Departament d'Enginyeria de Sistemes, Automàtica i Informàtica Industrial
UNIVERSITAT POLITÈCNICA DE CATALUNYA

Robot Kinematics, Dynamics and Control

ETSEIB

Master MAR

January 19, 2015

Write your name in all delivered sheets

Every problem must be solved in a separated sheet.

During the exam there is allowed a form DIN A4 written ONLY BY A SINGLE FACE.

The form WILL HAVE TO BE DELIVERED together with the exam.

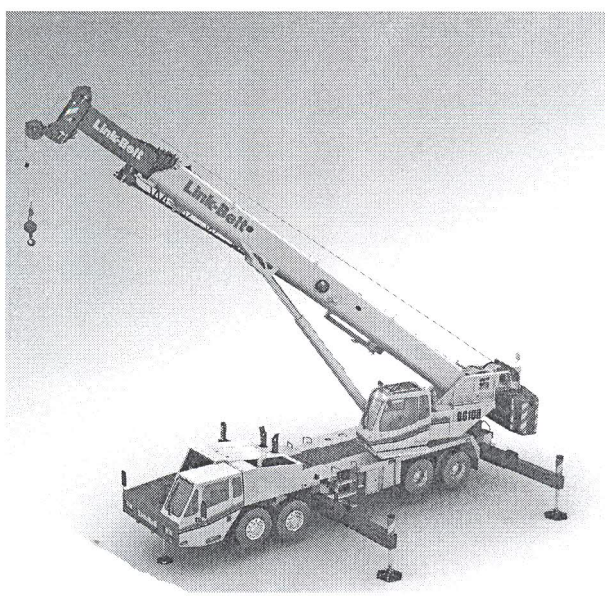
Problem #1 - Kinematics

1.- What are the robot morphology of the crane on the truck given in the next figure.

2.- Make a sketch of the links and joints that the crane use, to position its end effector.

2.- Derive its DH parameters (modified or standards).

3. Derive de Forward Kinematic equation and demonstrate that for a known parameters and variables the function will work.



Problem #2 - Dynamics

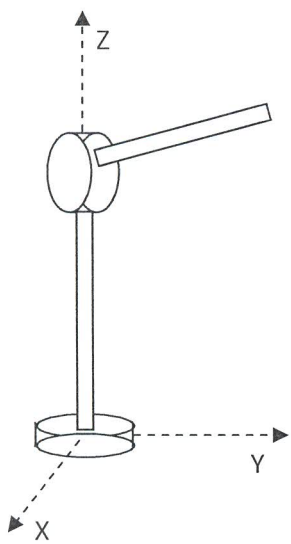
Take in account the robot shown in the next figure. This one consists of a rigid link formed by two parts of lengths l_1 and l_2, whose masses m_1 and m_2 are considered to be punctual by simplicity. Masses are placed at the end of the respective segments. φ is constant.

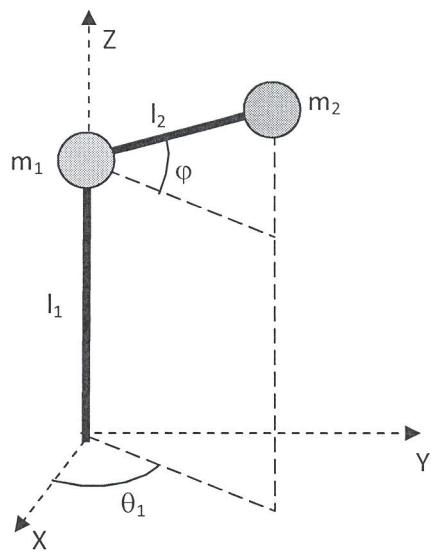
The robot only has one rotational joint θ_1 on Z axis.

a.- For this robot, obtain and justify the equations of dynamic model using Euler-Lagrange's equations.

b.- Find the value of the torque if the robot is moving with the following parameters

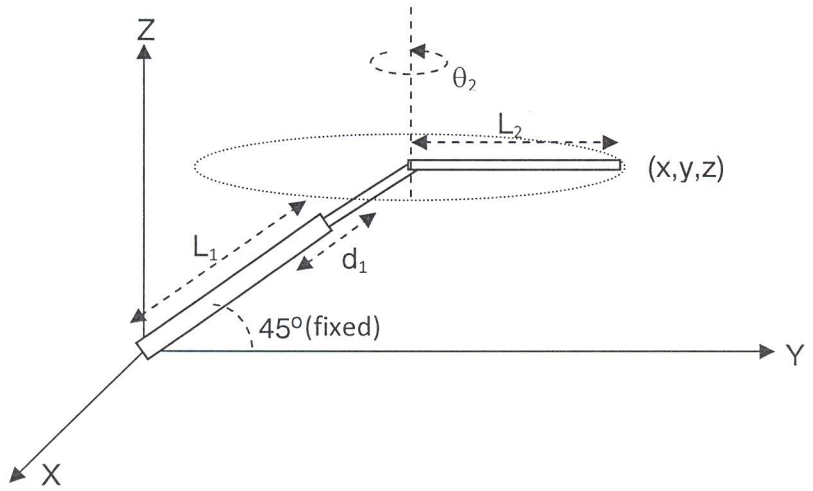
l_1=100 cm	**m1 = 1 Kg**	**φ = 45º**	**$\dot{\theta}1$ = 10º/sec**
l_2 = 50 cm	**m2 = 1 Kg**	**θ1 = 30º**	**$\ddot{\theta}1$ = 50º/sec^2**





Problem #3 – Path generation

Due to the optimization of a productive process, we have had to develop a 'customized' robot with the next morphology:



With:

$\mathbf{d_1}$ as a prismatic joint and θ_2 as a rotational one (PR).

$L_1 = L_2 = 40$ cm. and **d_1 has a maximum lenght = 40 cm.**

Testing the robot, we have programmed the following instructions:

move p1

move p2

move p1

where **p1 = (0, 89.5, 49.5)**

p2 = (28.28, 95.5, 67)

For the above given robot, it is desired to move it from initial point p1 to final point p2 in 10 seconds. Write a path generator system which calculates a trajectory in joint space based on cubic polynomials. The system must accomplish the desired motion with parabolic velocity profile. The robot is stopped at the beginning and brings the arm to rest at the goal.

Be aware!... Taking the found interpolating polynomials, the controller MUST BE ABLE to realize the requested movement.

Question #4 – Robot Control

Clarify the main idea to use a PID with Gravity Compensation controller in order to control Robot Position instead of to use a simple PID controller.