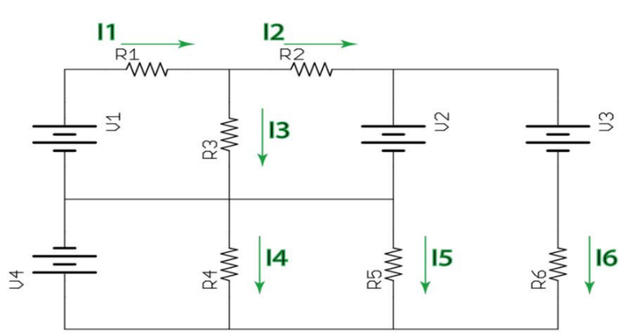

FIG. 2. Question-II diagram.

II. METHOD

A. Question I

Firstly free-body diagrams of all three objects were drawn and relations between M, l, T, θ were questioned leading to following equalities:

$$\begin{bmatrix} M_1 g \\ M_2 g \\ M_3 g \end{bmatrix} = \begin{bmatrix} 1, -1, 0, 0 \\ 0, 1, 1, 0 \\ 0, 0, -1, 1 \end{bmatrix} \begin{bmatrix} T_1 sin\theta_1 \\ T_2 sin\theta_2 \\ T_3 sin\theta_3 \\ T_4 sin\theta_4 \end{bmatrix}$$

$$\mathrm{T}_1 cos\theta_1 = T_2 cos\theta_2 = T_3 cos\theta_3 = T_4 cos\theta_4 \quad (*)$$

$$\begin{bmatrix} l_1, l_2, l_3, l_4 \end{bmatrix} * \begin{bmatrix} cos\theta_1 \\ cos\theta_2 \\ cos\theta_3 \\ cos\theta_4 \end{bmatrix} = D.$$

Multiplying D from left with pseudo-inverse of $[l_1, l_2, l_3, l_4]$ shall give an approximation for $cos\theta_i$. Fromthere on $acos()$ function can be utilized to find θ_i values.

B. Question II

After given constants were input, a matrix was formed as suggested.

$$\begin{bmatrix} R_1 & R_2 & 0 & 0 & 0 & R_6 \\ 0 & 0 & 0 & R_4 & -R_5 & 0 \\ 0 & 0 & 0 & 0 & -R_5 & R_6 \\ 0 & 0 & 0 & R_4 & 0 & 0 \\ R_1 & 0 & R_3 & 0 & 0 & 0 \\ 1 & -1 & -1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \\ I_4 \\ I_5 \\ I_6 \end{bmatrix} = \begin{bmatrix} V_1 - V_3 - V_4 \\ 0 \\ V_2 - V_3 \\ -V_4 \\ V_1 \\ 0 \end{bmatrix}$$

Using `inv()` function of MATLAB®and matrix multiplication `Current` array was solved in ampers. Next part ofthe question asked for plotting current as a function of R_6. Which have been accomplished by defining R_6 as symbolic variable and plotting $P = I_6^2 * R_6$ using `ezplot()`.

III. VERIFICATION OF THE PROGRAM

A. Question I

After calculating θ_i values as dscribed, to check error equation `(*)` will be used. As revealed after running the code, method used ended up with non-acceptable error:

$T_i cos\theta_i = T_i sin\theta_i * cot\theta_i$

$T_1 cos\theta_1 = 34.0699$
$T_1 cos\theta_2 = 6.0866$
$T_1 cos\theta_3 = 7.2170$
$T_1 cos\theta_4 = 86.5348$

(for $l_1 = 3, l_2 = 2, l_3 = 4, l_4 = 5, M_1 = 5, M_2 = 3, M_3 = 7, D = 8$)

B. Question II

Taking special case of $V_4 = 0$V into consideration, one expects $I_4 = I_5 = 0\Omega$. Since for resistances mentioned would have same potential at both of their respective ends. Program returns these values for currents:
$I_1 = -0.0909, I_2 = -0.4545, I_3 = 0.3636,$
$I_4 = 0, I_5 = 0, I_6 = -0.1667$

IV. DATA

A. Question I

There were no plots drawn, and data was not prone to error,thus not included.

B. Question II

For the first part following data was acquired:
$I_1 = -0.0909, I_2 = -0.4545, I_3 = 0.3636,$
$I_4 = -1.0000, I_5 = -0.8000, I_6 = -0.8333$

For the second part the figure (FIG.3.) is placed below.

V. ANALYSIS

A. QuestionII

As seen in FIG. 3. as R_6 decreases towards zero, dissipation power peaks enourmously. This is analoguous to a short-cut in circuit.

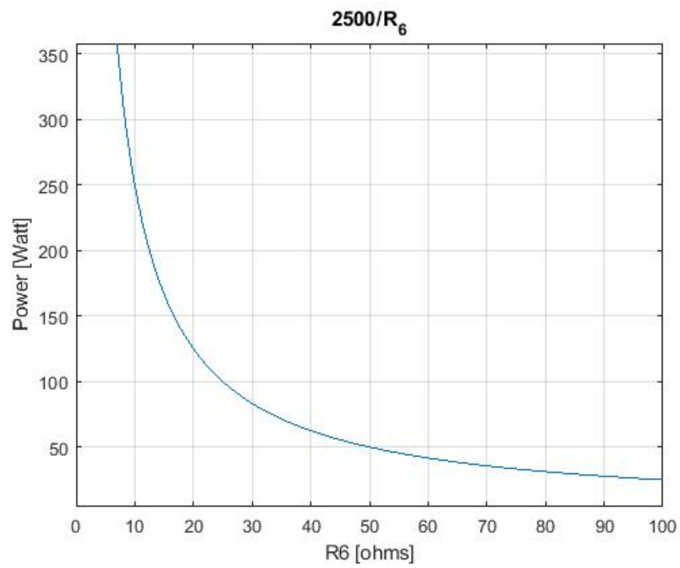

FIG. 3. Question-II plot

VI. INTERPRETATION