Project Two Worksheets (TEAM)

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MILESTONE ZERO (TEAM): TEAM DEVELOPMENT AND PROJECT PLANNING

PROJECT TWO: MILESTONE 0 – COVER PAGE

Team ID: Day-##

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Elaine Ocampo	ocampm6
Reem Basiouny	basiounr
Isabel Anderson	anderi3
Akinniyi Chidiebube	akinniyc
Luay Alkader	alabedal

Insert your Team Portrait in the dialog box below

MILESTONE 0 – SUB-TEAM CHARTER

Team ID: Thurs-16

Indicate which team member is on each sub-team in the table below.

- You may refer to the **P2P3 Overview** document on Avenue for information on each sub-team's requirements

Sub-Team	Team Member's Full Name
Modelling	Akinniyi Chidiebube
	Luay Alkader
Computing	Reem Basiouny
	Elaine Ocampo
	Isabel Anderson

MILESTONE 0 – TEAM CHARTER

Team ID: Thurs-16

Incoming Personnel Administrative Portfolio:

Prior to identifying Leads, identify each team members incoming experience with various **Project Leads**

	Team Member Name:	Project Leads
1.	Isabel Anderson	☐M ☐A ☐C ☒S
2.	Reem Basiouny	☐M ☒A ☐C ☐S
3.	Elaine Ocampo	☐M ☒A ☐C ☐S
4.	Luay Alkader	☒M ☐A ☐C ☐S
	Akinniyi Chidiebube	☐M ☐A ☐C ☒S

To 'check' each box in the Project Leads column, you must have this document open in the Microsoft Word Desktop App (not the browser and not MS Teams)

Project Leads:

Identify team member details (Name and MACID) in the space below.

Role:	Team Member Name:	MacID
Manager	Reem Basiouny	basiounr
Administrator 1	Isabel Anderson	anderi3
Administrator 2	Akinniyi Chidiebube	akinniyc
Coordinator	Elaine Ocampo	ocampm6
	Luay Alkader	alabedal

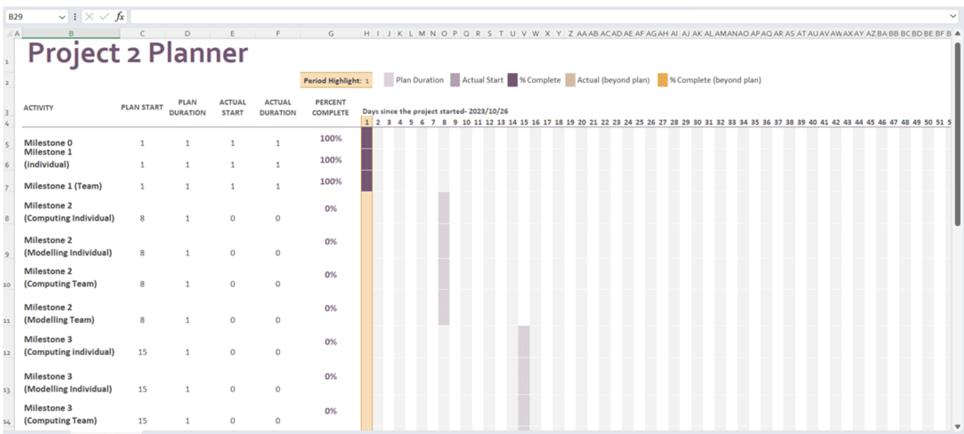
MILESTONE 0 – PRELIMINARY GANTT CHART (TEAM MANAGER ONLY)

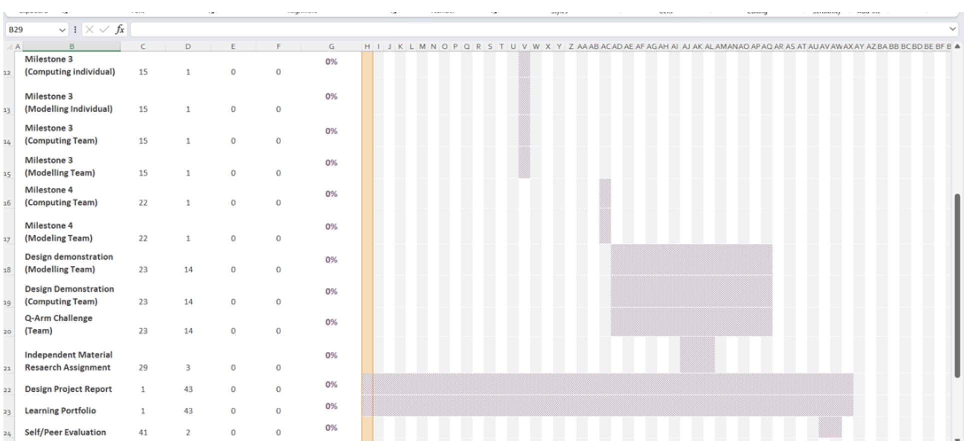
Te

Only the **Team Manager** is completing this section!

Full Name of Team Manager:	MacID:
Reem Basiouny	Basiounr

Preliminary Gantt chart:





MILESTONE ONE (TEAM): OBJECTIVES, MORPH CHART, & INITIAL DESIGN

PROJECT TWO: MILESTONE 1 – COVER PAGE

Team ID: Thurs-16

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Luay Alkader	alabedal
Elaine Ocampo	ocampm6
Isabel Anderson	anderi3
Reem Basiouny	basiounr
Akinniyi Chidiebube	akinniyc

MILESTONE 1 (STAGE 1) – LIST OF OBJECTIVES, CONSTRAINTS, AND FUNCTIONS

Team ID:

1. As a team, create a list of objectives, constraints, and functions in the table below.
   → The exact number you should have depends on what information you have gathered from the Project Module.

Objectives	Constraints	Functions
Should securely hold surgical tools.	Object must have weight and stability, smaller than the arm of robot.	Ability of container to be held.
Program should be time efficient and effective.	The container must sit in the given footprint.	Arm picks up and moves tools to the correct container.
The grip of the arm should be well balanced and strong enough to hold the weight.	Program must interact with Q-labs and use a potentiometer.	The code and the containers must be compatible with each other.
Minimal excess movement of the arm.	Tools must fit properly in the container.	Container can be closed once tool is inside.
Object inside the container can be sterilized within it.	Must have a total print time after scaling of less than two hours, and not part can be smaller than 2mm.	Tools have minimal movement inside container.

2. What is the primary function of the entire system?

The primary function of the entire system is to transfer the surgical tools safely from point A to B.

3. What are the secondary functions?

Able to store and hold containers safely.
Able to lift the container up by the arm.
Code moves arm correctly with no excess movement.
Tools have minimal movement inside container, so container securely holds tools. .

MILESTONE 1 (STAGE 2) – MORPHOLOGICAL ANALYSIS

Team ID: Thurs-16

1. Identify multiple means to perform the secondary functions that your team came up with during Stage 1 of this milestone. One sub-function (pick up) is already listed for you. The other two sub-functions are for your team to choose.
   → Make sure that every mean for the "pick up" sub-function assumes that the end effector of the robot arm is a gripper. The means for your other sub-functions do not need to follow this assumption.

Function	**Means**					
Pick up	Fork-lift style of lifting.	Hold the container with the robot gripper	Be able to securely squeeze the surgical tools	Gipper senses when to open and close.	Handle on the container that gripper can loop through.	Uses coordinate system to locate where to go.
Arm moves tools and containers	Securely bend down and lift object up	Securely move the object from point A-B	Arm can rotate in a different direction without dropping it	Arm can move with relation to the correct threshold.	Using a coordinate system to know where to move them to.	Gripper has a hard surface, so container does not slip.
Container securely holds tools	Container is same shape of the tools.	Container has straps	Tool can snap into place	The container is similar size to the tool.	Base of container has indent of tool shape.	Strong enough to not break while transferring the tools.

MILESTONE TWO (TEAM): SUB-TEAMS, SKETCHES, & WORKFLOW

PROJECT TWO: MILESTONE 2 – COVER PAGE

Team ID: Thurs-16

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Luay Alkader	alabedal
Isabel Anderson	anderi3
Reem Basiouny	basiounr
Elaine Ocampo	ocampm6
Akinniyi Chidiebube	akinniyc

MILESTONE 2 (STAGE 2) – LOW-FIDELITY PROTOTYPE OBSERVATIONS (MODELLING SUB-TEAM)

Team ID: Thurs-16

As a sub-team, document your observations for each low-fidelity prototype. Make sure to label your observations to indicate which prototype it belongs to. As a starting, consider the following: (note, this does not fully encompass all discussion points)

- → Advantages and disadvantages of each prototype
- → Extent to which each concept aligns (or does not align) with the List of Objectives, Constraints, and Functions you came up with for Milestone 1
- → Reliability of the design in being picked up by the QArm
- → Reliability of the design in securing the surgical tool
- → Extent to which it allows for tool sterilization

*Document your observations for each prototype in the space below. It is recommended you document observations in a **table** (it should be clear which prototype you are referring to for each observation).*

Akinniyi's Prototype - *The prototype created by Akinniyi was based on Luay's early sketch.*

- *The design is of a simple box with an opening.*
- *The container can effectively handle surgical equipment, and it features an entrance that permits equipment to be easily placed inside but presents some difficulties in removal.*
- *This complexity helps to ensure that the equipment remains inside while the container is relocated, but it also makes it more difficult for humans to remove the equipment.*
- *The design also lacks steam holes, making it ineffective as a sterilizing container.*

Luay's Prototype *- Luay's prototype was based on an Akinniyi rough sketch.*

- *The design is effectively sketched, and one of its advantages is that it has many slots that can suit many surgical tools.*
- *However, one problem is that it does not have enough holes, or anything designed for the steam.*
- *It also does not align with the constraints we established in milestone 1 because the way to hold the surgical tools is a bit difficult, and it will have some difficulty being picked up by the QArm, but it will perfectly hold the surgical tools.*

For sterilization, it has a limitation because it does not allow the steam to escape the box.

MILESTONE 2 (STAGE 2) – WORKFLOW PEER-REVIEW (COMPUTATION SUB-TEAM)

Team ID: Thurs-16

As a sub-team, document your observations, specifically any similarities and differences between each team member's visual storyboard or flowchart, and pseudocode in the table below.

Document your observations for each flowchart in the space below. When looking at our pseudocode and flowcharts, we found that the general ideas behind our workflows were similar, but the specific steps varied slightly depending on what aspects we focused more on. The general pattern of steps was similar, inputting coordinates, moving the arm gripping the object, moving it to and placing it in the auto clave. However, there were instances regarding decisions, such as checking if the box was correct and where the "yes" or "no" lead back that differed in technique and order. The level of detail also varied, for certain steps. For example, some people included the colours of the boxes as a check to ensure the correct autoclave was being used, while others involved the potentiometer into the decision of which size autoclave the object should be placed in, and the last person looked at looping back to earlier in the program if the autoclaves didn't match.

MILESTONE 2 (STAGE 2) – PROGRAM PSEUDOCODE COMPILATION (COMPUTATION SUB-TEAM)

Team ID: Thurs-16

As a sub-team, write out a pseudocode outlining the high-level workflow of your computer program in the space below. This should be a compilation of the pseudocode completed by each group member in Milestone 1.

Write your pseudocode here.

- start at home position
- check coordinates of desired autoclave
- is there a drawer a needs to be opened
    - if yes, then open the drawer
    - if no, continue
- input tool pick up location
- rotate arm to position
- pick up container
- what color is the container
    - if red, move to coordinates of red autoclave
    - if blue, move to coordinates of blue autoclave
    - if green, move to coordinates of green autoclave
- is the threshold greater than 50% and less than 100%
    - if yes, then move to position 1
    - if no, then check if the threshold is at 100%
        - if yes, then move to position 2
        - if no, move back to home position
- Drop off container
- Is the container at position 2

- if yes, close the drawer
  - if no, continue
    - deactivate autoclaves
    - return to home position
- loop through until all objects are placed properly
- end and return to home position

MILESTONE THREE (TEAM): PRELIMINARY MODEL & CODE

PROJECT TWO: MILESTONE 3 – COVER PAGE

Team ID: Thurs-16

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Elaine Ocampo	ocampm6
Isabel Anderson	anderi3
Reem Basiouny	basiounr
Akinniyi Chidiebube	akinniyc
Luay Alkader	alabedal

MILESTONE 3 (STAGE 1) – INITIAL DESIGN OF FINALIZED STERILIZATION CONTAINER (MODELLING SUB-TEAM)

Team ID: Thurs-16

As a team, review each other's preliminary solid models and discuss which features from each other's models align best with the project objectives, constraints and functions. Summarize this in the table below.

Container	Feature	How it aligns with project objectives, constraints and functions.
MULTIPLE COMPARTMENT CONTAINER	Has multiple holes in surface	Holes are present to allow entrance of steam and make it useful as a sterilization container.
	Container has a door (opening/closing mechanism)	To securely hold the tools during transportation (when closed) and allow tools to be put into the container (when open) (Although the placement of this "door" is questionable).
	The container has multiple compartments.	The compartments were added to transport multiple tools at once, as the footprint gave enough height to do so. The multiple compartments also limit the available space for movement of tools within the container and allows it to fit better within its compartment. (Idea gotten from Luay's initial prototype).
	Simple box shape	The container is to be picked by a robot arm, and we lack the information on what shapes would be most effective with the arm, so a simple box shape was chosen as it has been proven to work in Lab B sessions.
	Has a small thickness of about 1mm	As the size is limited to fit inside of the footprint, thickness of the container was minimised to maximise the volume withing the container. This may have been an error as container needs to be able to withstand the gripping strength of the end-effector.
INTERCONNECTED SQUARE CONTAINER	Contains rectangular openings	The openings are present to enable the container to act efficiently as a sterilization container.
	Has a lid	To secure the tool during relocation and allow tools to be put into and removed from the container.
	Has an **I** shape	Has this shape as it is believed that the arm will pick up container at its center and thinnest part. This part should be lined with rubber or other materials that could facilitate pick up.

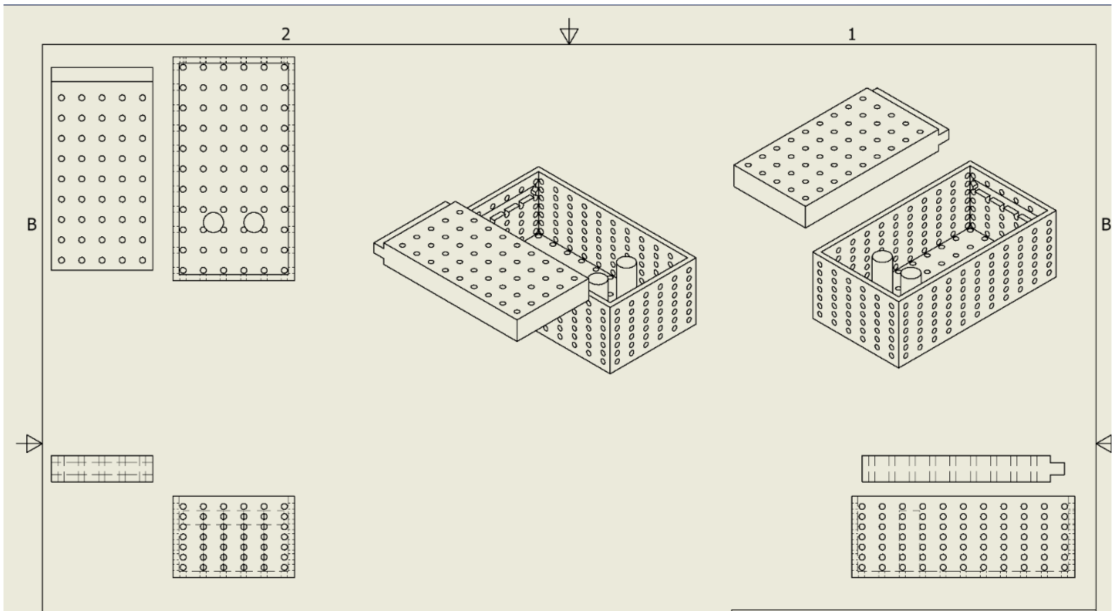
Create a preliminary solid model of your finalized sterilization container. This model should consider features from both team-members preliminary solid models.

Name (Team Member #1): LUAY ALABED ALKADER	**Name (Team Member #2):** AKINNIYI Chidiebube

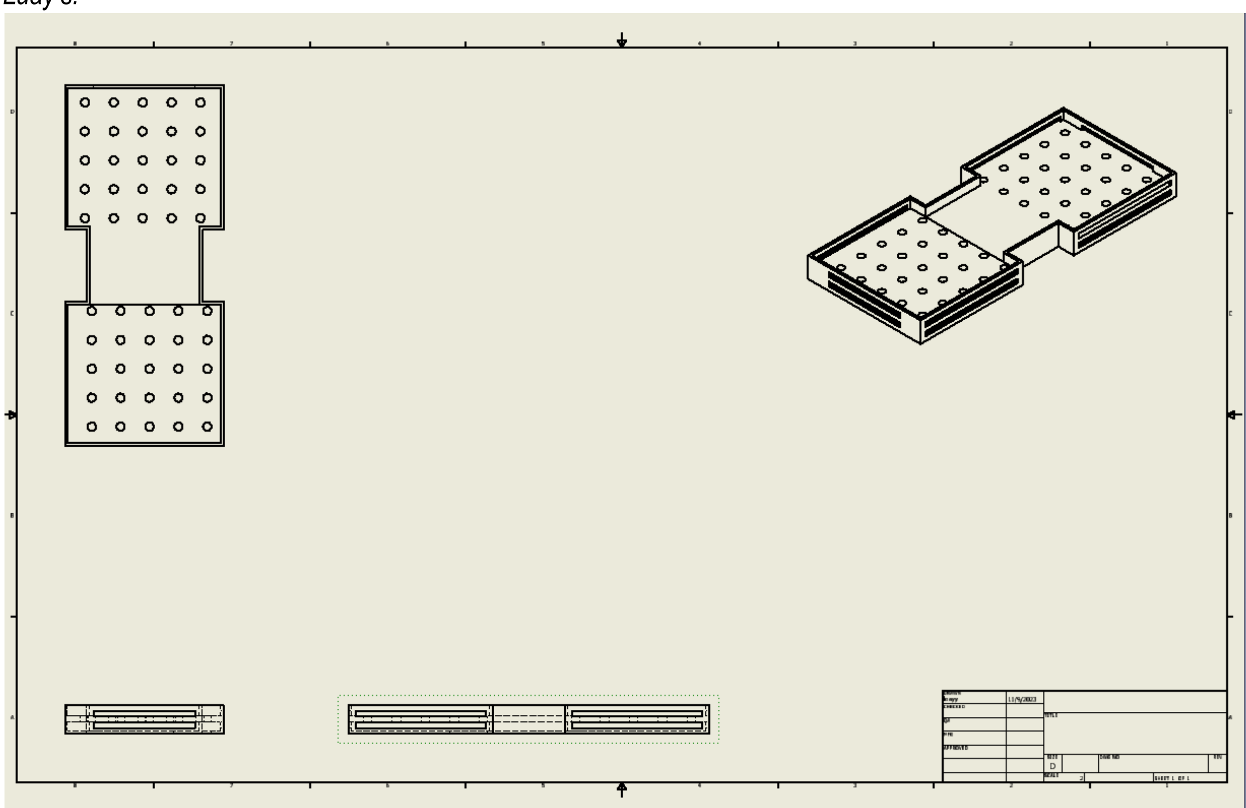
Insert an image of your solid model here.

Both designs:

AKINNIYI:



Luay's:



MILESTONE 3 (STAGE 1) – PROGRAM TASK PSEUDOCODE (COMPUTATION SUB-TEAM)

Team ID: Thurs-16

As a team, write out the pseudocode for each of the *remaining* tasks in your computer program in the space below.

Pick-up Container

- Input pickup location
- Transform location into coordinates
- Moves arm to coordinate location
- Close grip around container
- Return arm to home location while holding the object

Continue or Terminate Program

- Check if all containers have been sorted, has the program been run six times?
  - If not then continue to run program and return to the pickup location
  - If yes, terminate program, go to end of code

MILESTONE 3 (STAGE 2) – STERILIZATION CONTAINER DESIGN EVALUATION (MODELLING SUB-TEAM)

Team ID: Thurs-16

1. As a team, evaluate your designs for the sterilization container in the table below.
   → List your Criteria in the first column
   - You should include a minimum of 5 criteria

   → Fill out the table below, comparing your designs against the given baseline
   - Replace "Design A" and "Design B" with more descriptive labels (e.g., a distinguishing feature or the name of the student author)
   - Assign the datum as the baseline for comparison
   - Indicate a "+" if a concept is better than the baseline, a "–" if a concept is worse, or a "S" if a concept is the same

	Datum	**Multiple compartment design**	**Interconnected square Container.**	**Finalized Design**
Sterilization	S	S	-	S
Ability to Grib	S	S	-	S
size	S	S	S	S
Rigidity	S	-	+	+
Complexity (Less complexity means good)	S	+	-	S
Equipment Security	S	-	-	+
Total +	0	1	1	2
Total –	0	2	3	0
Total Score	0	-1	-2	2

*For a team of 3, click the top-right corner of the table to "Add a New Column"

2. Propose one or more design refinements moving forward.

Akinniyi's Multiple Compartment Design: • It needs a better method of securing the equipment. • The opening/lid needs to be repositioned to another face, keeping it on the front face makes it subject to the natural force of gravity which means it can accidentally open during relocation causing equipment's to fall out. • The container needs to be thicker; it currently has a thickness of 1mm which is enough to perform its primary task and allows more free space for the equipment, but low thickness will be a disadvantage as the arm's end effector might exert too much force and crush the container.
Luay's container, - Make more space for additional surgical tools. - Design and make tools holders to make sure they don't drop. - Resize and fits in autoclave without protruding upward. - Add more holes for sterilization.
Final Design • Appears too simple, needs a hint of sparkle. • Needs a better opening and closing mechanisms, the current design might not be the most efficient. • Might need to raise the tools so that the bottom can also be sterilised.

MILESTONE 3 (STAGE 2) – CODE PEER-REVIEW (COMPUTATION SUB-TEAM)

Team ID: Thurs-16

1. Document any errors and/or observations for each team member's preliminary Python program in the space below.

Rotate Q-arm Base	**Team Member Name**: Reem Basiouny
Enter code errors and/or observations here: NameError → was fixed with spelling of potentiometer. NameError → regarding delta being undefined Observation: - Code originally didn't do anything when it runs, it is dependent on the potentiometers but there should be refinements on how the potentiometers are used in the code. - After fixing a symbol in the code, the code will run, although potentiometer may be glitchy	

Drop-off Container & Return Home	**Team Member Name**: Isabel Anderson
Enter code errors and/or observations here: NameError → many of the variables used showed as not defined, even when temporary values were put in as place holders. → adding values fixed these issues AttributeError → for qarm to rotate_shoulder → corrected with spelling correction Observations: - It was observed that if the grip was open to begin with it asked for a value of +/- 45 but continued before an answer could be input. If the gripper begins closed however, as it would be based on prior commands, the code runs as expected. - It was also unclear if the function was properly connecting to the potentiometers and appeared to possibly be responding without their input. - When test values were put in place for all the variable the code did run all the way through. - An if statement was added in an attempt to correct this (seemingly yet unsuccesfull) but the code is unclear if it is correctly implementing the different options in the if statement.	

Drop-off Container & Return Home	**Team Member Name**: Elaine Ocampo
Enter code errors and/or observations here: Observations: - If the gripper started closed, since it is assumed that it is holding a container, the code runs with no errors and drops off the container. - It is a simple and straightforward code that could be improved to run more efficiently by running a code with the potentiometers. - If the gripper starts opened, it asks for a value of +/- 45 degrees after the code runs with no errors.	

*For a team of 3, copy and paste the table for the function that was done by 2 sub-team members. (Remember each sub-team member should have written their own code before this.)

2. Propose one or more refinements to your code moving forward.

<u>For the rotate base:</u> Reem's: - Change use of potentiometers in code. <u>For the drop off:</u> Elaine's: - Could include potentiometer in the code. Isabel's: - Less variables could also make the code cleaner to run, and it would be less dependent on other areas in the overall code. - Clarification needs to be made to see if the code is properly interacting with the potentiometers and the while loop.

MILESTONE 3 (STAGE 3) – PRELIMINARY DESIGN REVIEWS

Team ID: Thurs-16

Preliminary Design Review Planning:

Create an outline of topics you will cover during your preliminary design review. You should cover the following topics:

1. Both sub-teams:
    a. Integration of both sub-teams for the final deliverables
    b. Timeline for project completion
2. Modelling sub-team:
    a. Demonstrate your most recent prototype
    b. How your current sterilization container meets project objectives.
    c. Plan for fabrication
3. Computing sub-team:
    a. Demonstrate your current program.
    b. Updates on the workflow implementation (i.e. how much of the workflow has been implemented)
    c. Process of integrating both group member's code.

Both Teams:

- Ask about the integration of two pieces and how firm of arm can be.
- In two weeks' time, our goal is to have the whole code blocked out and mostly connected.
- By the time the code is completed, the finalised design (with a proper working lid) should be ready

Modelling:

- Inquire with the TA about any potential conflicts with the design while printing it.
- Look for more suggestions to improve the design in all aspects.
- Discuss the design to see if there is anything missing that is important to it.
- Does the container completely satisfy all objectives stated at the beginning of the project?
    - If not,
        - Why is this so?
        - How can we improve it?
- Can the container really be picked up by the arm,
    - is the width small enough to fit within the end effector.
- Implement ways of preventing the destruction of the container. Maybe through increasing the thickness of the container or reducing the gripping power of the arm

Computing:

- Ask TAs about certain errors and complications in the code. Such as the integration of the potentiometers and the use of global variables from previous sections of the code.
- Look through plans for future functions and the timelines.
- Review connection / order functions should be used in.

- Talk about changes that may need to be made to individual code to connect them together.
- Look at overall workflow and ask about certain real life components.

Modelling Sub-Team Preliminary Design Review Notes:

Use the space below to document feedback for your design.
- Take printer error into consideration
- Ensure that the separate pieces and the equipment can fit within the container
Use the space below to propose further design refinements based on the feedback.
- Increase the area where the lid s supposed to slide in or reduce the size of the lid to accommodate for printer error in the assembly (in case the printout of one component isn't in the same scale as the others.)
- Use the assembly function to check if pieces are within the right dimensions and are able to do what is intended

Computing Sub-Team Preliminary Design Review Notes:

Use the space below to document feedback for your design.

- Add more home position check points to pseudocode, for example, after the container is picked up, return home before drop off to reset.
- There is a function for opening the autoclave drawer, and it doesn't need to be manually opened by the qarm.
- Be careful with the greater than and less thans that they will correctly separate the options.

Use the space below to propose further design refinements based on the feedback.

- We will adjust the pseudocode based on the information we received regarding how things will occur.
- Some edits may be made to the individual functions, especially their relations to the potentiometers.
- We will work towards completing our remaining functions and connecting them.

MILESTONE FOUR: DETAIL DESIGN (DESIGN REVIEW AND FEEDBACK)

PROJECT TWO: MILESTONE 4 – COVER PAGE

Team ID: Thurs-16

Please list full names and MacID's of all *present* Team Members

Full Name:	MacID:
Elaine Ocampo	ocampm6
Isabel Anderson	anderi3
Reem Basiouny	basiounr
Luay alabed alkader	Alabedal
Akinniyi Chidiebube	akinniyc

MILESTONE 4 CHECKLISTS

Mentors and sub-teams will go through each checklist **together** and check off items if the design meets expectations. Mentors will give verbal feedback for each item on the checklists, and students will **summarize the feedback** before creating a list of **Action Items** to be completed before final project submission. *Note that these checklists are not project rubrics. They are a tool to help guide students to successfully meet certain project requirements.*

Team ID: THURS-16

MODELLING SUB-TEAM

- [ ] Design Meets Design Objectives
  - → Container fits inside the assigned footprint
  - → Surgical tools fit securely inside the container
  - → Container facilitates sterilization
  - → Design is creative with interesting features and/or connections
- [ ] Assembly model is complete and aesthetic, properly grounded and has no interference or errors
- [ ] Mass constraint is satisfied (does not exceed 350 g prior to scaling or 43.75 g after scaling to 50%)
  - → The design should intentionally minimize materials
- [ ] Total print time of **ALL** components does not exceed 2 hours
  - → All components on the bed when evaluating this
  - → Discuss if components need any support for 3D printing (i.e., for any overhanging features). If so, TA's will assist the sub-team in adding support.
- [ ] ALL features of container are 2mm or more
  - → Not only do features need to be 2mm or greater, but spaces between them as well
  - → Features between 2mm and 4mm are appropriately sized and will not compromise the printed design
- [ ] **APPROVED FOR PRINTING**

Mentor Comments: Use the space below to document mentor feedback for your design, including requirement for reviewing progress next design studio.

Mentor feedback: Change the design height to reduce printing time and tool movement. Provide support for certain pieces as the 3D printer prints by layers Reduce the surface Area to save material and printing time Change the hinge design to appear less like a circle.

Action Items: Use the space below to propose design refinements based on feedback.

Reduced the height to be just large enough to hold the equipment We provided connections/support for those pieces to the main body Changed the shape of the design to appear more like equipment on one end, at retained the box format at the other end for pick up. We used a similar hinge design as the demo used in Lab A earlier in the week.

COMPUTATION SUB-TEAM

Team ID: Thurs-16

☒ One cycle of pick-up/rotate/drop-off (one container of any size) sufficiently executes

- → *The general flow should be home → pick-up → rotate → drop-off → home*
- → *Containers dropped in random order, program identifies the correct drop off location and places the container successfully*
- → *If there is time, demo both a small and a large container, and experiment using the potentiometers incorrectly to test for malfunctions*

☒ *All required program tasks are written as their own function (Pick-Up Container, Rotate Q-arm Base , Drop-Off Container & Return Home)*

☒ *All program tasks are accounted for (Pick-Up Container, Rotate Q-arm Base , Drop-Off Container & Return Home, Continue or Terminate Program)*

☒ *Each task requiring potentiometer input (Rotate Q-arm Base , Drop-Off Container & Return Home) evaluates the potentiometer values before executing an action*

- → *Potentiometer values are evaluated INSIDE the functions and not outside and passing their values as arguments.*

☒ Team is running their program in their assigned environment.

☒ No errors in program

☒ Code well commented

Mentor Comments: Use the space below to document mentor feedback for your design, including requirement for reviewing progress next design studio.

- Adjust potentiometer code for rotate base to include coordinates to avoid missing the autoclaves.
- The comments we used were good and well placed.
- Potentiometers are used correctly.
- Needs to loop 6 times while using a different container each time.

Action Items: Use the space below to propose design refinements based on feedback.

- Get coordinates for each drop off location and use set potentiometer values as thresholds to tell the arm to move to these pre-set coordinates.
- Adjust the main function so it will loop through all six containers.

Project Two Worksheets (INDIVIDUAL)

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MILESTONE ONE (INDIVIDUAL): OBJECTIVES, MORPH CHART, & INITIAL DESIGN

MILESTONE 1 (STAGE 1) – LIST OF OBJECTIVES, CONSTRAINTS, AND FUNCTIONS

Please complete this worksheet in your corresponding team document.

MILESTONE 1 (STAGE 2) – MORPHOLOGICAL ANALYSIS

Please complete this worksheet in your corresponding team document.

MILESTONE 1 (STAGE 3) – PRELIMINARY CONCEPT SKETCHES (MODELLING SUB-TEAM)

Team ID: Day-##

1. Complete your sketch on a separate sheet of paper
   → Be sure to clearly write your Team ID, Name and MacID
2. Take a photo of your sketch
3. Insert your photo as a Picture (Insert > Picture > This Device)

Team ID:

Name:	MacID:
Insert screenshot(s) of your preliminary sketch below	

*For multiple sketches, please copy and paste the above on a new page

MILESTONE 1 (STAGE 3) – COMPUTER PROGRAM PSEUDOCODE (COMPUTATION SUB-TEAM)

Team ID: Thurs-16

Name: Isabel Anderson	MacID: anderi3

Write your pseudocode in the space below

- Start.
- Check if grip is open grip.
- If no open, if yes continue.
- Input coordinates of wanted location and box for depositing the tool.
- Check if a drawer needs to be opened.
- If yes move to that location; lower arm, grip drawer and pull open.
- If no continue.
- Input location to pick up tool.
- Move arm to desired location.
- Check to see if it is the correct box.
- If incorrect ask again for input and move to the correct location.
- If correct, ask for amount to lower gripper.
- Lower gripper and situate around container.
- Input grip strength.
- Close gripper around object.
- Lift arm.
- Input desired deposit location.
- Move arm to new location.
- Check to see if it is at the correct box.
- If incorrect ask for a new location of the box.
- If correct, ask for amount to lower by.
- Lower arm.
- Open gripper.
- Return to base location.
- End.

MILESTONE TWO (INDIVIDUAL): SUBTEAMS, SKETCHES, & WORKFLOW

MILESTONE 2 (STAGE 1) – LOW-FIDELITY PROTOTYPE (MODELLING SUB-TEAM)

Team ID:

Complete this worksheet before design studio 8 while creating the low-fidelity prototype based on your group members preliminary concept sketch.

1. Take multiple photos of the low-fidelity prototype
   - Include an index card (or similar) next to the prototype, clearly indicating your Team Number, Name and MacID on *each* picture
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *two* prototype photo's per page**

Team ID:

Name:	MacID:
Insert screenshot(s) of the low-fidelity prototype below	

MILESTONE 2 (STAGE 1) – COMPUTER PROGRAM WORKFLOW (COMPUTATION SUB-TEAM)

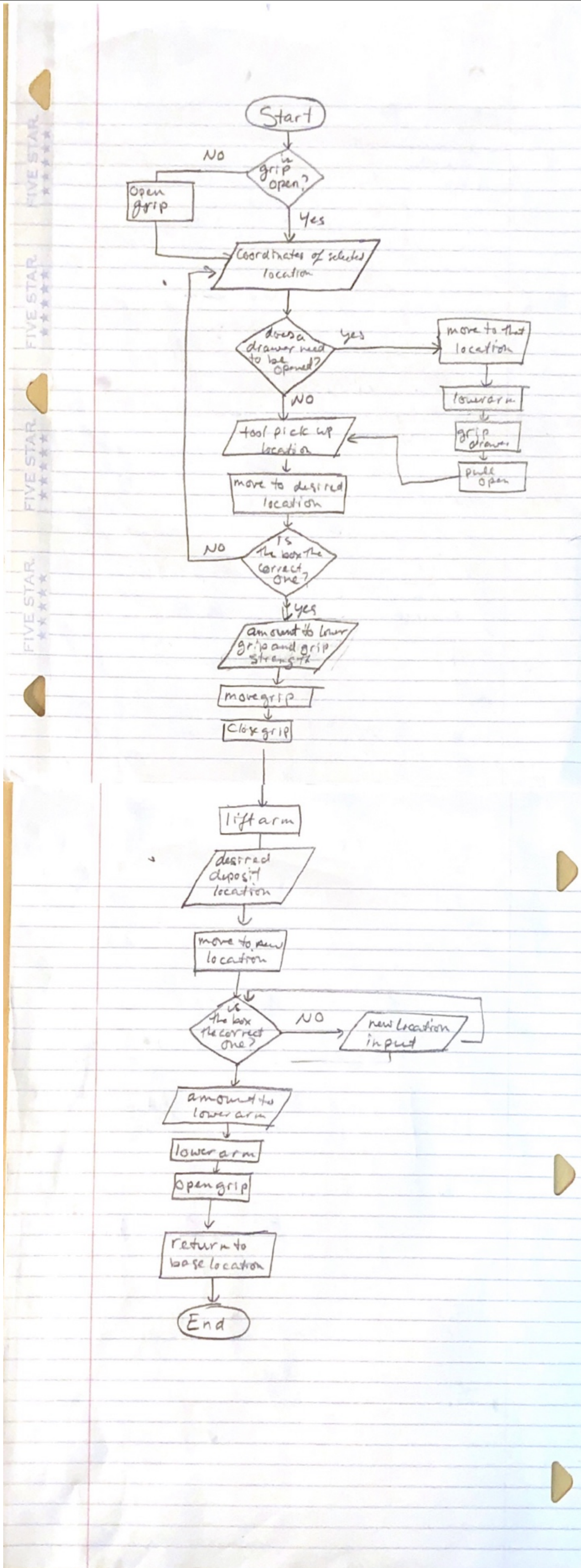
Team ID:	Thurs - 16

Complete this worksheet individually before coming to Design Studio 8.

1. Complete your storyboard or flowchart sketches on a separate sheet of paper
   → Be sure to clearly write your Team ID, Name and MacID on *each* workflow
2. Take a photo of your sketch
3. Insert your photo as a Picture (Insert > Picture > This Device)

Team ID: Thurs - 16

Name: Isabel Anderson	MacID: anderi3
Insert screenshot(s) of your workflow below	


Start
is grip open?
NO
Open grip
Yes
Coordinates of selected location
does a drawer need to be opened?
yes
move to that location
lower arm
grip drawer
pull open
NO
tool pick up location
move to desired location
Is the box the correct one?
NO
yes
amount to lower grip and grip strength
move grip
Close grip
lift arm
desired deposit location
move to new location
is the box the correct one?
NO
new location input
amount to lower arm
lower arm
open grip
return to base location
End

MILESTONE 2 (STAGE 2) – LOW-FIDELITY PROTOTYPE OBSERVATIONS (MODELLING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 2 (STAGE 2) – COMPUTER PROGRAM PSEUDOCODE COMPILATION & OBSERVATIONS (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 2 (STAGE 3) – PRELIMINARY SOLID MODEL (MODELLING SUB-TEAM)

Team ID:

Complete this worksheet individually during Design Studio 8.

1. Take multiple screenshots of your preliminary solid model
   - → You are also required to submit an IPT file of each solid model (see Submission Details section above)
   - → Be sure to label model with your Name and MacID
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *two* solid modelling screenshots per page**

Team ID:

Name:	MacID
Insert screenshot(s) of your model below	

*Limit screenshots to no more than 2 per page. For additional screenshots, please copy and paste the above on a new page

MILESTONE 2 (STAGE 3) – PRELIMINARY PROGRAM TASKS (COMPUTATION SUB-TEAM)

Team ID: Thurs-16

Complete this worksheet individually during Design Studio 8.

1. Take multiple screenshots of your code
   → You are also required to submit a Python (*.PY) file of your code (see Submission Details section above)
   → Be sure to label your tasks with your Name and MacID
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *one* screenshot per page**

Team ID: Thurs-16

Name: Isabel Anderson	MacID anderi3

Insert screenshot(s) of your code below

```
#note that the expected container ID is already known...and that there is a variable called ContainerID_Size that says if it is "small" of "large".
#also there are variables in place of the needed elbow and sholder movment for specific circumstnaces
#Assume that any drawers are already open if need be and that the object is already being held with the arm base rotated to the correct alignment for this function to begin.
def drop_container(drop_point):
    x = drop_point[0]
    y = drop_point[1]
    z = drop_point[2]
    arm.move_arm(x,y,z)
    item_can_drop = False

    while not item_can_drop:

        if (potentiometer.left() >=50 or potentiometer.left()<100) and ContainerID_size == small:
            arm.rotate_sholder(down1)
            arm.rotate_elbow(elbow1)
            item_can_drop = True
        elif potentiometer.left() == 100 and ContainerID_Size == Large:
           arm.rotate_sholder(down2)
           arm.rotate_elbow(elbow2)
           item_can_drop = True
        else:
            print("error, actual and expected container size do not match")

    time.sleep(2)
    arm.control_gripper(-45)
    time.sleep(2)
    print("The object has been dropped off, returning to home")
    arm.home()
```

*Limit screenshots to no more than 1 per page. For additional screenshots, please copy and paste the above on a new page

MILESTONE THREE (INDIVIDUAL): PRELIMINARY MODEL & CODE

MILESTONE 3 (STAGE 1) – INITIAL DESIGN OF FINALIZED STERILIZATION CONTAINER (MODELING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 1) – PROGRAM TASK PSEUDOCODE (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 2) – STERLIZATION CONTAINER DESIGN EVALUATION (MODELING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 2) – CODE PEER REVIEW (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

INDEPENDENT MATERIALS RESEARCH ASSIGNMENT

MATERIAL SELECTION (STAGE 1) - PROBLEM DEFINITION

Use the following information to help you in your assignment:

- Function: The containers must securely contain a surgical tool during the tool's sterilization period.
- Fixed Variable: Radius, melting temperature (100^{O}C, steam)
- Free Variable: Wall thickness
- Objective: Must minimize cost and mass (material density and CAD)

Use the following MPI's to select your final material:

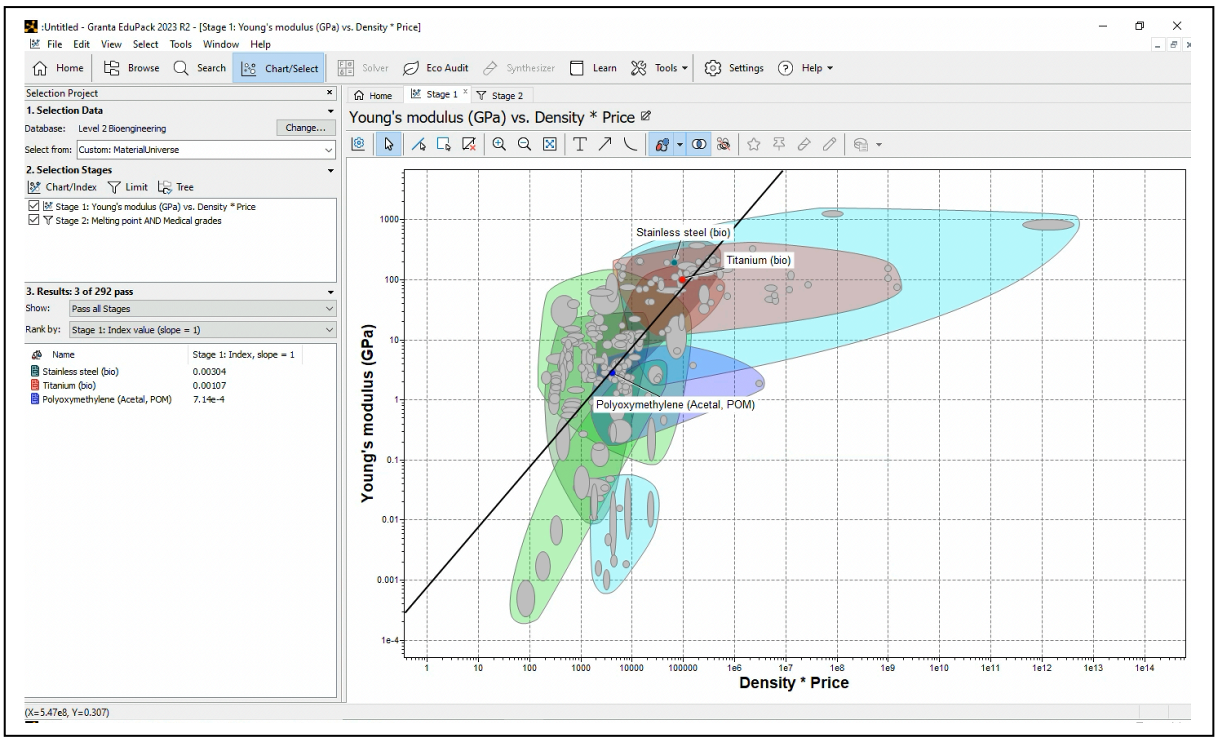
- Stiffness Design: $\frac{E}{\rho C_m}$
- Strength Design: $\frac{\sigma}{\rho C_m}$

Chosen Design	Chosen MPI	Objective
Stiffness	$\frac{E}{\rho C_m}$	Minimize mass and cost.
Please provide a short justification for your chosen design and MPI. I chose to use the stiffness design for choosing my container material. This is because, the goal is to both hold and protect the tools inside while still allowing them to be sanitized. This needs a relatively stiff material that is not likely to distort and damage the tool inside if it falls or hits another object. The related MPI connects to this in its maximization of Young's Modulus (the numerator) and the other objective is met with the denominator helping to find the reduction of mass and cost of material. Other things to consider when choosing the material are the constraints such as corrosion resistance as it will likely come into contact with steam and a high melting point so it can endure high temperatures without deforming or melting.		

MATERIAL SELECTION (STAGE 2) - MPI AND MATERIAL RANKING

Include a screenshot of your GRANTA graph in the text box below. The following should be included and clearly visible in your graph:

- X and Y axis
- MPI slope
- Material titles
    - The materials that you may choose from are those that are able to be 3D-printed (i.e., materials such as ceramics and glasses should be excluded from your database)
- Material family bubbles



Material Ranking			
	Rank 1	Rank 2	Rank 3
Assigned MPI: $\frac{E}{\rho C_m}$	Stainless Steel (bio)	Titanium (bio)	Polyoxmethylene (Acetal POM)

MATERIAL SELECTION (STAGE 3) - FINAL SELECTION

State your chosen material and justify your final selection

Chosen Material:	Stainless Steel (bio)

Discuss and justify your final selection in the space below (based on the MPI results and any other relevant considerations).

Stainless steel was chosen for the material choice for a variety of reasons including that it was the top material for the given MIP [1]. Through additional research it was found that stainless steel is ideal for medical situations due to its ability to be easily cleaned, sustain a high temperature, and resist corrosion compared to many other materials [2]. Many tools, as well as certain autoclaves are made from stainless steel, this would imply that it could easily serve as the material for a sterilization container as these items would experience similar circumstances [3]. Stainless steel is also abundant and therefore should not be difficult to source; it is also a material strong and stiff enough to protect the tools inside from becoming damaged. Additionally, methods for effectively 3D printing stainless steel do exist and involve starting with a powder, printing, and sintering [4].

References (If any):

[1] Ansys GRANTA EduPack software, ANSYS, Inc., Cambridge, UK, (www.ansys.com/materials)

[2] "Effective stainless steel usage in medical environments," Unified Alloys, [Online] https://www.unifiedalloys.com/blog/medical-stainless-steel [Accessed Nov. 24, 2023].

[3] "Autoclave Manufacturer: Avoiding Metal Contamination," Betastar.com, [Online] https://www.betastar.com/autoclave-manufacturer-avoiding-metal-contamination/#:~:text=This%20prevents%20any%20corrosion%20or,properties%20contained%20in%20stainless%20steel [Accessed Nov. 24, 2023].

[4] T. Duda and L. V. Raghavan, "3D Metal Printing Technology," *IFAC-JournalsOnLine*, vol. 49, no. 29, pp. 103–110, Dec. 2016. [Online] doi: https://doi.org/10.1016/j.ifacol.2016.11.111 [Accessed Nov. 24, 2023].

Project Two Worksheets (INDIVIDUAL)

TABLE OF CONTENTS

MILESTONE ONE (INDIVIDUAL): OBJECTIVES, MORPH CHART, & INITIAL DESIGN

MILESTONE 1 (STAGE 1) – LIST OF OBJECTIVES, CONSTRAINTS, AND FUNCTIONS

Please complete this worksheet in your corresponding team document.

MILESTONE 1 (STAGE 2) – MORPHOLOGICAL ANALYSIS

Please complete this worksheet in your corresponding team document.

MILESTONE 1 (STAGE 3) – PRELIMINARY CONCEPT SKETCHES (MODELLING SUB-TEAM)

Team ID: Thurs-16

1. Complete your sketch on a separate sheet of paper
   → Be sure to clearly write your Team ID, Name and MacID
2. Take a photo of your sketch
3. Insert your photo as a Picture (Insert > Picture > This Device)

Team ID: Thurs-16

Name:	MacID:
Insert screenshot(s) of your preliminary sketch below *No ()*	

*For multiple sketches, please copy and paste the above on a new page

MILESTONE 1 (STAGE 3) – COMPUTER PROGRAM PSEUDOCODE (COMPUTATION SUB-TEAM)

Team ID: Thurs-16

Name: Reem Basiouny	MacID: basiounr

Write your pseudocode in the space below

- Start at home position
- Arm senses the container at pick up position and moves to position the Gipper at the coordinate of the pick-up site
- Gripper closes securely around the container
- Arm picks up the container and returns to Home position
- Arm verifies the color of the container and transfers the container to the coordinate associated with that color
- Arm senses the correct threshold and transfers container to the correct drop-off position. (should I say if arm senses threshold greater than 50% and less than 100%, then it moves to position 1 on top of the autoclave drawer and then the same with position 2?... then verifies the size of the container matches the position its at aka small at 1 and large at 2)
- if arm senses threshold greater than 50% and less than 100%, then it moves to position 1 and places the container on top of the autoclave
- If arm senses threshold at 100%, then it moves to position 2 and places the container inside the autoclave drawer
- Gipper opens and releases the container
- If it is a large container, arm closes the autoclavee door
- All autoclaves are deactivated
- Arm moves back to home position
- Arm repeats steps 5 more times and then program terminates

MILESTONE TWO (INDIVIDUAL): SUBTEAMS, SKETCHES, & WORKFLOW

MILESTONE 2 (STAGE 1) – LOW-FIDELITY PROTOTYPE (MODELLING SUB-TEAM)

Team ID: Thurs-16

Complete this worksheet <u>before</u> design studio 8 while creating the low-fidelity prototype based on your group members preliminary concept sketch.

1. Take multiple photos of the low-fidelity prototype
   - Include an index card (or similar) next to the prototype, clearly indicating your Team Number, Name and MacID on *each* picture
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **<u>Do not include more than *two* prototype photo's per page</u>**

Team ID:

Name:	MacID:
Insert screenshot(s) of the low-fidelity prototype below You weren't as present as the rest of us. You worked fine during the design studios, but then would not contribute outside of them. You did not show up to team meetings and you did not communicate outside of the design studios. We can see when you have opened a chat, but you would never respond or acknowledge what the rest of us were talking about. Your role as manager was unfulfilled to the point where the rest of the group complimented me on being a good manager.	

MILESTONE 2 (STAGE 1) – COMPUTER PROGRAM WORKFLOW (COMPUTATION SUB-TEAM)

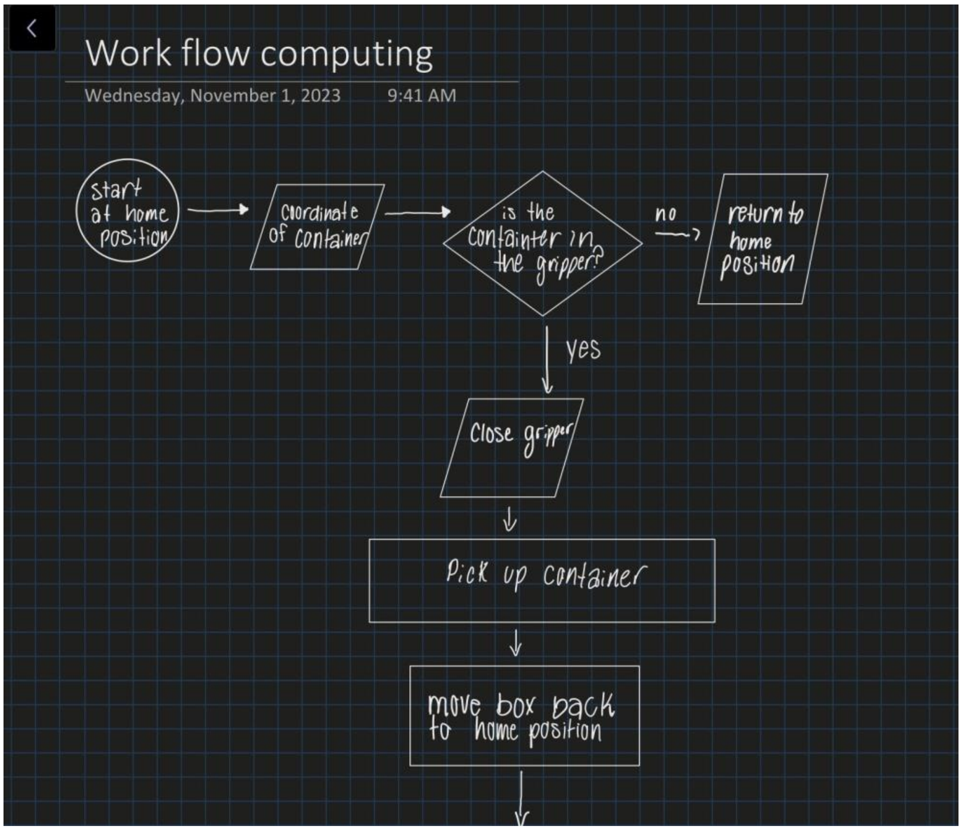
Team ID: Thurs-16

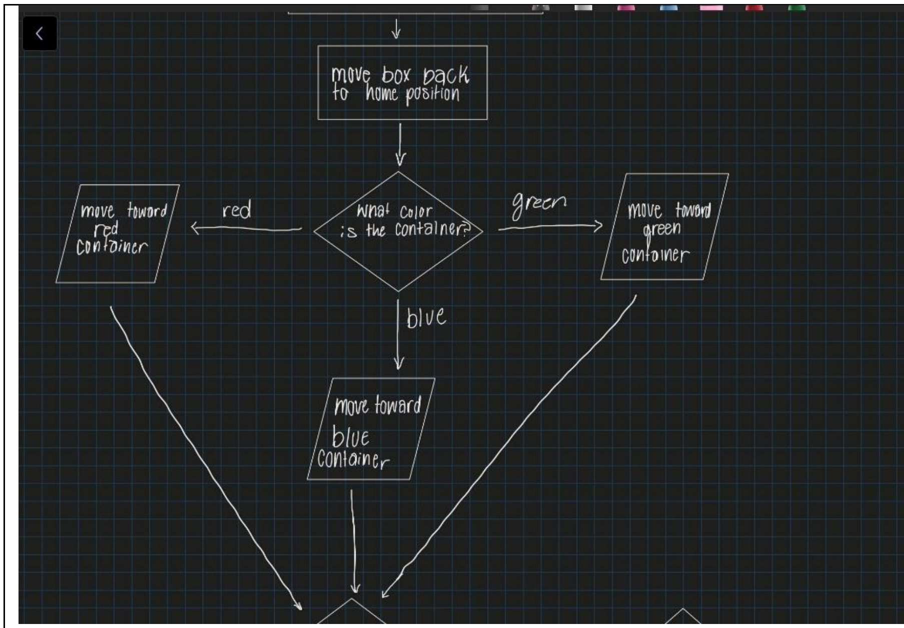
Complete this worksheet individually before coming to Design Studio 8.

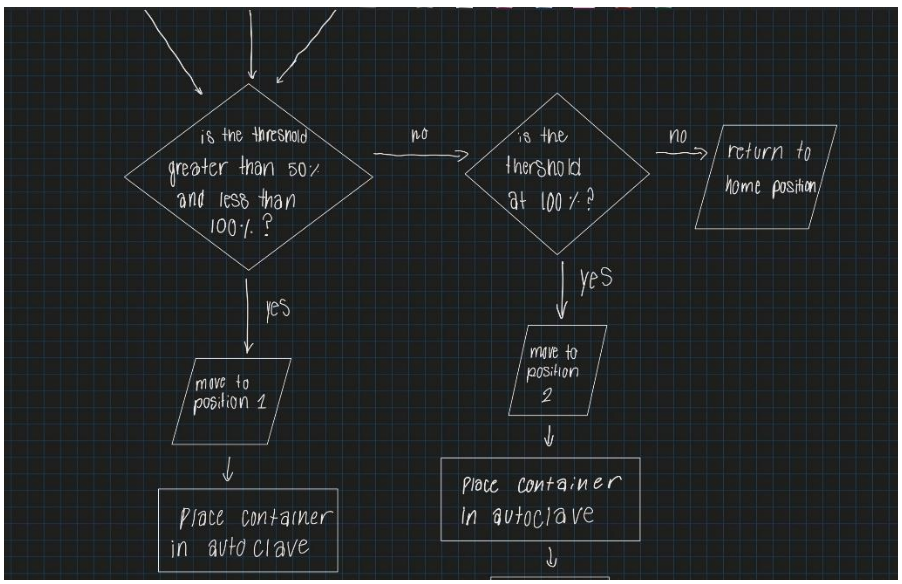
1. Complete your storyboard or flowchart sketches on a separate sheet of paper
   → Be sure to clearly write your Team ID, Name and MacID on *each* workflow
2. Take a photo of your sketch
3. Insert your photo as a Picture (Insert > Picture > This Device)

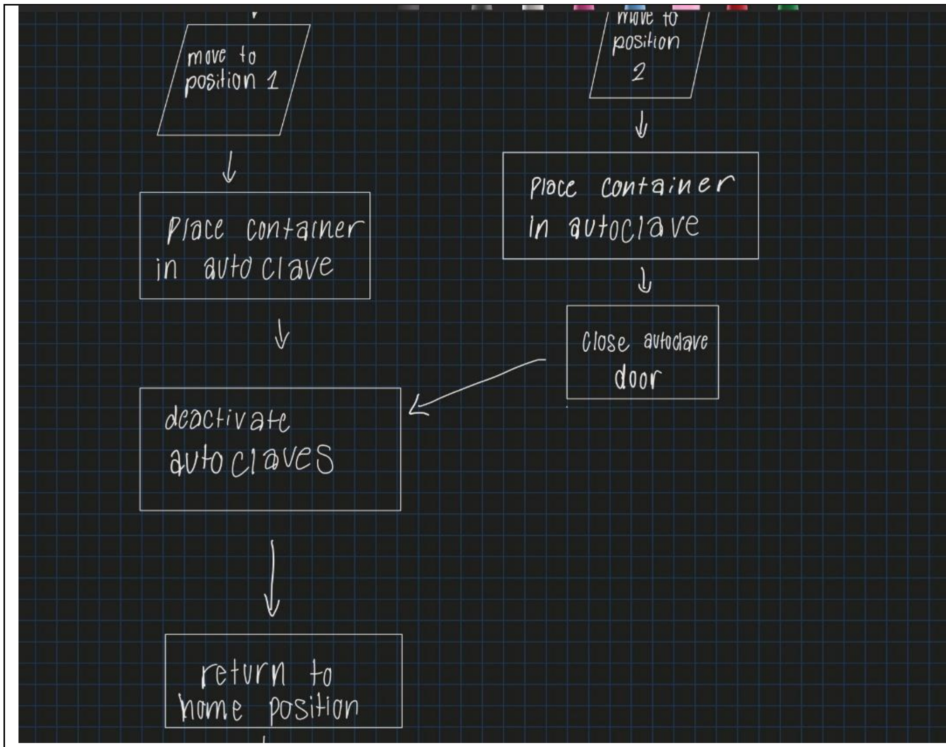
Team ID: Thurs-16

Name: Reem Basiouny	MacID: basiounr
Insert screenshot(s) of your workflow below	

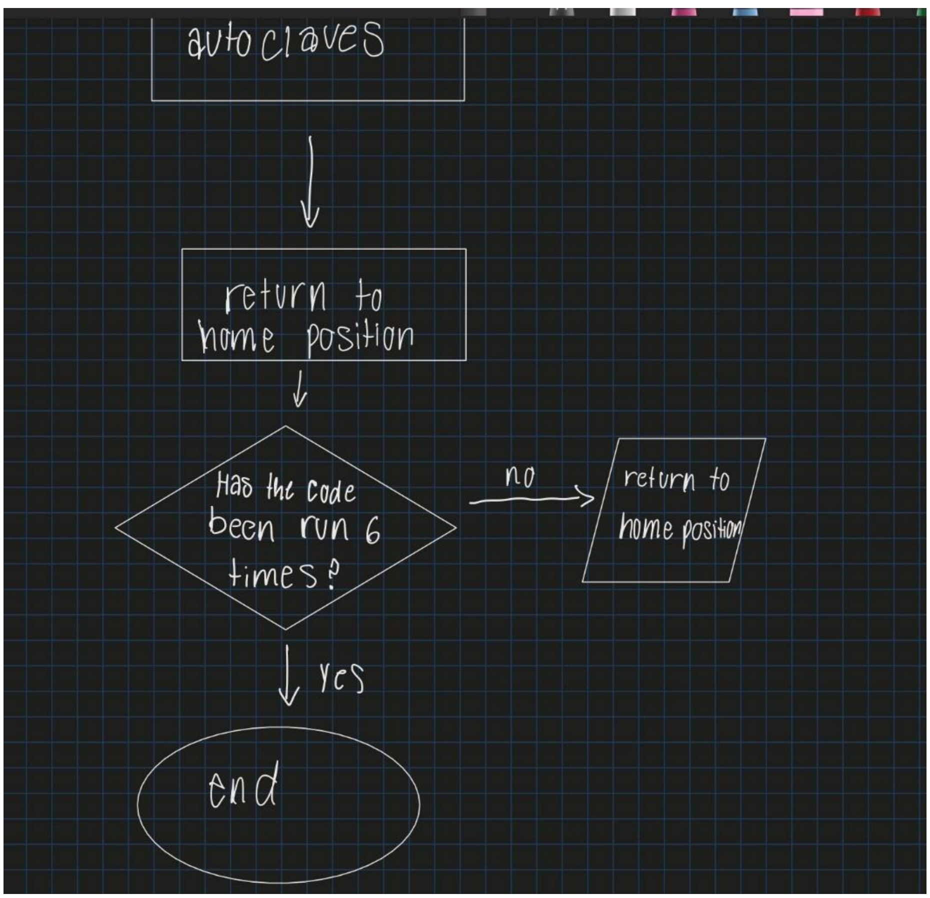



move box back to home position
what color is the container?
red
green
blue
move toward red container
move toward green container
move toward blue container


is the threshold greater than 50% and less than 100%?
no
is the thershold at 100%?
no
return to home position
yes
yes
move to position 1
move to position 2
place container in auto clave
Place container In autoclave



move to position 1
Place container in auto clave
deactivate autoclaves
return to home position
move to position 2
Place container in autoclave
Close autoclave door



autoclaves
return to home position
Has the code been run 6 times?
no
return to home position
yes
end

MILESTONE 2 (STAGE 2) – LOW-FIDELITY PROTOTYPE OBSERVATIONS (MODELLING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 2 (STAGE 2) – COMPUTER PROGRAM PSEUDOCODE COMPILATION & OBSERVATIONS (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 2 (STAGE 3) – PRELIMINARY SOLID MODEL (MODELLING SUB-TEAM)

Team ID:

Complete this worksheet individually <u>during</u> Design Studio 8.

1. Take multiple screenshots of your preliminary solid model
   → You are also required to submit an IPT file of each solid model (see Submission Details section above)
   → Be sure to label model with your Name and MacID
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **<u>Do not include more than *two* solid modelling screenshots per page</u>**

Team ID:

Name:	MacID
Insert screenshot(s) of your model below	

*Limit screenshots to no more than 2 per page. For additional screenshots, please copy and paste the above on a new page

MILESTONE 2 (STAGE 3) – PRELIMINARY PROGRAM TASKS (COMPUTATION SUB-TEAM)

Team ID: Thurs-16

Complete this worksheet individually during Design Studio 8.

1. Take multiple screenshots of your code
   → You are also required to submit a Python (*.PY) file of your code (see Submission Details section above)
   → Be sure to label your tasks with your Name and MacID
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **Do not include more than *one* screenshot per page**

Team ID: Thurs-16

Name: reem basiouny	MacID basiounr

Insert screenshot(s) of your code below

Arm.rotate_base()

*P2_Simulation_Template.py - C:\Users\reemb\Downloads\Q-Labs Python Files\Q-Labs Pyth...

File Edit Format Run Options Window Help

```
ip_address = 'localhost' # Enter your IP Address here
project_identifier = 'P2B' # Enter the project identifier i.e. P2A or P2B
#--------------------------------------------------------------------------------
import sys
sys.path.append('../')
from Common.simulation_project_library import *

hardware = False
QLabs = configure_environment(project_identifier, ip_address, hardware).QLabs
arm = qarm(project_identifier,ip_address,QLabs,hardware)
potentiometer = potentiometer_interface()
#--------------------------------------------------------------------------------
# STUDENT CODE BEGINS
#--------------------------------------------------------------------------------
def transfer ():
    item_dropped = False

    old_reading = potentimeter.right()

    while not item_dropped:
        if potentimeter.left() == 0.0
            new_reading = potentimeter.right()
            delta.position = new_reading - old_reading
            x = 360°delta.position
            arm.rotate_base (x)
            time.sleep(2)
            old_reading = new_reading

        elif pontentimeter.left() == 1.0:
            arm.control_gripper(-45)
            time.sleep(2)
            item_dropped = True



#--------------------------------------------------------------------------------
# STUDENT CODE ENDS
#--------------------------------------------------------------------------------
```

Ln: 32 Col: 32

*Limit screenshots to no more than 1 per page. For additional screenshots, please copy and paste the above on a new page

MILESTONE THREE (INDIVIDUAL): PRELIMINARY MODEL & CODE

MILESTONE 3 (STAGE 1) – INITIAL DESIGN OF FINALIZED STERILIZATION CONTAINER (MODELING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 1) – PROGRAM TASK PSEUDOCODE (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 2) – STERLIZATION CONTAINER DESIGN EVALUATION (MODELING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 2) – CODE PEER REVIEW (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

INDEPENDENT MATERIALS RESEARCH ASSIGNMENT

MATERIAL SELECTION (STAGE 1) - PROBLEM DEFINITION

Use the following information to help you in your assignment:

- Function: The containers must securely contain a surgical tool during the tool's sterilization period.
- Fixed Variable: Radius, melting temperature (100^{O}C, steam)
- Free Variable: Wall thickness
- Objective: Must minimize cost and mass (material density and CAD)

Use the following MPI's to select your final material:

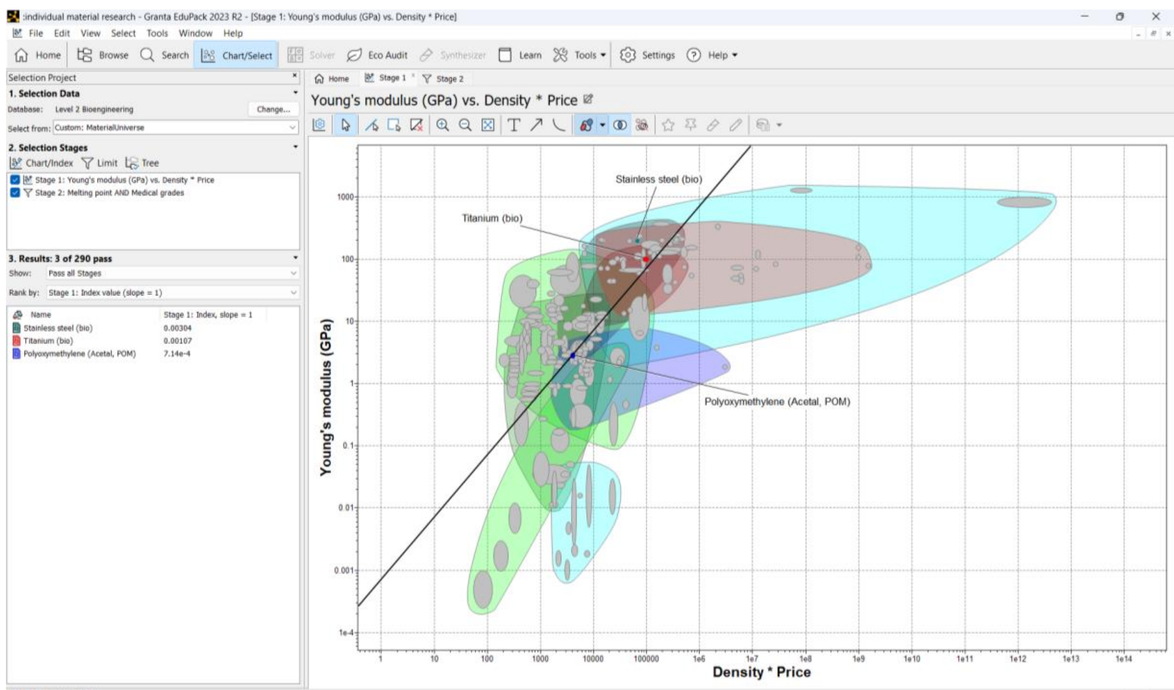
- Stiffness Design: $\frac{E}{\rho C_m}$
- Strength Design: $\frac{\sigma}{\rho C_m}$

Chosen Design	Chosen MPI	Objective
• Stiffness Design	• $\frac{E}{\rho C_m}$	Minimize cost and mass (material density and CAD)
Please provide a short justification for your chosen design and MPI. My chosen design is stiffness with the objective of minimizing mass and cost. There are benefits to both the strength design and the stiffness design. However, a stiffness design for this cylindrical container seems to be more beneficial as this container will experience high temperatures and internalized pressure. The stiffness design offers properties that resist deformation from stress and can support the resistance to change of the selected material at high temperatures. This also has impacts on the design and can lead to effective material choices, which can reduce costs.		

MATERIAL SELECTION (STAGE 2) - MPI AND MATERIAL RANKING

Include a screenshot of your GRANTA graph in the text box below. The following should be included and clearly visible in your graph:

- X and Y axis
- MPI slope
- Material titles
    - The materials that you may choose from are those that are able to be 3D-printed (i.e., materials such as ceramics and glasses should be excluded from your database)
- Material family bubbles



Material Ranking			
	Rank 1	Rank 2	Rank 3
Assigned MPI: $\frac{E}{\rho C_m}$	Stainless steel (bio)	Titanium (bio)	Polyoxymethylene (Acetal, POM)

MATERIAL SELECTION (STAGE 3) - FINAL SELECTION

State your chosen material and justify your final selection

Chosen Material:	Stainless Steal (bio)
Discuss and justify your final selection in the space below (based on the MPI results and any other relevant considerations). Considering the MPI results shown in Granta, the final material I have selected for this cylindrical container design is stainless steel [1]. While polyoxymethylene has water and fatigue resistance, it has a relatively low Young's modulus compared to the other materials [1]. Titanium is a stable material, but it is not the most efficient as it has a high cost and lower stiffness and density compared to stainless steel [1]. As a medical grade material, stainless steel is shown to be the most suitable of the available materials that can withstand the autoclave temperature range of 120-140ºC. Its Young's modulus is the greatest out of the top three materials, which shows that the qualities of a stiff design would be best displayed using stainless steel material [1]. Additionally, the material cost and density are average and contribute to why stainless steel is the most efficient material option [1].	
References (If any): [1] Ansys GRANTA EduPack software, ANSYS, Inc., Cambridge, UK, 2023(www.ansys.com/materials)	

Project Two Worksheets (INDIVIDUAL)

TABLE OF CONTENTS

MILESTONE ONE (INDIVIDUAL): OBJECTIVES, MORPH CHART, & INITIAL DESIGN

MILESTONE 1 (STAGE 1) – LIST OF OBJECTIVES, CONSTRAINTS, AND FUNCTIONS

Please complete this worksheet in your corresponding team document.

MILESTONE 1 (STAGE 2) – MORPHOLOGICAL ANALYSIS

Please complete this worksheet in your corresponding team document.

MILESTONE 1 (STAGE 3) – PRELIMINARY CONCEPT SKETCHES (MODELLING SUB-TEAM)

Team ID: Thurs-16

1. Complete your sketch on a separate sheet of paper
   → Be sure to clearly write your Team ID, Name and MacID
2. Take a photo of your sketch
3. Insert your photo as a Picture (Insert > Picture > This Device)

Team ID: Thurs-16

Name: Elaine Ocampo	MacID: ocampm6
Insert screenshot(s) of your preliminary sketch below	

*For multiple sketches, please copy and paste the above on a new page

MILESTONE 1 (STAGE 3) – COMPUTER PROGRAM PSEUDOCODE (COMPUTATION SUB-TEAM)

Team ID: Thurs-16

Name: Elaine Ocampo	MacID: ocampm6

Write your pseudocode in the space below

1. Start the Q-arm in the home position
2. Identify which container to pick up from the colour of the container
3. Using the coordinate given, position arm to said coordinate to get ready for pick up
4. Close the gripper to get a secure hold of the container
5. The Q-arm picks up the container
6. The Q-arm moves from pickup position to the desired position to where the corresponding autoclave is
7. Verify that the container colour matches the autoclave at where the Q-arm is positioned
8. If the threshold is greater than 50% but less than 100%, the drop-off location corresponds to position 1, placing the small container on top of the autoclave
9. If the threshold is at 100%, the drop-off location corresponds to position 2, placing the large container inside the autoclave drawer
10. Verify that the correct size containers are at their proper drop-off locations
11. Q-arm opens its grippers, releasing the container
12. If at position 2, close the drawer
13. Deactivate the autoclaves if at position 1 or position 2
14. Q-arm moves back to home location
15. Repeat steps above until all containers are sorted
16. Stop the program

MILESTONE TWO (INDIVIDUAL): SUBTEAMS, SKETCHES, & WORKFLOW

MILESTONE 2 (STAGE 1) – LOW-FIDELITY PROTOTYPE (MODELLING SUB-TEAM)

Team ID: Thurs-16

Complete this worksheet <u>before</u> design studio 8 while creating the low-fidelity prototype based on your group members preliminary concept sketch.

1. Take multiple photos of the low-fidelity prototype
    - Include an index card (or similar) next to the prototype, clearly indicating your Team Number, Name and MacID on <u>*each*</u> picture
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. <u>**Do not include more than *two* prototype photo's per page**</u>

Team ID: Thurs-16

Name:	MacID:
Insert screenshot(s) of the low-fidelity prototype below	

MILESTONE 2 (STAGE 1) – COMPUTER PROGRAM WORKFLOW (COMPUTATION SUB-TEAM)

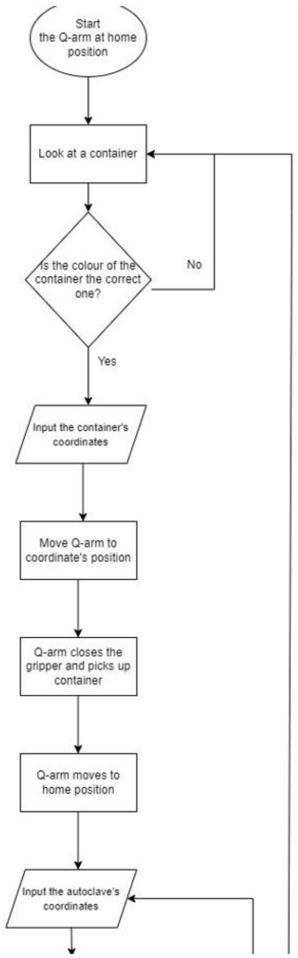
Team ID: Thurs-16

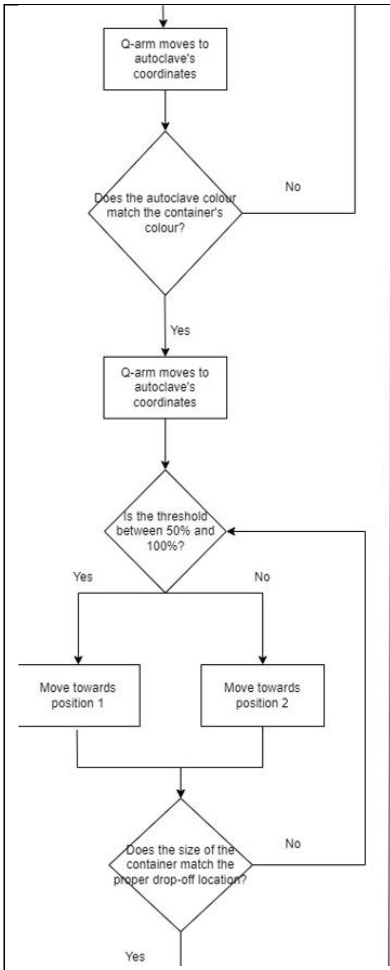
Complete this worksheet individually <u>before</u> coming to Design Studio 8.

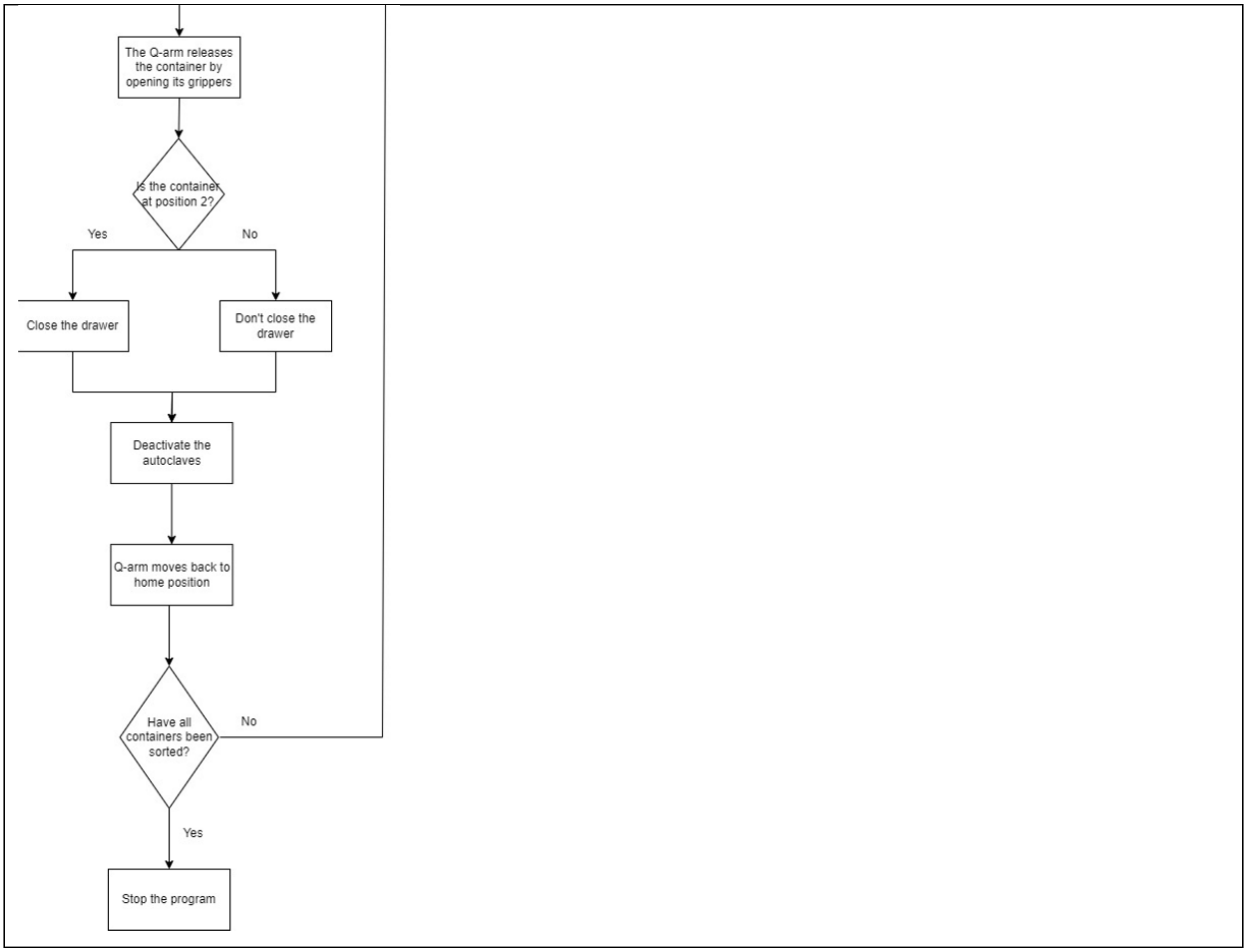
1. Complete your storyboard or flowchart sketches on a separate sheet of paper
   → Be sure to clearly write your Team ID, Name and MacID on *<u>each</u>* workflow
2. Take a photo of your sketch
3. Insert your photo as a Picture (Insert > Picture > This Device)

Team ID: Thurs-16

Name: Elaine Ocampo	MacID: ocampm6
Insert screenshot(s) of your workflow below	




Q-arm moves to autoclave's coordinates
Does the autoclave colour match the container's colour?
No
Yes
Q-arm moves to autoclave's coordinates
Is the threshold between 50% and 100%?
Yes
No
Move towards position 1
Move towards position 2
Does the size of the container match the proper drop-off location?
No
Yes


The Q-arm releases the container by opening its grippers
Is the container at position 2?
Yes
No
Close the drawer
Don't close the drawer
Deactivate the autoclaves
Q-arm moves back to home position
Have all containers been sorted?
No
Yes
Stop the program

MILESTONE 2 (STAGE 2) – LOW-FIDELITY PROTOTYPE OBSERVATIONS (MODELLING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 2 (STAGE 2) – COMPUTER PROGRAM PSEUDOCODE COMPILATION & OBSERVATIONS (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 2 (STAGE 3) – PRELIMINARY SOLID MODEL (MODELLING SUB-TEAM)

Team ID: Thurs-16

Complete this worksheet individually <u>during</u> Design Studio 8.

1. Take multiple screenshots of your preliminary solid model
   → You are also required to submit an IPT file of each solid model (see Submission Details section above)
   → Be sure to label model with your Name and MacID
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **<u>Do not include more than *two* solid modelling screenshots per page</u>**

Team ID: Thurs-16

Name:	MacID
Insert screenshot(s) of your model below	

*Limit screenshots to no more than 2 per page. For additional screenshots, please copy and paste the above on a new page

MILESTONE 2 (STAGE 3) – PRELIMINARY PROGRAM TASKS (COMPUTATION SUB-TEAM)

Team ID: Thurs-16

Complete this worksheet individually <u>during</u> Design Studio 8.

1. Take multiple screenshots of your code
   → You are also required to submit a Python (*.PY) file of your code (see Submission Details section above)
   → Be sure to label your tasks with your Name and MacID
2. Insert your photo(s) as a Picture (Insert > Picture > This Device)
3. **<u>Do not include more than *one* screenshot per page</u>**

Team ID: Thurs-16

Name: Elaine Ocampo	MacID: ocampm6

Insert screenshot(s) of your code below

Function for Drop-off Container:

*P2_Simulation_Template.py - C:\Users\elain\Downloads\Q-Labs Python Files\Q-Labs Python...

File Edit Format Run Options Window Help

```
ip_address = 'localhost' # Enter your IP Address here
project_identifier = 'P2B' # Enter the project identifier i.e. P2A or P2B
#--------------------------------------------------------------------------------
import sys
sys.path.append('../')
from Common.simulation_project_library import *

hardware = False
QLabs = configure_environment(project_identifier, ip_address, hardware).QLabs
arm = qarm(project_identifier,ip_address,QLabs,hardware)
potentiometer = potentiometer_interface()
#--------------------------------------------------------------------------------
# STUDENT CODE BEGINS
#--------------------------------------------------------------------------------
def drop_off_container(drop_off_location):
    x = (drop_off_location[0])
    y = (drop_off_location[1])
    z = (drop_off_location[2])
    arm.move_arm(x, y, z)
    time.sleep(2)
    arm.control_gripper(-45)
    time.sleep(2)



#--------------------------------------------------------------------------------
# STUDENT CODE ENDS
#--------------------------------------------------------------------------------
```

Ln: 25 Col: 0

*Limit screenshots to no more than 1 per page. For additional screenshots, please copy and paste the above on a new page

MILESTONE THREE (INDIVIDUAL): PRELIMINARY MODEL & CODE

MILESTONE 3 (STAGE 1) – INITIAL DESIGN OF FINALIZED STERILIZATION CONTAINER (MODELING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 1) – PROGRAM TASK PSEUDOCODE (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 2) – STERLIZATION CONTAINER DESIGN EVALUATION (MODELING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 2) – CODE PEER REVIEW (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

INDEPENDENT MATERIALS RESEARCH ASSIGNMENT

MATERIAL SELECTION (STAGE 1) - PROBLEM DEFINITION

Use the following information to help you in your assignment:

- Function: The containers must securely contain a surgical tool during the tool's sterilization period.
- Fixed Variable: Radius, melting temperature (100^{O}C, steam)
- Free Variable: Wall thickness
- Objective: Must minimize cost and mass (material density and CAD)

Use the following MPI's to select your final material:

- Stiffness Design: $\frac{E}{\rho C_m}$
- Strength Design: $\frac{\sigma}{\rho C_m}$

Chosen Design	Chosen MPI	Objective
Stiffness	$\frac{E}{\rho C_m}$	Maximize stiffness, minimize cost and mass

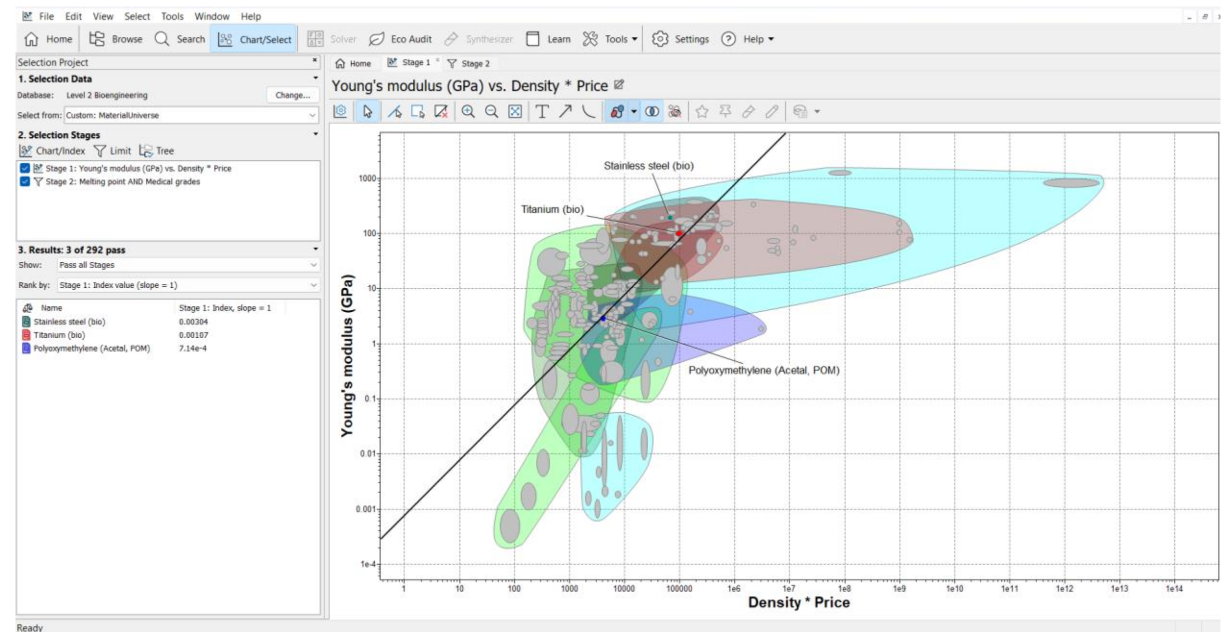
Please provide a short justification for your chosen design and MPI.

Since high temperatures reduce the material's stiffness and autoclaves undergo high temperatures, it is crucial that stiffness should be maximized. When the container goes through the autoclave, it should be able to come out with little reduced stiffness. Therefore, if the stiffness was maximized in the beginning, they would produce a lower thermal expansion after the sterilization process, which is ideal for making a long-lasting container.

MATERIAL SELECTION (STAGE 2) - MPI AND MATERIAL RANKING

Include a screenshot of your GRANTA graph in the text box below. The following should be included and clearly visible in your graph:

- X and Y axis
- MPI slope
- Material titles
    - The materials that you may choose from are those that are able to be 3D-printed (i.e., materials such as ceramics and glasses should be excluded from your database)
- Material family bubbles



Material Ranking			
	Rank 1	Rank 2	Rank 3
Assigned MPI: Stiffness $\frac{E}{\rho C_m}$	Stainless steel (bio)	Titanium (bio)	Polyoxymethylene (Acetal, POM)

MATERIAL SELECTION (STAGE 3) - FINAL SELECTION

State your chosen material and justify your final selection

Chosen Material:	Stainless Steel
Discuss and justify your final selection in the space below (based on the MPI results and any other relevant considerations). Based on the MPI results, stainless steel (bio) was the best material that met all the objectives the best (maximize stiffness and minimize cost and mass). Firstly, while stainless steel isn't the cheapest out of titanium (~$20 per kg) and polyoxymethylene (~$3 per kg) at ~$8 per kg, it is still the best option as polyoxymethylene placed last in the top 3 selections, and its other factors make up for it to cost more than plastic, such as its Young's Modulus. Second, although stainless steel is the densest out of the three, which does not necessarily minimize mass, it costs ~2x less than titanium and its other properties outperform that of plastic and titanium. Overall, stainless steel is the best option as its properties are well rounded to meet the objectives.	
References (If any): [1] Ansys GRANTA EduPack software, ANSYS, Inc., Cambridge, UK, 2023 (www.ansys.com/materials)	

Project Two Worksheets (INDIVIDUAL)

TABLE OF CONTENTS

MILESTONE ONE (INDIVIDUAL): OBJECTIVES, MORPH CHART, & INITIAL DESIGN

MILESTONE 1 (STAGE 1) – LIST OF OBJECTIVES, CONSTRAINTS, AND FUNCTIONS

Please complete this worksheet in your corresponding team document.

MILESTONE 1 (STAGE 2) – MORPHOLOGICAL ANALYSIS

Please complete this worksheet in your corresponding team document.

MILESTONE 1 (STAGE 3) – PRELIMINARY CONCEPT SKETCHES (MODELLING SUB-TEAM)

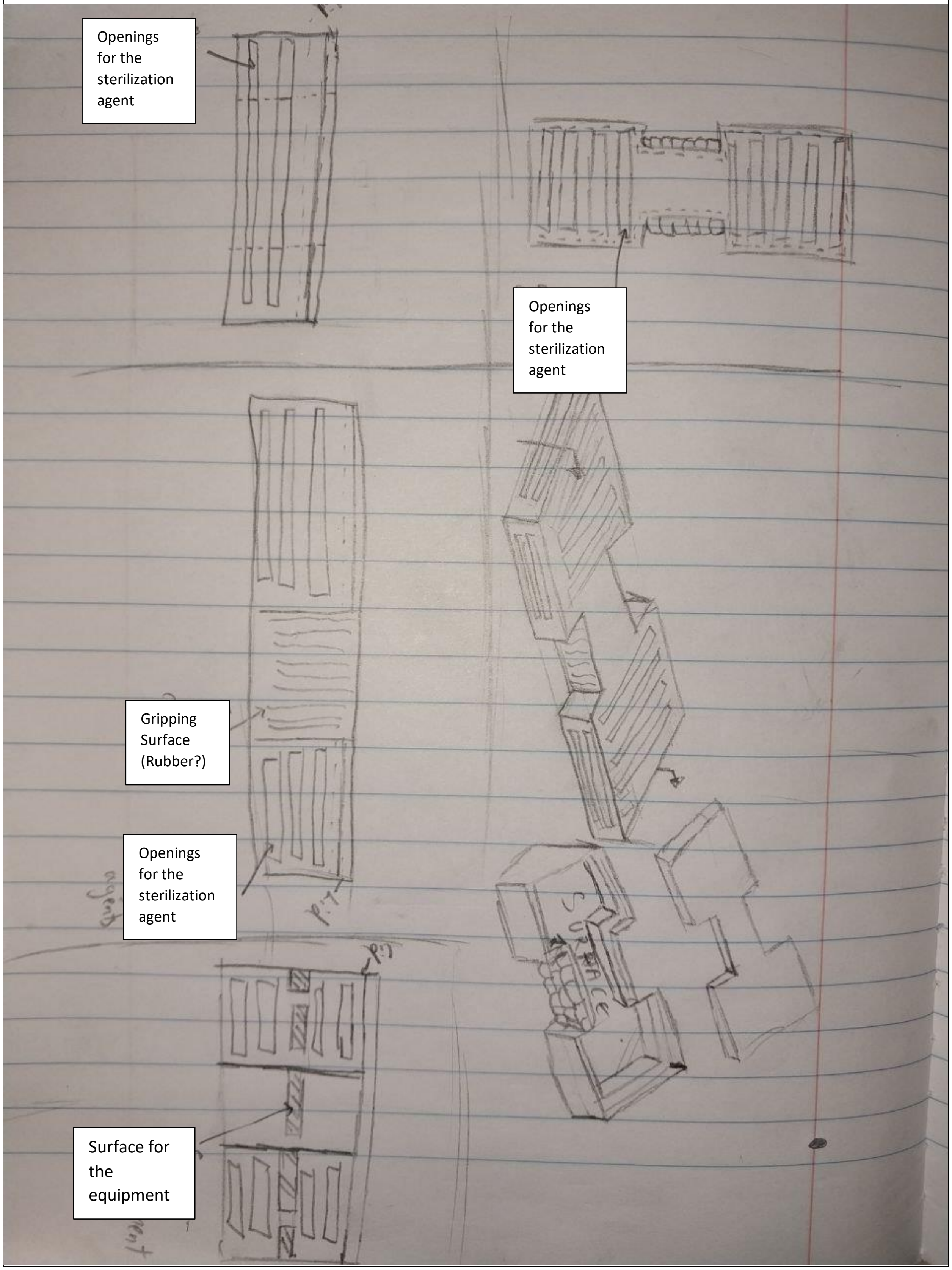
Team ID: Thurs-16

1. Complete your sketch on a separate sheet of paper
   → Be sure to clearly write your Team ID, Name and MacID
2. Take a photo of your sketch
3. Insert your photo as a Picture (Insert > Picture > This Device)

Team ID: Thurs -16

Name: Akinniyi Chidiebube	MacID: akinniyc

Insert screenshot(s) of your preliminary sketch below



*For multiple sketches, please copy and paste the above on a new page

MILESTONE TWO (INDIVIDUAL): SUBTEAMS, SKETCHES, & WORKFLOW

MILESTONE 2 (STAGE 1) – LOW-FIDELITY PROTOTYPE (MODELLING SUB-TEAM)

Team ID:

Complete this worksheet before design studio 8 while creating the low-fidelity prototype based on your group members preliminary concept sketch.

1. Take multiple photos of the low-fidelity prototype
    - Include an index card (or similar) next to the prototype, clearly indicating your Team Number, Name and MacID on *each* picture
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3. **Do not include more than *two* prototype photos per page**

Team ID:

Name:	MacID:
Insert screenshot(s) of the low-fidelity prototype below	

MILESTONE 2 (STAGE 1) – COMPUTER PROGRAM WORKFLOW (COMPUTATION SUB-TEAM)

Team ID:

Complete this worksheet individually before coming to Design Studio 8.

1. Complete your storyboard or flowchart sketches on a separate sheet of paper
   → Be sure to clearly write your Team ID, Name and MacID on *each* workflow
2. Take a photo of your sketch
3. Insert your photo as a Picture (Insert > Picture > This Device)

Team ID:

Name:	MacID:
Insert screenshot(s) of your workflow below	

MILESTONE 2 (STAGE 2) – LOW-FIDELITY PROTOTYPE OBSERVATIONS (MODELLING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 2 (STAGE 2) – COMPUTER PROGRAM PSEUDOCODE COMPILATION & OBSERVATIONS (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 2 (STAGE 3) – PRELIMINARY SOLID MODEL (MODELLING SUB-TEAM)

Team ID:

Complete this worksheet individually during Design Studio 8.

1. Take multiple screenshots of your preliminary solid model
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Team ID:

Name:	MacID
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MILESTONE 2 (STAGE 3) – PRELIMINARY PROGRAM TASKS (COMPUTATION SUB-TEAM)

Team ID:

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Team ID:

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Insert screenshot(s) of your code below	

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MILESTONE THREE (INDIVIDUAL): PRELIMINARY MODEL & CODE

MILESTONE 3 (STAGE 1) – INITIAL DESIGN OF FINALIZED STERILIZATION CONTAINER (MODELING SUB-TEAM)

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MILESTONE 3 (STAGE 2) – STERLIZATION CONTAINER DESIGN EVALUATION (MODELING SUB-TEAM)

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MILESTONE 3 (STAGE 2) – CODE PEER REVIEW (COMPUTATION SUB-TEAM)

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INDEPENDENT MATERIALS RESEARCH ASSIGNMENT

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Use the following information to help you in your assignment:

- Function: The containers must securely contain a surgical tool during the tool's sterilization period.
- Fixed Variable: Radius, melting temperature (100^{O}C, steam)
- Free Variable: Wall thickness
- Objective: Must minimize cost and mass (material density and CAD)

Use the following MPI's to select your final material:

- Stiffness Design: $\frac{E}{\rho C_m}$
- Strength Design: $\frac{\sigma}{\rho C_m}$

Chosen Design	Chosen MPI	Objective
Stiffness Design	$\frac{E}{\rho C_m}$	Minimizing cost and mass

Please provide a short justification for your chosen design and MPI.

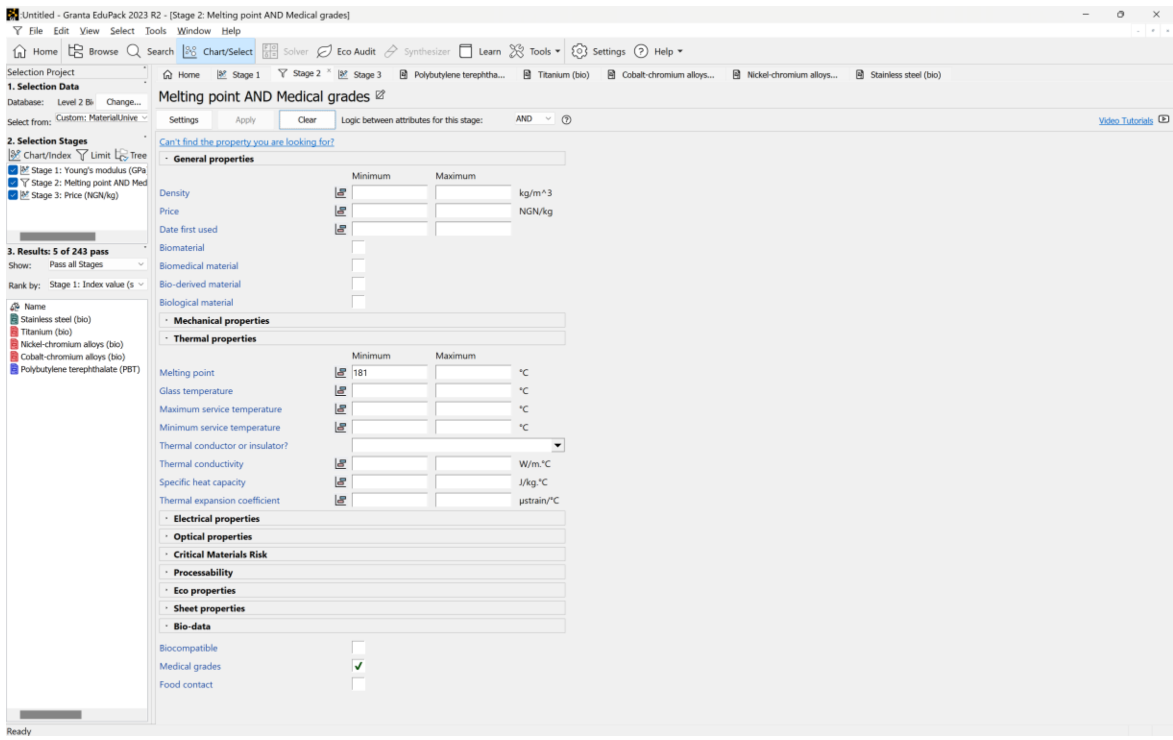
Stiffness can be described as the ability of a material to resist deformation under load, while yield strength is a measure of the stress a material stops undergoing elastic deformation and becomes plastic.
In respect to strength and stiffness, the problem should not be whether it will permanently deform, but rather how much will it deform.
Inside an autoclave, the material/container is subject to pressure and temperature. The function of the container is to secure the equipment within it while being subject to those conditions. The material used for production would then need a yield strength able to withstand the pressure at that temperature, so we need a material with a yield strength value above that of the expected pressure at the expected temperature. This will serve as a constraint to our material selection and nothing more.
The stiffness, however, is a measure of how much deformation would occur at given loads; with low stiffness, even with high yield strength, the container would expand/compress (depending on the scenario) itself - but will return to its previous shape when removed from the conditions - and may be unable to carry out the function for which it was created. In an autoclave with high temperature and pressure, a material with high stiffness (at the temperature) would be preferred, so that minimal changes would be caused to the design under that pressure and it successfully carries its function.

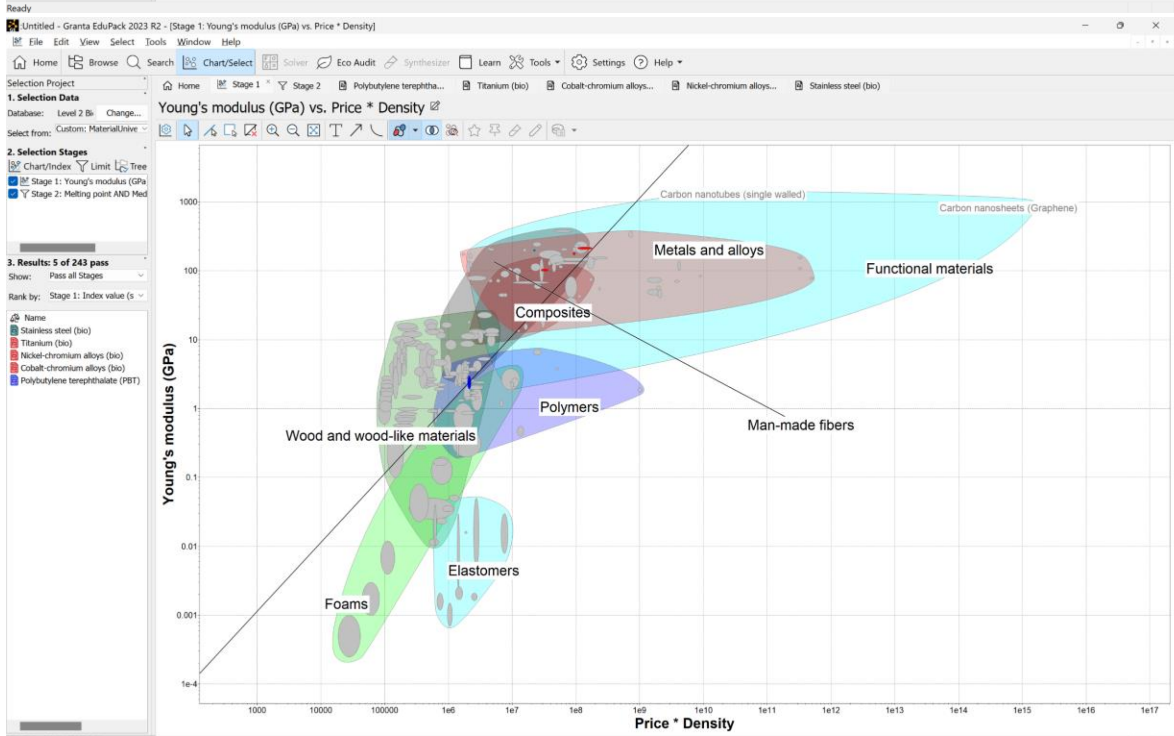
MATERIAL SELECTION (STAGE 2) - MPI AND MATERIAL RANKING

Include a screenshot of your GRANTA graph in the text box below. The following should be included and clearly visible in your graph:

- X and Y axis
- MPI slope
- Material titles
  - The materials that you may choose from are those that are able to be 3D-printed (i.e., materials such as ceramics and glasses should be excluded from your database)
- Material family bubbles

Material Ranking			
	Rank 1	Rank 2	Rank 3
Assigned MPI:	Stainless Steel	Titanium	Nickel-Chromium Alloy


Untitled - Granta EduPack 2023 R2 - [Stage 2: Melting point AND Medical grades]
Melting point AND Medical grades
Settings
Apply
Clear
Logic between attributes for this stage: AND
Video Tutorials
Can't find the property you are looking for?
General properties
Minimum
Maximum
Density
kg/m^3
Price
NGN/kg
Date first used
Biomaterial
Biomedical material
Bio-derived material
Biological material
Mechanical properties
Thermal properties
Melting point
181
°C
Glass temperature
Maximum service temperature
Minimum service temperature
Thermal conductor or insulator?
Thermal conductivity
W/m.°C
Specific heat capacity
J/kg.°C
Thermal expansion coefficient
µstrain/°C
Electrical properties
Optical properties
Critical Materials Risk
Processability
Eco properties
Sheet properties
Bio-data
Biocompatible
Medical grades
Food contact
Selection Project
1. Selection Data
2. Selection Stages
Stage 1: Young's modulus (GPa
Stage 2: Melting point AND Med
Stage 3: Price (NGN/kg)
3. Results: 5 of 243 pass
Show: Pass all Stages
Rank by: Stage 1: Index value
Name
Stainless steel (bio)
Titanium (bio)
Nickel-chromium alloys (bio)
Cobalt-chromium alloys (bio)
Polybutylene terephthalate (PBT)
Ready


Untitled - Granta EduPack 2023 R2 - [Stage 1: Young's modulus (GPa) vs. Price * Density]
Young's modulus (GPa) vs. Price * Density
Carbon nanotubes (single walled)
Carbon nanosheets (Graphene)
Metals and alloys
Functional materials
Composites
Polymers
Man-made fibers
Wood and wood-like materials
Elastomers
Foams
Young's modulus (GPa)
Price * Density
Selection Project
1. Selection Data
2. Selection Stages
Stage 1: Young's modulus (GPa
Stage 2: Melting point AND Med
3. Results: 5 of 243 pass
Name
Stainless steel (bio)
Titanium (bio)
Nickel-chromium alloys (bio)
Cobalt-chromium alloys (bio)
Polybutylene terephthalate (PBT)
(X=7.41e16, Y=2.46e-4)

MATERIAL SELECTION (STAGE 3) - FINAL SELECTION

State your chosen material and justify your final selection

Chosen Material:	Stainless Steel
Based on the MPI results Stainless Steel had the highest Stiffness to price density* ratio (in the database), which were considered medical grade and had a melting point above 181^{o}C. The desired properties of our final material should include high strength, stiffness, corrosion resistance/inert, high thermal conductivity, lightweight (for transportation ease), ease of access, and low cost per kg. Thermal conductivity is a factor as it might ease the sterilization process; Polybutylene terephthalate is not a good conductor of heat and is, therefore, unsuitable. [1] All chosen materials are either chemically inert or corrosion resistant. And satisfy all desired requirements. The chromium alloys (nickel-Chromium alloy and Cobalt-Chromium alloy) have very good properties, but they are more expensive and harder to acquire than their substitutes. The same also goes for titanium when compared to stainless steel. [2] [3] Considering all this, stainless steel becomes the best choice with "minimizing cost" as our main objective.	

References (If any):

REFERENCES

[1] "Polybutylene terephthalate," Britannica, [Online]. Available: https://www.britannica.com/science/polybutylene-terephthalate. [Accessed 2023].

[2] "Titanium vs Steel," CNCLATHING, 17 September 2020. [Online]. Available: https://www.cnclathing.com/guide/titanium-vs-steel-whats-the-difference-titanium-and-steel-comparison-cnclathing.

[3] "Stainless Steel or Aluminium," CRETEX, 8 June 2022. [Online]. Available: https://www.cretexmedical.com/blog/2022/06/08/stainless-steel-or-aluminum-material-considerations-for-sterilization-cases-trays/#:~:text=The%20primary%20metals%20used%20to%20manufacture%20sterilization%20cases,can%20offer%20different%20advantages%20during.

Project Two Worksheets (INDIVIDUAL)

TABLE OF CONTENTS

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MILESTONE 1 (STAGE 2) – MORPHOLOGICAL ANALYSIS

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MILESTONE 1 (STAGE 3) – PRELIMINARY CONCEPT SKETCHES (MODELLING SUB-TEAM)

Team ID: Thurs-16

1. Complete your sketch on a separate sheet of paper
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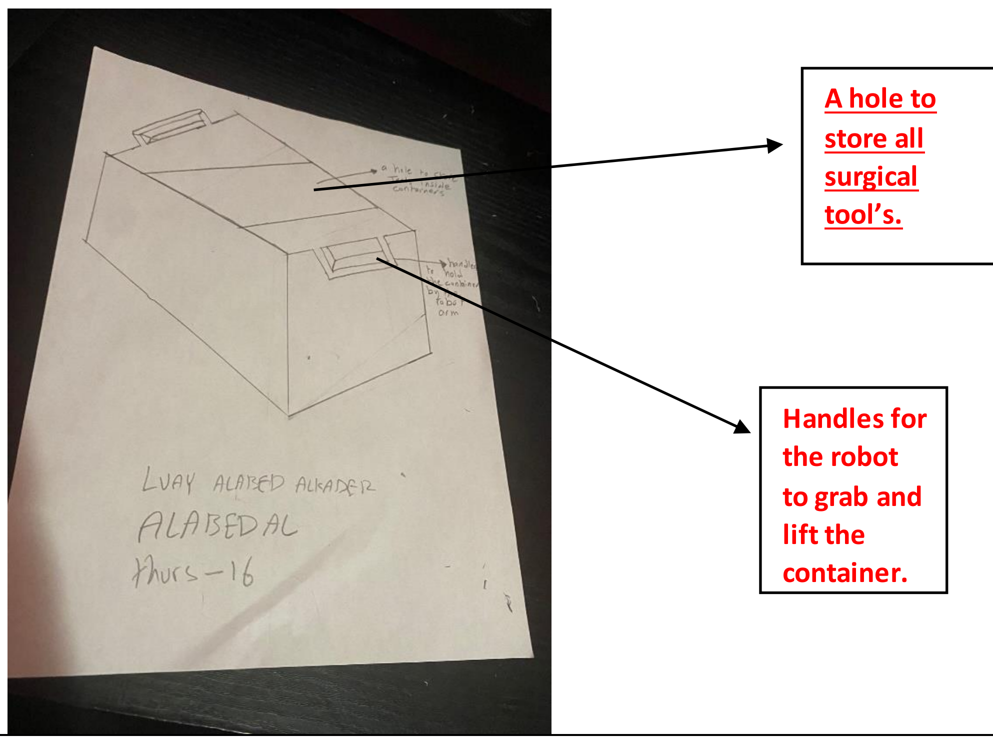
2. Take a photo of your sketch
3. Insert your photo as a Picture (Insert > Picture > This Device)

Team ID: Thurs-16

Name: Luay alabed alkader	MacID: alabedal



*For multiple sketches, please copy and paste the above on a new page

MILESTONE 1 (STAGE 3) – COMPUTER PROGRAM PSEUDOCODE (COMPUTATION SUB-TEAM)

Team ID:

Name:	MacID:
Write your pseudocode in the space below	

MILESTONE TWO (INDIVIDUAL): SUBTEAMS, SKETCHES, & WORKFLOW

MILESTONE 2 (STAGE 1) – LOW-FIDELITY PROTOTYPE (MODELLING SUB-TEAM)

Team ID: THURS-16

Complete this worksheet before design studio 8 while creating the low-fidelity prototype based on your group members preliminary concept sketch.

1. Take multiple photos of the low-fidelity prototype
   - Include an index card (or similar) next to the prototype, clearly indicating your Team Number, Name and MacID on *each* picture
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3. **Do not include more than *two* prototype photos per page**

Team ID:

Name:	MacID:
Insert screenshot(s) of the low-fidelity prototype below	

MILESTONE TWO (INDIVIDUAL): SUBTEAMS, SKETCHES, & WORKFLOW

MILESTONE 2 (STAGE 1) – LOW-FIDELITY PROTOTYPE (MODELLING SUB-TEAM)

Team ID: | THURS-16

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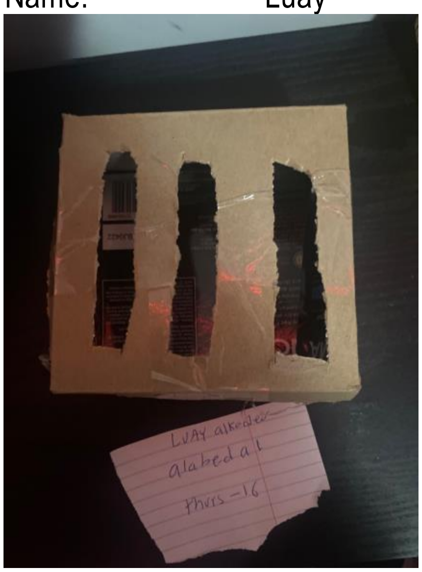
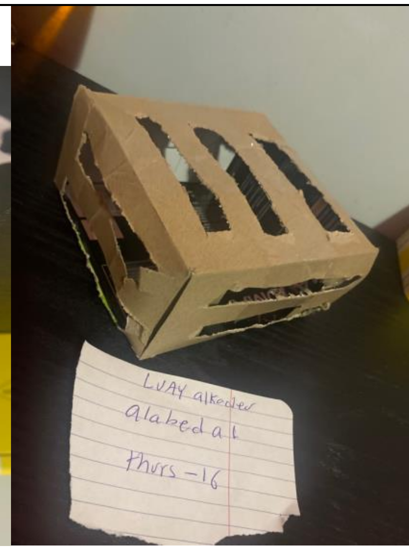
4. **<u>Do not include more than *two* prototype photos per page</u>**

Team ID: | THUR-16

Name: Luay Alkader	MacID: Alabedal
	


LUAY alkoder
alabedal
Thurs -16

MILESTONE 2 (STAGE 2) – LOW-FIDELITY PROTOTYPE OBSERVATIONS (MODELLING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 2 (STAGE 2) – COMPUTER PROGRAM PSEUDOCODE COMPILATION & OBSERVATIONS (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 2 (STAGE 3) – PRELIMINARY SOLID MODEL (MODELLING SUB-TEAM)

Team ID: THURS-16

Complete this worksheet individually during Design Studio 8.

1. Take multiple screenshots of your preliminary solid model
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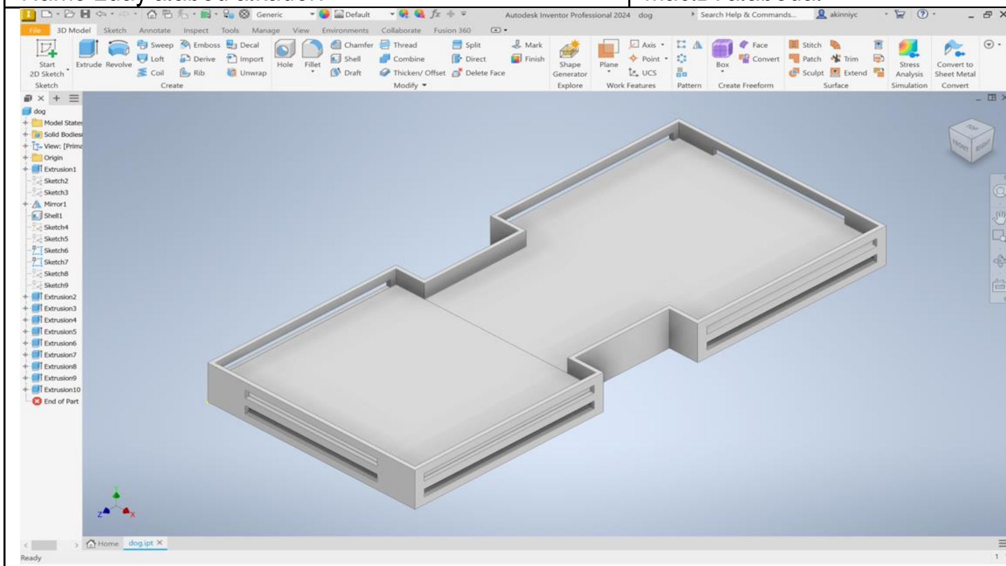
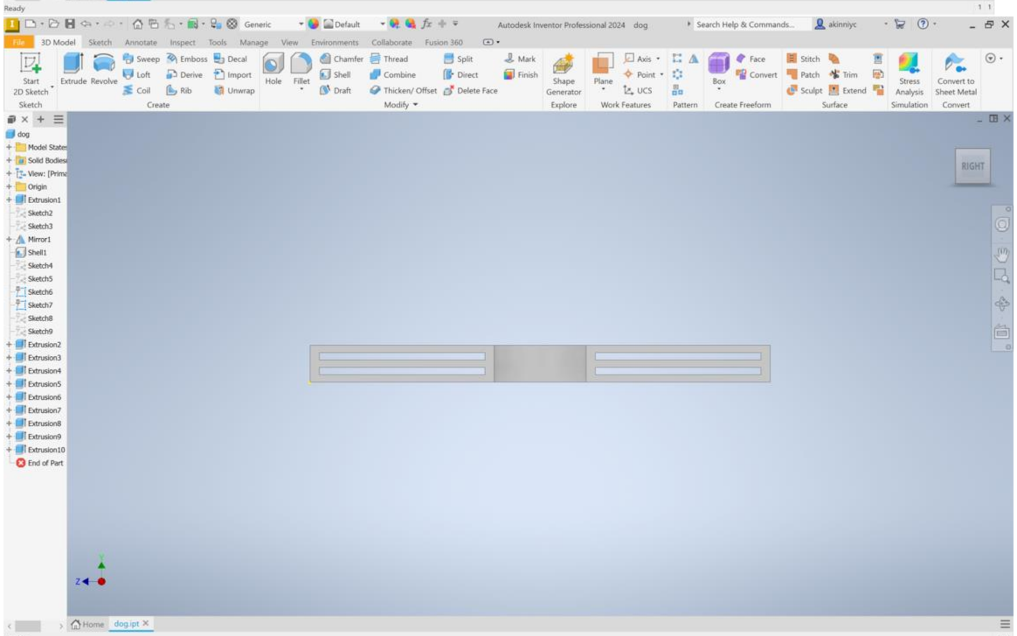
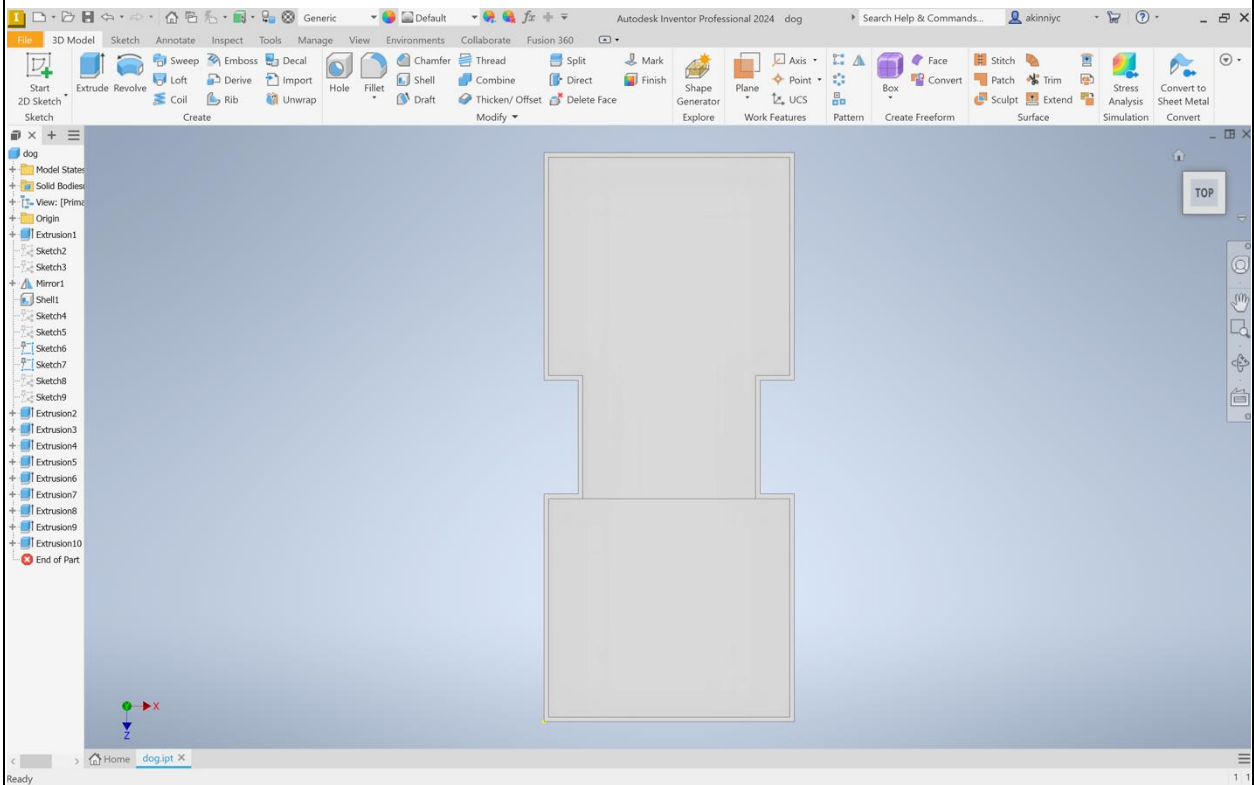
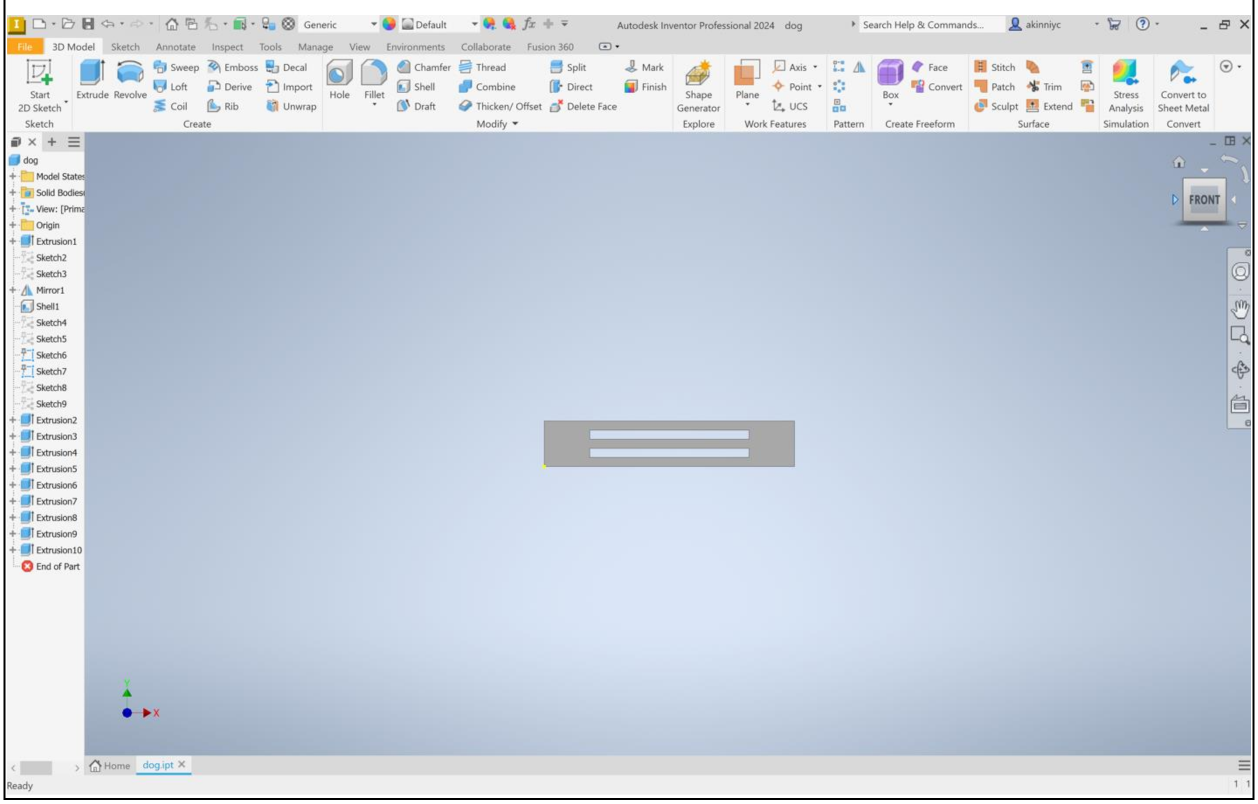
TeamID: Thurs-16

Name Luay alabed alkader:	MacID: alabedal






Autodesk Inventor Professional 2024 dog
TOP
Ready


Autodesk Inventor Professional 2024 dog
FRONT
Ready

*LIMIT SCREENSHOTS TO NO MORE THAN 2 PER PAGE. FOR ADDITIONAL SCREENSHOTS, PLEASE COPY AND PASTE THE ABOVE ON A NEW PAGE MILESTONE 2 (STAGE 3) – PRELIMINARY PROGRAM TASKS (COMPUTATION SUB-TEAM)

Team ID:

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Team ID:

Name:	MacID
Insert screenshot(s) of your code below	

*Limit screenshots to no more than 1 per page. For additional screenshots, please copy and paste the above on a new page

MILESTONE THREE (INDIVIDUAL): PRELIMINARY MODEL & CODE

MILESTONE 3 (STAGE 1) – INITIAL DESIGN OF FINALIZED STERILIZATION CONTAINER (MODELING SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 1) – PROGRAM TASK PSEUDOCODE (COMPUTATION SUB-TEAM)

Please complete this worksheet in your corresponding team document.

MILESTONE 3 (STAGE 2) – STERLIZATION CONTAINER DESIGN EVALUATION (MODELING SUB-TEAM)

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INDEPENDENT MATERIALS RESEARCH ASSIGNMENT

MATERIAL SELECTION (STAGE 1) - PROBLEM DEFINITION

Use the following information to help you in your assignment:

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- Fixed Variable: Radius, melting temperature (100^{O}C, steam)
- Free Variable: Wall thickness
- Objective: Must minimize cost and mass (material density and CAD)

Use the following MPI's to select your final material:

- Stiffness Design: $\frac{E}{\rho C_m}$
- Strength Design: $\frac{\sigma}{\rho C_m}$

Chosen Design	Chosen MPI	Objective
Stiffness Design	$\frac{E}{\rho C_m}$	Minimize cost and mass
To prevent deformation of the materials under high pressure and load from the surgical tool that has many holes for sterilization, I have chosen stiffness. Additionally, it minimizes and resists deflection, preventing the object from collapsing and losing its form.		

MATERIAL SELECTION (STAGE 2) - MPI AND MATERIAL RANKING

Include a screenshot of your GRANTA graph in the text box below. The following should be included and clearly visible in your graph:

- X and Y axis
- MPI slope
- Material titles
  - The materials that you may choose from are those that are able to be 3D-printed (i.e., materials such as ceramics and glasses should be excluded from your database)
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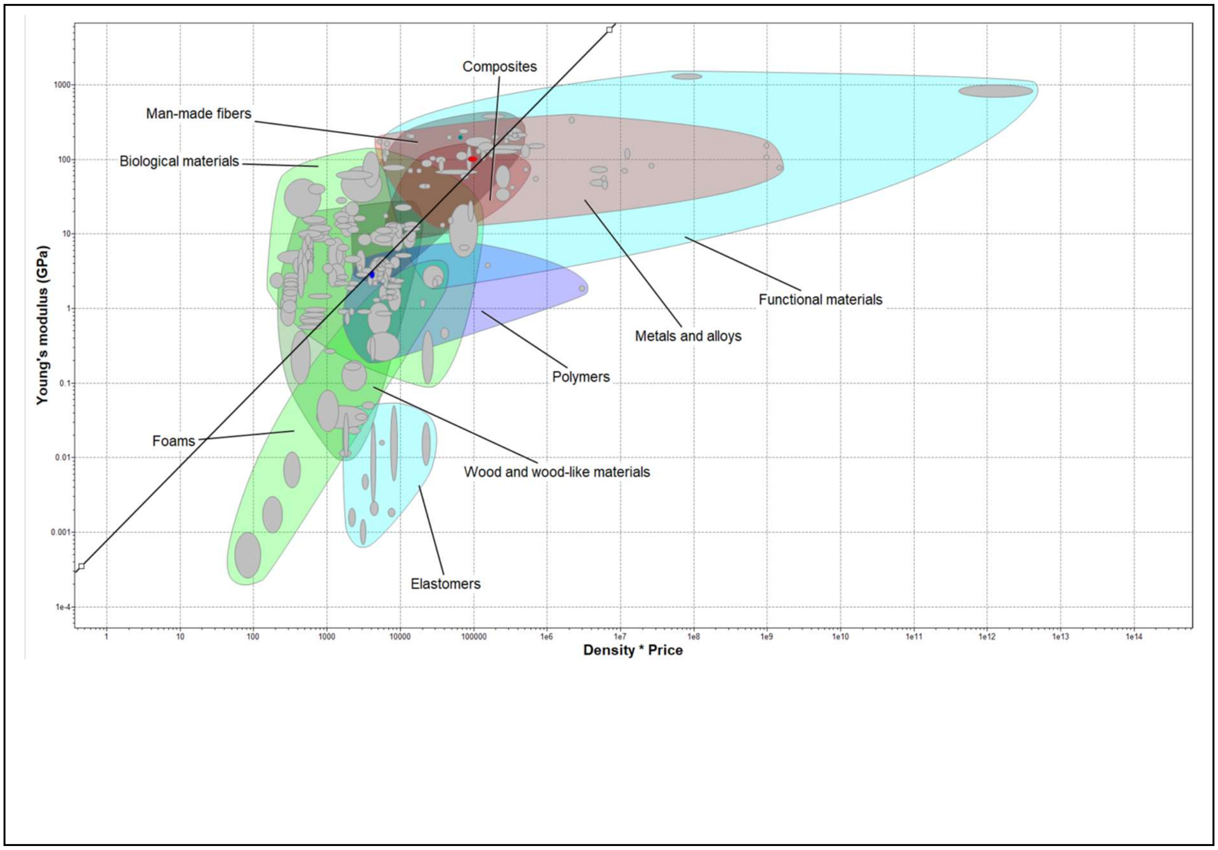

Material Ranking			
	Rank 1	Rank 2	Rank 3
Assigned MPI:	Stainless steel (Bio)	Titanium (Bio)	Polyoxymethylene (Acetal, POM)

MATERIAL SELECTION (STAGE 3) - FINAL SELECTION

State your chosen material and justify your final selection.

Chosen Material:	Stainless Steel

Discuss and justify your final selection in the space below (based on the MPI results and any other relevant considerations).

The primary reason I went for stainless steel is that it is a medical-grade substance that the human body can handle. Because the containers will be submerged in hot steam to clean the instruments, stainless steel has high insulating qualities. The contents in the containers won't be harmed by the heat, allowing the sterilization to proceed safely. Furthermore, stainless steel has a high tensile strength, which gives the container strength and rigidity. Moreover, stainless steel has a high level of corrosion resistance. Consequently, the primary reasons stainless steel appeals to me are its strength, sterilizability, and lack of reactivity.

References (If any):

[1] *"Understanding stainless steel in healthcare," Understanding Stainless Steel In Healthcare, https://www.statmedicalcanada.com/blog/blog/understanding-stainless-steel-in-healthcare (accessed Nov. 25, 2023).*

[2] Ansys Granta: Materials information management, https://www.ansys.com/products/materials (accessed Nov. 25, 2023).