



Robotics Studio MECE 4611  
Spring 2024  
Assignment 1  
Nicolino Primavera (ncp2136)  
Submission: 1/28/24 at 8:40pm  
Grace hours: 96+3:20

# Concept 1 - Spider/Arachnid design

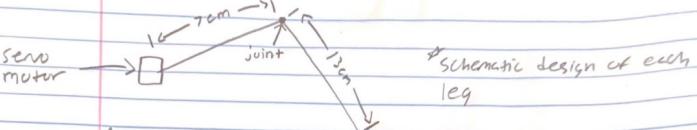
- This design is of an eight-legged robot that is inspired by spiders' physical characteristics.

Calculations for spider design:

Volume of body =  $144 \text{ in}^3 \cdot \left(\frac{2.54 \text{ cm}}{1 \text{ inch}}\right)^3 = 2359.737 \text{ cm}^3$

mass of body =  $(2359.737 \text{ cm}^3)(1.249 \text{ g/cm}^3)(0.10) = 292.61 \text{ g}$

\* each leg is 20cm long (there are 8 total legs)



\* based on the design, each motor is critical

the legs are cylindrical with a 2cm diameter  $\rightarrow V = \pi r^2 h$   
 $V = \pi \cdot (1\text{cm})^2 (20\text{cm}) = 62.832 \text{ cm}^3$  (volume of each leg)

mass of each leg =  $V \cdot d \cdot 0.10 = (62.832 \text{ cm}^3)(1.249 \text{ g/cm}^3)(0.10) = 7.791 \text{ g}$

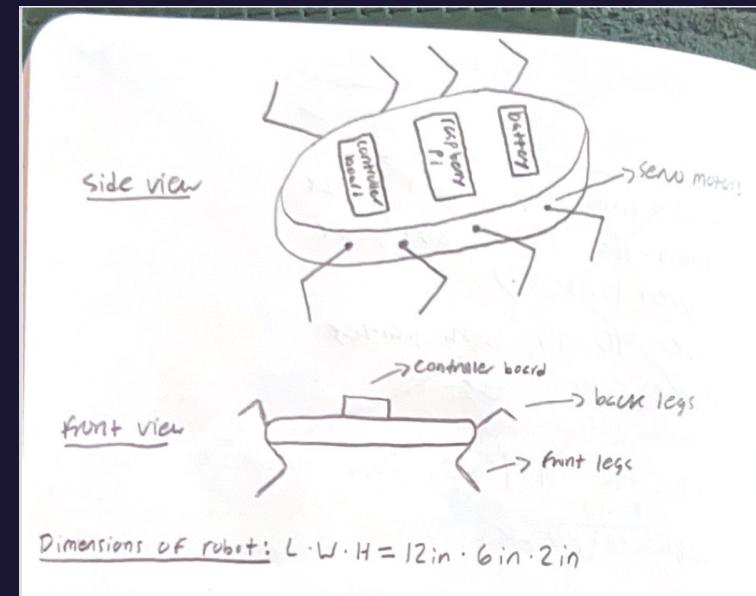
(each leg) Weight =  $m \cdot g = 7.791 \text{ g} \cdot 9.81 \text{ m/s}^2 = 76.43 \frac{\text{g} \cdot \text{m}}{\text{s}^2} = 0.07643 \text{ N}$

(Weight plus servo motor) Force =  $(52 \text{ g} + 7.791 \text{ g}) \cdot 9.81 \text{ m/s}^2 = 586.55 \frac{\text{g} \cdot \text{m}}{\text{s}^2} = 0.58655 \text{ N}$

Static torque for each motor =  $0.58655 \text{ N} \cdot 20 \text{ cm} = 11.731 \text{ N} \cdot \text{cm}$

\* The motor specification is  $17 \text{ kg} \cdot \text{cm}$ , which is  $166.7 \text{ N} \cdot \text{cm}$   
 since:  $(11.731 \text{ N} \cdot \text{cm}) \lll 166.7 \text{ N} \cdot \text{cm}$

Conclusion: the design is well within motor specifications



Walking distance

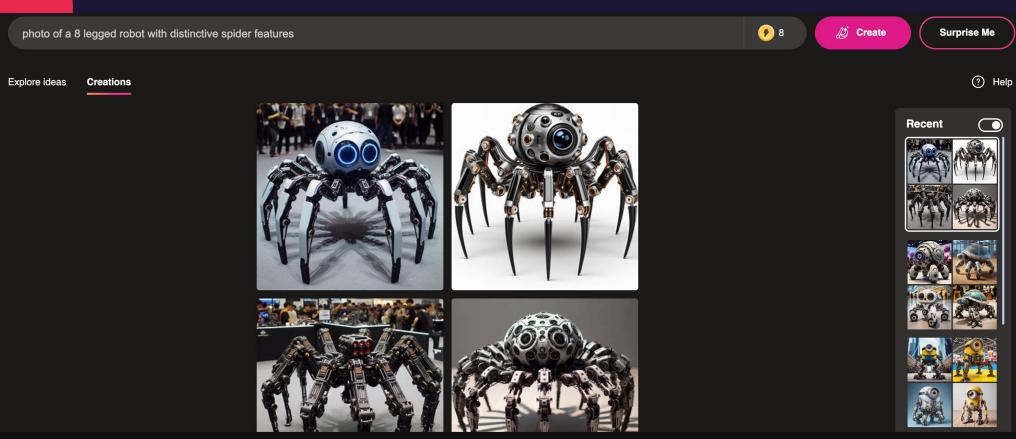
each motor

Power =  $\frac{\text{Work}}{\text{time}}$ , Work = Force  $\cdot$  distance =  $8(586.55 \frac{\text{g} \cdot \text{m}}{\text{s}^2})(10\text{m}) = 46924 \frac{\text{g} \cdot \text{m}^2}{\text{s}^2} = 46.924 \text{ N} \cdot \text{m}$

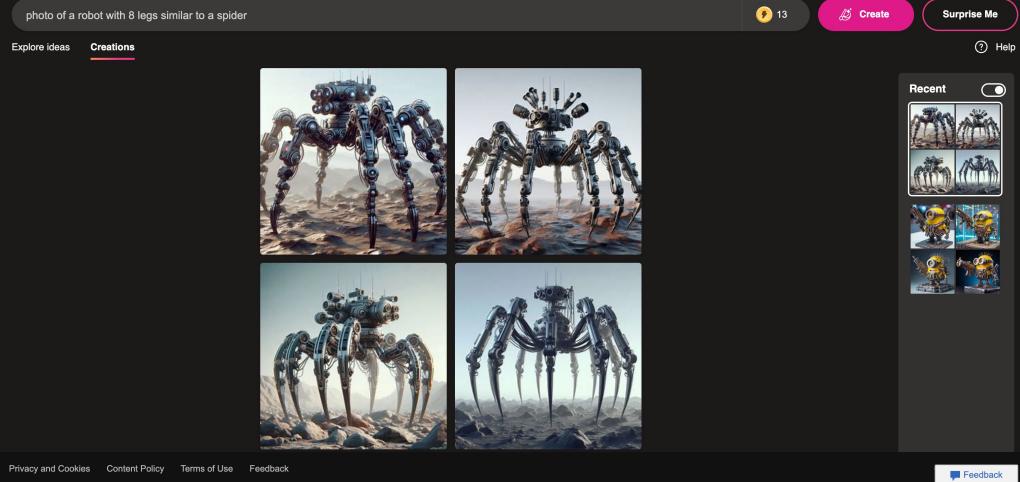
Power =  $30 \text{ W} = 30 \frac{\text{N} \cdot \text{m}}{\text{s}}$

time =  $\frac{46.924 \text{ N} \cdot \text{m}}{30 \text{ N} \cdot \text{m/s}} = 1.56 \text{ s}$  \* take 1.56s to walk 10 meters

# Concept 1 - Spider/Arachnid design using AI

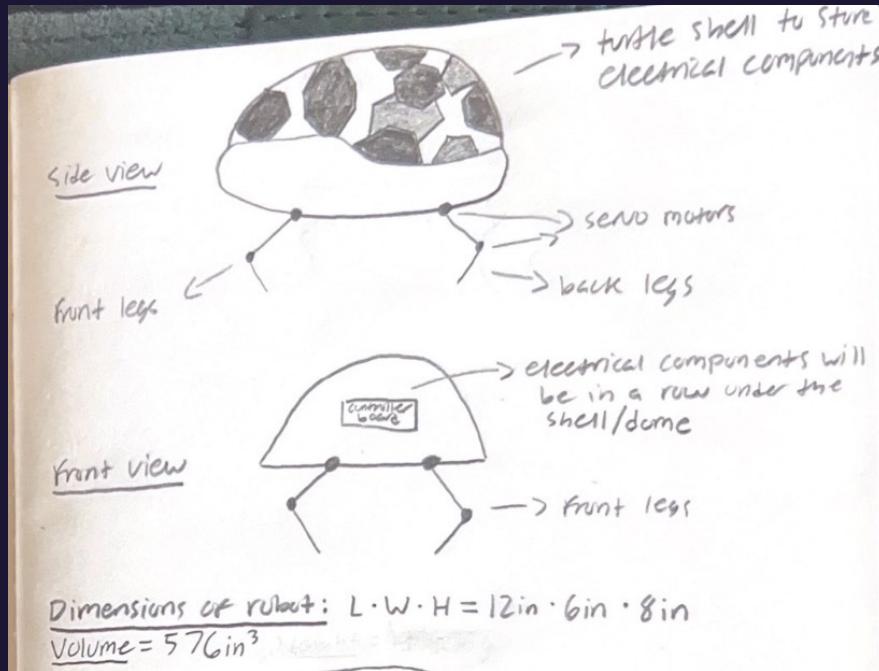


- I used the generative AI models to improve my designs and sketches.
- They helped me position joints and servo motors in spots I wouldn't have initially chosen.



# Concept 2 - Turtle/Quadruped design

- This design is of a four-legged robot that is inspired by turtles' physical characteristics.

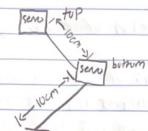


Calculations for turtle design:

Volume of body =  $576 \text{ in}^3 \cdot \left(\frac{2.54 \text{ cm}}{\text{in}}\right)^3 = 9438.95 \text{ cm}^3$

mass of body =  $(9438.95 \text{ cm}^3) / (1.249 \text{ g/cm}^3) / (0.10) = 1170.43 \text{ g}$

\* each leg is 20cm long (there are 4 total legs)



\* schematic design of each leg (8 total motors)

\* based on the design, the top motor is critical and the bottom is not since the torques required to move knees are less than hip motors → heaviest load

The 4 legs are cylindrical with a 2cm diameter →  $V = \pi r^2 h$

Volume of one link =  $\pi(1 \text{ cm})^2(10 \text{ cm}) = 31.4 \text{ cm}^3$

mass of one link =  $(31.4 \text{ cm}^3) / (1.249 \text{ g/cm}^3) / (0.10) = 3.9 \text{ g}$

Weight of one link =  $3.9 \text{ g} \cdot 9.81 \text{ m/s}^2 = 38.26 \frac{\text{g} \cdot \text{m}}{\text{s}^2} = 0.03826 \text{ N}$

Static torque for top motor =  $\frac{(52 \text{ g} + 3.9 \text{ g})(9.81 \text{ m/s}^2)(10 \text{ cm})}{\text{N} \cdot \text{cm}}$   
 $\frac{(52 \text{ g} + 3.9 \text{ g} + 3.9 \text{ g})(9.81 \text{ m/s}^2)(20 \text{ cm})}{\text{N} \cdot \text{cm}} = 17.22 \text{ N} \cdot \text{cm}$

\* the motor specification is  $17 \text{ kg} \cdot \text{cm} = 166.7 \text{ N} \cdot \text{cm}$   
 since  $(17.22 \text{ N} \cdot \text{cm}) \ll (166.7 \text{ N} \cdot \text{cm})$ , the design is well within motor specifications

time =  $\frac{\text{work}}{\text{power}} = \frac{8((52 \text{ g} + 3.9 \text{ g})(9.81 \text{ m/s}^2))(10 \text{ cm})}{30 \frac{\text{N} \cdot \text{m}}{\text{s}}} = \frac{43.870 \text{ N} \cdot \text{m}}{30 \frac{\text{N} \cdot \text{m}}{\text{s}}} = 1.463$

\* time it takes the robot to walk 10 meters

# Concept 2 - Turtle/Quadruped design using AI

photo of a 4 legged robot with distinctive turtle features like a shell

Explore ideas Creations

The interface shows a search bar with the query "photo of a 4 legged robot with distinctive turtle features like a shell". Below it, there are two rows of two images each, displaying various quadruped robots with shells. A sidebar on the right is titled "Recent" and shows a grid of smaller thumbnail images. At the bottom left, there are links for "Privacy and Cookies", "Content Policy", "Terms of Use", and "Feedback".

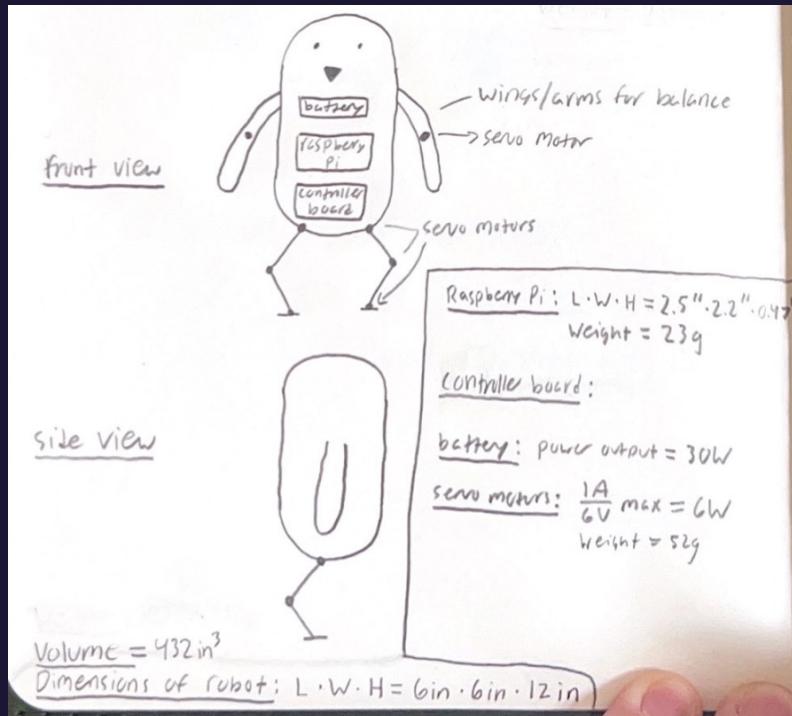
photo of a robot with 4 legs similar to a turtle

Explore ideas Creations

The interface shows a search bar with the query "photo of a robot with 4 legs similar to a turtle". Below it, there are four large, detailed images of quadruped robots with metallic shells and complex mechanical designs. A sidebar on the right is titled "Recent" and shows a grid of smaller thumbnail images. At the bottom left, there are links for "Privacy and Cookies", "Content Policy", "Terms of Use", and "Feedback".

# Concept 3 - Penguin/Bipedal Robot design

- This design is of a two-legged robot that is inspired by penguins' physical characteristics.



Calculations for Penguin design:

Volume of body =  $432 \text{ in}^3 \cdot \left(\frac{2.54 \text{ cm}}{1 \text{ in}}\right)^3 = (7079.213 \text{ cm}^3)$

mass of body =  $(7079.213 \text{ cm}^3)(1.24 \text{ g/cm}^3)(0.10) = (877.82 \text{ g})$

\* each leg is 20 cm long (2 total legs)

schematic design of each leg (2 total)

hip      top      \* top motor is critical and bottom two are not  
servo motor      knee      since the torques required to move the knee  
                        10cm      and feet are less than hip motors → heaviest  
servo motor      feet      load is attached to the hip motors

The 2 legs are cylindrical w/ a 2cm diameter →  $V = \pi r^2 h$

Volume of one link =  $\pi (1 \text{ cm})^2 (10 \text{ cm}) = (31.4 \text{ cm}^3)$

mass of one link =  $(31.4 \text{ cm}^3)(1.24 \text{ g/cm}^3)(0.10) = (3.9 \text{ g})$

Weight of one link =  $(3.9 \text{ g})(9.81 \text{ m/s}^2) = (38.26 \frac{\text{N}}{\text{s}^2}) = 0.03826 \text{ N}$

Static torque for top motor =  $(52 + 3.9g)(9.81 \text{ m/s}^2)/(10 \text{ cm}) + (52 + 3.9g + 3.9g)(9.81 \text{ m/s}^2)/(20 \text{ cm}) = (17.22 \text{ N} \cdot \text{cm})$

\* the motor specification is  $17 \text{ kg} \cdot \text{cm} = 166.7 \text{ N} \cdot \text{cm}$   
Since  $(17.22 \text{ N} \cdot \text{cm} \ll 166.7 \text{ N} \cdot \text{cm})$ , the design is well within motor specifications

time =  $\frac{\text{work}}{\text{power}} = \frac{6(52g + 3.9g)(9.81 \text{ m/s}^2)(10 \text{ cm})}{30 \text{ N} \cdot \text{m/s}} = \frac{32.90274 \text{ N} \cdot \text{m}}{30 \text{ N} \cdot \text{m/s}} = (1.097 \text{ s})$

\* time it takes the robot to walk 10 meters

# Concept 3 - Penguin/Bipedal Robot design using AI

The image shows two separate search results from the Microsoft Bing AI interface, each featuring a different penguin/bipedal robot design.

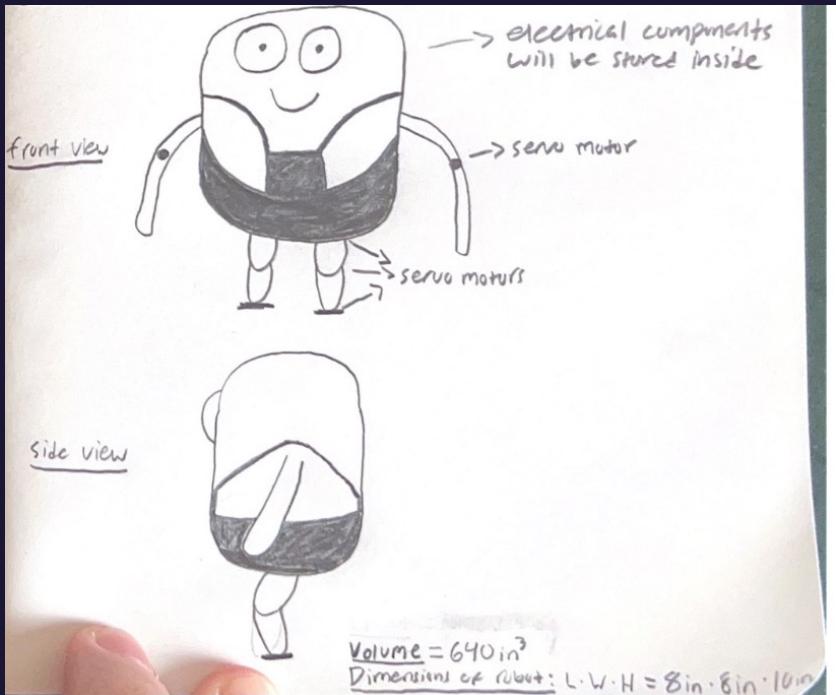
**Top Result:** The search query is "photo of a 2 legged robot with distinctive penguin features". The results show two images of real-world robots that resemble penguins. The first image is a white and black bipedal robot with large, expressive eyes and a penguin-like body. The second image is another white and black bipedal robot with a more mechanical, segmented appearance. A sidebar on the right shows a grid of recent image results, mostly related to penguin robots.

**Bottom Result:** The search query is "photo of a robot with 2 legs similar to a penguin". The results show two images of a highly detailed, realistic-looking penguin robot standing on a rocky beach. The robot has a white body with black markings and a penguin-like head. A sidebar on the right shows a grid of recent image results, mostly related to penguin robots.

**Common Interface Elements:** Both results share a dark-themed interface with a top bar showing a yellow notification badge (7 or 11), a "Create" button, and a "Surprise Me" button. Below the search bar are "Explore ideas" and "Creations" tabs. At the bottom of each result page are links for "Privacy and Cookies", "Content Policy", "Terms of Use", "Feedback", and a "Feedback" button. On the far right of the bottom result page is a "Help" link.

# Concept 4 - Despicable Me Minion design

- This design is of a two-legged robot that is inspired by the Despicable Me minions' physical characteristics.



Calculations for minion design:

Volume of body =  $640 \text{ in}^3 \cdot \frac{(2.54 \text{ cm})^3}{(1 \text{ in})^3} = 10487.72 \text{ cm}^3$

mass of body =  $(10487.72 \text{ cm}^3)(1.24 \text{ g/cm}^3)(0.10) = 1300.48 \text{ g}$

\* each leg is 20 cm long (2 total legs)

hip [servo motor] top knee [servo motor] knee [servo motor] feet [servo motor]

\* schematic design of each leg (2 total)

\* top motor is critical and bottom two are not since the torques required to move the knee and feet are less than hip motors → heaviest load is attached to the hip motors

The 2 legs are cylindrical w/ a 2cm diameter →  $V = \pi r^2 h$

Volume of one link =  $\pi (1\text{cm})^2 (10\text{cm}) = 31.4 \text{ cm}^3$

mass of one link =  $(31.4 \text{ cm}^3)(1.24 \text{ g/cm}^3)(0.10) = 3.9 \text{ g}$

Weight of one link =  $(3.9 \text{ g})(9.81 \text{ m/s}^2) = (38.26 \text{ g}\cdot\text{m}) = 0.03826 \text{ N}$

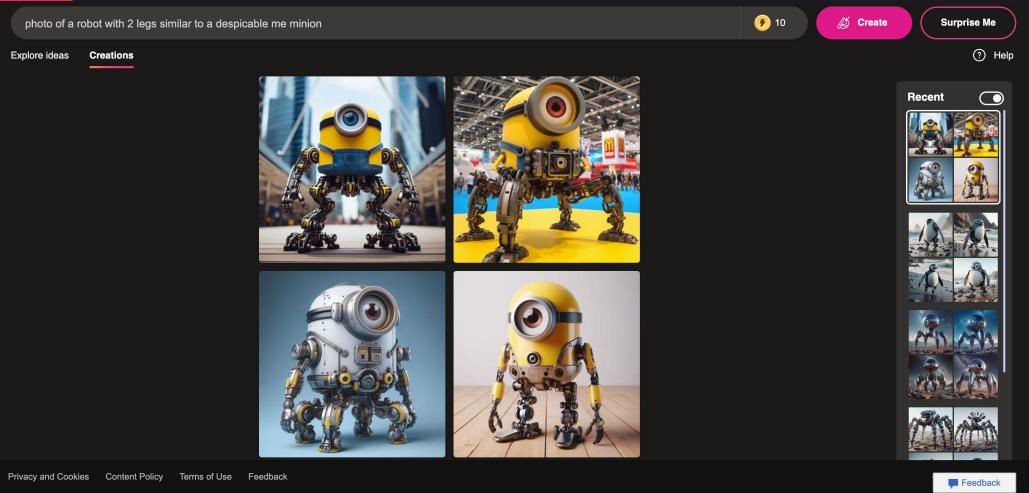
Static torque for top motor =  $(52 + 3.9g)(9.81 \text{ m/s}^2)(10\text{cm}) + (52 + 3.9g + 3.9g)(9.81 \text{ m/s}^2)(20\text{cm})$   
 $= 17.22 \text{ N}\cdot\text{cm}$

\* the motor specification is  $17 \text{ kg}\cdot\text{cm} = 166.7 \text{ N}\cdot\text{cm}$   
 Since  $(17.22 \text{ N}\cdot\text{cm} < 166.7 \text{ N}\cdot\text{cm})$ , the design is well within motor specifications

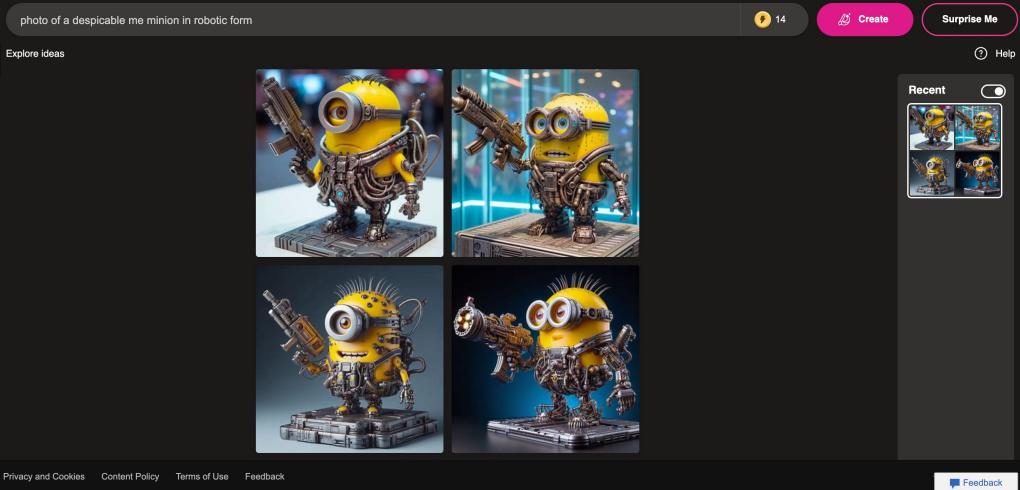
time =  $\frac{\text{work}}{\text{power}} = \frac{6(52g + 3.9g)(9.81 \text{ m/s}^2)(10\text{cm})}{30 \text{ N}\cdot\text{m/s}} = \frac{32.90274 \text{ N}\cdot\text{m}}{30 \text{ N}\cdot\text{m/s}} = 1.097 \text{ s}$

\* time it takes the robot to walk 10 meters

# Concept 4 – Despicable Me Minion design using AI



- The minion in the bottom right corner is exactly what I look to do.



# Rubric Checklist

- At the end of the assignment, list all the rubrics and points you believe you should receive, along with page numbers to support your claim.
- 5 Points Title slide complete (slide 1)
- 5 Points overall aesthetics, layout and formatting of the slides
- 5 Points posting a sketch of your robot on the discussion board at least 24h in advance of the deadline (slide 12)
- 5 Points Comment (constructively) on at least three other's postings (slide 11)
- 5 Points showing three robot designs from an AI-generator (e.g. StableDiffusion) along with the prompt (slides 3, 5, 7, 9)
- 5 Points 3D sketch, with key dimensions and labels (slides 2, 4, 6, 8)
- 5 Points shading and shadows (slides 4 and 8)
- 5 Points weight estimate, gait and stability analysis (slides 2, 4, 6, 8)
- 5 Points power estimates (including estimated run time) (slides 2, 4, 6, 8)
- 5 Points including Computer, controller, battery labels (slides 2, 4, 6, 8)
- 5 Points showing in multiple poses (slides 2, 4, 6, 8)
- 10 Points showing generative AI assistance (slides 3, 5, 7, 9)

# Comment (constructively) on at least three other's postings

Nico Primavera 2 days ago

Great sketches! I had a similar idea to the crab except I called it spider and used 8 legs.

Comment Edit Delete ...

Add comment

Aleksandr Vankov 2d

Thank you, I look forward to seeing your design with 8 legs. I thought of some myriapods with so many legs, but ended up with crab.

Reply ...

Nico Primavera Now

Nice Grogu! I also used animated movie characters for inspiration

Comment Edit Delete ...

Nico Primavera 26m

I like your turtle design! I had a similar idea

Reply Edit Delete ...

Nico Primavera 17 hours ago

Nice designs! I particularly like the 4 legged one.

Comment Edit Delete ...

# ED Discussion Board post

The screenshot shows a Safari browser window with the following details:

- Address Bar:** edstem.org
- Tab Bar:** Google Calendar - Week of Janua..., M (2) - nicolinoprimavera@gmail.co..., Robotics Studio Design Drawings..., ROBOTICS STUDIO - Section 1, (6) MECE 4611 S1 – Ed Discussion
- Page Title:** ed MECE 4611 S1 – Ed Discussion
- Left Sidebar:** Courses (MECE 4606, MECE 4611 S1), Categories (General, Sketches, CAD design, Working robot, Simulation), and a message about 36 others online.
- Search Bar:** Search and Filter dropdown.
- Post List:** A list of posts under the category "Sketches".
  - Pair (General, KashafJabbar 21h): Concept Sketch #1 Guanjie(Bill) Zhao (Sketches, Guanjie Zhao 21h)
  - Concept Sketch #1 (Sketches, Aileen Liu 22h)
  - Prelim Concept Sketches 1-3 - James Vic... (Sketches, James Vickery 23h)
  - Concept Sketches - Nico Primavera (Sketches, Nico Primavera 23h)
  - Concept Sketch (Sketches, Rishabh Dhotrekar 24h)
  - Concept Sketches 2&3 -Zelin Tao (Sketches, Zelin Tao 1d)
  - Concept Sketches (Sketches, KashafJabbar 1d)
  - The Griddy (Sketches, Daksh Garg 1d)
- Post Preview:** Nico Primavera's post titled "Concept Sketches - Nico Primavera #21".
  - Profile picture: N
  - Author: Nico Primavera
  - Time: 23 hours ago
  - Category: Sketches
  - Views: 61
  - File: HW1 - Sketches.pdf
  - Message: Hi all,  
Attached are a few of my sketches. I used spiders, turtles, penguins and minions for inspiration. I am not the best artist but I hope you can still see what I was going for.
  - Actions: Comment, Edit, Delete, ...
- Comments:** 3 Answers.
  - Alexa Ocel (Profile picture: A): I really like the turtle shell design to enclose the electrical components, nice work.  
Comment: ...
  - Nico Primavera (Profile picture: N): Thank you!  
Reply, Edit, Delete, ...