Universidad de San Carlos de Guatemala

Facultad de ingeniería

Examen final de robótica

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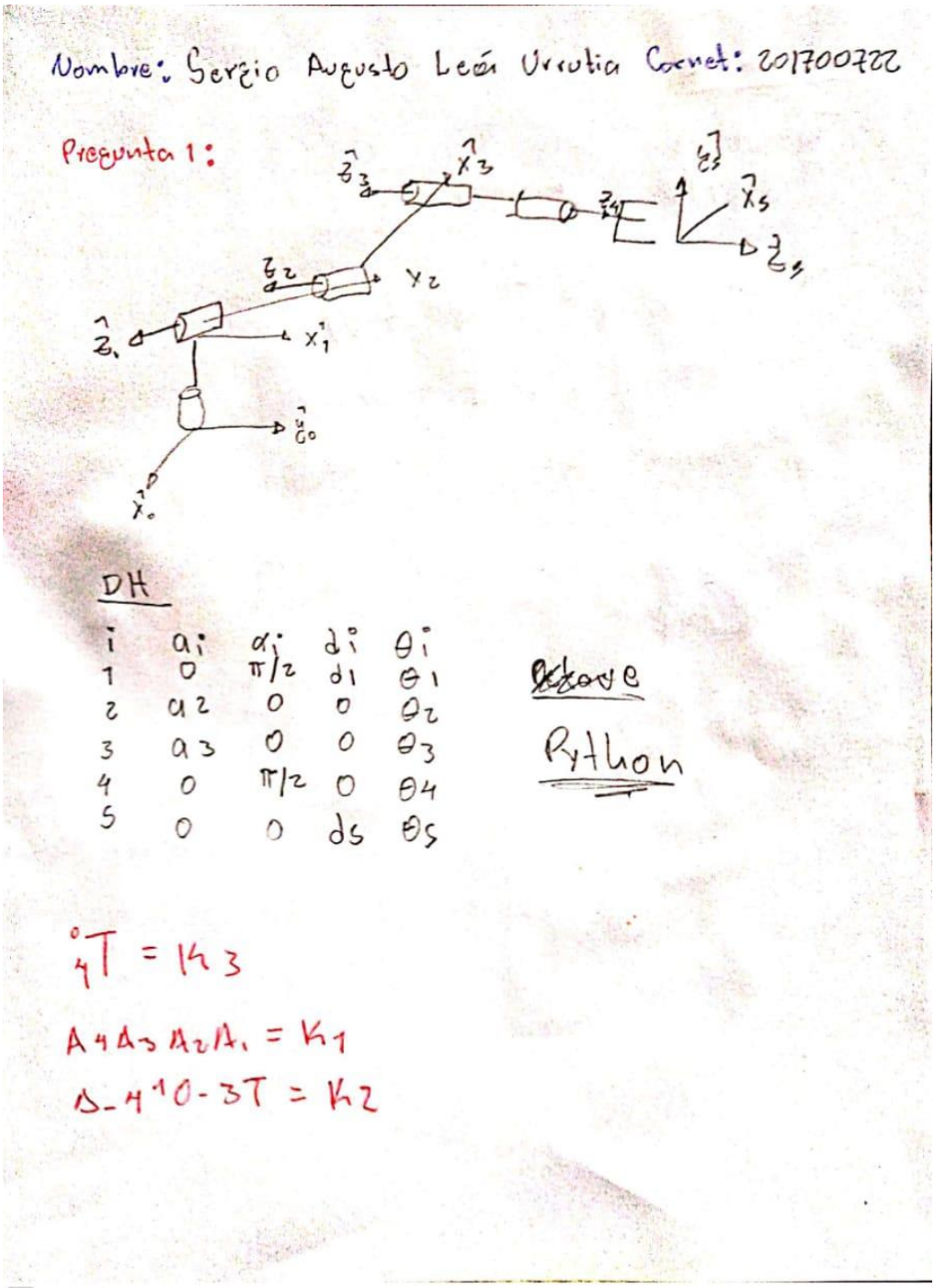
Problema #1:



Programa utilizado:

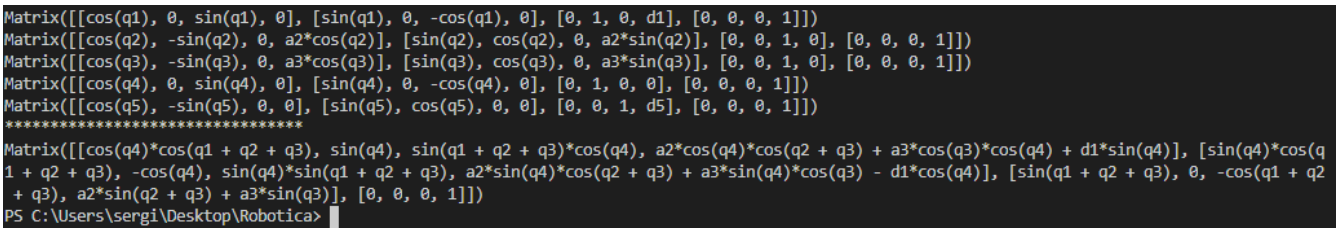
```
import sympy as sp

#FUNCION DE DH
def sTdh(a, alpha, d, th):
    cth = sp.cos(th); sth = sp.sin(th)
    ca = sp.cos(alpha); sa = sp.sin(alpha)
    Tdh = sp.Matrix([[cth, -ca*sth,  sa*sth, a*cth],
                     [sth,  ca*cth, -sa*cth, a*sth],
                     [0,        sa,     ca,      d],
                     [0,         0,      0,      1]])
    return Tdh

#MAIN
q1,q2,q3,q4,q5=sp.symbols('q1,q2,q3,q4,q5')
d1,d2,d3,d4,d5=sp.symbols('d1,d2,d3,d4,d5')
a1,a2,a3,a4,a5=sp.symbols('a1,a2,a3,a4,a5')
#transformadas homogeneas
T01=sTdh(0, sp.pi/2, d1, q1)
T12=sTdh(a2, 0, 0, q2)
T23=sTdh(a3, 0, 0, q3)
T34=sTdh(0, sp.pi/2, 0, q4)
T45=sTdh(0, 0, d5, q5)

print(T01)
print(T12)
print(T23)
print(T34)
print(T45)
resultado = sp.simplify(T34*T23*T12*T01)
print("********************************")
print(resultado)
```

Resultado del programa:



Matrix([[cos(q1), 0, sin(q1), 0], [sin(q1), 0, -cos(q1), 0], [0, 1, 0, d1], [0, 0, 0, 1]])

Matrix([[cos(q2), -sin(q2), 0, a2*cos(q2)], [sin(q2), cos(q2), 0, a2*sin(q2)], [0, 0, 1, 0], [0, 0, 0, 1]])

Matrix([[cos(q3), -sin(q3), 0, a3*cos(q3)], [sin(q3), cos(q3), 0, a3*sin(q3)], [0, 0, 1, 0], [0, 0, 0, 1]])

Matrix([[cos(q4), 0, sin(q4), 0], [sin(q4), 0, -cos(q4), 0], [0, 1, 0, 0], [0, 0, 0, 1]])

Matrix([[cos(q5), -sin(q5), 0, 0], [sin(q5), cos(q5), 0, 0], [0, 0, 1, d5], [0, 0, 0, 1]])

****

Matrix([[cos(q4)*cos(q1 + q2 + q3), sin(q4), sin(q1 + q2 + q3)*cos(q4), a2*cos(q4)*cos(q2 + q3) + a3*cos(q3)*cos(q4) + d1*sin(q4)], [sin(q4)*cos(q1 + q2 + q3), -cos(q4), sin(q4)*sin(q1 + q2 + q3), a2*sin(q4)*cos(q2 + q3) + a3*sin(q4)*cos(q3) - d1*cos(q4)], [sin(q1 + q2 + q3), 0, -cos(q1 + q2 + q3), a2*sin(q2 + q3) + a3*sin(q3)], [0, 0, 0, 1]])

Problema #2

Problema 2

$\lambda = 1$

$T_0 = (\lambda = 0)$

$T_1 (\lambda = 1)$

1) $T_1 (\lambda = 1) = T_0 (\lambda = 0) R_1 (\lambda)$

$T_1 (\lambda = 1) [T_0 (\lambda = 0)]^{-1} = R_2 (\lambda)$

entonces $R_2 = T_1 * inv(T_0)$

$$ {}^{0}_{n}T = \begin{bmatrix} C & -S & 0 & X \\ S & C & 0 & Y \\ 0 & 0 & 1 & Z \\ 0 & 0 & 0 & 1 \end{bmatrix} {}^{r}_{n}T $$

$$ R = \begin{bmatrix} 0.89330 & 0.44772 & -0.03015 & 1.79239 \\ 0.15443 & -0.24373 & 0.95747 & -20.13768 \\ 0.42091 & -0.86355 & -0.28130 & 4.74444 \\ 0 & 0 & 0 & 1 \end{bmatrix} $$

Programa en octave

--Matriz T1 dada

t1=[0.769421 -0.25 0.587785 0.519421; 0.309017 0.951057 0 1.26007; -0.559017 0.181636 0.809017 -0.377381; 0 0 0 1]

--Matriz T2 dada

t0=[0.5 0 0.866025 0; 0.75 -0.5 -0.433013 -1.33975; 0.433013 0.866025 -0.25 22.3205; 0 0 0 1]

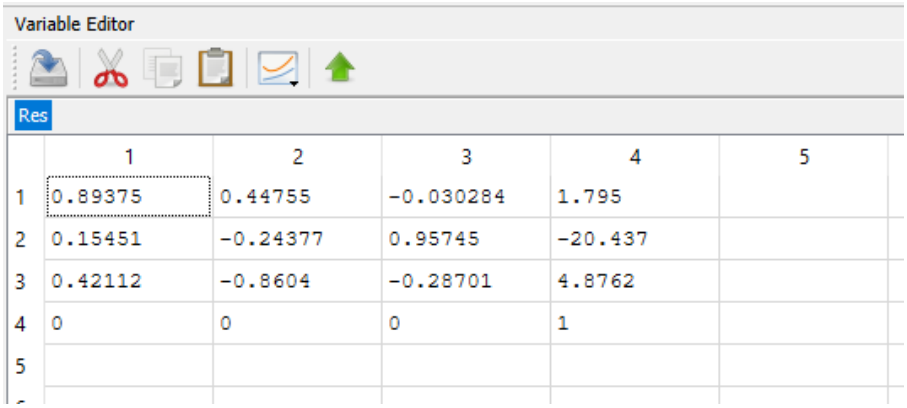
--Resultado en base al calculo

Res=t1*inv(t0)

--Angulo

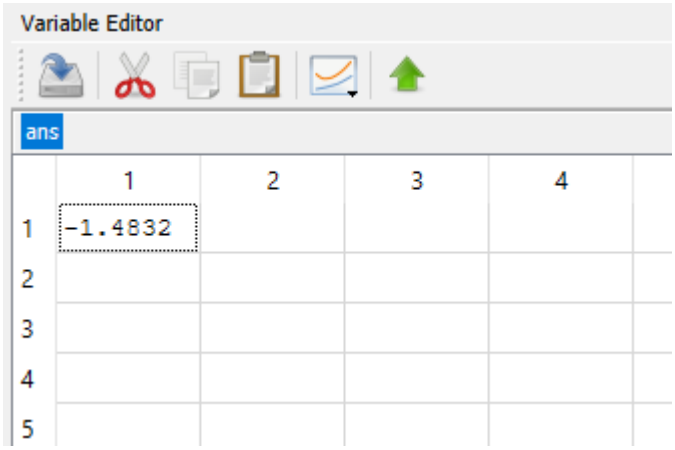
atan2(Res(2,4),Res(1,4))

Resultado del programa:



	1	2	3	4	5
1	0.89375	0.44755	-0.030284	1.795	
2	0.15451	-0.24377	0.95745	-20.437	
3	0.42112	-0.8604	-0.28701	4.8762	
4	0	0	0	1	
5					

Angulo:



	1	2	3	4
1	-1.4832			
2				
3				
4				
5				

Para encontrar Ks:

$$\begin{bmatrix} k_x \\ k_y \\ k_z \end{bmatrix} = \frac{1}{2\sin\theta} \begin{bmatrix} r_{32} - r_{23} \\ r_{13} - r_{31} \\ r_{31} - r_{12} \end{bmatrix}$$

$$= \frac{1}{2\sin(-1.48352)} \begin{bmatrix} -0.86255 - 0.95247 \\ -0.83015 - 0.4291 \\ 0.15443 - 0.44277 \end{bmatrix}$$

$k_x = 0.90347$

$k_z = 0.30508$

$k_z = 0.147134$

Problema #3: