

# ME 639 MidSem Exam

## Question 5-9

- 5. Yes
- 6. No
- 7. Yes
- 8. Yes
- 9. Yes

## Question 2

- A. I feel that a soft gripper should be used instead of a hard gripper. Given the robot will be used for pill-picking job, the robot will have to pick up delicate pills which may break upon action of excessive force. A soft gripper will enable the robot to pick and also give it a cushioning to ensure that the pill does not break. Moreover, a 1DOF hard gripper cannot pick up pills in any orientation. The gripper will have definite positions it takes to pick up, in this process if the pill is kept in a orientation which is bigger than the what the gripper picks up, the gripper will crush the pill. This is easily countered in case of soft gripper, wherein the pill once in contact with the picker will still have some room to move and will self-adjust. The gripper can pneumatically be actuated for better results.
- B. Soft robotic grippers will suffice. Universal Gripper cannot be used for a single Flexible, Origami & paper grippers are fine but they cannot be made in a compact form factor. Universal grippers cannot be used to pick up single pills, its main purpose is to grab multiple objects at once. Moreover, paper and origami gripper cannot fit in a compact form factor as stated in the question and hence would not prefer to use them either.

<https://youtu.be/X0XGure7mak>

<https://youtu.be/BYAwP7Gn4N4>

## Question 3

- A. First link length (hip to knee) = 50 cm  
Second link length (knee to toe) = 43.5 cm

**Gait Trajectory** is the path traversed by the ankle joint of the lower limb while walking. The gait trajectory varies from person to person and it can be tracked using ETS, Force sensors, Accelerometers, gyroscope etc. In general the gait trajectory is shown in the diagram below:

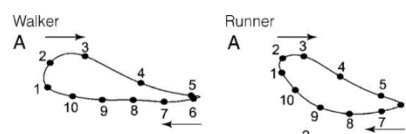


Figure 1: <https://jov.arvojournals.org/article.aspx?articleid=2122197>

**Step Height** is the maximum height attained by the heel of a person in a single gait cycle. It can be obtained from the above diagram:

$$\text{Step height} = \text{maximum}(z) - \text{minimum}(z)$$

**Step Length** is the maximum horizontal distance between points on the trajectory. As can be seen from the figure, the step length would be

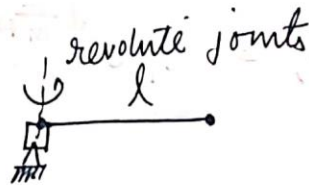
$$|x(\text{point 6}) - x(\text{point 1})|$$

#### Question 4

A)

DH parameters

$a_i$	$\alpha_i$	$d_i$	$\theta_i$
$l$	$0$	$0$	$\theta_1$



B)

$$ml^2 \frac{d^2 q}{dt^2} = \tau$$

$$\tau = +kq$$

$$ml^2 \frac{d^2 q}{dt^2} = kq$$

$$\frac{d^2 q}{dt^2} = \frac{kq}{ml^2}$$

putting  $q \rightarrow e^{at}$

$$a^2 e^{at} = \frac{k e^{at}}{ml^2}$$

$$a = \pm \sqrt{\frac{k}{ml^2}}$$

$$\therefore q = c_1 e^{\sqrt{\frac{k}{ml^2}} t} + c_2 e^{-\sqrt{\frac{k}{ml^2}} t}$$

at time  $t=0$ , we give perturbation as  $q_0$

We can see the equation is in the form of a sinusoid i.e the link will oscillate about origin indefinitely.  $G$  is taken as 0. The stiffness  $k$  commands how the fast or slow the link moves.